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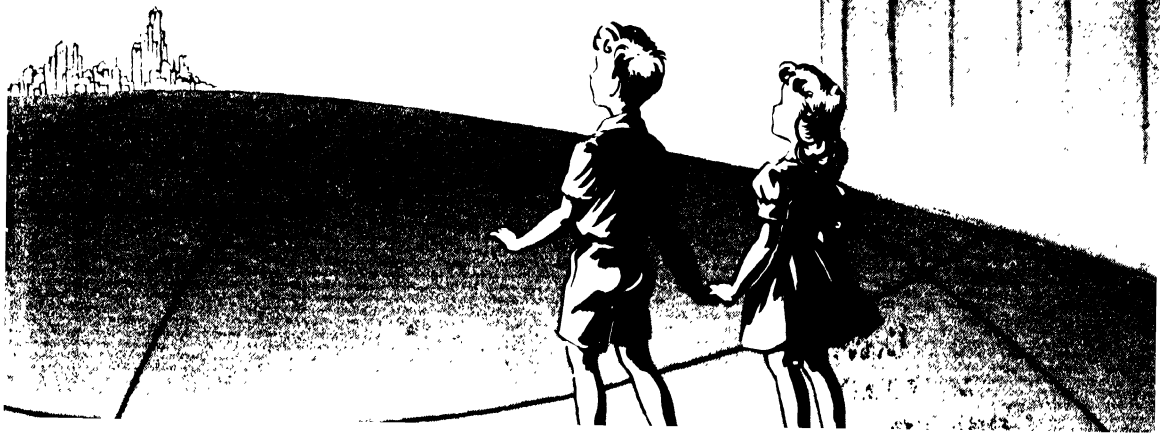
This is the Fortieth Anniversary of The Book of Knowledge

We are as proud and happy as we can be, and we should like to tell you why. This is the Fortieth Anniversary of THE BOOK OF KNOWLEDGE. It is also The Grolier Society's fiftieth year of publishing.

Men and women who have long loved THE BOOK OF KNOWLEDGE have sent congratulations and Happy Birthday messages—very busy men and women, who are serving mankind in many different, important ways.

Yet many of them took time from their work to send special messages to the boys and girls of America. We knew you would like to read their letters. So here they are, on the following pages.

THE EDITORS



A Message from Admiral Byrd to the Young People of America

IT GIVES me great pleasure to wish THE BOOK OF KNOWLEDGE a Happy Birthday. The boys and girls who explore its pages are embarking on two of life's greatest adventures —the winning of knowledge and the winning of wisdom.

I have spent much of my life exploring the unknown areas at the ends of the earth. And I have found that most young people are interested in exploration. But exploration is adventure. So exploration and adventure go hand in hand.

But I have discovered that to explore and enjoy adventure one does not have to go to the far places of the earth. Right in one's own home or wherever one may be one can engage, at least to a degree, in what I consider to be the most interesting of all exploration—exploration into the realms of thought and the human spirit. But, strangely, I had to go to the end of the earth fully to comprehend this fact.

Once upon a time on one of my expeditions to the bottom of the world, I found myself, through a combination of unforeseen circumstances, alone during the long polar night living in the shadow of the South Pole. The inland weather of an area in the clutches of an ice age had never been studied, so I had established a meteorological station for this purpose. And also I was taking observations of the aurora australis. My tiny shack was buried under the snow and there was 800 feet of ice under the shack.

Copyright 1950,

Thus, I was at the world's end near the axis of the earth and cut off by the darkness and the cold and ice from any physical contact with the rest of the world.

There was no dust at the Advance Base, so that the celestial bodies took on a brightness and a beauty—yes, and even a meaning—unknown in civilization. I was living under the aurora australis, which was most brilliant and awe-inspiring when the great spots appeared on the sun 90,000,000 miles away. And every second when it was clear I could see a meteorite flashing brilliantly across the sky. Often there were ice crystals, created by the bitter cold, that scintillated in the light of the celestial bodies until they resembled myriads of diamonds floating through the air. The stars did not rise and set but made a circle of their course in the sky.

I had the strange feeling that somehow I had gotten onto another planet and that I was witnessing the imponderable processes and forces of the cosmos, harmonious and soundless. But out of the silence I felt a gentle rhythm—the music of the spheres, perhaps. The conviction came to me that that rhythm was too orderly, too harmonious, too perfect, to be a product of blind chance. I realized that there must be purpose in the whole and that man was part of that whole and not an accidental offshoot—that therefore in the creation of man there must have been a design. Thus, there at the end of the earth I had found a confirmation of man's faith.

As the weeks of the long night wore on the temperature got lower and lower. The barrier ice contracted and began cracking as if with the sound of cannons. Bottomless crevasses opened up around my shack. My meteorological records began to show that probably I had come upon the world's coldest area.

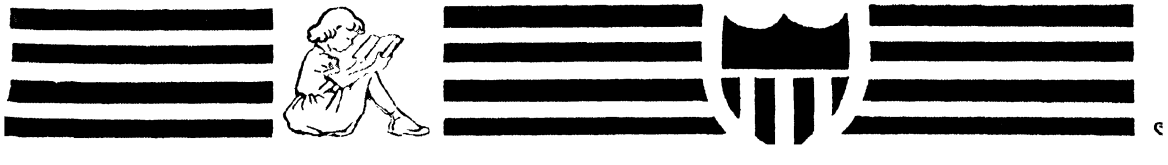
Suddenly, disaster struck me. In the middle of the polar night I was poisoned by carbon monoxide from the faulty burner of my oil stove. To cut down the poison I had to keep my stove out twelve hours out of the twenty-four. The ice started crawling up the walls of my small shack and then across the ceiling and did not melt. Soon the poison affected my eyes so that the flickering candles no longer afforded enough light to read the books I had on my shelf.

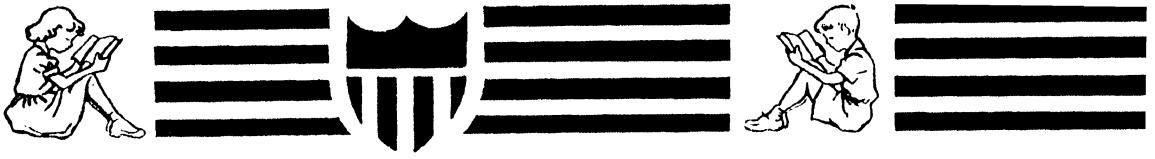
Thus, most of the time I found myself lying in my sleeping-bag in the darkness, with nothing to do but think. I was living, in effect, precariously on the edge of an abyss. My thoughts, naturally enough, were on the gloomy side and they soon began to take charge of me.

And so I found that I must somehow take charge of my thoughts and completely control them. And thus I began to explore my mind to see what I could find there in the realm of imagination and thought that might help me.

The cold, the silence, the darkness, the "evenness of things," were rude and persistent companions. Difficult though they were to ignore, it was either deny their effect on me "or else."

Gradually I was able to control my thoughts more and more. In the field of imagination there seemed no time-space limitations. I found that I could throw my thoughts backward or forward in the stream of time to any place I chose. It was as if my mind were a motion-picture screen and I could run on it whatever picture I selected from an unlimited list. You





may be sure that most of my scenarios took me to places as different as possible from my very gloomy surroundings, such as warm sunny lands.

Thus there were moments when my predicament was forgotten; when I was conscious only of a peaceful mind adrift upon the adventurous tides of imagination.

But these adventures of the imagination were in the physical field and they were not enough. It was not so simple as that. I had to find other assets within myself if I hoped to survive. To substitute pleasant thoughts for gloomy ones was good but something more was needed.

So I explored as best I could into the uncharted and unknown areas of the mind; and slowly, as the days passed, I came on to some things. I discovered how much a man's world can be a world of the mind. And that a man himself determines or makes his world, which thus, to a degree, is the reflection of his own inner self wherein dwells the universal spirit of good.

It seemed to me that if a man could bring about the domination of his spiritual self over his worser self he could dry up the springs of fear and could then be captain of his ship and invulnerable to any fate, even to the sting of death.

And so went my battle at the Advance Base. It was an adventure of the mind and the spirit.

And now, many years later I am passing on through this splendid BOOK OF KNOWLEDGE some of the knowledge I got during the long night in the shadow of the South Pole.

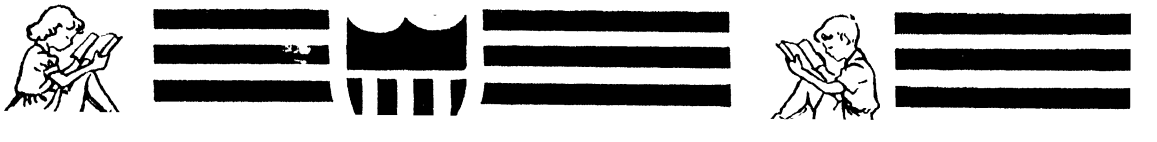
Much has happened in those years. Probably very few of you find it necessary to look within yourself for help. And you do not have to depend upon your imagination for entertainment. You are literally flooded with adventure stories by the radio, television and the movies. And now there are the atom bombs, rockets, the faster-than-sound planes and so forth.

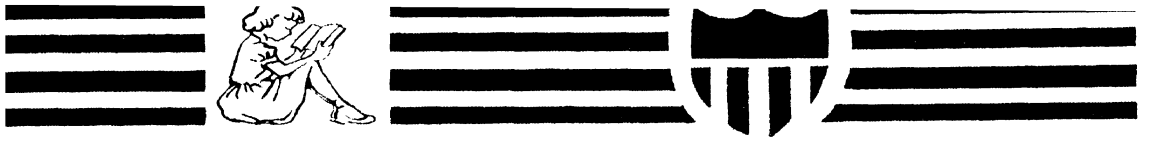
All of that seems quite wonderful. But in the meantime there is universal confusion. Freedom is in danger the world over and there are threats of a third world war. You, my young friends, will have the job of solving these problems left you by your blundering elders.

May I tell you frankly what I believe to be the mistake we, your fathers and your grandfathers, have made? The trouble started in the twentieth century, the technological century. There have been more technical advances in the first half of the twentieth century than were made in the entire previous history of the world.

Man has been making, for the past fifty years, the very costly mistake of believing that real human progress consists in the development of ever more powerful weapons of destruction and in the development, more particularly, of all sorts of mechanical appliances and apparatus to bring him greater comforts and ease, diversions and entertainment, and all manner of pleasures.

Thus, most of the genius that man possesses has been used in the field of the material sciences. Man has shrunk the world with lightning-like rapidity and has thereby created among human beings a great interdependence with which he is not ready to cope. In other words, he has created an extremely complicated environment into which he can not ad-





quately fit himself, thus making people everywhere easy prey to the "isms" taught by the false prophets. Man is too selfish to change his environment to fit himself. Therefore he must change himself to fit his environment.

And so man's problem in the last analysis is not the atom bomb or technology or the war-mad leaders and the false prophets, *but is man himself.* If he is to emerge a victor instead of a slave he must explore his mind and his spirit so as to know himself.

A man beset by evil within and from without can mobilize his spiritual self to conquer that evil. Just so can the human race mobilize its moral and spiritual power to defeat the material power of evil that threatens it.

As I see it, the absolute essential for a peaceful and free world is a human race united—I repeat united—against the onward march of evil.

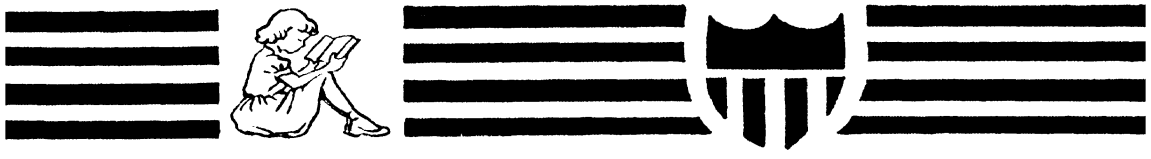
Here is how I believe man can achieve a united world if he so wills. We know that in the affairs of men it is essential to have a common purpose in order to achieve unity. As I see it, man has for long had that common purpose. All decent men and women the world over, of whatever creed or race or color, desire for themselves and their loved ones *a chance for the pursuit of happiness, and liberty and freedom of worship.* This is our common global purpose.

And to achieve this purpose there is a workable method—the Golden Rule, which men and women of all religions can understand. It is the idea of consideration, ordinary everyday kindliness and decency, good will and friendliness, justice, mercy and human sympathy. In short, it is the brotherhood-of-man idea. It is the realization that the well-being of one man depends upon the well-being of his neighbor, the well-being of one group depends upon the well-being of its neighbor group, and that the well-being of a nation depends upon the well-being of its neighbor nation. And all nations are now neighbors.

But we must not make the mistake of considering what the Great Teacher told us two thousand years ago as a teaching based on weakness. Above all things, it is important for man to base his fight for brotherhood and unity upon firmness, strength and fortitude behind what is right and just.

We know, however, that it will take time to mobilize the moral and spiritual force of man so as to unite the world behind our common, global purpose. And we also know that until the world is so united, the war-like leaders and false prophets must be held in leash by physical force.

By Rear Admiral Richard E. Byrd, U.S.N. (Ret.)



BLACKSTONE STUDIOS, INC.

That anything so young, so spirited and gay should be having a Fortieth Birthday—how absurd, and yet how good! To me, this Fortieth Anniversary BOOK OF KNOWLEDGE brings memories of all that is best in childhood. I envy the fortunate children of *now* who turn these beautiful pages. They will be better young people, I believe—more wide-awake and stronger, more wise because of their acquaintance with many things that are true. To these boys and girls I doff my hat respectfully; and to THE BOOK OF KNOWLEDGE, the happiest of all its forty birthdays.

CONSTANTIN ALAJÁLOV
ARTIST

Good books are friends. They are the kind of friends who are always ready to help when they are needed. Their reward is that the words on their pages are read and that the reader gains in knowledge or wisdom or enjoyment. The generations of boys and girls who have pored over the pages of each new edition of THE BOOK OF KNOWLEDGE share a common rich experience. This book is an old friend, ever youthful and vigorous. It is as welcome to boys and girls on its Fortieth Birthday as it was on its first.

DAVID W. ARMSTRONG
EXECUTIVE DIRECTOR, BOYS' CLUBS OF AMERICA

You often hear that science is shrinking the world. Day by day the airplane is bringing far-away places and people closer to us.

As people become closer neighbors, it is more and more important for them to understand each other and the earth on which they live. We learn about our world in large measure through books—books of knowledge.

Never have we needed this knowledge more. The good citizen needs it in order to take his part in building a peaceful world. The earlier he begins to accumulate this knowledge, the greater the understanding he will be able to achieve during his lifetime.

THE BOOK OF KNOWLEDGE is a good beginning for the explorer who hopes to know a great deal about the world in which he lives.

WARREN R. AUSTIN
UNITED STATES REPRESENTATIVE TO THE UNITED NATIONS

Forty years ago I was seventeen and starting to write, so I thought I knew everything. I was mistaken. My father bought me the first set of THE BOOK OF KNOWLEDGE and it gave me not only pleasure but the answers to many questions.

That set has long since been lost in moving about; but as soon as my oldest child could read, I bought another. This has been used by four children. It is still in use, although the youngest is twenty-two.

In these books you will find adventure, excitement and good fun; passports to new lands, new thoughts, wider imagination. You will learn that the basic general knowledge you acquire is truly power. For it is not enough to guess . . . it is necessary to *know*.

Happy reading to all of you!

FAITH BALDWIN
NOVELIST

You boys and girls of today live in a swift-moving world where facts pile up with lightning speed. One of the important things for you to learn is how to find new information—how to guide your eyes and hands to seek new facts.

As you use THE BOOK OF KNOWLEDGE you will be gaining valuable experience along this line. The many gateways to knowledge in your public libraries will become less mysterious. They will open more readily into avenues leading toward wisdom because of the familiarity you gain with the explorer's way.

DOROTHY BARUCH
CHILD PSYCHOLOGIST AND WRITER

"A little learning is a dangerous thing; Drink deep, or taste not the Pierian spring," said Pope. Happily, everybody who has THE BOOK OF KNOWLEDGE handy can take deep, generous draughts whenever he's thirsty. And the interesting thing is that this beverage always "tastes after more."

I congratulate THE BOOK OF KNOWLEDGE on its Fortieth Birthday and I congratulate its many young readers.

H. R. BAUKHAGE
COMMENTATOR, AMERICAN BROADCASTING COMPANY

I will show you," said my friend in Paris, "the oldest and newest in the garden," and led me to a great evergreen each of whose dark branches was tipped—for it was spring—with living green bright as tomorrow.

That tree comes to mind at this anniversary of THE BOOK OF KNOWLEDGE. The neighbors' children who on rainy days would gather in our living-room, each lost in a volume, now read the same many-volumed fascinator over their own children's shoulders, finding it has grown up along with the times but kept, in essence, reassuringly the same. It has become part of many lives; it has, in its own way, a life of its own.

MAY LAMBERTON BECKER
READER'S GUIDE,
"NEW YORK HERALD TRIBUNE WEEKLY BOOK REVIEW"

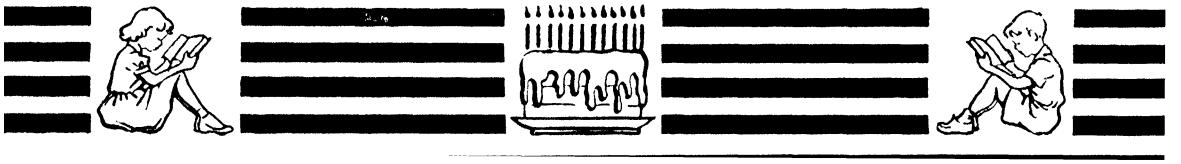
The sugar industry of Hawaii was started more than a century ago, in the days of the ox cart and the sailing ship. The beginnings were small, production meager and quality poor. It has grown until now its annual production is about a million tons. Our industry includes all steps from plowing the fields to the refining that yields the shining crystals on your breakfast table.

The soil, the sunshine and the water were always here; men have created the industry. Here, as everywhere, successful men have possessed character, knowledge and ability to use knowledge. Those can become part of one, and no buffets of fortune can take them away. THE BOOK OF KNOWLEDGE is a tool for acquiring knowledge. Use it!

R. G. BELL
PRESIDENT, HAWAIIAN SUGAR PLANTERS' ASSOCIATION

"And Jesus increased in wisdom and stature, and in favor with God and man." One of the oldest colleges in America was founded that "learning and good manners might flourish and abound." THE BOOK OF KNOWLEDGE is an invaluable help to young people in search of knowledge. As they increase in wisdom and stature, we shall hope that through the influence of the home, the school and the Church, they may increase in favor with God and man. We shall hope that their learning may include a knowledge of God and their duty to Him as they learn of their fellow-man and their responsibilities as members of the community.

THE RIGHT REVEREND JOHN B. BENTLEY
VICE-PRESIDENT, THE NATIONAL COUNCIL OF THE
PROTESTANT EPISCOPAL CHURCH



On behalf of America's 360,000 Camp Fire Girls I am happy to send greetings to the hundreds of thousands of girls and boys who will read this Fortieth Anniversary BOOK OF KNOWLEDGE.

Many, many years ago Francis Bacon wrote: "Knowledge is power." I think if Francis Bacon had lived in the twentieth century he would have written, "Knowledge is freedom."

I sincerely hope that all your lives you will be the questioners, the seekers of learning who have since the beginning of time made this a better world in which to live.

RUBY WOOTTEN BLALOCK
NATIONAL PRESIDENT, CAMP FIRE GIRLS, INC.

WIDE WORLD

It is a great thing to grow up in America! All of us know what it means to be free, to think our own thoughts, to worship as we please, to choose our friends and to seek the truth. All these things we cherish.

As THE BOOK OF KNOWLEDGE reaches a new milestone in the year 1950, my wish is that it may continue to enrich the heritage that is America's.

LOU BOUDREAU
MANAGER, CLEVELAND INDIANS

I can think of few things more valuable in the life of a young person than THE BOOK OF KNOWLEDGE. The more we know, the more fascinating a place the world and the universe become. The more we know the more valuable we become as individuals to the rest of the world. But curiosity and knowledge, which go hand in hand, comprise very largely the secret of good living and of satisfaction in all that we do. The man equipped with curiosity and knowledge never knows boredom and never knows defeat because he possesses the very keys to life itself.

LOUIS BROMFIELD
NOVELIST AND AGRICULTURAL EXPERT

HARRIS & EWING

The world is at our door these days. Television, rocket planes and all the other machines of modern science have telescoped distance and time. But they have not brought knowledge. They have not answered our questions: "Why, and what, and where?" We need today more than ever to get behind the television screen, behind the loudspeaker, to find out what makes things tick and what happened in the rich background of today's events stretching down through the fruitful years of history.

THE BOOK OF KNOWLEDGE today more than ever answers the questions that the breathless, raucous media of our time leave unanswered. The inquiring mind of youth demands the response that comes from the accumulated and co-ordinated knowledge of the past projected into the present and the future.

ERWIN D. CANHAM
EDITOR, "THE CHRISTIAN SCIENCE MONITOR"

Young people facing the complex world of today vitally need information on which to base wise decisions as individuals and citizens. Public libraries and home libraries can assure easy access to facts and opinions on all sides of important questions. Making library materials available is a continuing responsibility of each generation if free and unhampered progress toward world peace and understanding are to be achieved.

JOHN MACKENZIE CORY
EXECUTIVE SECRETARY, AMERICAN LIBRARY ASSOCIATION

During most of our lifetime we have heard from parents and grandparents how they treasured early editions of THE BOOK OF KNOWLEDGE. It has been such a long-standing, worth-while book we feel sure the new generation will gain similar benefit from it.

BING CROSBY
MOTION PICTURE AND RADIO STAR

I think you are indeed very fortunate young folks who have this fine, inspiring BOOK OF KNOWLEDGE as your teacher and your guide.

Even at my age I find it full of most interesting knowledge on so many different subjects and all such inspiring reading.

In my childhood I never had such a book all filled with subjects so captivating to the young inquisitive mind. And so I realize personally how rich you children are today who have this book.

The world is much richer today, far more interesting in a thousand ways, than it was then.

What you learn from THE BOOK OF KNOWLEDGE will fill your mind with riches as nothing else can do. So read it eagerly, carefully; and strive to store your memories with its treasures.

LEE DE FOREST
"FATHER OF RADIO"

WIDE WORLD

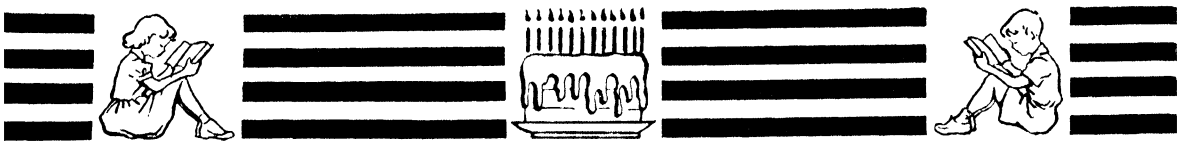
Forty years ago when THE BOOK OF KNOWLEDGE first appeared, I had just finished college. We thought then that we knew almost everything there would ever be to know. How wrong we were, a comparison of the Fortieth Anniversary BOOK OF KNOWLEDGE with the first edition will readily show. More has happened, for good or bad, in the last forty years than in any other period of similar length in the world's history. There has been no change, however, in the rules of how to live, such as the Golden Rule or the Ten Commandments. Nor is there still any better method of learning than educating yourself. By this I mean developing a curiosity about things and satisfying that curiosity by hunting out the answers yourself in THE BOOK OF KNOWLEDGE or in other books recommended by your parents or teachers.

H. W. DODDS
PRESIDENT, PRINCETON UNIVERSITY

A good book is a wonderful thing; it can delight or inform thousands, even millions. For children it is especially wonderful; for in childhood, delight is keenest and learning has greatest value.

THE BOOK OF KNOWLEDGE is celebrating its Fortieth Anniversary. That means it is serving a third generation of boys and girls. Lucky children, to be able to find information and delight wrapped up together in one thrilling package.

DENNIS CARDINAL DOUGHERTY
ARCHBISHOP OF PHILADELPHIA

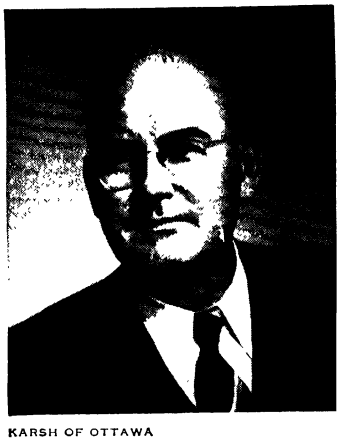


It may be true that the hand that rocks the cradle rules the world, but it can not build a better world without knowledge and good will. Facts are the building blocks of modern civilization. Truth and beauty are common denominators of our daily lives. The light of the whole world dies without knowledge.

It is a great accomplishment to bring truth and beauty and knowledge to the men and women of tomorrow. They are the hope of the generations to come.

Congratulations on the Fortieth Anniversary of THE BOOK OF KNOWLEDGE and on four decades of distinguished and priceless service to humanity.

DONALD W. DOUGLAS
PRESIDENT, DOUGLAS AIRCRAFT COMPANY, INC.



KARSH OF OTTAWA

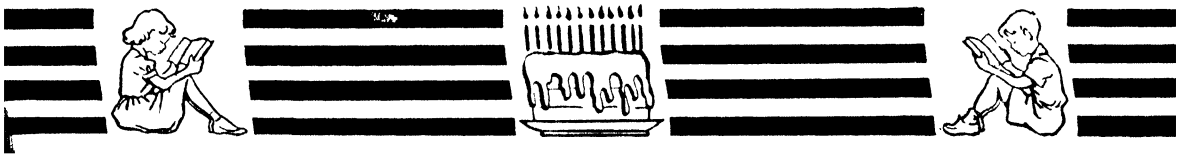
To The Grolier Society, and to the authors of THE BOOK OF KNOWLEDGE in particular, I offer hearty congratulations on the Fortieth Anniversary of this invaluable service to American boys and girls.

To the present generation of American youth, I commend THE BOOK OF KNOWLEDGE for earnest and careful study. As an authoritative source of vital facts about America, THE BOOK OF KNOWLEDGE can not be recommended too highly. Its real significance, however, is in the story it portrays of the American way of life which underlies and gives meaning to these facts. You who are about to shoulder the great responsibility for preserving and perpetuating that way of life will profit by a study of THE BOOK OF KNOWLEDGE in this light.

WILLIAM T. FARICY
PRESIDENT, ASSOCIATION OF AMERICAN RAILROADS

In the lives of the children of Hawaii, THE BOOK OF KNOWLEDGE has played an important part over a period of a great many years. I am sure that not only those like myself, who were introduced to it many years ago, but the children of today would be happy to join me in extending sincerest congratulations to the publishers on having achieved the Fortieth Anniversary of this great work. It has undergone many changes during this period, but has always remained a source of inspiration to the boys and girls of our country who want to know just what this life and world of ours are all about. I have traveled in many parts of the Pacific and the world but have never seen any publication that quite approaches THE BOOK OF KNOWLEDGE.

J. R. FARRINGTON
DELEGATE FROM HAWAII, CONGRESS OF THE UNITED STATES



THE BOOK OF KNOWLEDGE is in my opinion the most valuable tool that can be given to an American child.

The fact that it is readable, full of essential information in all the major fields of life, makes it the most profitable single investment parents can make.

As one who is constantly writing in, and reporting on, the educational field, I feel that anything I can say of it is really an understatement.

HUGH RUSSELL FRASER
EDUCATION EDITOR, "PATHFINDER"

Today our young people are growing up in an America that has been made wonderful through individual achievement, founded on faith and knowledge. But it is a different America from the one we of the older generation cherished when we were children. Our need for knowledge has grown as each succeeding generation has expanded our frontiers and planted its milestones of progress. As we grow, so must a work like THE BOOK OF KNOWLEDGE grow and expand through the years; it must grow wiser but never older. It must rediscover the fountain of youth for each new generation. It has done so; and I salute it and the new generation.

ALFRED C. FULLER
CHAIRMAN OF THE BOARD, FULLER BRUSH COMPANY

I should like to offer my congratulations to the editors and publishers of THE BOOK OF KNOWLEDGE, on the occasion of the Fortieth Birthday of this great work. This is indeed an important occasion and one that deserves proper celebration.

The millions of children who have had access to these volumes are most fortunate. Personally, I recall how often I referred to THE BOOK OF KNOWLEDGE years ago, when my young son and daughter asked questions that I could not properly answer.

It would be a great blessing if all children could enjoy the benefits that these important volumes offer.

EDWIN FRANKO GOLDMAN
CONDUCTOR, THE GOLDMAN BAND

This is a wonderful and yet a most disturbing age. It is the era of the airplane, the radio, the television set, the electron microscope, the 200-inch telescope, plastics, wonder-working drugs, jet planes, rockets and atomic energy. It is an era, too, of world wars, revolutions and rapid social change. It is a time in which every young person will need to be equipped with accurate knowledge in many fields of human endeavor. For that reason the Fortieth Anniversary of THE BOOK OF KNOWLEDGE is an especially important occasion, and I am happy to salute The Grolier Society for its success in informing so many generations of young Americans.

CAPTAIN HARRY F. GUGGENHEIM, U.S.N.R.
AVIATION PIONEER

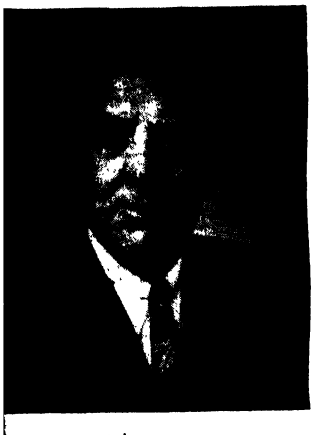
You are living in the greatest country in the world, the finest ever fashioned by man with the help of God. As a citizen of the United States you have rights equaled by the citizens of few other countries and surpassed by none.

Among these is the right to read what you wish to read, think your own thoughts and form your own opinions. You have the right to voice these opinions.

As Americans you are sharing in freedom handed down by forefathers who fought oppression. You in turn are charged with doing your part to keep that freedom alive. Sound education makes for better citizenship. In your ownership of THE BOOK OF KNOWLEDGE you have an aid to sound education that will, I am certain, be of great value in the days ahead.

OVETA CULP HOBBY
EXECUTIVE VICE-PRESIDENT, "THE HOUSTON POST"

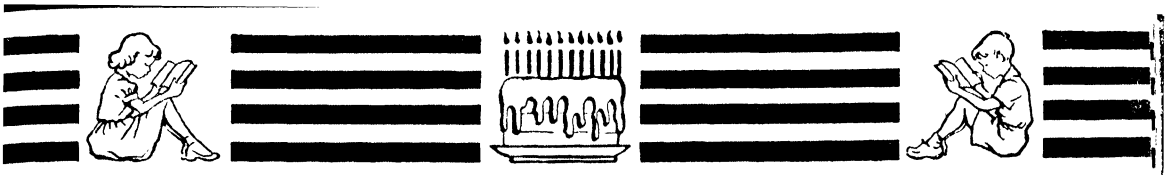
FABIAN BACHRACH



America's children have long had advantages in citizenship, education and personal happiness that have made them the envy of other children throughout the world. These advantages are among the heritages of our democracy; and because of them, our children have an obligation to help the boys and girls of other lands.

The children of today's America should never feel their task has been completed until every child, wherever he may live in our world, has gained the security and happiness that we take so much for granted.

PAUL G. HOFFMAN
ADMINISTRATOR, ECONOMIC COOPERATION ADMINISTRATION

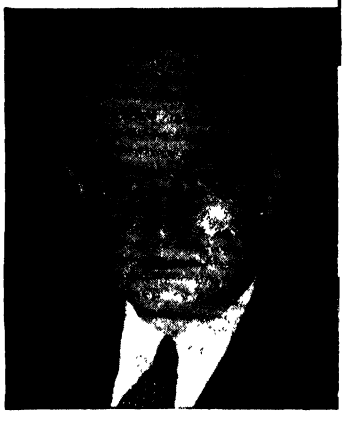


To the boys and girls of America who are privileged to read this Fortieth Anniversary BOOK OF KNOWLEDGE, I offer my sincerest greetings.

Thousands of men and women of today can attribute successful careers to youthful interests made keener by what they read and learned from early editions of this publication. There can be no doubt that the challenging imaginations of boys and girls in this mid-century epoch will be similarly whetted by knowledge and understanding acquired from this Fortieth Anniversary BOOK OF KNOWLEDGE.

I am confident that the result will be seen in better leadership and finer citizenship in future years.

PALMER HOYT
EDITOR AND PUBLISHER, "THE DENVER POST"



Socrates, we are told, was the wisest man that ever lived. This is because he was the first to proclaim the eternal quest for knowledge as the solution of all life's problems, the ultimate goal that would give to the human race a sound moral foundation.

"There is only one good," he said. "That is knowledge. There is only one evil. That is ignorance."

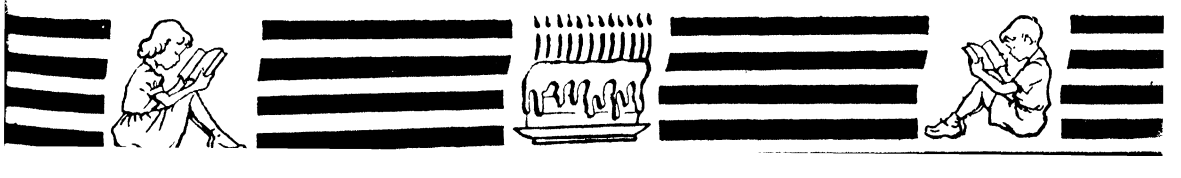
THE BOOK OF KNOWLEDGE has shown itself through forty years to be a splendid beginning in the capturing of the child's imagination and implanting unforgettable glimpses of history, science and literature that make the paths to education an inviting road as the teen-age years rise and wane.

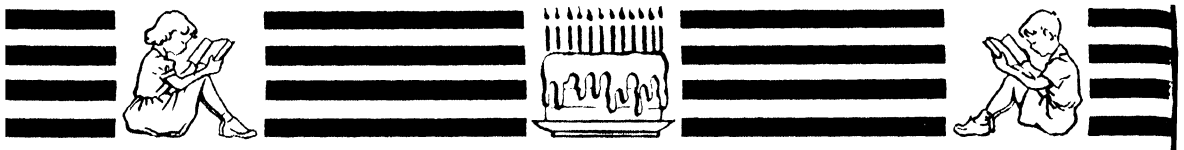
JOHN S. KNIGHT
PUBLISHER, KNIGHT NEWSPAPERS

Browsing through THE BOOK OF KNOWLEDGE brought back my childhood days. Here was a great wide world of interest and information at my finger tips.

I think every young person should have THE BOOK OF KNOWLEDGE, and most of the older people too! Much to my satisfaction, I find the articles in my field of arts and crafts, color and design particularly good.

DOROTHY LIEBES
TEXTILE DESIGNER



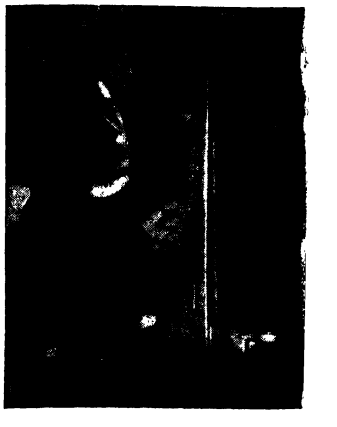


You boys and girls who read this are the most fortunate people on earth—for a multitude of reasons. You are fortunate to be young, to be living in our wonderful country where each and every one of you has the opportunity to go as far in later life as your abilities will take you. You are fortunate to be living in such an exciting age where every day our statesmen, scientists, clergymen and other leaders are advancing our civilization and making our lives more useful to society and more enjoyable to live. You are also fortunate to have in THE BOOK OF KNOWLEDGE a review of the past linked to a chronicle of the present and a preview of the future. Make good use of these excellent volumes—they will guide you to successful and fruitful years of maturity.

LOU LITTLE
HEAD FOOTBALL COACH, COLUMBIA UNIVERSITY

Youth is a time of exploration and discovery, and the young voyager who sets his course for the farthest outpost of human accomplishment can find in THE BOOK OF KNOWLEDGE a trusty guide and companion. Together, you can scale forbidding mountains, penetrate the thickest jungles and examine the secrets of sunless ocean floors. And in all these wayfarings you can make camp whenever you choose with the wisest men and the greatest story-tellers of the ages. THE BOOK OF KNOWLEDGE will introduce you to them.

LAWRENCE W. LOWMAN
VICE-PRESIDENT, COLUMBIA BROADCASTING SYSTEM



A Rembrandt or a Rubens in painting or a Stradivarius in violin-making has left a unique and distinguishing mark of the master in his work. So the Creator has left His very distinguishing mark on the Master in His handiwork, the universe. As the theologian by studying the message of the Creator as handed down by tradition or in the Bible has increased our knowledge of God, so has the natural scientist, the chemist with his retort, the physicist with his Geiger counter and the geologist with his hammer uncovered more and more of our knowledge of nature and hence of the Author of nature, our Creator.

Young people therefore should be encouraged to study natural science hand in hand with their religion as a means of increasing their knowledge of their Creator.

THE REVEREND J. JOSEPH LYNCH, S.J.
CHAIRMAN OF PHYSICS DEPARTMENT, FORDHAM UNIVERSITY

To make facts come alive is an art. To make them a thrilling part of our early memories, and on top of that to make us want to know more—this has long seemed to me the very special province of THE BOOK OF KNOWLEDGE.

These beautiful volumes have more than the gift of filling the child's cup of wonder to the brim. For millions of children, they have laid the groundwork of a growing interest in many things and in many kinds of people.

The child who has access to—or still more fortunately owns—THE BOOK OF KNOWLEDGE is well on the road to developing the broad viewpoint that turns men into leaders of men.

LAWRENCE C. MARSHALL
PRESIDENT, BANK OF THE MANHATTAN COMPANY

WIDE WORLD

The world today is filled with things of interest and importance to young people. All around you, in your daily life, you see things that arouse your interest and start you thinking and asking questions. This is the beginning of a road of adventure that may lead to great heights of achievement.

When I was a boy, I was interested in kites. I watched the flight of birds, and studied their wings, so that I might build kites that would fly better. I read what little there was to read on the subject of flight. That led me to build an airplane, and after that to make a lifetime career of aircraft manufacturing.

With the entire expanse of the world's knowledge available to you, through the wonderful realm of books, you will find facts more fascinating than fiction, and will be prepared to face a world filled with a challenge to adventure and exploration in uncharted fields.

GLENN L. MARTIN
CHAIRMAN OF THE BOARD, THE GLENN L. MARTIN COMPANY

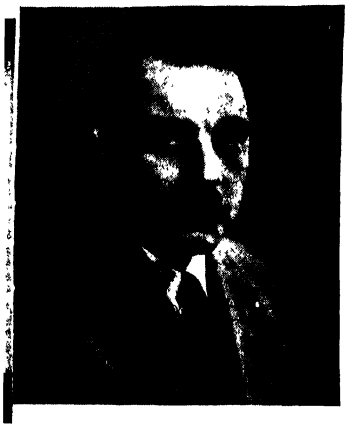
The poet Marlowe might have been thinking of THE BOOK OF KNOWLEDGE when he spoke of "infinite riches in a little room," for the space that its twenty volumes fill on the bookshelves is truly a realm of gold. Happy is the boy or girl who has these books. In their pages the child can travel through time and space, entering and taking possession of many worlds. He learns to know fascinating people who have said and done wonderful things, and all that they have accomplished becomes a part of his own heart and soul.

MRS. JAMES P. McGRANERY
MEMBER OF THE NATIONAL BOARD AND NATIONAL EXECUTIVE COMMITTEE OF THE GIRL SCOUTS OF THE U.S.A.

To satisfy bodily needs, we crave air and water and food and shelter. But just as soon as we grow comfortable, the real hungers begin. Then we go places and do things; we try to understand the strange and wonderful world in which we live.

Like scientists, then, we probe the mysteries with experiments; like scientists, we turn to books that describe the experiments of others. To find answers to puzzling questions is like a refreshing drink when thirsty. THE BOOK OF KNOWLEDGE, ready at hand, is a storehouse of answers and an invitation to adventure. More, it is what young people need to grow up.

MORRIS MEISTER
PRINCIPAL, BRONX HIGH SCHOOL OF SCIENCE



Knowledge is a vital tool in man's hands, but knowledge is not enough. Wisdom is the hand and knowledge is the tool. It is through both wisdom and knowledge that man can find his way and reach his goal.

LUIS MUÑOZ MARÍN
GOVERNOR OF PUERTO RICO

© CHASE-STATLER PHOTO

During the past forty years, since THE BOOK OF KNOWLEDGE was born, we in the United States have made great strides in learning—especially in learning to work together, to live together and to appreciate the other fellow's point of view.

We still have many old problems that have to be solved—and we always will have new problems. One of the surest roads to their solution is for us to gain more knowledge and one of the best ways for us to do this is through the reading of good books. With natural curiosity and good books, the children of America can learn to build upon what we have started and to solve the problems we have helped to create.

PHILIP MURRAY
PRESIDENT, CONGRESS OF INDUSTRIAL ORGANIZATIONS

How fortunate you are to have THE BOOK OF KNOWLEDGE. If you can read, you can find the answers to nearly all your questions and the questions your baby brother or sister asks, that nobody in the family could answer.

And just see the smile on the little person's face as you read to him or her—as happy as the smile you had when your father or mother used to read to you from one of these books.

Besides, you and your friends can browse through these big books for hours and hours, over days and days, looking at the pictures, reading about them and gathering wisdom only college professors used to know. You and your playmates, little brother and sister, your father and mother, your grandfather and grandmother, your teacher and any other person can enjoy this set of books together, just as Mrs. Myers and I and our children and grandchildren have.

GARRY CLEVELAND MYERS
EDITOR, "HIGHLIGHTS FOR CHILDREN"

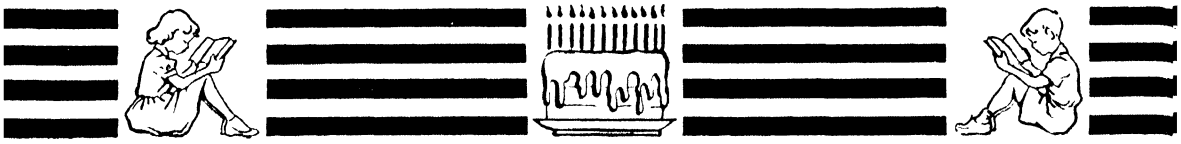
The Police Athletic League provides a recreation program for thousands of boys and girls in New York City. I have had personal contact with these youngsters—many of them I know by name. Having come to know them, I have great confidence in them and the contribution they will make to the future of our country. These boys and girls are typical American youngsters. They are like any other youngster in any part of our country, in fact, in any other part of the world. They are ready and eager to acquire the knowledge and to develop the physical, mental and moral qualities that are so necessary.

In competitive sports we appreciate that certain rules are necessary. We accept these rules and develop a willingness to comply with them because only then can we achieve our objective. This very often calls for self-discipline.

In our society we also have rules that we call laws. Each and every one of us, young and old, must comply with them. Government, if it is to exist, must enforce these laws and does so through the medium of the policeman.

Children who learn to appreciate and respect these rules of conduct will recognize the policeman as their protector and their friend. If you learn to respect this policeman and the laws that he enforces, you will have little difficulty in getting along with others through the difficult path of life.

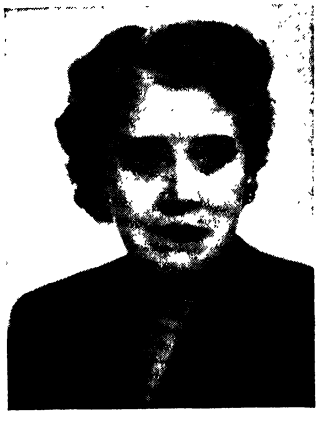
JAMES B. NOLAN
DEPUTY POLICE COMMISSIONER, NEW YORK CITY
PRESIDENT OF THE POLICE ATHLETIC LEAGUE



My dear boys and girls of this generation and the next, and of all future generations who shall read this book: Your BOOK OF KNOWLEDGE contains many scientific and historical facts—but I know little about these. I have been your Stories Editor, and the world I have brought to you has been the imaginary world, sometimes of magic and wonder and sometimes of real people.

Many of the stories you will read in these volumes have come to you as a heritage from generations of story-tellers, and I want you to know—for it is true—that these tales are as much a form of knowledge as all the chemistry and physics that you can learn. They are the recordings of life's experiences as seen through the imagination, and their basic truths are as immortal as the soul of man.

When you have read these stories and reread them until they have become a part of you, you will look with new eyes upon the many-featured world about you, to be thrilled by the bravery and the beauty of this life of ours, itself brief as a tale. You will know people better and love them more, and the great gift of imagination will be yours.



MARGARET NORGAARD
CO-AUTHOR, "CHILDREN'S READING"

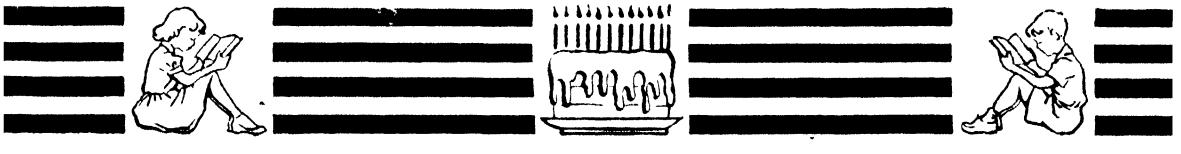
I hope the start in learning that you will get from THE BOOK OF KNOWLEDGE will give all of you a love of the arts and peoples of all nations. I hope your knowledge and understanding of others and their ways will grow with the years—for you boys and girls will one day be the men and women who control the world.

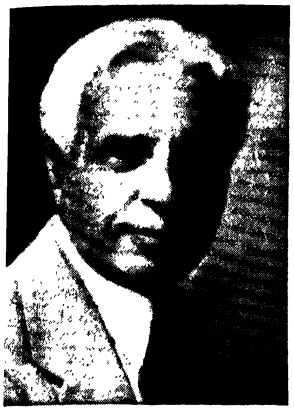
WILLIAM O'DWYER
MAYOR OF THE CITY OF NEW YORK

THE BOOK OF KNOWLEDGE has been a source of enlightenment and happiness in many homes. To impart knowledge without making it smug and uninteresting is in itself an art, which THE BOOK OF KNOWLEDGE has certainly achieved. Its pages convey a sense of adventure and a desire for further exploration. I welcome the Fortieth Anniversary BOOK OF KNOWLEDGE.

ACME

MME. VIJAYA LAKSHMI PANDIT
FIRST AMBASSADOR FROM INDIA TO THE UNITED STATES





Forty years is a long time in a man's life, but it is only an instant in the life of such a work as THE BOOK OF KNOWLEDGE. Truth never grows old, beauty of the mind and spirit is ageless; so, though the years pile upon it, the dust of disuse will never dim its usefulness. Wise men, fine teachers, devoted leaders of youth keep renewing the facts that are the body of THE BOOK OF KNOWLEDGE so it is always Today within its pages, while Tomorrow looks over the edges. Children of Yesterday still turn its pages and Today's children turn to them as a never failing source of knowledge, an ever ready friend that takes the knots out of school problems and makes the scholars' way easy. Many happy returns of its birthday.

ANGELO PATRI
EDUCATOR

We who were young at the turn of the century see in you all the dreams of our youth. We wish to share with you the hopes and heritages of this free and happy land. Breathe deeply of it. Read and learn about it, so that you can mold its greater future.

Many of our early families lived in cabins and sod houses. They had only the land, the axe, the hoe and the Bible. There were few doctors, schools and books; no motor cars, radios or movies. Learning was hard. But they had faith, and they thirsted for knowledge. They labored long to improve living for you and for me.

With their improvements came many wonderful things we enjoy today. Among the greatest of these were good books. Treasure and grow with this BOOK OF KNOWLEDGE. For knowledge is the tool of wisdom, and only through both can we find our way and reach our goal.

J. C. PENNEY
HONORARY CHAIRMAN OF THE BOARD,
J. C. PENNEY CO., INC.

For nearly, if not quite, forty years our family has had THE BOOK OF KNOWLEDGE, lived with it and rejoiced in it. First the children wore it out. Now the grandchildren, thirteen of them (count them!) have their own editions. The youngest are not yet able to do more than endanger the beauty of the rare and wonderful volumes, but it will not be long now until they too will begin and continue as their parents did before them.

What a library of wonder, information, inspiration and delight!

THE REVEREND DANIEL A. POLING
EDITOR, "THE CHRISTIAN HERALD"
PRESIDENT, THE WORLD CHRISTIAN ENDEAVOR UNION

Never was there so much to learn, and never was it so easy to learn, as today. Young people whose curiosity is active, whose horizon is wide, can get an understanding of themselves, of other peoples, and of the world we all live in, that the greatest scholars of the past could never attain. If we are to live at peace with our neighbors and prosperously among ourselves, such knowledge must become part of our everyday life. Such books as this open all the doors for us. Let us pass through these doors, and keep going forward!

PAUL POPENOE
DIRECTOR, AMERICAN INSTITUTE OF FAMILY RELATIONS

There is an old philosophical tenet to the effect that "all knowledge begins in the senses." A child knows that fire is hot when he has burned his fingers.

This is knowledge, but only the beginning of knowledge. The fingers will not tell him why fire is hot. He may learn this in several ways, if at all. His parents possibly may be able to tell him. Or he can go to his teacher. Probably the best way is for him to learn it for himself, from a book.

The wonderful thing about THE BOOK OF KNOWLEDGE is that the facts in it are so fascinating that, lured by them, children may learn to use books as tools. What is learned in this way gives not only knowledge, but a sense of personal achievement. This in turn is a spur to the development of still further initiative in learning.

STANLEY RESOR
PRESIDENT, J. WALTER THOMPSON COMPANY

Congratulations to THE BOOK OF KNOWLEDGE on its Fortieth Birthday. Many adults of today look back on their experience with this set as their introduction to the pleasures of wide reading.

JOHN S. RICHARDS
LIBRARIAN, SEATTLE PUBLIC LIBRARY;
PRESIDENT, DIVISION OF PUBLIC LIBRARIES,
AMERICAN LIBRARY ASSOCIATON

Boys and girls are full of questions, eager to know more about the world in which we live. That is one of the things I like most about young people.

As you look for answers to your questions in this Fortieth Anniversary BOOK OF KNOWLEDGE, you will probably stop here and there among the pages to look at a picture or an article on some fascinating subject that is completely new to you. Perhaps your pleasure in this book will grow into a lifelong enjoyment of learning. I hope so, because understanding of nature, science, the arts and other people is a great spiritual treasure as well as a help in the business of everyday living.

CONSTANCE MORGAN RITTENHOUSE
NATIONAL DIRECTOR, GIRL SCOUTS OF THE U.S.A.

I am happy to send this message to the readers of THE BOOK OF KNOWLEDGE. I came to know it first many years ago when I gave it to my own children. It is the kind of book in which all children can find something that will entertain them and keep them interested. No matter what their special interest may be, children can look it up in THE BOOK OF KNOWLEDGE. It provides entertainment and adds to knowledge in many fields, and I think has been for many children the beginning of a habit that took them later to the encyclopaedias to find out what they needed to know.

As we, none of us, can know all there is to know in the world, the best equipment we can have is training in the manner in which we find out that which we need to know. THE BOOK OF KNOWLEDGE serves that purpose admirably. My congratulations on the Fortieth Birthday celebration, and may many children in the future have the joy from this publication that mine had in the past.

UNITED NATIONS PHOTO

ELEANOR ROOSEVELT

THE BOOK OF KNOWLEDGE is truly what its title implies, a treasure house of information—my children were brought up on it. It covers an amazingly wide range of important subjects in an enchanting style. The value it yields to the impressible minds of youth is beyond reckoning. The stimulus it gives to the reading of good books in general is scarcely less important. Boys and girls of America are to be congratulated upon this excellent set of books being kept constantly available to them with such additions incorporated as are necessary to keep it abreast of the times.

NELLIE TAYLOE ROSS
DIRECTOR OF THE MINT

When man discovered the way to preserve his food, he won one of his greatest battles.

When he discovered how to preserve ideas, he accomplished even more.

There has not yet been offered a substitute for the printed page. Especially the book!

Here are signposts, landmarks and trail-blazings, which, if followed, will lead your generation to the ideal toward which we are all working—*a better world*—physically, financially, morally and spiritually.

Your BOOK OF KNOWLEDGE is a treasure house. Keep it and read it often.

GERTRUDE ROUNSAVELLE
PRESIDENT, WOMEN'S DIVISION,
LOS ANGELES CHAMBER OF COMMERCE

To physically handicapped boys and girls knowledge is of the utmost importance; for, lacking the physical abilities that most children possess, they depend particularly upon knowledge.

Today, with knowledge plus the insight, understanding, patience and tolerance in which the physically handicapped seem to excel, thousands of boys and girls, although handicapped in body, are leading useful, valuable, productive, happy lives. They are helping to make their homes, schools and the nation better places for all of us. They are the proof that you can't disable ambition and the will to succeed, for despite their physical handicaps, each of them has far more *ability* than disability.

HOWARD A. RUSK, M.D.
ASSOCIATE EDITOR, "THE NEW YORK TIMES";
PROFESSOR AND CHAIRMAN,
DEPARTMENT OF REHABILITATION AND PHYSICAL MEDICINE,
COLLEGE OF MEDICINE, NEW YORK UNIVERSITY

In today's rapidly changing world, the youthful reader who has ready access to volumes especially prepared to satisfy his thirst for knowledge enjoys an advantage that was denied to most of his forebears. The facts thus acquired by the young boy and girl may prove to be the foundation stones for the careers they will follow as adults.

Whether attracted by the arts or by one of the many branches of applied science such as television, aviation, medicine or chemistry, the youth's education is well on its way if his early interest is quickened by carefully selected readings from sources such as THE BOOK OF KNOWLEDGE.

DAVID SARNOFF
CHAIRMAN OF THE BOARD,
RADIO CORPORATION OF AMERICA

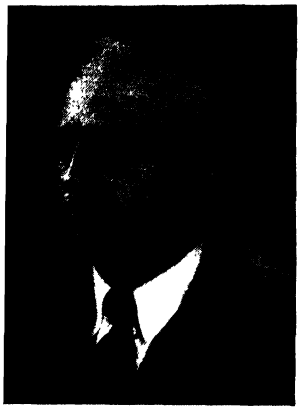
I hope that your Fortieth Anniversary will be a success. For years THE BOOK OF KNOWLEDGE has brought to the attention of the boys and girls of America accurate information about the Boy Scouts of America, and the co-operation between the two organizations has, I'm sure, been mutually helpful. I trust we may continue these happy relationships for another four decades.

ARTHUR A. SCHUCK
CHIEF SCOUT EXECUTIVE,
BOY SCOUTS OF AMERICA

You and I are very lucky. As human beings we alone of all earth's creatures can experience the excitement of opening a book and finding in its pages a whole world which until that moment had never existed for us. It is an ability we humans take for granted, yet no magic can equal it. While sitting at home we can be exploring the stone caves of men who lived thousands of years ago. While studying at school we can be scaling the mountains of the moon.

Within the covers of THE BOOK OF KNOWLEDGE are many, many such wonderful experiences. I know you will enjoy them.

DOROTHY SHAVER
PRESIDENT OF LORD & TAYLOR



Happy Birthday to THE BOOK OF KNOWLEDGE and its many young readers all over the world on this Fortieth Birthday, and many more years of happy reading in a truly good set of books.

LOUIS SHORES
DEAN, SCHOOL OF LIBRARY TRAINING AND SERVICE,
FLORIDA STATE UNIVERSITY

BLACKSTONE STUDIOS, INC

I am very pleased to send a message through THE BOOK OF KNOWLEDGE to the youth of America. The twentieth century will undoubtedly come to be known in history as the American Century. Because of its wealth and power, America is destined to be the paramount influence in the affairs of the world. Much will depend upon the quality of leadership that the American people will be prepared to give to the world. In the last analysis, this quality of leadership will be determined by the knowledge and the moral inspiration of the present generation of American youth.

It is not at all clear at the moment whether the future will belong to the forces of reaction and dictatorship or to the forces of freedom and democracy. In the world-wide struggle that is now unfolding between these two opposing forces, victory will come to those who are equipped with knowledge, with wisdom based on a true understanding of the past, and with moral courage that derives from the inspiring records of the struggles of men in all parts of the world, through the ages, against all forms of tyranny and oppression, for the unalienable rights of man as a child of God.

This is a great age in which to live, for vast issues are being decided. The free citizens of this blessed Republic in this generation face the opportunity and the challenge to lead the world to such a just and satisfactory solution of these issues as will bring to pass an enduring peace and the good society.

THE REVEREND ABBA HILLEL SILVER
RABBI, THE TEMPLE, CLEVELAND, OHIO
FORMER PRESIDENT OF THE ZIONIST ORGANIZATION OF AMERICA

The pattern established by THE BOOK OF KNOWLEDGE has shown it to be an early and lasting influence for countless youngsters through forty years of growth in maturing America. Its earliest readers have never forgotten the many experiences they encountered in its pages, and the enthusiasm they pass on to their children finds ready acceptance in every generation.

The glittering magic of knowledge beckons every young mind, and those lucky enough to have access to THE BOOK OF KNOWLEDGE have found a stimulating source of apparently timeless authority and usefulness. The applications of learning are many.

PAUL C. SMITH
EDITOR AND GENERAL MANAGER,
"SAN FRANCISCO CHRONICLE"

Greetings and best wishes to THE BOOK OF KNOWLEDGE on its Fortieth Birthday.

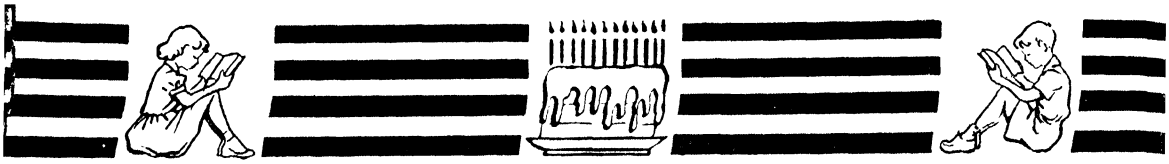
HAROLD E. STASSEN
PRESIDENT, UNIVERSITY OF PENNSYLVANIA

HARRIS & EWING

To be a child in this awe-inspiring age of speed and power and infinite possibilities for exploration is a fearful and wonderful thing. We must face a whole new world of knowledge and master it for the good of all mankind. This we can not do alone. So we need to know, through their culture and art, the desires of people in all lands. Only by understanding the hearts of others can we ever hope to build with them a happier and healthier home on this tiny globe, hung in the lonely wilderness of the stars.

Let us work that we may think and learn together about this world of heart and mind and matter in which we live.

RAYMOND S. STITES
CURATOR OF EDUCATION,
NATIONAL GALLERY OF ART, WASHINGTON, D. C.



Knowing is the key to acting wisely. Knowledge means knowing what is useful, what is true, what can or can not be done; above all, knowledge means understanding what is important and why it is important.

What THE BOOK OF KNOWLEDGE really means and says to you is this: The world is yours. Come and discover it. What you carry in your head no man can take away from you, and to seek to know is the greatest adventure of all. The wonderful thing about it is that to this adventure there can be no end so long as life goes on. And the earlier you start on this adventure the greater and longer the adventure will be.

THE BOOK OF KNOWLEDGE offers you a wonderful instrument for a better, a fuller, a safer and a richer life.

LELAND STOWE
EUROPEAN EDITOR, "THE REPORTER"

WIDE WORLD

This is an anniversary of special significance for me as well as for my old friend, THE BOOK OF KNOWLEDGE. It was in 1910 that both of us set out with the high ideal of winning young people to a love of learning. That year I finished earning my way through college (as a union bricklayer, no less!) and became the principal of the Guthrie Center High School, Iowa. Since then I have watched THE BOOK OF KNOWLEDGE grow and keep pace with the times. As a teacher I have long had a particular admiration for the way these books can teach. In the schools, year after year, I have seen THE BOOK OF KNOWLEDGE prove its extraordinary and, indeed, its unique usefulness. To wish it well on this anniversary gives me the very greatest pleasure.

J. W. STUDEBAKER
VICE-PRESIDENT AND CHAIRMAN OF THE EDITORIAL BOARD, "SCHOLASTIC" MAGAZINES

To THE BOOK OF KNOWLEDGE Boys and Girls:

This is a good book; an interesting book; and, if you don't mind, a helpful book. I have read it; my children have read it and their children will read it, and we did pretty well by reading it.

You don't have to work through it at fixed sittings. It is the sort of thing you can dip into and enjoy yourself each time you do it. And if by chance you ever master all its contents, you will be a whiz kid ready to take on all the other mental heavyweights.

HERBERT BAYARD SWOPE
JOURNALIST AND POLICY CONSULTANT

We face today a struggle of ideas and not of armaments. If we can win that struggle, we need not have another war.

What we need is to arouse the same religious fervor for the American doctrine of liberty and free government as the Communists have for communism. Such a crusade by America can re-establish liberty throughout the world.

This crusade for American doctrines of liberty can best be started by our young people. Boys and girls, keep your drive for liberty alive and strengthen it with each year of your lives.

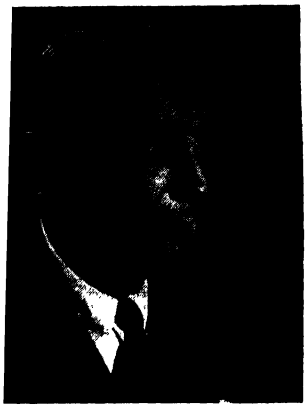
ROBERT A. TAFT
UNITED STATES SENATOR

When I was a boy I had to earn my own spending money, and a great percentage of that went to buy a complete set of THE BOOK OF KNOWLEDGE. At various times my ambition was to become a sheriff, like my father, a Shakespearean actor, and an opera singer. I used to browse in THE BOOK OF KNOWLEDGE to read all that I could on these subjects, and learned so much that all the other kids thought I had had a great deal of personal experience in these fields.

My twin sons were just as fascinated with this source of information as I had been, and it gave them a background for all of their childhood ambitions until one of them finally became an actor and the other a real-estate broker. My youngest son has gained an immense general fund of learning from the books, which will be of great value to him in whatever career he chooses.

Today, all over the world, children are growing up in an age that is vastly different from that in which I spent my childhood. But of one thing I am certain: as soon as my grandchildren are able to read, they will enjoy the same opportunities I had for learning about the past and becoming inspired with dreams for the future.

LAWRENCE TIBBETT
CONCERT AND OPERA SINGER



Between the covers of this Fortieth Anniversary BOOK OF KNOWLEDGE the boys and girls of America can find riches that far surpass in value the treasure troves of legend. Those of you who are now coming upon this wealth of knowledge have a great advantage over the boys and girls who owned and loved the first edition. For forty years of aeronautical progress, in the meantime, have ushered in a new Age of Flight. Now, on the printed page, you can discover the wonders of far places with the added thrill of knowing that the airplane makes it possible for you someday actually to see them at first hand.

As one who has traveled this way before you, I envy you the high adventure that THE BOOK OF KNOWLEDGE holds in store.

JUAN TRIPPE
PRESIDENT, PAN AMERICAN WORLD AIRWAYS

It is hard to realize that THE BOOK OF KNOWLEDGE is actually celebrating its Fortieth Anniversary! When my two sons were seven and eight years old, I gave them one of the earliest editions; and among our happy memories are those of hours spent with THE BOOK OF KNOWLEDGE. When the boys grew up I gave the set away, and I soon regretted that. Now (I suppose like many another fond grandparent) I am sending the latest edition to the grandchildren. And I'm happy to see that while the new BOOK OF KNOWLEDGE has "all the modern improvements," it has kept its magic.

GRACE H. TYSON
A "BOOK OF KNOWLEDGE" GRANDMOTHER

I'm glad there are millions of boys and girls in this country like you, who can and do look for knowledge wherever you like and use it as you see fit. In many countries, you know, they can't do that. But how are you using your knowledge?

You are as free to explore as were the early pioneers who made our wilderness ready for homes and families. Your challenge is to use courageously every day all the knowledge you can get to overcome ignorance and prejudice about persons and peoples who are different from one another.

If you succeed well enough so that we live without war during your lifetime, folks may learn to use their knowledge to solve their problems peaceably. Many of us who are older believe you can and will do just this. So you may become the most important generation of boys and girls that ever lived.

ETHEL B. WARING
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"Knowledge is power," so they say. And power without knowledge is dangerous—in business, in the professions, in government, in private life.

In Washington, there are many of us engaged in finding the facts, so that decisions made by industry, by government, and by individuals may be based on up-to-date knowledge, well analyzed and brought to bear on the problems of today. The problems of today have their basis in history. We must look to compendiums like THE BOOK OF KNOWLEDGE to help us place them in proper perspective.

ARYNESS JOY WICKENS
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"You can not teach an old dog new tricks" is one of those bits of wisdom out of the experience of our fathers with which the printed word abounds. Certainly, when we are young and the film of our mind is most sensitive is when we most easily absorb light.

Whatever we hear or read, wherever we look, it is apparent that the highest rewards of maturity go to those who, while young, have best equipped themselves to return the most to mankind.

Despite all the advancement of science, no medium for the preservation and transmission of learning has yet equaled the vast treasure house of the printed word.

ROBERT R. YOUNG
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VOLUME I

The Book of Knowledge

The Children's Encyclopedia

THAT LEADS TO LOVE OF LEARNING

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The

BOOK OF KNOWLEDGE

The Children's Encyclopedia

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E

Contents of Volume I

This is a guide to the principal contents of this volume. It is not possible to give all of the questions in the Department of Wonder, but the pages are given where such sections begin. The big Index in Volume 20 is a guide to your whole set. There you will find every subject that is in THE BOOK OF KNOWLEDGE.

The Earth

PAGE

The Big Ball We Live On 17
How Did the Earth Begin? 133
The Earth's Yearly Journey around the Sun 235
The Stuff of the Earth 279

Science

What Are Things Made Of? 145
Looking inside the Atom 307

Wonder Questions

Why do I laugh and cry? 73
What makes the sea taste of salt? . . 74
Why do we sometimes see two rainbows? 75
What is it that makes a nettle sting? . 76
How does the speedometer of a motor car work? 77
Why is it dark at night? 78
What is the fastest living thing? . . 141
Are animals in the zoo contented? . 142
Who are Lloyd's of London? . . . 144
Where does dust come from? . . . 284
What is the substance known as ozone? 285
What is the air made of? 286
Why does silver tarnish in the air while gold does not? 287
Is night air bad for us? 288
What do we mean by humidity? . . 289

Animal Life

Nature's Wonderful Family 91
Apes, Monkeys, Lemurs, etc. . . . 204
Bats, Furry Animals That Fly and Insect-Eaters 314
Animals That Never Were 352

Plant Life

PAGE

The Plant World 117
The Great Groups of Plants 218
A Plant's Struggle for Life 329
Conservation 379

Our Own Life

Life That Fills the Earth 48
Animals With Backbones 255

Familiar Things

Footpaths in the Air 26
How We Get Aluminum . . . . . 15.
Riders on the Wind 166
The Ship Beneath the Waters . . . 197
The Talking Machine and Its Records 260
Ships That Sail the Sky 344
The World's Bread and Butter . . . 369

All Countries

This Great World of Ours 42
The Great Continent of Asia 121

The United States

The Continent of North America . . 152
North America Before White Men . . 240
The Panama Canal 360

The Dominion of Canada

The Dominion of Canada 104

Fine Arts

The Rich Treasure That Is Ours . . 61
The Cave-Men and Their Pictures . . 189
The Artists of the Old Empires . . . 290

Contents of Volume I—continued

Literature

PAGE

Our Unwritten Literature 215
Men Who First Wrote English . . . 299

Famous Books

The Last of the Mohicans 266

Stories

Saint George and the Dragon . . . 53
The Story of Beowulf 55
The Wild Goat's Kid 201

Read-Aloud Stories

The Three Little Pigs 321
The Lambikin 323

Poetry

Indian Children 98
A Mortifying Mistake 98
Sea Shell 98
The Wonderful World 98
Thanksgiving Day 99
I Saw a Proud Mysterious Cat . . . 100
Grace for a Child 100
Seven Times One 100
Taxis 101
Armies in the Fire 101
A Boy's Song 101
A Child's Thought of God 102
Travel 102
A Swing Song 103
The Duel 103
Lullaby 223
Baby 223
The Children's Hour 223
Shuffle-Shoon and Amber-Locks . . 224
A Gaelic Lullaby 224
A Parental Ode to My Son 225

Poetry—continued

PAGE

The Barefoot Boy 226
Only a Baby Small 228
Lullaby of an Infant Chief 228
Norse Lullaby 228

Read-Aloud Poems

The Old Woman and Her Pig . . . 325

Golden Deeds

The Beloved Physician 229

Men and Women

Men Who Made the World Known . 79

Things to Make and Things to Do

Telling stories by means of sticks . . 129
The boy carpenter's box of tools . . 130
A useful paper-knife made of wood . 132
A circus party 231
Dolls of all nations 232
An elephant made of black-walnut shells 234
Making designs with a lollypop stick . 335
How to paint with stencils 336
How to use a needle 337
How to make and play jump-peg . . 339
Jelly children can make 339
How the sailor ties his knots 340
Build a house for your favorite bird . 342

Colored Plates

The Space No Man Can Measure . facing 17
The Everlasting Glory of Art . . . 65-72
The Animals Most Like Man . . 209-212
The Color of the Ancient Empires . 293-296

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LAWRENCE K. ROSINGER, A.B., A.M.
Foreign Policy Association — *India; Burma*

BEATRICE SCHWARTZ, A.B.
Bayard, The Flower of Chivalry

EMMA SENA, A.B.
Editorial Assistant, P. F. Collier and Son
American Colleges and Universities
The Men Who Gave Us Schools

GEORGE N. SHUSTER, PH.D.
President, Hunter College, New York
The Story of Germany

ELEANOR BOOTH SIMMONS
Expert on Cats, New York Sun
Domestic Cats

HALLETT D. SMITH, PH.D.
Williams College, Williamstown, Mass.
From Chaucer to Shakespeare
The Works of William Shakespeare
Shakespeare's Fellows

HARRIET SMITH, A.M.
Assistant Professor Geography, Sam Houston State Teachers College, Texas
The Southern States

ALBERT SONNICHSEN
Author and Journalist
When the Fire Alarm Rings

ALEXANDER J. STODDARD, ED.D., L.H.D., LL.D.
Introduction

GERALD E. TAUBER, A.B.
Assistant in Physics, University of Minnesota
The Pressure of Liquids and Gases
Light and How It Behaves
Color and What Makes It

R. BRUCE TAYLOR, A.M., D.D., LL.D.
Formerly Principal, Queen's University. Author, Ancient Hebrew Literature; etc.
The Book of Canada

HOLLAND THOMPSON, PH.D., LL.D.
Late Professor of History, The College of the City of New York; sometime Lecturer in History, Columbia University. Author, from Cotton Field to Cotton Mill; The New South; The Age of Invention, etc.
American History and Civics

L. ROBERT TSCHIRKY, A.B.
Paleontology

AMY VANDERBILT
American Spice Trade Association
Spice Plants

HERBERT T. WADE, A.B.
Formerly Editor, New International Year Book — *Adviser on Physics and Electrical Engineering*

ETHEL B. WARING, PH.D.
Professor of Child Development and Parent Education, Cornell University
Helps to Learning

SIMON WEISSMAN, A.M., M.S. (Ed.)
Teacher of Physics and Engineering, Brooklyn Technical High School
Force, Work, Energy, Power
How Heat Works for Us

BERTRAM W. WELLS, PH.D.
Professor of Botany, North Carolina State College of Agriculture and Engineering
Wild Flowers of the South

GERALD WENDT, PH.D.
Science Writer and Lecturer; formerly Professor at the University of Chicago and Dean at The Pennsylvania State College
Synthetic Rubber

WILLIAM C. WHITE, E.E.
Director of the Electronics Laboratory, General Electric Company
The Magical Electron Tube

PHYLLIDA M. WILLIS, A.M., PH.D.
Wellesley College, Department of Chemistry
Metals and Non-Metals

S. T. WOOD
Commissioner, Royal Canadian Mounted Police, Ottawa
The Royal Canadian Mounted Police

WALLACE A. WORSLEY, JR.
Assistant Director, Metro-Goldwyn-Mayer Studios — *Motion Pictures*

FRANK ZAIC
Editor of Model Aeronautical Publications
Model Airplanes

DOROTHY F. ZELIGS, A.B., A.M., B.E.
Author, A Child's History of the Hebrew People; A History of Jewish Life in Modern Times; etc. — *The Story of the Jews*

A FEW OF THE ARTISTS AND ILLUSTRATORS

CONSTANTIN ALAJÁLOV
Illustrator of Cinderella, Our Hearts Were Young and Gay, and other books; murals and magazine covers
Poetry

GEORGE AVISON
Author and illustrator of Winds of Chance, and other books; mural painter
Golden Deeds

MARGARET AYER
Illustrator of Anna and the King of Siam, and numerous other books
Literature, Poetry, Stories, Wonder

ALPHONSE BARE *Poetry*

JEANNE BENDICK
Writer and illustrator of books for children
Wonder

THOMAS HART BENTON
Fine-arts Painter; illustrator of Life on the Mississippi, and other books
Folk Songs

GRAHAM BERNBACH
Illustrator of Last Semester, and other books
Poetry

EDNA L. BEUTENMULLER
American Butterflies

ELINORE BLAISDELL
Illustrator of Little Men, Little Women, Lamb's Tales from Shakespeare, and other books; winner of the Julia Ellsworth Ford Foundation Prize, 1939
Famous Books, Poetry, Stories

VIVIENNE BLAKE
Illustrator of The Alphabet from A to Z, and other books
Famous Books

ELSE BOSTELMANN
Illustrator of Sea Horse Adventure, and of marine life, animals, fish, flowers; artist for the Beebe Expedition
Animal Life

MAURICE BREVANNES
Illustrator, The Treasure Bag and other books
Poetry

MAJOR ALLAN BROOKS *Western Birds*

MABEL BROOKS *Science*

LEE BROWN COYE
Book illustrator and mural painter
Poetry

JAMES CUTTER
Illustrator of technical subjects for Newsweek and other magazines
Science

JAMES DAUGHERTY
Illustrator of Abraham Lincoln, Daniel Boone, and other books; winner of Newbery Medal, 1940
Poetry, Stories

MORGAN DENNIS
Author and illustrator of Himself, Burlap, and other dog stories
Famous Books

PELAGIE DOANE
Illustrator of Nursery Songs, Tell Me about God, and other books
Stories

LLOYD DOTTERER
Illustrator of Slappy the Circus Seal, and other books
Poetry, Wonder

VICTOR I. DOWLING
Illustrator of Joey Goes to Sea, and other books; winner of the Suydam Silver Medal
Poetry

ANNE-MARIE DRUTZU
Illustrator of Rosanna *Wonder*

ROGER DUVOISIN
Author; illustrator of Mother Goose, A Child's Garden of Verses, and many other books. In American Library Association's Exhibit of nine best books of the year, 1937; Caldecott Medal, 1948
Poetry

OLIVE FISCHER
Illustrator of medical textbooks; staff artist of New York Hospital for Joint Diseases
Our Own Life

RICHARD FLOETHE
Illustrator of Picture Book of Astronomy, Robinson Crusoe, and other books
The Earth

RUDOLPH FREUND
Illustrator of Moths and Butterflies, American Garden Flowers, and other nature books; murals at American Museum of Natural History, New York
Poetry

ALMA FRODERSTROM
Illustrator of The Wonderland of Science, and other books
Animal Life, Wonder

FREDERICK FUGLISTER
Mural painter and staff artist of the Oceanographic Institute, Woods Hole, Mass.
The Earth

ARTISTS AND ILLUSTRATORS

WANDA GÁG
Author and illustrator of Millions of Cats, and many other books
Stories

BERTA and ELMER HADER
Writers and illustrators of Picture Book of Mother Goose, Midget and Bridget, The Big Snow, and numerous other books for children; Caldecott Medal, 1949
Stories
Introductions

RAY L. HERMAN
Staff artist, Everybody's Weekly; artist for Fels Planetarium, Philadelphia
The Earth

F. HUPPENBAUER
Vice-President, Hagstrom Company, New York
Familiar Things

ELIZABETH JAMES
Painter of murals, costumes for theatrical pageants and illuminations on vellum
Poetry, Stories

MARIE LAWSON
Author and illustrator of Hail Columbia, Dragon John, and other books
Poetry

ROBERT LAWSON
Author and illustrator of Rabbit Hill; illustrator of Ferdinand, and many other books; winner of Caldecott Medal, 1941; Newbery Medal, 1945
Poetry

JAMES MACDONALD
Illustrator of Audubon, Ghosts of London, and other books
Poetry

THOREAU MACDONALD
Illustrator of Maria Chapdelaine, and other books
Canadian Poetry

LOIS MALOY
Illustrator of Star Wish, Wooden Shoes in America, and other books
Poetry

LUCILE PATTERSON MARSH
Illustrator of magazine articles and magazine covers
Science

FREDERICK MASON
Staff artist, American Museum of Natural History
The Earth

CONNIE MORAN
Illustrator with Diana Thorne of Cats and More Cats, Looking for Lucky, and other books
Little Verses, Stories

DOROTHY BAYLEY MORSE
Illustrator of Stars to Steer By, Julia Ann, and other books
Science, Stories, Poetry

ROBERTA PAFLIN
Illustrator of Tales from Grimm, Little Thunder, and other books
Poetry

FRANK R. PAUL
Illustrator of technical subjects
Wonder

HENRY MOORE PICKEN
Illustrator of children's books
Poetry, Science, Stories, Wonder

HENRY PITZ
Illustrator of Princesses and Peasant Boys, The Tale of the Warrior Lords, and many other books for children; director of illustrations and decoration in Pennsylvania Museum School of Industrial Art
Poetry

EDOUARD SANDOZ
Famous Books, Wonder

ARNO SCHEIDING
Art Director; industrial designer with Russel Wright and Norman Bel Geddes; former teacher, Laboratory School of Industrial Design, New York
Familiar Things

ELLEN SEGNER
Illustrator of Gulliver Joins the Army, Molly and the Tool Shed, and other books
Stories

HELEN SEWELL
Illustrator of Once There Was a Little Boy, Boat Children of Canton, and numerous other books
Poetry

WILLIAM SHARP
Illustrator of Leonardo—Master of the Renaissance, The Moonstone, and other books
Poetry

HARRY STERNBERG
Poetry

DORIS STOLBERG
Illustrator of Little Dutch Toyland, Fairy Tales, and other books for children
Poetry, Stories, Wonder

ARTISTS AND ILLUSTRATORS

DAN SWEENEY
Illustrator of books; artist for Fortune magazine
Poetry

SALLY TATE
Illustrator of The Wooly Lamb, The Gingerbread Man, and other books
Poetry, Stories

CATHARINE TAYLOR
Illustrator of Puppies and Kittens, Sleepytime Tales, and others
Poetry

DIANA THORNE
Author and illustrator of Dog Basket, Cats As Cats Can, Major and the Kitten, and many other books
Poetry, Stories

L. ROBERT TSCHIRKY
Maps

ROGER VERNAM
Illustrator of Drawing People for Fun, Jungle Animals, and other books
Our Own Life, Poetry, Stories

THOMAS W. VOTER
Illustrator of The Wonderland of Science, and other books; painter of murals; Director of Art, American Museum of Natural History, New York
The Earth, Wonder

LYND WARD
Illustrator of The Innocent Voyage, The Cat That Went to Heaven, and many other books
Poetry

ERIKA WEIHS
Illustrator of Hello, I'm Adeline, and other books
Poetry, Wonder

KURT WIESE
Illustrator of The Jungle Books, Ping, Young Fu of the Upper Yangtze, and many other books for children; winner, International Des Arts and Techniques, Paris
Stories

GARTH WILLIAMS
Painter of murals; portrait painter; illustrator of Stuart Little, and other books; winner of Prix de Rome for British Empire, 1936
Stories

JAMES PERRY WILSON
Staff artist, the American Museum of Natural History, New York; painter of habitat groups
The Earth

HARRIET WOLPIN
Illustrator of Mother Goose Collection, and other books
Poetry, Stories

Those Who Wonder Shall Reign

IT IS NATURAL FOR HUMAN BEINGS TO WONDER, and those who wonder most and who also wonder about the most worth while subjects are very apt to reign. That is, they are very likely to live the most satisfying lives; and others will look to them for leadership.

It is because men have wondered and searched for knowledge and passed on what they learned that we have built such a marvelous civilization. As you know, recording knowledge and passing it on from one generation to another was not always easy to do. In fact, there were times long ago when civilization stood still for thousands of years at a stretch, when generation followed generation without change, as one day follows another on the silent wastes of a changeless desert. Really, when one stops to think about it, the storing up of knowledge and putting it into words and pictures that are easy to understand is a marvelous accomplishment. Probably our ability to do that is one of the greatest differences between human beings and other forms of life.

As people grew in their ability to pass on an ever increasing proportion of what they knew, knowledge increased by leaps and bounds, until today there is so much to know that no one person can master it all in a lifetime. So each person must pick and choose and try to learn what he believes will be most useful and interesting to himself. All of us will learn some things in common, but there will always be individual preferences that make life more fun because of its variety. A good encyclopedia, such as THE BOOK OF KNOWLEDGE, helps us to choose the more valuable things to learn. Even so, we would gasp if we thought we had to learn everything at one time. But the good thing about such books is that we do not have to take what they have to offer all at once.

This desire to know is born in us. Some may have more of the wonder spirit than others, but most of us have enough if we will only develop what we have. One interesting thing about knowledge is that it "snowballs," that is, as we ac-

quire knowledge it becomes easier and more interesting to get more and more knowledge.

The purpose of the schools is to give to every person, as far as it is possible to do so, the key to great riches. Every one of us at birth has waiting for him a rich inheritance of knowledge that is worth all the gold in the universe. Yet this inheritance can be claimed only by those who will prepare themselves to be worthy of it.

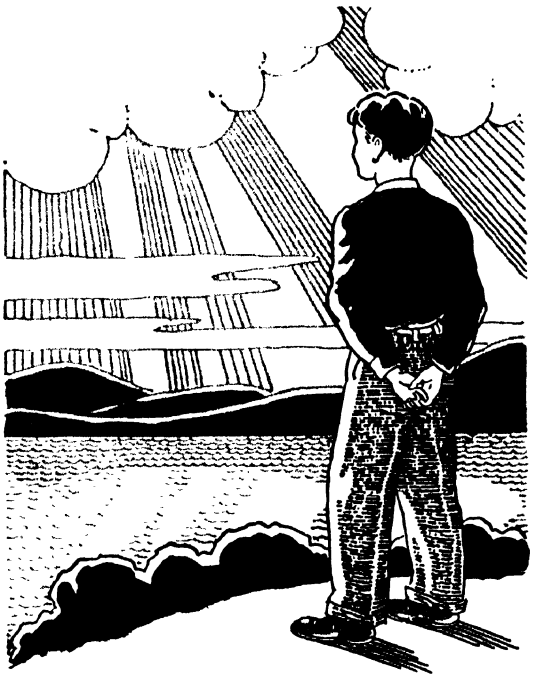
Merely dotting our land with buildings that point their spires heavenward, or hanging the masterpieces of art on our walls, or making countless books available through a thousand libraries, or bringing the drama of the ages into every city, village and hamlet, or making the great music available to all—these things will not bring happiness by themselves.

Only those who have mastered the skills of interpreting, who have learned the meanings of the various languages through which the messages are spoken, who have attuned their eyes and ears, their thoughts and their feelings, to catch the messages that are all about us like the unsensed and uncaught radio waves which in the dead of night flood the world, only those can expect to succeed in the age-old quest for happiness. While the possession of knowledge does not guarantee happiness, it may raise considerably the amount and quality of happiness. Ignorance is not bliss.

Our teachers can help us to find the storage places of knowledge, they can help us develop the skills to unlock the treasure chests, but each one of us must actually do the unlocking for ourselves. There may be classrooms or homes where this or any other encyclopedia gets lonesome on the shelves, because these volumes, beautiful though they are, can beckon to us but can not compel us to use them. One of the sad sides of life is that in trying to guarantee to people the right to learn, we must also grant them the right not to learn. THE BOOK OF KNOWLEDGE makes the pursuit of learning a pleasant task, but it can not do the actual learning for us. We are glad that this is so, because the search for knowledge, the satisfaction of "I wonder what and where and when and why and how" is great fun all through life, from earliest childhood to old age.

As far back as my boyhood days certain experiences have produced strange feelings that I could not understand. Sometimes it was a gorgeous sunset, or a view off across the ocean, or a cloudburst in the Rockies, or the sight of billowy white clouds from an airplane window, or the stars sparkling in a brilliant winter sky.

I have this feeling when I look through the thousands of pages of this encyclopedia. Even one volume contains so much that I had not known before! The knowledge that has been accumulated through the ages is as vast as the ocean, as high as the sky at night. No encyclopedia can include all knowledge because the total amount is so vast that only a small part of the whole can be put into a set of books. What I like especially about THE BOOK OF KNOWLEDGE is that evidently the greatest care has been taken to select that knowledge which a large number of very wise people have found to be useful and interesting.



No one can ever acquire more than a small part of all knowledge. But this encyclopedia places at our command so much information that time and our own desires are the only limitations to what we may know. What is almost equally important is the manner and form in which the information is given. The old statement that truth is stranger than fiction may be an exaggeration, but even a partial reading of these volumes will give abundant evidence that facts and knowledge can be made as interesting, or even as thrilling, as stories.

Books are far more attractive now than when I was a boy. THE BOOK OF KNOWLEDGE is good to look at on a shelf; but take down a volume and open it at almost any point and the pages that lie before you are so appealing that you immediately begin to read. We all like pictures. The pictures in these books are a story in themselves. Browse through a volume just looking at the pictures and you will get a lot of satisfaction. But the pictures are so much a part of the whole text that one finds himself led irresistibly into reading. Few books balance the reading and pictorial materials as skillfully as it is done in these volumes.

That leads me to say a word in conclusion about the last volume, which is the index to THE BOOK OF KNOWLEDGE. If you would make the best use of this great storehouse, you should first acquire skill in using the set as a whole and in using all of its parts. While it is good fun just to browse through book after book, picking up first one and then another at random, an important purpose of this encyclopedia is its use as a reference book. Therefore, study the last volume very carefully, because it is the key to the whole treasure chest. Teachers and parents will do well if they will urge the young people to become skillful in using the index volume as one uses a timetable or a road map when going on a journey.

Happy hunting to you as you travel through this entrancing BOOK OF KNOWLEDGE!

Alexander J. Stoddard

Superintendent of Schools
Los Angeles, California

A Unique Aid in Elementary Education

Books should to one of these four ends conduce:
Wisdom, piety, delight or use.

—Sir John Denham

IN INTRODUCING THE BOOK OF KNOWLEDGE as a unique aid in elementary education, the first thing that comes to mind is the esteem in which it is held by millions. Among them are many adults who credit much of their life-long love of reading to the happy hours they spent with THE BOOK OF KNOWLEDGE in childhood. Many experts—teachers, and librarians—rank the set highest as a work of science, but it will be treated here as an unparalleled work of art. This is done deliberately in the belief that what children are learning to love, when they read, is more important than *what* they are learning.

Those of us who grew up with THE BOOK OF KNOWLEDGE think of it as something which delighted us in childhood. We may not remember everything that we learned from it, but not one of us will forget the thrill that came with each reading. Its scientific and historic facts were wonderful. That they were carefully arranged in logical order never occurred to us. We learned from THE BOOK OF KNOWLEDGE without knowing that we were learning. Through its many stories and pictures, we moved enchantedly in our world of make-believe. Each article or picture was personalized for us by delicious differences. That is why THE BOOK OF KNOWLEDGE is perhaps best remembered for its magic power to educate while entertaining.

While granting that THE BOOK OF KNOWLEDGE has a magic potency, children prefer to think of it as a friend, learned in the sciences, distinguished in literature and art, and always a wonderful story-teller. They like it most for the way it

sets forth, in colorful words and pictures, countless facts about a wondrous world, all told in delightfully simple story-form. They may turn to it, as directed by the index in Volume 20, for help with a school assignment, only to find their attention captured by another subject, when the school work has been done. This extension of the reader's interest beyond the information required at the moment is brought about by wisely closing every leading article with a sentence that points like an arrow to its next of kind. It is also due to the skill with which irresistible pictures and gripping titles are combined to entice him to explore the article immediately following the one he has just read.

In its sheer power to delight children lies, I think, the greatest value of THE BOOK OF KNOWLEDGE. Rarely, indeed, are whole sets of books endowed with such power. Other reference works for children attain it to a degree corresponding with their willingness to break up the mechanically alphabetical continuity of their arrangement. But THE BOOK OF KNOWLEDGE has always held to the sound psychological arrangement appropriate for juveniles, yet providing a kit of tools (indexes) adequate for unlocking any particular door to knowledge. They may choose to browse through a series of pictures that tell a story of industry, or plant life. They may read a chapter of history. Or, in more active mood, they may follow a constructive idea in the department of Things to Make and Things to Do.

THE BOOK OF KNOWLEDGE is unique because it is a reference work intended to operate as a power-house and not as a storehouse. Only a small part of its power for good is realized if it is used for reference merely. It is not satisfied to play the passive rôle customarily assigned to encyclopedias in libraries or schools. It does not wait for those occasions, very rare in the life of a young child, when fact-finding is more important than fact-gathering. On the contrary, it beckons. Children who have once glimpsed its wonders go to it again and again, of their own accord, and as often as they have time to do so.

Now, I think you will understand why I interpret THE BOOK OF KNOWLEDGE in terms of the creative faculty of delight from which spring wisdom and nobility. Such an interpretation liberates it from some of the restricted uses associated with reference works, and gives to it a place in every library or schoolroom comparable to that which it holds in the homes of the privileged children whose parents have made it available.

Leonard Power

The Purpose and the Plan

LEARNING IS EASY WHEN IT IS INTERESTING. One of the aims of THE BOOK OF KNOWLEDGE is to make a vast amount of the world's store of knowledge interesting and therefore easy for young people to learn and to remember. Open a volume, any volume, at any page. It is almost sure to hold your attention and to tell you something you had not known before.

This is no happy accident. The editors have planned for it most carefully and they have had the aid of many scholars, writers, illustrators and other experts. We give you the names of some of these men and women in the list of contributors in the front of this volume.

THE BOOK OF KNOWLEDGE began many years ago. Some of the children who had, and loved, the first edition are today grandparents. You who treasure today's bright, modern set owe a good deal to those little boys and girls of long ago, for they showed that THE BOOK OF KNOWLEDGE idea was right. They proved that THE BOOK OF KNOWLEDGE plan charms and educates. They took to THE BOOK OF KNOWLEDGE so instantly that a second edition was soon printed, and a third, and a fourth, and many more. Translations were made into French, Spanish, Italian, Portuguese—even into Chinese! For almost forty years the printing presses have been busy turning out sets of THE BOOK OF KNOWLEDGE for millions of boys and girls. Every printing has contained revisions. New stories, new articles, new pictures, even new departments have appeared, in place of material no longer timely. That is how THE BOOK OF KNOWLEDGE has remained young. If you should see one of the early sets you would probably not recognize it as the grandparent, or rather the great-great-great- and many another great-grandparent of THE BOOK OF KNOWLEDGE.

Yet, as certain traits may come down in a family for generations—red hair or blue eyes or long fingers—there is still a family resemblance between the first BOOK OF KNOWLEDGE and this one.

The information is still presented in departments, and within each department its story of knowledge is told, step by step, in proper reading order. Articles are still long enough to round out topics, yet short enough to hold a young reader's attention to the end.

There is an old Chinese proverb which says "A good picture is worth 1,000 words." The first edition of THE BOOK OF KNOWLEDGE contained 10,000 illustrations, many of them drawn especially for the book by talented artists. These pictures showed life in other lands, explained what was known about the universe, and cut machinery open to reveal what went on inside. Today most of

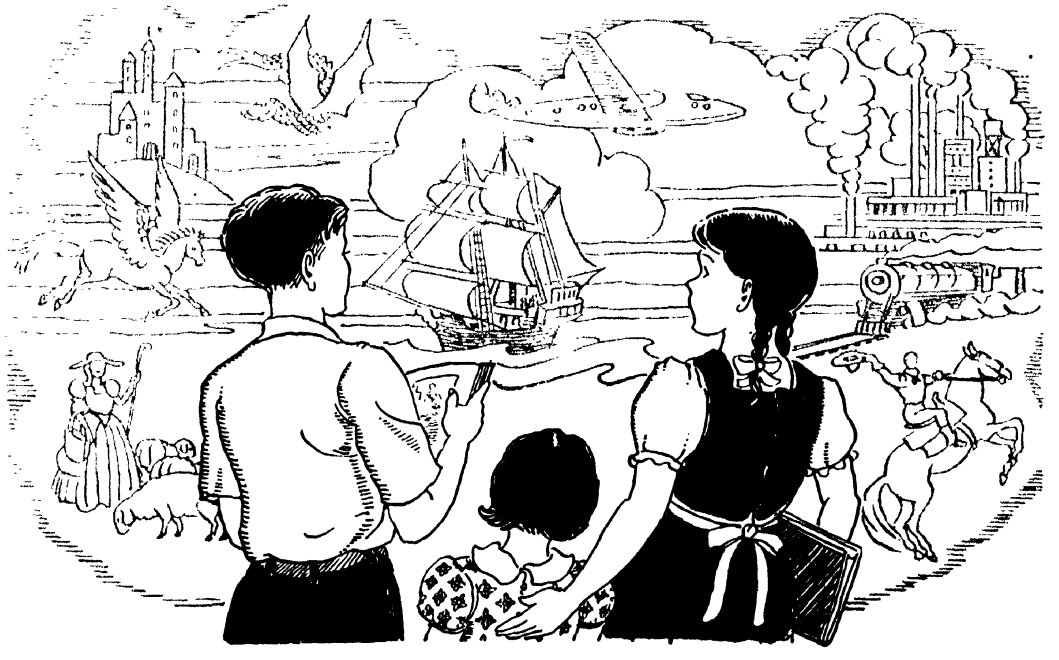
those pictures would look strange and historic to a child. In today's BOOK OF KNOWLEDGE there are 15,000 modern illustrations—photographs, drawings, charts, pictures in color, in gravure and in black-and-white, marvels of present-day photography, drawing, painting and engraving. They take you on fascinating trips over land and sea, and even to the mysterious worlds beneath the oceans, and out into the far reaches of the starry heavens. They show the growth of a flower from seed to fruit, layers of the earth's crust, an atom of U-235 exploding. They picture animal life, and science. They take you through great manufacturing plants. There are hundreds of reproductions of famous masterpieces of art; and there are hundreds of illustrations of stories, poems and famous books drawn for THE BOOK OF KNOWLEDGE by artists of renown. Pictures and diagrams guide you in hobbies, handicrafts and games. The pictures are indexed.

The first edition of THE BOOK OF KNOWLEDGE contained an introduction by a wise and thoughtful man, a man who by his lifetime efforts put forward the cause of education. In his introduction occurred this paragraph:

> "Suppose a boy of ten were to spend fifteen minutes a day in reading these pages . . . he would at thirteen know more about the earth and the life on it than the wisest man knew a few generations ago."

Your editors believe that those words are strikingly true of your BOOK OF KNOWLEDGE today.

The Editors



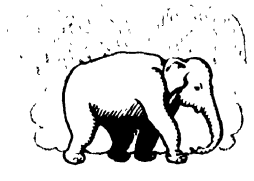
The Eighteen Departments of The Book of Knowledge

The Earth . . . The wonderful ball on which we live, its core and its crust, its seas and rivers and its airy envelope. Climate, wind and weather. Soils and crops. Volcanoes, earthquakes, geysers, glaciers, underground caves. The tilt and motions of the earth that give us day and night, and the seasons. That bright star, the sun, around which our earth revolves, and the other planets that are also whirling around the sun. Our moon and the tides. Eclipses. Comets, meteors and star dust. The starry dome of the heavens. The pictures in the sky that we call constellations. The mysterious cosmic rays that forever bombard us. The zodiac. The Milky Way. Nebulae. Atom-smashing in the universe. The fathomless depths of space, and the countless universes that appear to be running away from us. The astronomer's wonderful instruments by which he gets a closer view of the heavens, measures the size and the weight of heavenly bodies, and tells what the stars are made of. A visit to an observatory. A visit to a planetarium. In short, *the story of land, air, sea and sky.*

Science . . . We are all scientists today, in a big or little way, for we live in a world of scientific marvels. The basis of modern knowledge in most fields is matter and energy—and in the Department of Science we give a background course in matter and energy that is easy to understand and interesting to read. The ninety-odd different kinds of atoms (the elements) of which everything in our universe seems to be made. A look inside the atom—electrons, protons, neutrons, smaller particles. The electrical balance that holds an atom together. How atoms combine to form molecules of substances very different from any of the combining atoms. How molecules herd together. Three states of matter, solid, liquid and gaseous. Pressure of liquids and gases. The great force we know as gravitation. How things are measured. How energy is

measured. Machines. What we mean by force, energy, light, heat, power, sound, growth. Light and how it behaves. Our sources of light. Color. Optical instruments. How the camera takes pictures. Sound. Acoustics—everyday sound. What electricity is, how we send it over wires, make it work, control it, measure it. How electric lamps are made. The wonders of electronics: radio, television, radar, other devices. Energy from the atom's core (atom-smashing and the uses we make of it). The many kinds of rays: X-rays, ultraviolet and infrared, the light we can see, other rays. What chemical behavior is, and what we owe to chemistry. The language of chemistry that is known around the world. How the different elements act—the metals, the non-metals, the radioactive elements. The carbon compounds that give us light, heat, power, plastics and a myriad other substances. The chemistry of life. Acids, bases and salts. Ions, colloids and dust —matter in small pieces. The theories of Albert Einstein. Lastly, a view down the road that lies ahead of us in science.

Step by step you are carried along this course, beginning with ideas easily comprehended, and leading up to those more advanced. The articles are by distinguished scientists from many universities and colleges and schools of technology—*men and women who have a genius for making scientific information interesting, for reference, for browsing.*

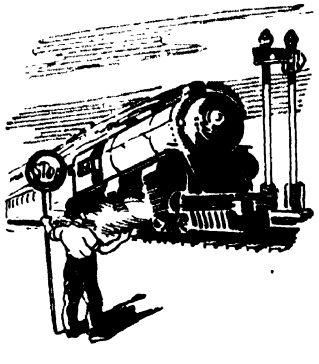


Animal Life . . . Nature's living family in earth and air and sea. Animals with backbones. Those with skeletons outside. Other forms of life.

Many chapters on mammals, the most complex animal forms, tell of the apes, the bats, the great group of meat-eaters (cats, dogs, civets, hyenas, weasels, bears, seals, walruses and their kin); the animals that gnaw and burrow; the families of plant-eaters (cattle, deer, sheep, goats, camels, pigs and others); strange mammals such as kangaroos, whales, animals in armor, mammals that lay eggs. There are more than twenty chapters on the families of birds. The reptiles and snakes are described; and the wonderful amphibians which spend part of their life in water and part of it on land; then the many fishes; the crabs, lobsters and their kin; the insect families; the mollusks, and the worms and other lowly creatures. Hundreds of pictures, some in the colors of nature, others in black-and-white. The chapters are arranged in scientific order beginning with the highest orders and ending with the lowliest. ***Natural history told accurately and entertainingly.***

Plant Life . . . The story of growing things in the great plant world, from the tiny, simple yeast spore to the biggest of trees. There are hundreds of pictures in the brilliant colors of nature, and in gravure. The families of plants are described. We learn how flowers are born, grow and scatter their seeds. We learn the many ways in which plants serve man, giving him foods, fuel, homes, clothing, giving him meat and leather and other products from animals that live on plants. How animal life, in turn, serves plants. *A clear working knowledge of the plant life of the world is acquired by the children who read these chapters.*

Our Own Life . . . The structure of our bodies and how to care for them—anatomy, physiology and hygiene. We read of food and its uses; the story of vitamins. We learn about the wonderful mechanism of our eyes and of our ears; our other senses are explained: smelling, tasting and feeling. Speech is explained, and how our minds work. In a separate division of this department the child learns how our lives are bound to the lives of others. The meaning of citizenship is set forth, and the wider citizenship which the atom bomb imposes. The reason for law is explained, and the principles of economics treated with a clearness which *brings these subjects within the grasp of the child's mind.*

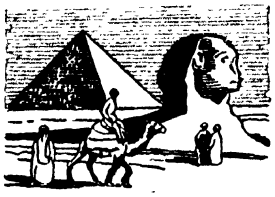


Familiar Things . . . The stories of the wonderful everyday things grownups so often take without a thought—commonplace to us but mysterious to the child until they are explained: trains, airplanes, ships; bridges and tunnels and roads; how we get silk, cotton, wool, linen, rubber, tea, steel, coal and oil; how we make glass, cement, paper, watches and clocks. The new inventions that may change all our lives, including television, nylon and synthetic rubber. How by-products are turned into riches. How we get power to turn the wheels of industry. How new industries are changing the face of the world. *The world of industry made plain.*

Literature . . . A history of literature that reads like a story. The great writings in the English language, beginning with Chaucer and others who first wrote English, and coming up to the present era. American literature, the writers of Canada. Literature of other countries. How the literature of a country reflects its place and its period of history. How the authors of these great books lived and wrote, what their influence has been upon the world and what they mean today. What each nation has contributed to the world's fine writings. *An outline of literature in simple form, guiding the child toward the best in books and reading.*

Stories . . . Fairy stories, folk stories, true stories, legends, historical stories, translated stories, stories from poems and plays, fables, stories of heroism and adventure on land and sea, old favorites, new favorites—stories! stories! stories! There is a generous selection of read-aloud stories for the parents or older children to read to the little ones at bedtime, or on rainy days. All have been chosen by an expert on children's reading. She has selected them with the aid of big and little groups of children *and the children have had the final vote on whether or not a story should go into The Book of Knowledge.*

Famous Books . . . Such classics as THE ILIAD, THE ODYSSEY, Chaucer's CANTERBURY TALES; Shakespeare; great novels by Dickens, Hugo, Dumas, Kingsley, Cooper, Scott and others are made familiar. In some cases we give the story of the book, along with a considerable extract in the author's own words. In the case of Shakespeare, we give two of Lamb's TALES, entire. The ILIAD and THE ODYSSEY are presented as gems from the world's treasure chest which the child is urged to read for himself; the articles in THE BOOK OF KNOWLEDGE serve to awaken his appetite, and point out some of the pleasure in store for him when he reads these great works. This, in fact, is the aim of the Department of Famous Books—to send the child to the library for the complete books, ***thus introducing him to the great masterpieces which are a part of his heritage of culture.***



All Countries . . . A bird's-eye view of many of the nations today; and the great events of the past. The slow, steady growth of democracy. Thousands of pictures, in gravure as well as in black-and-white make the story vivid. This is not a dry record of dates and names, but a *connected narrative, linking history and geography. The life, manners and customs of the different peoples. The growth of nations and of governments.*

The United States . . . First, a regional survey of the nation is given. Then historical chapters carry us from the first struggling colonies to the modern, powerful democracy of today. The great cities and their industries, the farming regions and their crops, the mines, forests and other natural resources are described and pictured. *The story of the United States, its people, its government, its history and its ideals.*

Canada . . . Our good neighbor, Canada, with its rugged mountain ranges and snow-tipped peaks; its vast prairies with their sheep and cattle ranches; its busy cities; its Royal Mounted Police; its distant northern lands, and the mineral treasures to be found there; its great fur industry; its far-flung railroads. *We read the story of the land from its settlement down to the present day; its marvelous natural resources; its industries; its people; its progress and great future.*

Wonder Questions . . . The child's active mind can ask enough questions to furnish the basis of a liberal education. A famous educator once said "The world is filled with brilliant children and boys and girls who fail to carry out the bright promise of their early years. This is a tragedy which ought not to happen." The Department of Wonder in THE BOOK OF KNOWLEDGE has much to keep alive the excitement and the delight of learning new things. Why is the sky

blue? How does a magnifying glass make objects look bigger? Where does the day begin? Why does heat make things shimmer? Why do some things shrink in washing? These and a thousand other questions are answered scientifically in simple words, with many pictures and diagrams to make the answers doubly clear. *This department leads the child through his own curiosity into many of the great fields of knowledge.*

Men and Women . . . In these chapters the children meet the great men and women whose names and work will never die. These biographies are in chapters that read like stories . . . the early star-gazers and the men who mapped the skies; the physicians who pushed forward the frontiers of medical knowledge; the long line of scientists to whom the world owes so much; patriots who advanced the cause of free government; thinkers; geniuses of literature; painters; sculptors; musicians; composers; architects; statesmen; explorers; inventors; teachers; doctors; soldiers; sailors; pioneers; kings and queens—*all of whom have left their mark upon the history of the world.*

Golden Deeds . . . Parents and teachers know that character education is best achieved through wholesome entertainment. In the Department of Golden Deeds, children derive practical inspiration from the stories of great deeds of kings and slaves, soldiers, wise men and little children—men and women in all walks of life. These true accounts of Golden Deeds picture many lands, many periods of history; and *through them all shine high ideals.*

Poetry . . . This is a truly remarkable collection of poems on many themes, in many styles, from many centuries. For the youngest children there are nursery rimes and little verses easy to learn by heart. For the boy or girl searching out a poem for recitation or scrapbooks, there are groups by subject—Home, Courage, Animals, Babies, Flowers, Friendship, Patriotism, Humor and so on. There are ballads and folk songs, story-poems and sonnets. Shakespeare, Milton, Dryden, Keats, Tennyson, Wordsworth, the

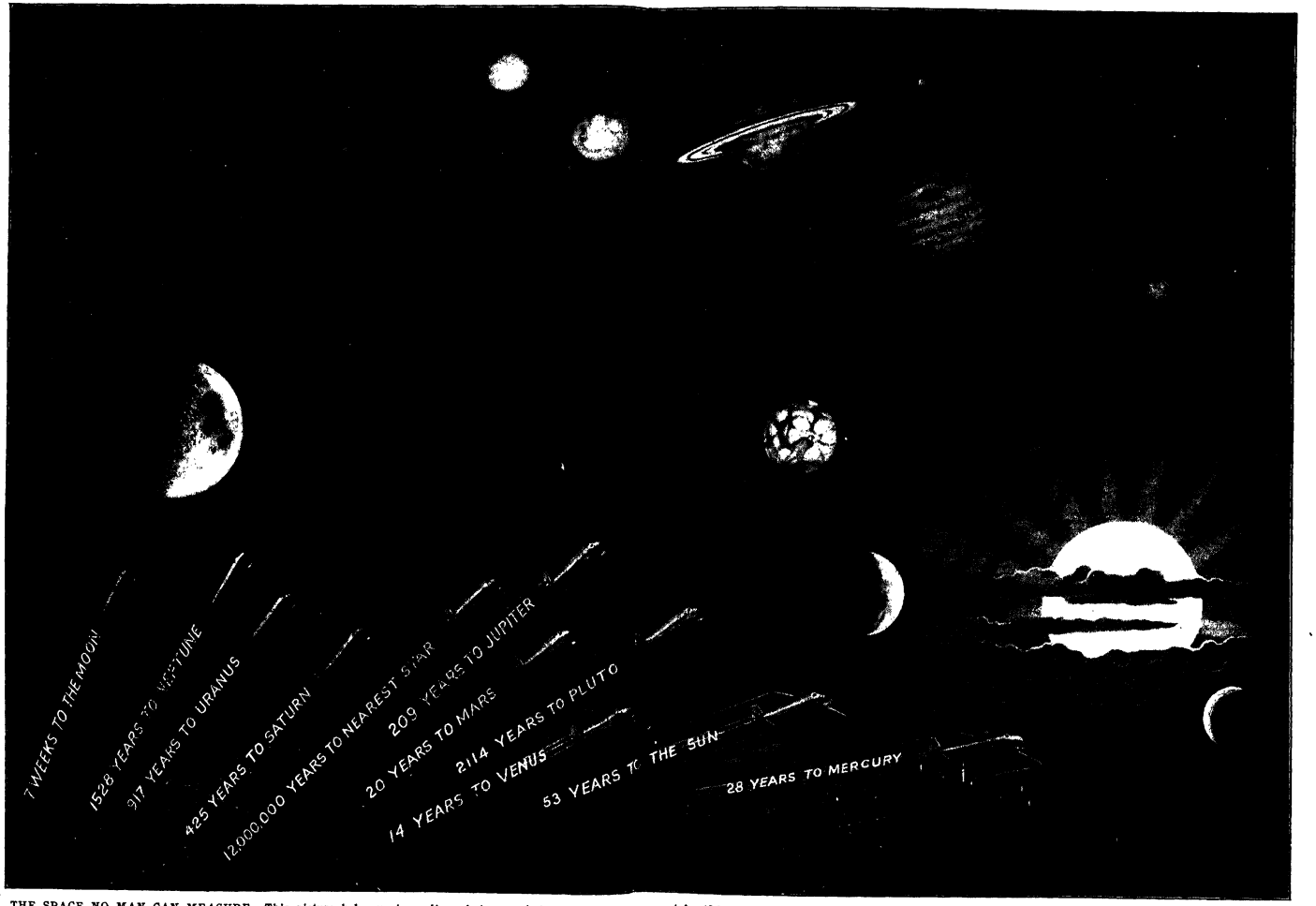
Brownings, Shelley, Moore, Hunt, Longfellow, Lowell, Whittier, Lanier, Walt Whitman, Emily Dickinson, Edna Millay, Edwin Arlington Robinson, Carl Sandburg and a host of other masters of the singing word are here represented.

The poetry is illustrated by some of our foremost artists and illustrators, including Thomas Hart Benton, Constantin Alajálov, Robert Lawson, Elinore Blaisdell, Henry Pitz, and others. *The hundreds of poems are indexed in Volume 20, by title and by author, and by first line and by subject.*

The Fine Arts . . . The history of man's achievements in the arts—painting, sculpture, architecture, music—beginning with the crude drawings scratched on the walls of the cave-man's shelters. The life and times of great artists. What we may see when we look at a great masterpiece; what we may hear when listening to great music. There are more than a thousand reproductions of treasured masterpieces in color, gravure and halftone. *The child becomes familiar with the best, and learns unconsciously to recognize true beauty.*

Things to Make and Things to Do . . . Hundreds of ways in which boys and girls may exercise their constructive ability profitably and pleasantly, together with games and puzzles for play hours. What a boy may do with his box of tools and what a girl may do with her needle and work basket; photography, stamp collecting, hockey, baseball, basketball, tennis. Indoor amusements such as dominoes, chess, games to play at parties. *The child, while amusing himself, learns to use his hands, to create, to carry out an idea.*

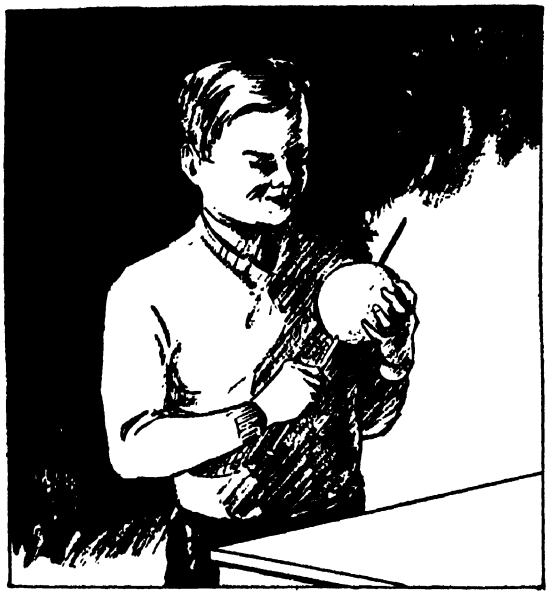
FLYING 12,000,000 YEARS TO THE NEAREST STAR BEYOND OUR SOLAR SYSTEM



THE SPACE NO MAN CAN MEASURE. This picture helps us to realize what our minds can hardly understand—the wonderful size of the universe. Even the slower airplanes today can fly at 200 miles an hour. Yet such an airplane, if it could fly continuously through outer space, would take 53 years to travel from the earth to the sun; and if it started from the earth for the star nearest our solar system it would take 12,000,000 years! In this imaginary picture we see a number of airplanes starting to fly into space, and the figures behind each give the time it would take, at 200 miles an hour, to reach the planets when they are nearest to the earth. This picture shows only our own solar system, and yet that system is only a tiny part of the Milky Way Galaxy; and there are many other galaxies stretching out into unimaginable space.

THE BIG BALL WE LIVE ON

IN this department of our book we are going to tell you about the earth on which all of us live. We shall describe its lands and its oceans, rivers and seas, the wonderful blanket of atmosphere that wraps the earth and helps to keep us comfortable in summer's heat and winter's cold. You may read why July is hot and January is cold in New York and Toronto, while in Melbourne and Buenos Aires the seasons are the other way round, with Christmas during the summertime.



Run a knitting needle through a grapefruit, where the top and bottom are flattened. Think of the needle as the axis piercing the crust at the Poles.

What the earth is made of, and what you would find if you could dig down inside to the very centre—these and hundreds of other questions we shall try to answer for you, in this and other chapters.

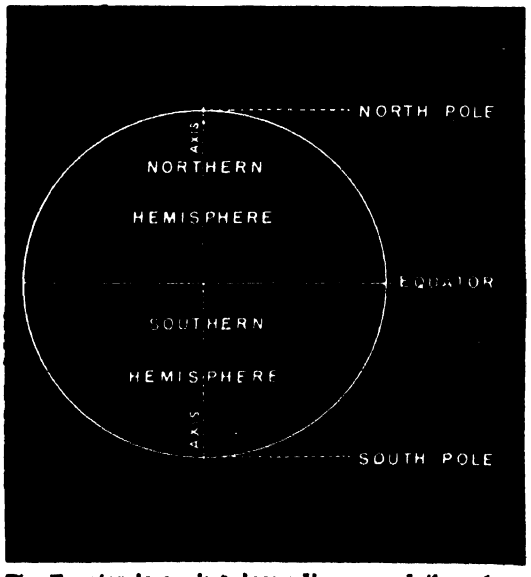
Look into the sky on a bright night. It is dotted with stars—about three thousand of them can be seen at one time; and many more can be seen with the aid of a telescope. And the hazy band of light across the sky, which we call the Milky Way, is also made up of stars. A great star that we do not see at night, but only in the daytime, is our sun. In this department we shall tell you also about the sun and the other stars, and about the moon which is not a star, though it seems to us to be so full of light. We shall tell you also about other moons, and about other planets which, like our earth, wheel around the sun.

If you could fly in an airplane far out in space, you would see the earth shining in the sky like a bright ball. We shall tell you why it shines, although, as you know, it has no light of its own.

Let us begin our story with the earth. In shape it is something like a ball, or sphere, or globe. It seems to us very large, but it is only a speck compared with millions of the other bodies in space. It is not a perfectly round ball but is slightly flattened at two places as if it were pressed between a giant's thumb and forefinger. Between the flattened ends it bulges a bit, as any ball would if it were pressed.

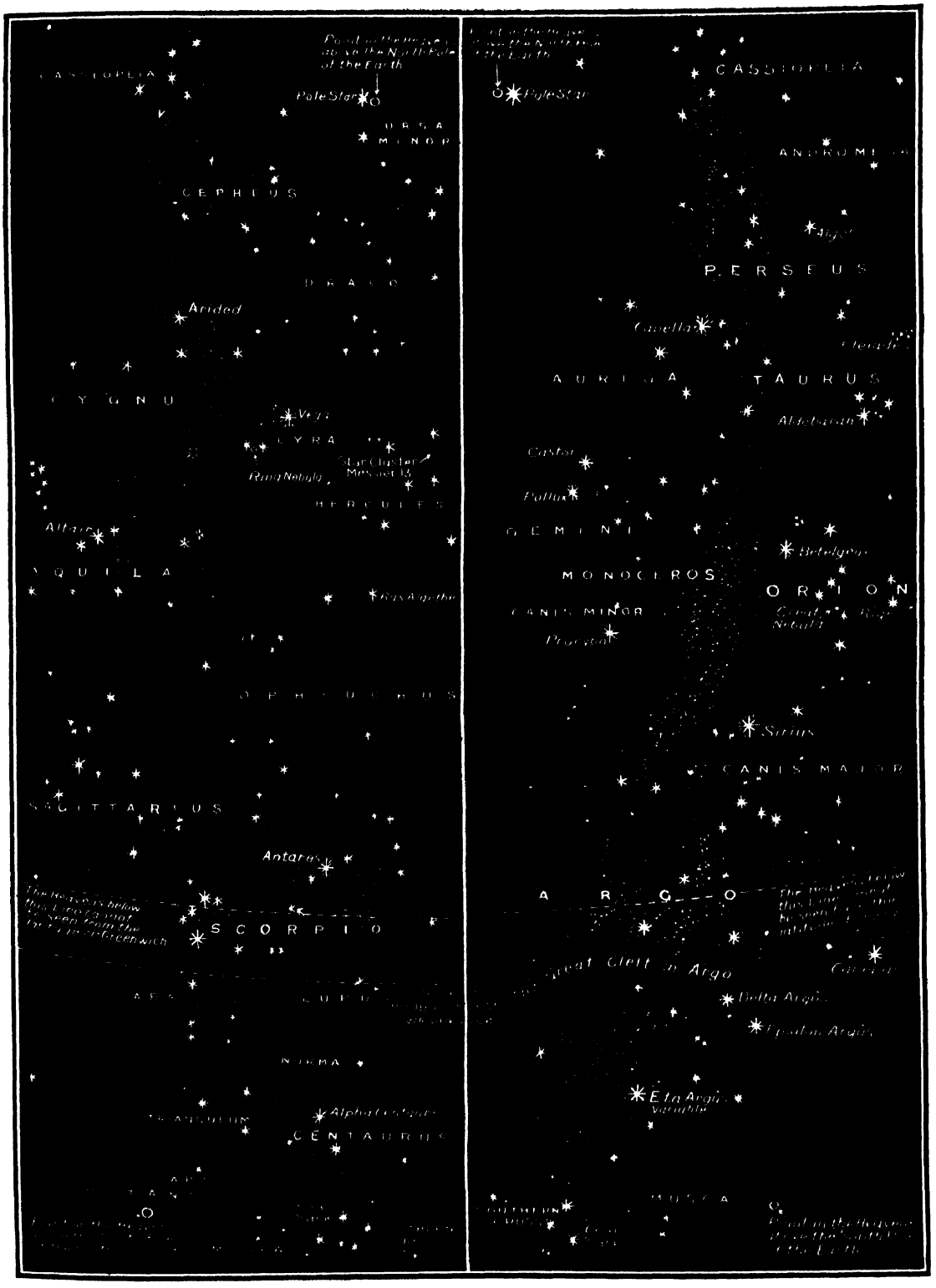
The very centres of the flat places we call Poles, the North Pole and the South Pole. If you force a knitting needle through a grapefruit so that the ends come out through the two flattened ends, the two ends of the needle might be called the North and South Poles. The needle would be the axis. Remember that word, axis. The line around the middle of the ball we call the Equator. It divides the earth into two equal parts; one half is north of the Equator; the other half is south of the Equator. We call these halves the Northern and Southern Hemispheres. We live in the Northern Hemisphere. The word hemisphere means half a sphere. Your grapefruit is cut in two at its equator when you eat it for breakfast. You eat one of the hemispheres. Of course there is no line drawn on the earth at the Equator any more than around a grapefruit's equator. On our maps and globes we draw lines which help us in our understanding of the earth's surface. The Equator is one of these helpful lines.

The earth's nearest companions in the heavens belong to the same family, the family of the sun. In the centre of this great family group is the sun, a bright, hot glowing star. Wheeling around the sun are nine bodies which we call planets. The name planets comes from the Greek word for wanderers. The earth is one of the nine planets. They have no light of their own, but the sun



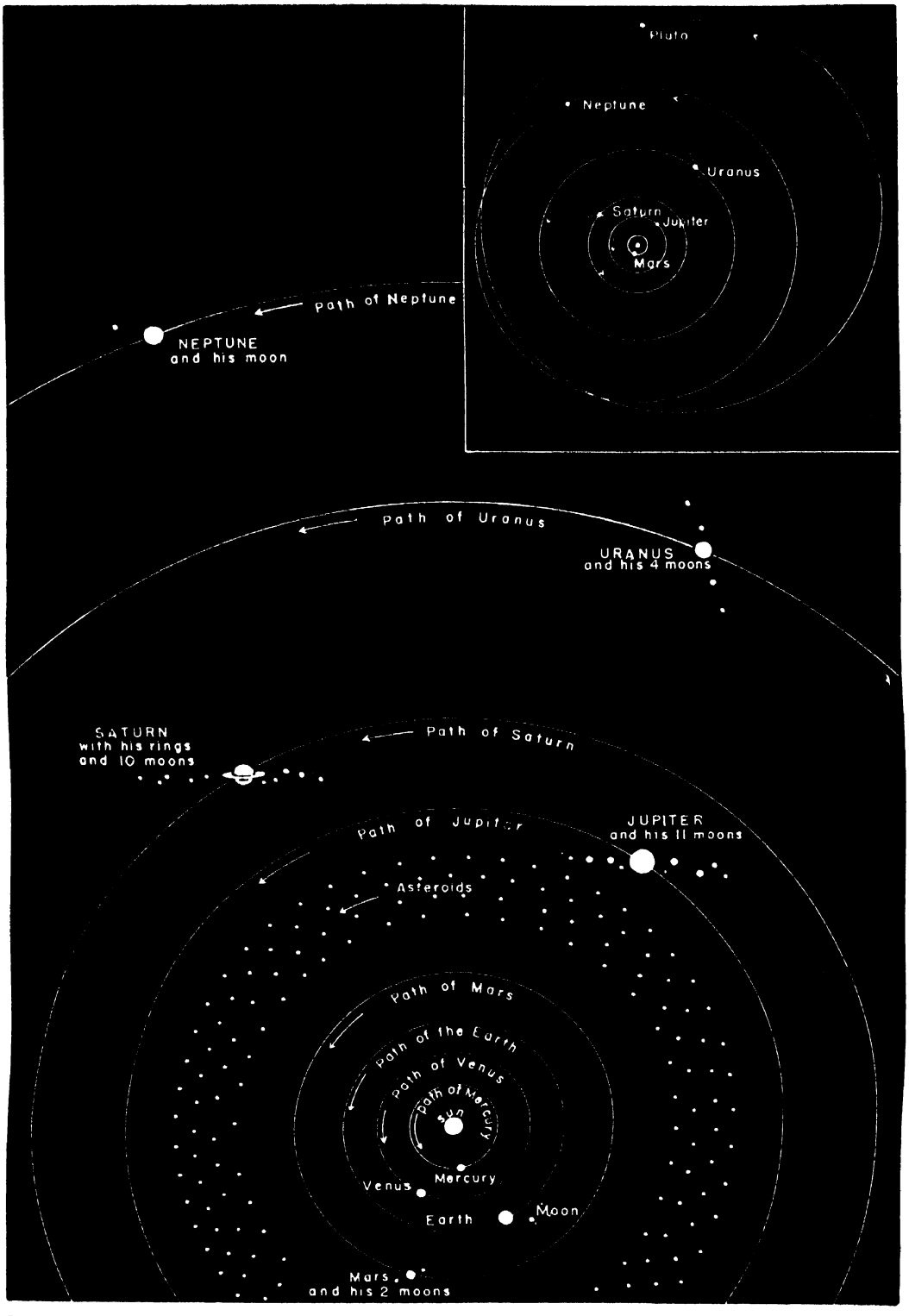
The Equator is an imaginary line around the sphere at its widest part. It divides the earth into a Northern and a Southern Hemisphere, or half-sphere.

THE MILKY WAY, POWDERED WITH STARS



The Milky Way, as we see it, looks like a ring of powdery light, with bright stars crowded around it and in it. Actually, it is the rim of a city of stars, of which our sun is one.

THE SUN AND ITS FAMILY



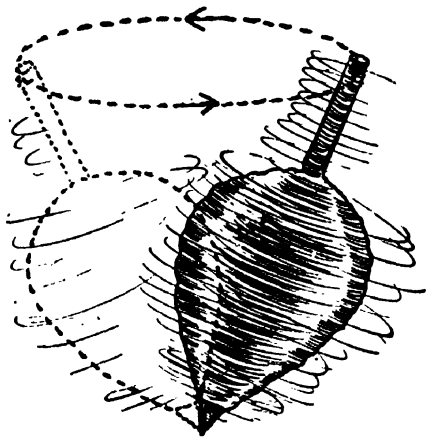
In the center of our solar system is a bright, hot star, the sun, around which revolve the nine planets, including the earth. Asteroids, comets and meteors also travel around the sun. Saturn was once thought to have ten moons, but now we believe it has nine. A fifth moon of Uranus was discovered in the year 1948.

shines upon them and they reflect the sun's light, as a mirror in a room reflects the light from a lamp. They have no heat of their own, but the ones that are near enough to the sun are warmed by it.

Some of the planets have moons which wheel around them. There are other bodies besides planets wheeling around the sun; asteroids, meteoroids and comets, and small bits and pieces of matter. All these—the sun, the nine planets and their moons, the asteroids, meteors and comets—make up the sun's family, or the solar system. Solar means "belonging to the sun."

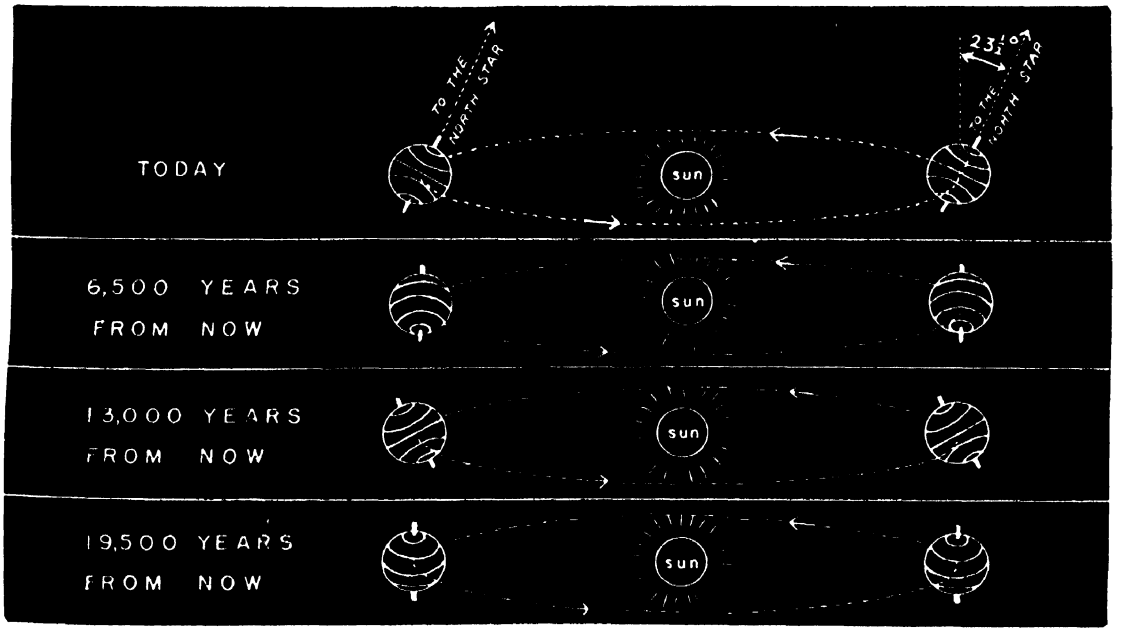
You must not think that most of the space occupied by the solar system is filled with heavenly bodies. Most of the space is empty. There are vast distances of nothingness between the members of the sun's family. Outside the solar system are millions of other bright stars and between them spread still greater empty stretches. The universe is immense, and most of it consists of lonely space. In the Department of the Earth we shall tell you more of the immensity of the universe, and of the stars. We begin our story with the solar system.

So then, the centre of our solar system is a great star, the sun, and around it whirl the sun's family of worlds, never stopping, most of them traveling forever in closed paths, so that they return and repeat their journeys. Some comets, however, return only after thousands of years have passed. All the planets travel in the same direction, like one-way traffic; but some of the moons of the planets go the "wrong" way round them, and many of the comets travel around the sun in the opposite direction, too. The motion of a body around the sun we call its revolution.



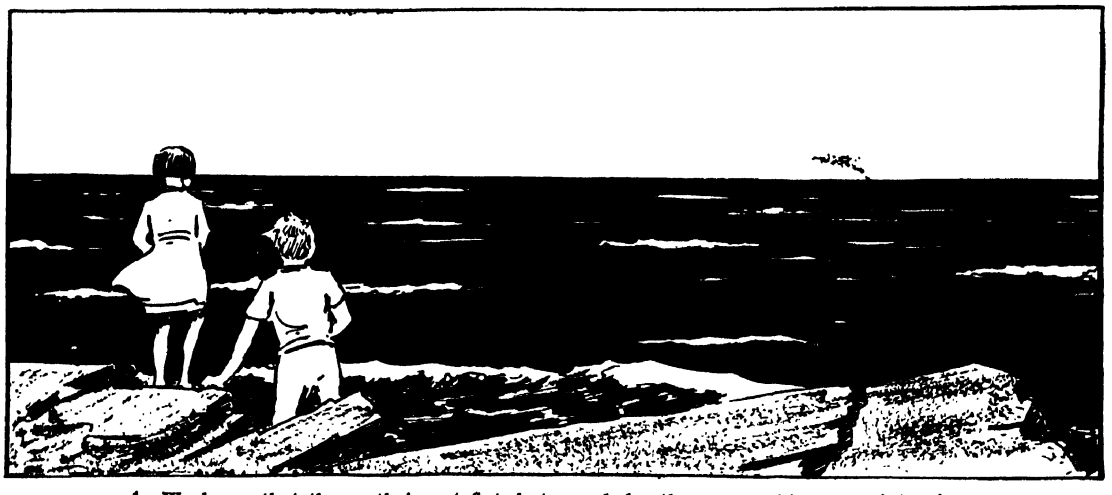
The spinning earth wobbles, somewhat as a spinning top does; but the earth's wobble is very slow. See the diagrams below.

The length of time needed for a planet to complete a trip around the sun is called its period of revolution. For the earth, the period of revolution is called the year; and it is a little more than 365 days. Planets near the sun have smaller orbits (paths) and they move faster; so they have shorter periods. Planets farther from the sun have longer orbits, and

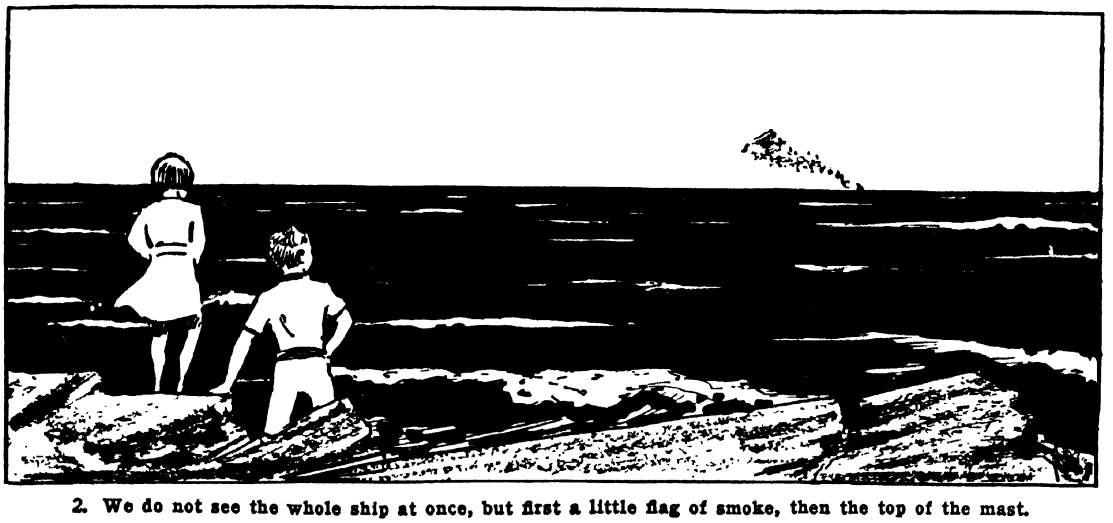


As our earth spins on its axis, it wobbles just a little bit, completing one entire wobble in a period of about 26,000 years. This period of time is known as the Great Year. The wobbling motion is called precession.

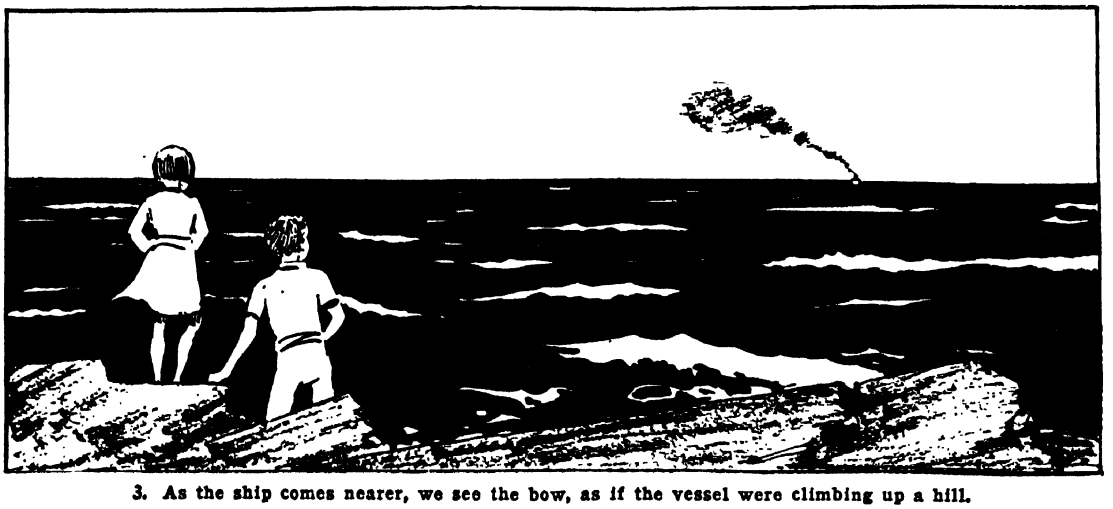
HOW WE KNOW THE EARTH IS ROUND



1. We know that the earth is not flat, but round, by the way a ship comes into view.



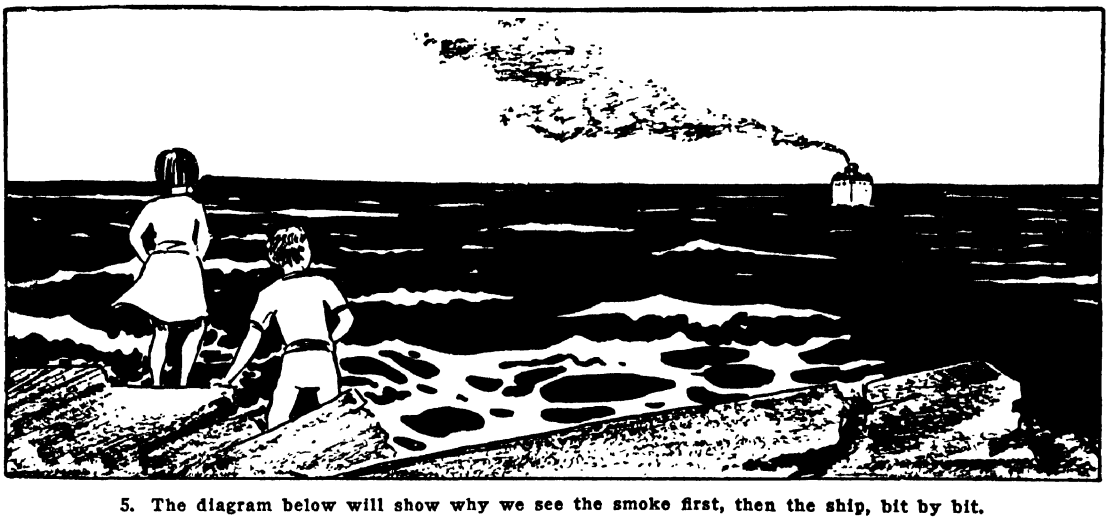
2. We do not see the whole ship at once, but first a little flag of smoke, then the top of the mast.



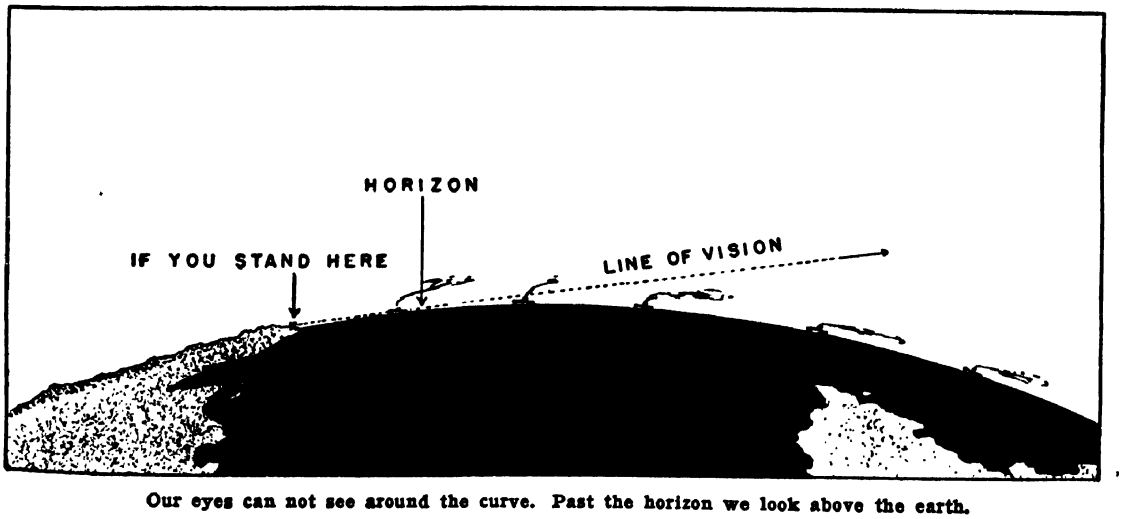
3. As the ship comes nearer, we see the bow, as if the vessel were climbing up a hill.

A SHIP COMING OVER THE CURVE

4. At last the ship is over the curve, and we can see the whole vessel.



5. The diagram below will show why we see the smoke first, then the ship, bit by bit.



Our eyes can not see around the curve. Past the horizon we look above the earth.

The X on the ball stands for your town on earth. The candle is the sun. Twirl the ball. Note how your town turns from light into darkness.

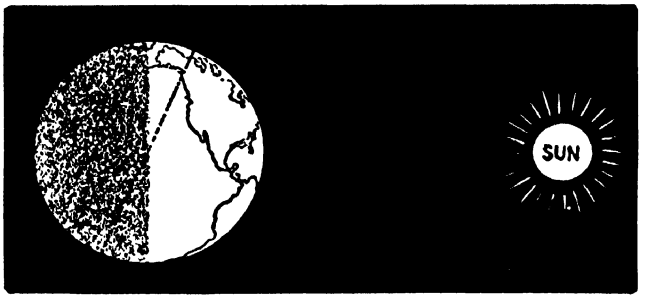
they move more slowly; therefore they have longer periods of revolution. The planet Pluto, farthest away, has a period 249 times as long as the earth's year. Imagine how old you would grow in one year on this wandering planet.

Besides wheeling around the sun, the earth is also spinning, somewhat as a top spins. You have seen the way a top sometimes travels along the floor while it spins. It is moving in two ways at the same time. The earth does this also. It spins and it travels around the sun. The result of the earth's spinning is that any spot on earth is sometimes facing toward the sun, sometimes facing away from it. The place where you live, for instance, will be turning toward the sun as the earth spins and you say it is morning. After a few hours your home will face the sun directly, and you say it is noon. Then your home turns away from the sun, during afternoon: it keeps spinning until it faces the part of the sky on the other side of the earth from the sun. There is darkness, with faint twinkles from distant stars and other heavenly bodies to give a little light; that is night-time. The earth keeps spinning and soon your home is turning toward the sunlight, and morning again. It takes one whole day and one whole night for the earth to make a complete spin, or turn. We call this period of time a day, and we have divided it into twenty-four equal parts, which we call hours. Our year and day are measured by the earth's motions.

You can understand how we have daylight and darkness if you will take a small globe, or an orange or a rubber ball and hold it in your hand opposite a lighted candle in a room where everything else is dark. The side of the ball next to the candle will be lighted, and the side away from the candle will be dark. Put a spot of ink on the ball and call it your house, and hold the ball so that the spot is opposite the candle. Now turn the ball slowly round, and the spot will travel round until at last it loses the light of the candle. Then, as you go on turning, the spot will be lighted again.

The ball stands for the earth and the candle stands for the sun, and when the spot is just opposite the candle, that is midday, or noon. Then, as the ball goes on turning, the spot slowly loses the candlelight; that is to say, the sun sets, and it is night. Then the spot, turning always in the same direction, faces again toward the light, and if you were on that spot you would say that the sun was rising once more.

Think what it would be like if it were always day, or if it were always night. If the earth were not forever spinning round and



North America, on a summer day, receiving the sun's light and warmth. The North Pole is in the light, the South Pole is in darkness, due to the tilt of the axis.

North America on a summer night is in darkness because it faces away from the sun. Yet around the North Pole there is light at night, and around the South Pole there is darkness day and night.

round like a top, one half of it would always be in daylight, while the other would have an endless night. So long as you hold your ball or globe or orange still, one half of it must be next to the candle, and the other half away from it.

What do you think would happen to us all if the earth were to stop spinning round and round? If it stopped with our part facing the sun, we should say, "the sun is standing still in the heavens!" There would be no night at all; it would go on being day. Do you think that all the people from the other side of the world, where it was night all the time, would jump into airplanes and ships and come over to our side so as to see the sun again? Probably they would, but before long we should all be very glad to get on to the dark side of the earth—for a time, at any rate. The best thing for us is that the earth should go on spinning as it spins now, and that we should have the day to be awake in and the night for sleep.

Long, long ago, even the very wisest men thought that the earth stands still and that the sun moves around it. Even to-day we say that the sun rises in the east and sets in the west, but that is just a manner of speaking; we know that the earth spins from west to east.

The spinning of the earth is called its rotation.

So now you have learned about two of the earth's motions—its revolution around the sun (which takes a year), and its spin, or rotation (which takes a day and a night for one complete turn).

THE EARTH'S THIRD MOTION WHICH ACCOUNTS FOR THE SEASONS

The earth has a third motion, a wobble. As it spins and revolves, the ball is not upright but tilted.

If you have a globe, you must have noticed that it is not set squarely in its frame. The North Pole is not at the very top and the South Pole at the bottom, but the globe is tilted. This tilting of the earth's axis as it goes round the sun is very important indeed, for it is responsible for the seasons. It means that the northern half of the earth will get the sun's rays pouring very directly down upon it during one part of the year, which we call summer, but not so directly during the other part of the year, the winter. That is why summer is hot and winter, cold.

Now, the wobbling we have mentioned has to do with this tilting of the earth's axis. It is always tilted by practically the same amount, but not always in the same direction. Remember the spinning top we spoke of earlier? As it spins on its axis, it also wobbles; its axis points in different directions. Now, the top spins very fast, and the axis wobbles fast, too. For the earth the spinning is slow, and so is the wobble. Indeed, one wobble takes nearly 26,000 years. The spinning top dies down after a while, and the wobble becomes greater. The earth does not slow down, so its wobble is the same always. In our time, the earth's axis points to a star we call the North Star. A few thousand years ago that was not true, nor will it be true a few thousand years in the future. But about 26,000 years from now our present North Star will again serve the same purpose. This wobble of the axis of the earth is called precession.

These, then, are the three chief motions of the earth—its rotation or spin, its revolution round the sun and its wobbling tilt, or precession.

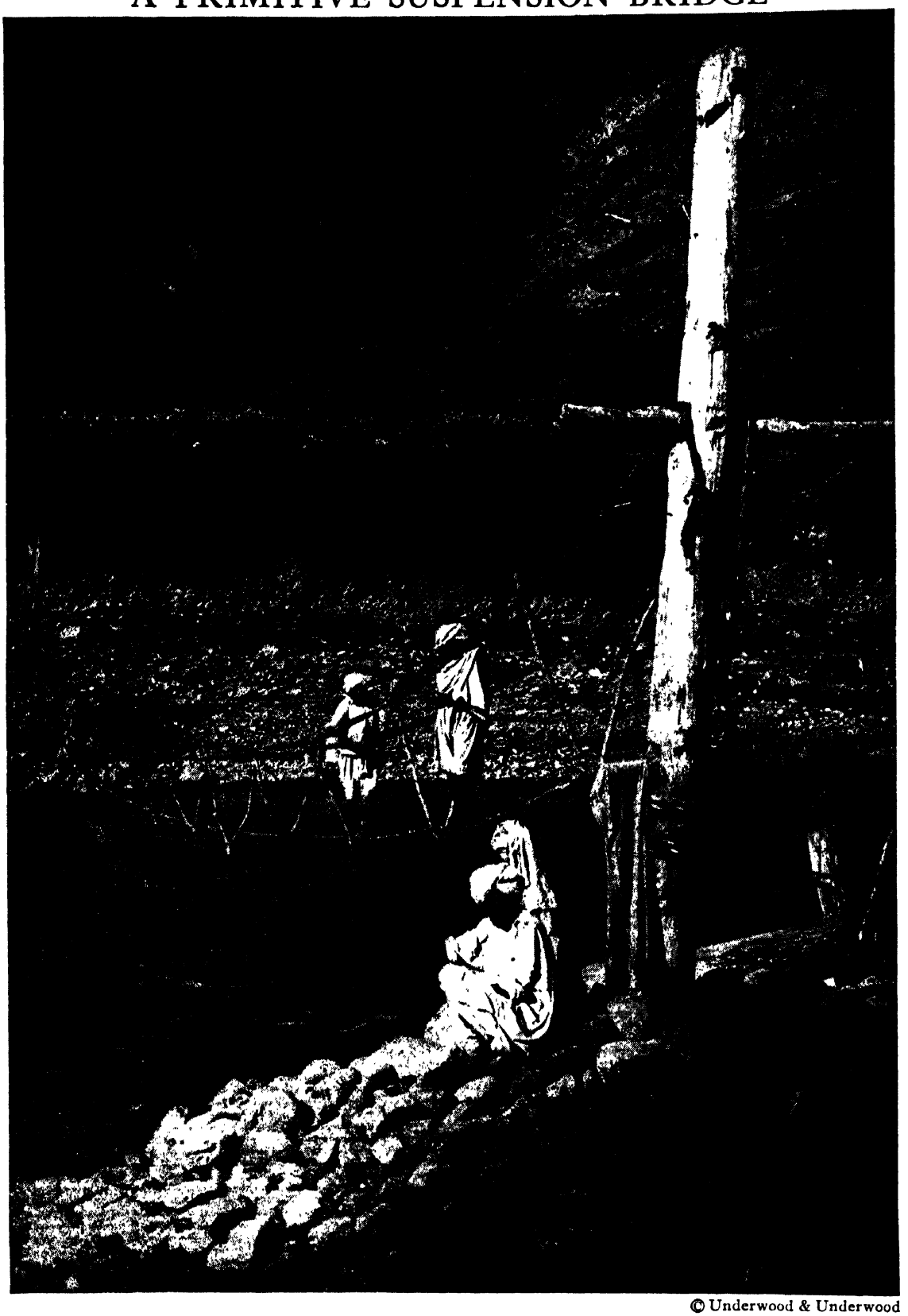
In the chapters of this Department that follow, we shall tell you more about the earth's place in the heavens, and how it depends upon the sun for light and heat. We shall tell you about the blanket of air that protects us, about the lands and the waters, and the substance of our earth's crust, and the conditions that we think exist far inside the crust. In a series of chapters we trace the life upon the earth from earliest days. We shall tell you about winds and ocean currents and other influences that make climate and weather different at different times and places. Then we shall turn our eyes to the heavens once more, and study the great star our sun, the worlds that whirl round it as the earth does, the strange wanderers we call comets and those even more mysterious visitors, the meteorites.

We shall explain what causes magnetic storms, auroras, and short-wave radio fade-out. The other bright stars that form our star-city, and distant star-cities far out in space, and misty nebulæ we shall study.

We take you on a visit to a planetarium, and to one of the world's great observatories, where an astronomer points out the distant wonders in the heavens which you can see by means of powerful modern instruments. When you have read all the articles in this Department of The Earth, you will have a background of knowledge that will surely be interesting and useful to you, all your life long.

THE NEXT STORY OF THE EARTH IS ON PAGE 133.

A PRIMITIVE SUSPENSION BRIDGE



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These natives in the hills of India have made a simple bridge of rope. Their ancestors used vines.

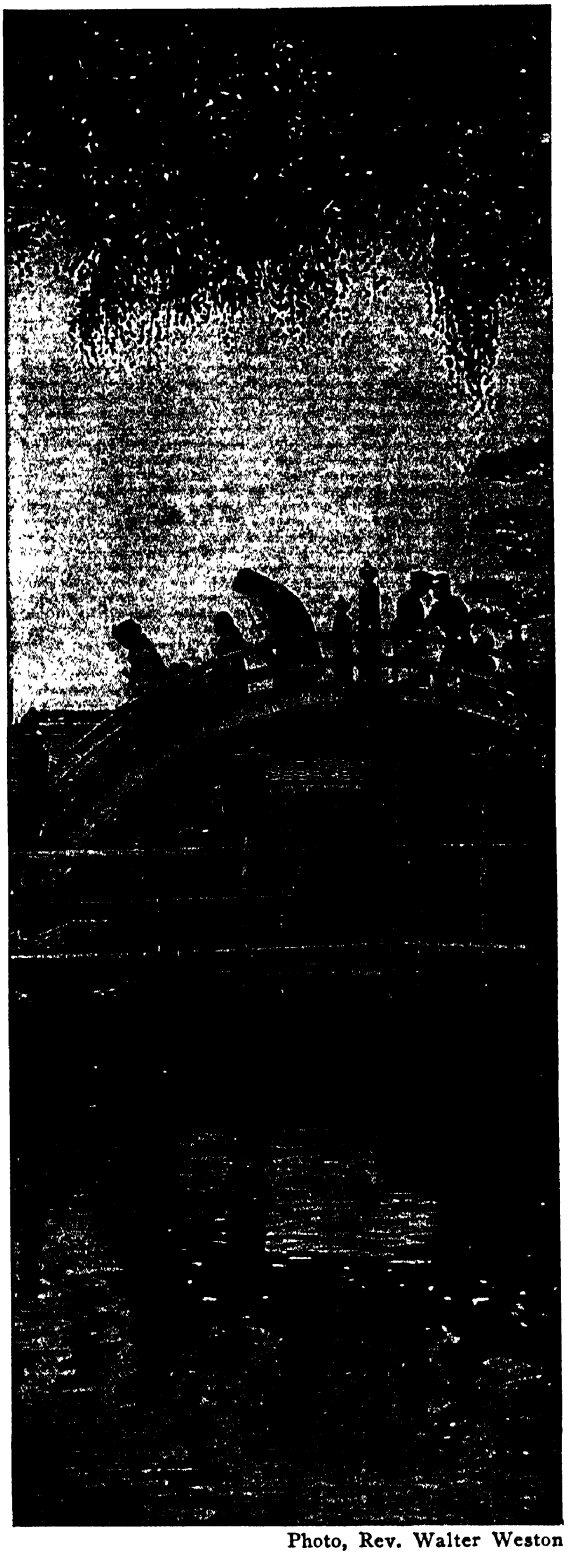
FOOTPATHS IN THE AIR

NO one can say when or by whom the first bridge was built. It is likely that Nature was man's teacher. Primitive man would use a natural bridge, consisting of a tree-trunk that had fallen across a stream, or he would swing across a chasm, by holding fast to a twisted vine. Later he would make his own bridges. He would chop down trees and lay them across streams. He would make suspension bridges built of vines twisted together and fastened to solid supports on either side of a chasm.

We know that the construction of bridges goes back to a very early day. The Chinese built bridges long before the Christian era—arched affairs, high enough in the middle to allow boats to pass under them. The grades were steep; hence the bridges were often provided with steps for pedestrians.

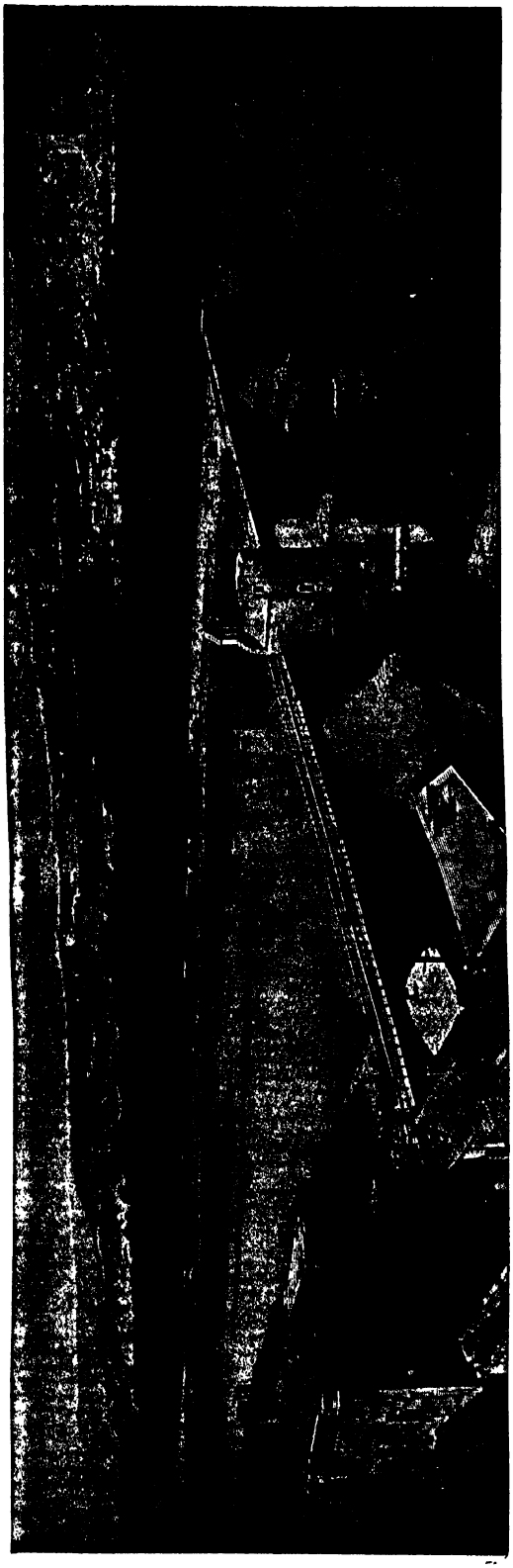
The Greeks built many bridges of wood and of stone. The greatest bridge builders of antiquity, however, were the Romans. When they entered upon their career of conquest, they found that bridges provided a necessary means of communication in many of their far-flung possessions. Not one of the wooden bridges that they built has been preserved, but a number of their stone and concrete bridges are still standing. Among the most striking of these are huge aqueducts, built to supply large population centres with water. The word *aqueduct* comes from two Latin words meaning pipe or canal for water; the aqueducts were really water pipes carried on bridges. The aqueduct known as the Pont du Gard, at Nîmes in France, is still practically intact. (See page 5351.) It has three tiers of arches, set one upon the other. There are also famous Roman aqueducts at Segovia and Tarragona, in Spain.

After the Roman Empire fell, few new bridges were put up and many of the older ones were permitted to fall to pieces. In the twelfth century, however, there was a great revival in bridge building in Europe, and many fine bridges were put up in England, France, Germany and other countries.



Photo, Rev. Walter Weston

The Japanese copied the Chinese in many ways. Japanese bridges with their steep arches imitated the early Chinese ones. This pretty footbridge crosses a pond at a Shinto shrine in Tokyo, Japan.



Across the Rhone River in Southern France, at Avignon, are the ruins of a stone bridge built in the twelfth century. On a pier is a little chapel.

The first stone bridge over the Thames at London was completed in the first years of the thirteenth century. It had a covered gallery of wood and was lined on both sides with shops, just like a street. These flimsy wooden structures on the bridge were burned down and rebuilt a number of times in the centuries that followed; not until 1756 were they removed entirely. The bridge itself, repaired and widened, was in use until the early part of the nineteenth century, when a new bridge was constructed on its site.

Many other fine bridges were constructed in Europe in the Middle Ages. One of the most famous was the Ponte Vecchio (Old Bridge) in Florence, Italy. Like the London Bridge, the Ponte Vecchio, originally built in 1177 and rebuilt in 1362, had a covered gallery, with a double line of booths and small shops. This bridge is still intact; for centuries it has been the Mecca of tourists. France boasts of an even more picturesque medieval bridge—an ornamental structure of seven arches that forms part of the Chenonceaux Castle in Touraine. A striking German medieval bridge had eighteen semicircular arches. This bridge was built across the Elbe River at Dresden.

A great number of bridges, large and small, were built in the centuries that followed the Middle Ages. In the second half of the eighteenth century the use of cast iron in the construction of bridges ushered in a new era. The first bridge in which cast iron was used exclusively was the one across the Severn near Ironbridge, England. This structure, built in 1779, consisted of a single arch with a span of 100 feet (the span is the distance between two supports). Engineers found, however, that though cast iron can bear great pressure, it cannot stand much pull. By the nineteenth century, therefore, bridge builders generally used wrought iron instead of cast iron. Wrought iron cannot be pulled apart easily and at the same time it can bear great pressure.

The use of iron-bar chains brought about a great change in the construction of suspension bridges at the beginning of the nineteenth century. Formerly bridges of this type had been suspended by ropes. The use of iron chains made suspension bridges far stronger. One of the first modern suspension bridges, constructed in 1801, spanned Jacobs Creek in Pennsylvania. The iron chains, strung from towers, supported a roadway extending from one side of the creek to the other. This general principle is still applied in even the most modern suspension bridges.

A further advance in suspension bridge construction was the use of iron wire instead of chains for suspension purposes in the Gotteron Bridge, spanning a chasm at Fribourg, Switzerland; the structure was completed in 1834. A striking feature of this bridge, which had a span of 870 feet, was the fact that the cables were strung, not from towers, but from rocks at each side of the chasm.

A highly important factor in revolutionizing bridge construction was the development of the railway in the first half of the nineteenth century. The railway was far less flexible than horse-drawn vehicles; it could not negotiate such steep grades and sharp turns. Therefore, when a railway bridge was to be constructed across a valley stream, it now became necessary in many cases to bridge the entire valley.

Again, bridges had been built to carry comparatively light loads, and the weight of the locomotive and the trains that it drew now created new engineering problems. Fortunately the development of the truss enabled engineers to provide added strength and rigidity to bridge structures.

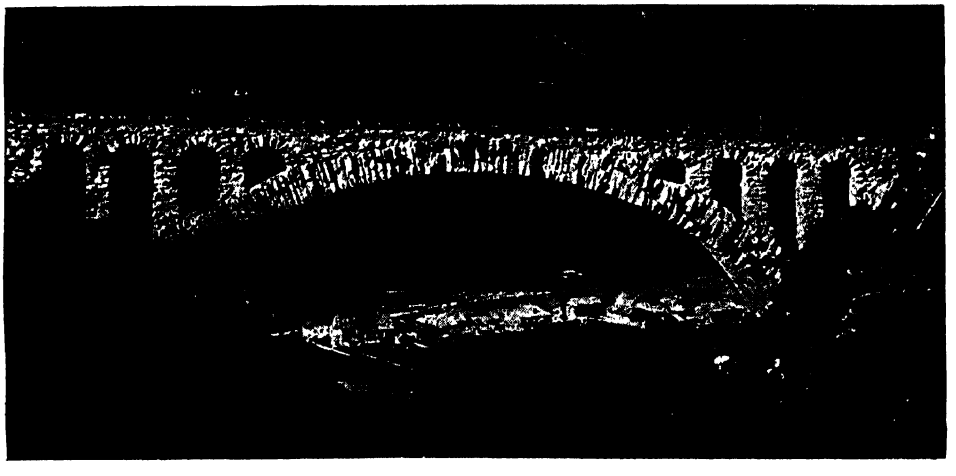
A truss is really a rigid framework, composed of members or parts joined together at their intersections. The most rigid form of framework is the triangle; it is the only figure the shape of which cannot be changed without changing the sides. (See the diagram on page 33.) The triangle, therefore, is the essential truss element; all trusses, no matter how complicated, consist of a series of triangles. In some cases trusses and foundation piers form the sole support of the roadway or floor system; bridges of this sort are known as truss bridges. In other cases trusses are used to strengthen suspension or arch bridges.

An old-fashioned wooden bridge in Vermont. At one time bridges of this sort were very common; at present they are to be found only in a few states.

In the early days of railroad bridge construction, stone was considered to be an excellent material for the purpose. The oldest railway bridge in existence, the Carrollton Viaduct of the Western Maryland Railroad, was built entirely of stone in 1829. One of the finest of stone railway bridges was the Starucca Viaduct, built to carry the tracks of the Erie Railroad over the Starucca Creek. This structure, built in 1847, had 17 arches and its floor was 110 feet above the creek. Other outstanding stone railway bridges were built. Stone bridges, however, are costly and take a long time to build.

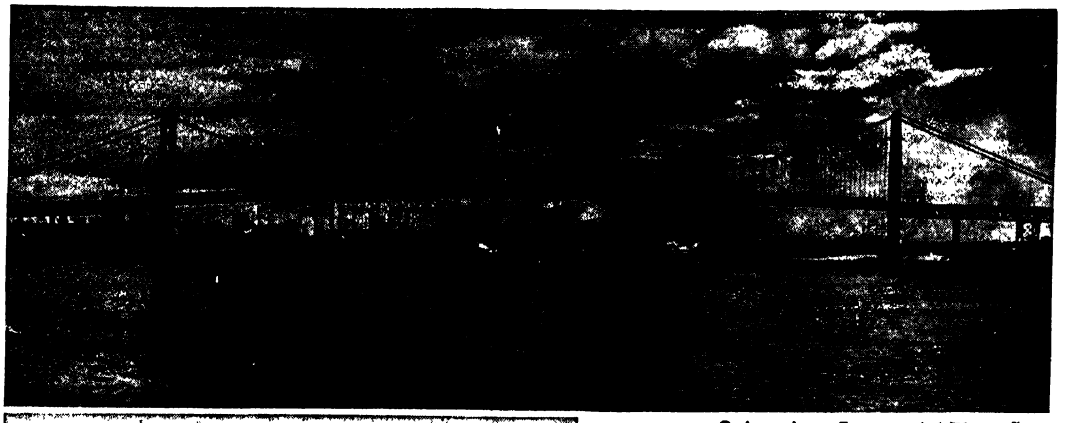
As we have seen, wrought iron soon replaced cast iron in the construction of railway bridges and other bridges as well. One of the most original iron bridges ever built

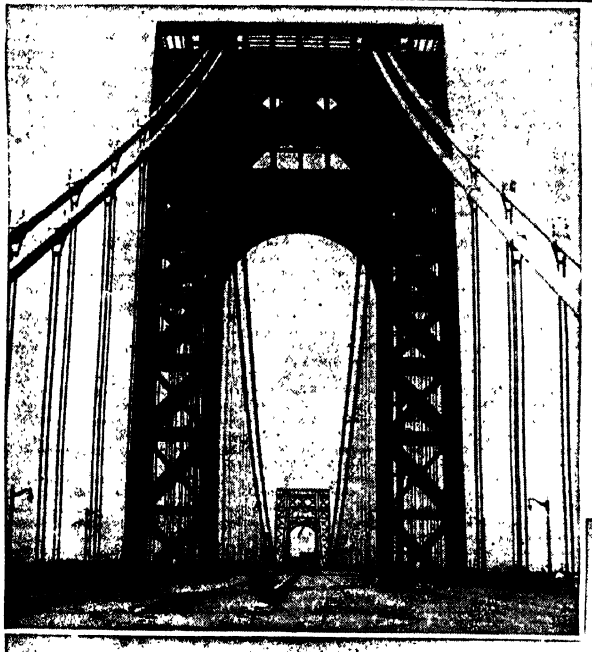
A STONE ARCH BRIDGE



A stone railroad bridge across a valley in the Austrian Alps.

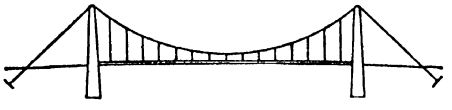
THREE GRACEFUL SUSPENSION BRIDGES





© American Commercial Photo Co.

The Ambassador Bridge, connecting the United States and Canada at Detroit, Michigan, and Sandwich, Ontario.

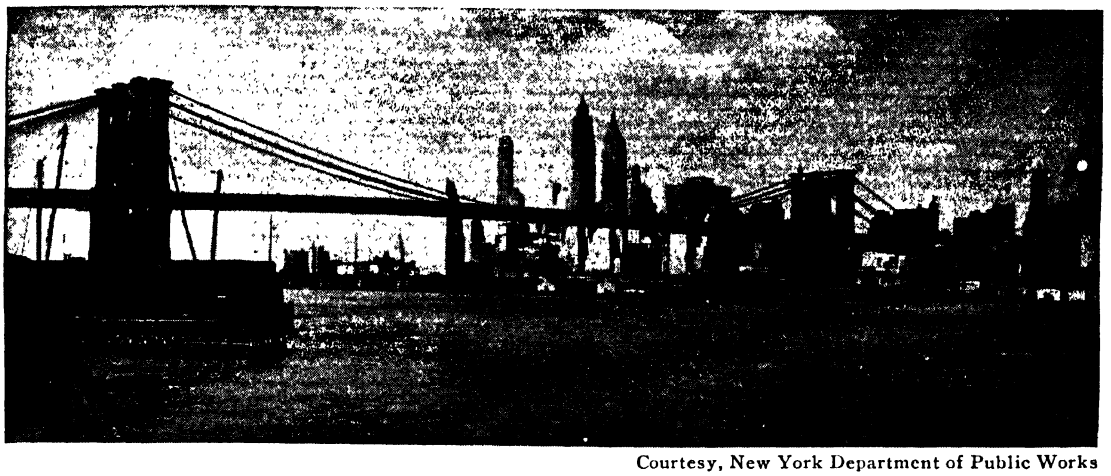


The roadway of a suspension bridge hangs (is suspended) from ropes anchored to lofty towers.

Courtesy, Port of New York Authority

Looking across the George Washington Bridge, from the New York side, toward New Jersey.

The bridge over the Delaware River connecting Philadelphia, Pennsylvania, and Camden, New Jersey, is one of the world's longest suspension bridges; the main span is 1,750 feet long, 135 feet above sea level.



Courtesy, New York Department of Public Works

Brooklyn Bridge, and the skyline of lower New York. The main span of this suspension bridge is 1,595½ feet long.

was the Britannia Bridge, crossing the Menai Straits in Wales. This structure consisted of two rectangular iron tubes, mostly of wrought iron plates; each of these tubes carried one of the tracks of the Holyhead Railway. The Britannia Bridge was constructed about 1850 and it is still in use. The largest tubular bridge ever built was the old Victoria Bridge over the St. Lawrence River at Montreal; this was replaced by another bridge in 1898. Tubular bridges were never very popular and are no longer built.

A much more effective type of construction, and one which is still widely employed, is the cantilever bridge. We may consider the cantilever, which is a development of the truss, as a sort of bracket. Secured firmly at one end, a wall-bracket in your home will bear a heavy weight. The cantilevers forming a bridge are really huge brackets, each of which rests on a pier and is anchored behind the pier. (See the diagram on page 34.) The outer parts of these brackets meet in the centre of the span. Sometimes they do not quite meet but are connected by a truss that closes the gap.

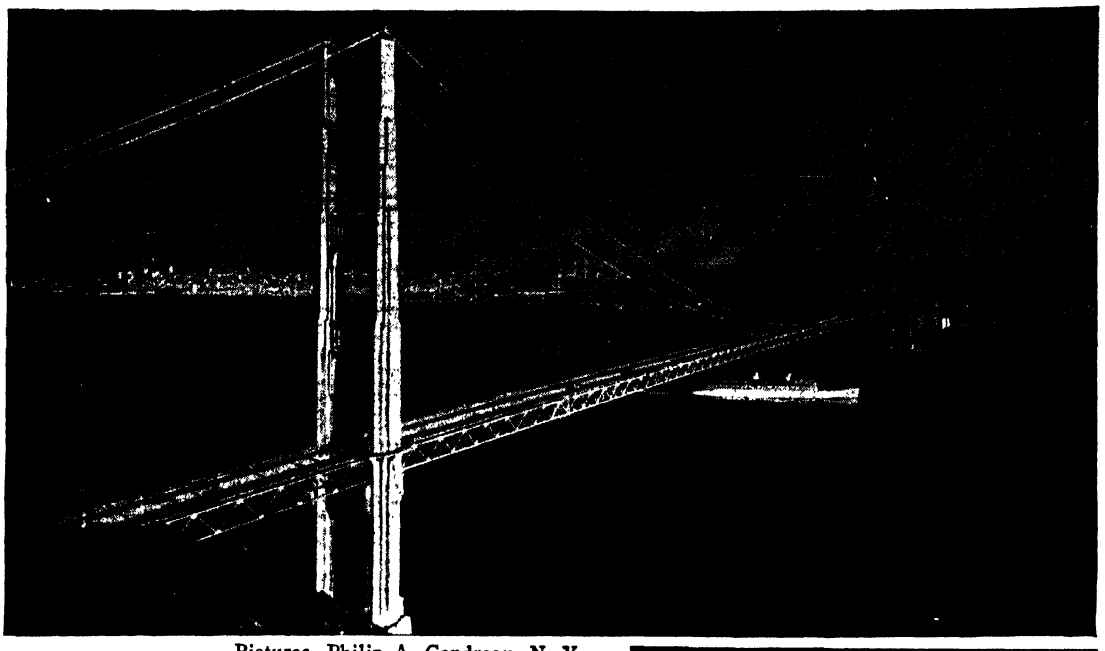
Bridges were constructed on the cantilever principle at an early period in the history of bridge building. Little real progress could be made, however, until iron and steel were made available as bridge materials. One of the earliest of modern cantilever bridges was the Gerber Bridge (a highway bridge), over the Main River, at Hassfurt, Germany; this structure was built in 1867. The first cantilever bridge for the use of railroads was constructed in 1876 at Posen, Germany.

About the year 1875 steel began to be used on a large scale in bridge building and another milestone was reached. Steel was used, though not exclusively, in the Eads Bridge, completed in 1875, over the Mississippi at St. Louis. An all-steel railway bridge was completed at Glasgow, Missouri, in 1879. Undoubtedly the most famous of the early American steel bridges was the Brooklyn Bridge, a suspension bridge crossing the East River in New York and connecting the boroughs of Manhattan and Brooklyn. The bridge was opened to traffic in 1883. The suspension system consisted of four steel-wire cables, made up of parallel wires. The bridge, which has a span of 1,595 feet, has been repaired and altered and is still in use.

Another famous early all-steel bridge was the Forth Bridge, a cantilever structure over the Firth (Estuary) of Forth at Edinburgh, Scotland. This bridge was opened to traffic in 1889 and is still in use. The cantilevers, of which there are three pairs, carry the bridge across two wide stretches of water, separated by an island in the middle of the Firth. The two spans between the three cantilevers measure 1,710 feet each.

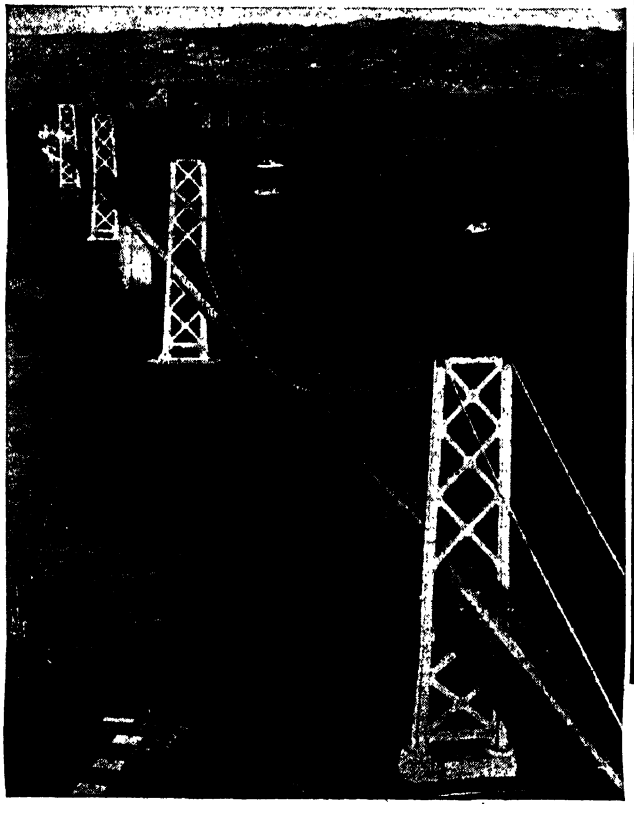
The year 1894 saw the completion of the famous Tower Bridge over the Thames River at London. This structure is an excellent example of the movable bridge. In this kind of bridge a section (called a leaf) may be swung to one side or lifted up in order to permit the passage of ships. Sometimes there are two leaves. In the swing bridge, a central leaf revolves on a turntable. In the elevator or vertical lift bridge, a leaf is raised vertically to the required height. Another type of movable bridge is the bascule bridge, in which the two leaves (sometimes one) which are called bascules, fold up.

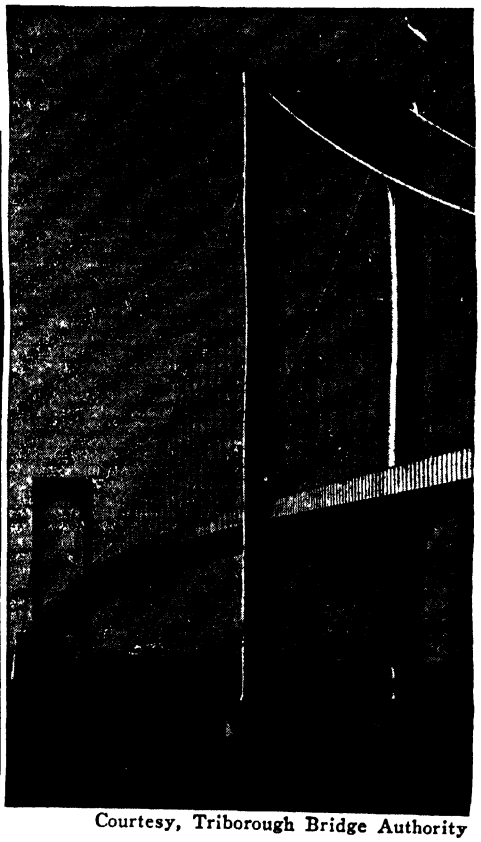
THE GREAT MODERN BRIDGES



Pictures, Philip A. Gendreau, N. Y.

Above is the spectacular Golden Gate Bridge at San Francisco, with an ocean liner passing beneath it. Below is the San Francisco-Oakland Bay Bridge, which is really a series of bridges, as you can see.





Courtesy, Triborough Bridge Authority

The Bronx-Whitestone bridge spans New York City's East River, from the Bronx to Queens, Long Island. Its clear, airy lines are typical of the modern style in bridge building.

The Tower Bridge is of the bascule type, with two bascules. The two steel towers of the bridge are faced with masonry; they are connected, near their tops, by a footbridge.

The opening of the twentieth century saw the first attempt to build a bridge across the St. Lawrence River at Quebec. A series of mishaps marked the construction of this famous bridge, on which work began in 1900. It was not until 1917 that the bridge, of the cantilever type, was opened to traffic. This bridge, which carries the trains of the Canadian National Railways, has a span of 1,800 feet. Another outstanding cantilever bridge is the Queensborough Bridge at New York. This structure spans the East River from Manhattan to Long Island by way of Welfare Island. It was completed in 1909.

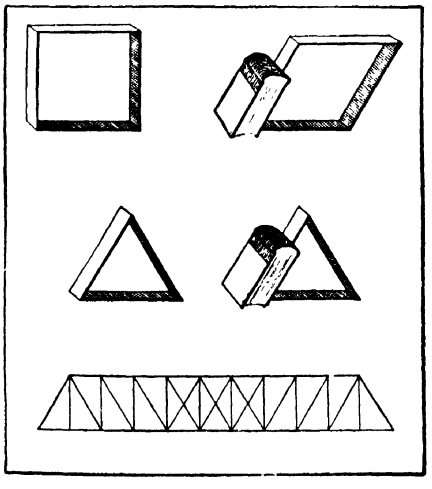
Some fine specimens of steel arch bridges have been built in recent years. One of the most famous is the Hell Gate Railroad Bridge, connecting Long Island with the Bronx. This structure is really a unit in a system of railway bridges and viaducts known as the New York Connecting Railway. A huge steel arch is the Bayonne Bridge, extending from Bayonne, New Jersey, to Staten Island, New York. The Bayonne Bridge, completed in 1931, has a ,652-foot span. In the following year the steel arch known as the Sydney Harbor Bridge, at Sydney, Australia, was opened to traffic. It is 160 feet wide and has a span of 1,650 feet.

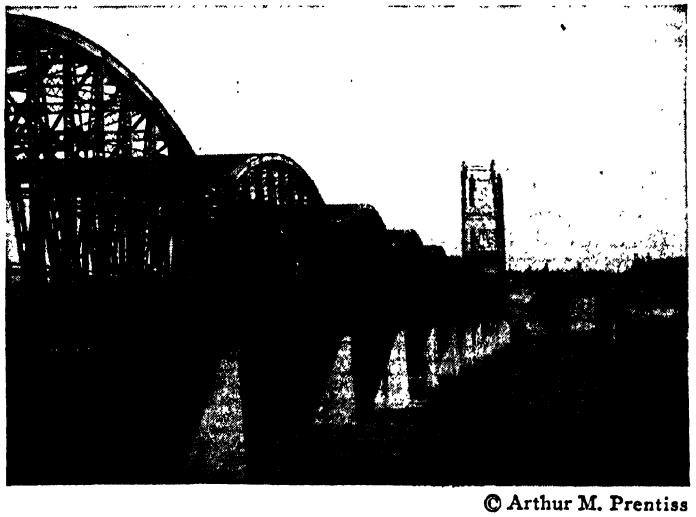
The concrete bridges of the twentieth century are mainly of the arch type, though other kinds have been built. In present practice the concrete is reinforced with steel bars or rods. A particularly interesting concrete bridge is the floating bridge over Lake Washington, in the State of Washington. For 6,560 feet this bridge, which was completed in 1940, is made up of concrete pontoons which float half in and half out of the water. In the centre there is a 200-foot sliding span, which may be opened to let boats pass through. The Lake Washington Bridge is based, of course, on the same principle as the bridge of boats of King Xerxes I of Persia.

Of the many moveable bridges built within recent years none is more striking than the Buzzard's Bay Bridge at the south entrance of the Cape Cod Canal in Massachusetts. This structure, completed in 1935, has the longest lift span in the world. It is of the vertical or elevator lift type; when the lifting span is up there is clear headroom of 139 feet over the water.

The public generally pays little attention to girder and truss bridges. Yet by far the greatest number of bridges are of these two types. A girder bridge consists of horizontal beams connected by crosspieces and fastened to supports at either end. Sometimes a girder bridge extends over a series of supports. Truss bridges are girder bridges strengthened by the addition of trusses. We explain the principle of the truss elsewhere on this page.

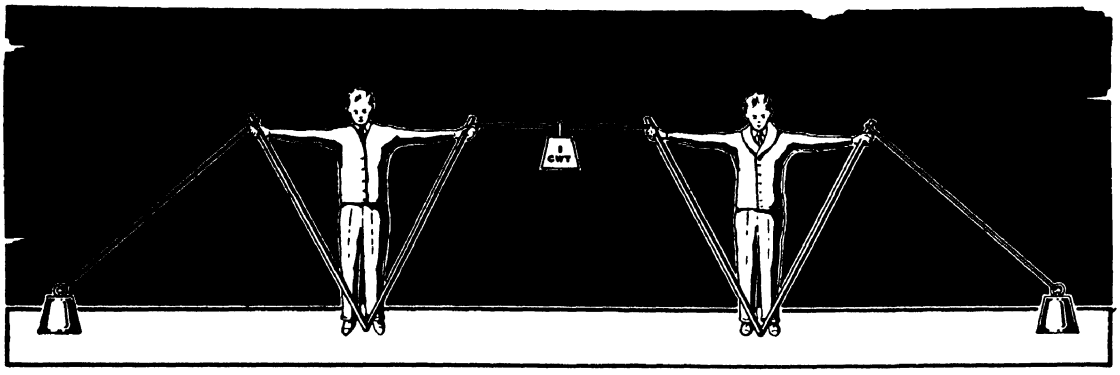
We have already mentioned some outstanding suspension bridges of the nine-





© Arthur M. Prentiss

The diagram shows the principle of the truss bridge, which relies upon the fact that a triangle is, of all shapes, the most unyielding. The steel truss bridge illustrated here is the Interstate Bridge over the Columbia River, from Portland, Oregon, to Vancouver, Washington. The total length from bank to bank is 3,531 feet. There are 13 spans. The bridge was built in 1917. Many modern bridges are combinations of the truss and cantilever. Such a combination is the Quebec Bridge, shown on page 35.



A bridge must support the weight of the materials in it, as well as the loads it has to carry, and it must withstand snow, wind and storms. What we call the cantilever is simply an overhanging bracket, which might overturn if not secured. If, however, two adjacent cantilevers are joined together and are secured at their outer ends, they will counterbalance one another. Each of the boys here represents a cantilever. The outer sticks are tied to weights and cannot collapse inwardly; the inner sticks support a weight which is equally distributed.

teenth century. In the present century this type of bridge has been still further developed. The year 1903 saw the completion of the Williamsburgh Bridge over the East River, at New York. This structure, which has a span of 1,600 feet, is the first great suspension bridge to employ towers of steel instead of masonry. The Delaware River Bridge, which crosses the Delaware River at Philadelphia, was hailed at the time of its construction in 1926 as a second Brooklyn Bridge. Two years later the Ambassador Bridge, over the Detroit River, was opened to traffic. This fine suspension bridge, which connects the city of Detroit with the cities of Windsor and Sandwich in Canada, has a span of 1,850 feet and a clearance at midstream of 152 feet.

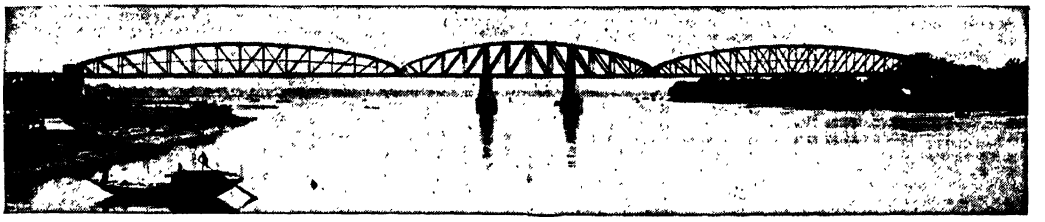
All previous suspension bridges were dwarfed by the great George Washington Bridge over the Hudson River at New York. The main span of this beautiful bridge, completed in 1931, measures 3,500 feet. The bridge is supported by four cables, which are suspended from two steel towers, each 588 feet high. At present the bridge has a single deck, for motor vehicles and pedestrians. It is planned to add a lower deck.

For six years the George Washington Bridge bore the distinction of having the longest span of any bridge in the world; then it yielded its supremacy to the Golden Gate Bridge at San Francisco. This majestic structure is built across the outer mouth of the great harbor of San Francisco. Its main span is 4,200 feet in length—almost four-

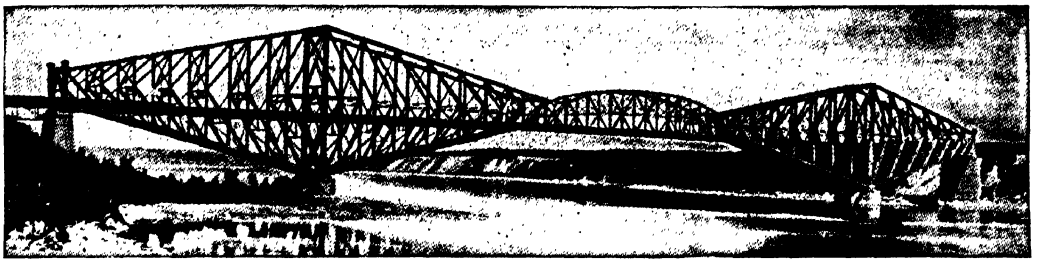
Philip Gendreau

Forth Bridge, Scotland. The three main piers are built upon caissons. The pillars are of hollow steel.

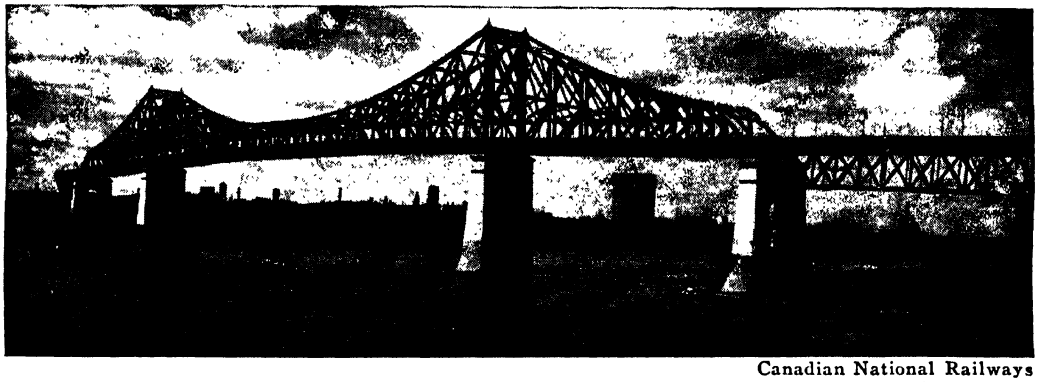
CANTILEVER BRIDGES ON TWO CONTINENTS



The Jubilee Bridge over the Hooghli River, near Calcutta, India, is a railway bridge.

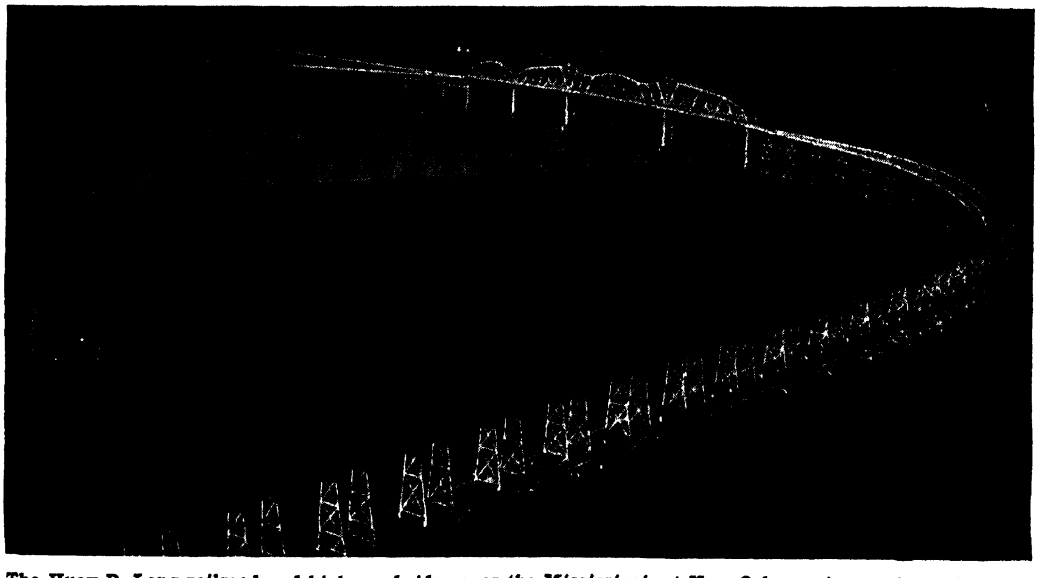


Quebec Bridge over the St. Lawrence has two cantilevers with a truss between. The span is 1,800 feet long.



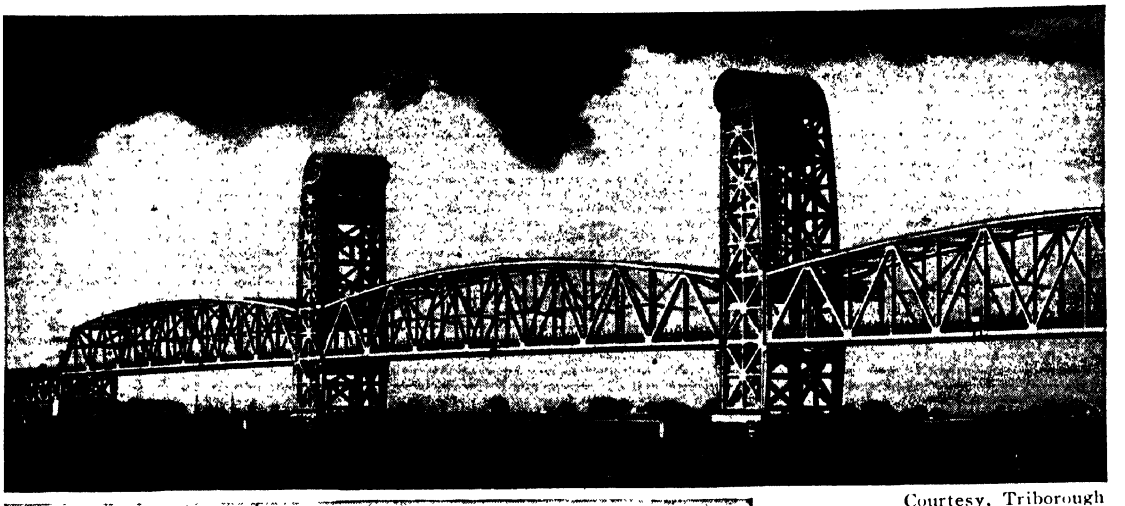
Canadian National Railways

The Jacques Cartier Bridge spans the St. Lawrence River from Montreal to Longueuil.



The Huey P. Long railroad and highway bridge over the Mississippi, at New Orleans, is a series of bridges.

TWO TYPES OF LIFT BRIDGES



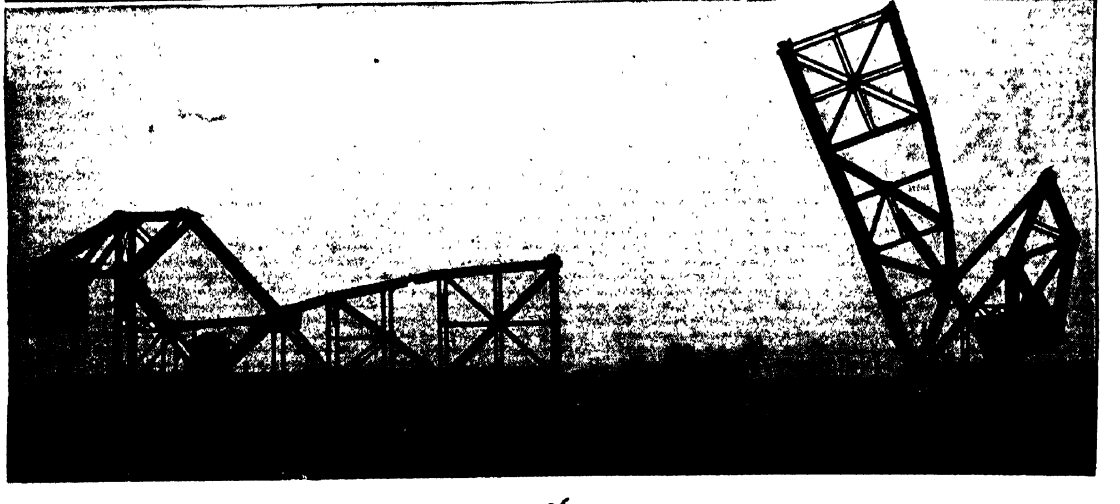
Courtesy, Triborough Bridge Authority

The Marine Parkway Bridge, at Rockaway Inlet, New York. One of the three spans lifts to let boats through.

The Tower Bridge over the Thames, at London. This is a bascule bridge, with two leaves that fold back to allow river traffic.

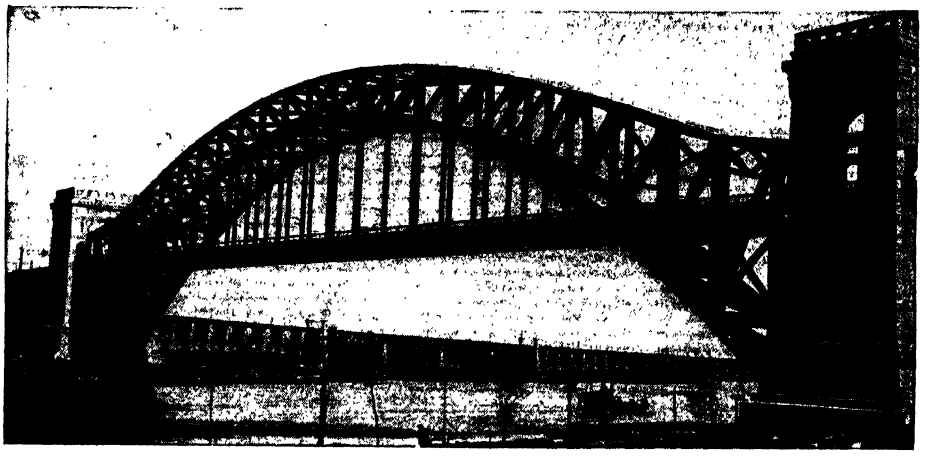
Courtesy, Canadian Pacific Railway

Another bascule bridge with two leaves is this one, over the United States Ship Canal. It connects Sault Sainte Marie, Ontario and Sault Sainte Marie, Michigan.



TWO BEAUTIFUL STEEL ARCH BRIDGES

The Hell Gate Bridge (1,017 feet) spans the East River and connects the Pennsylvania R. R. tunnels from Long Island to New Jersey.



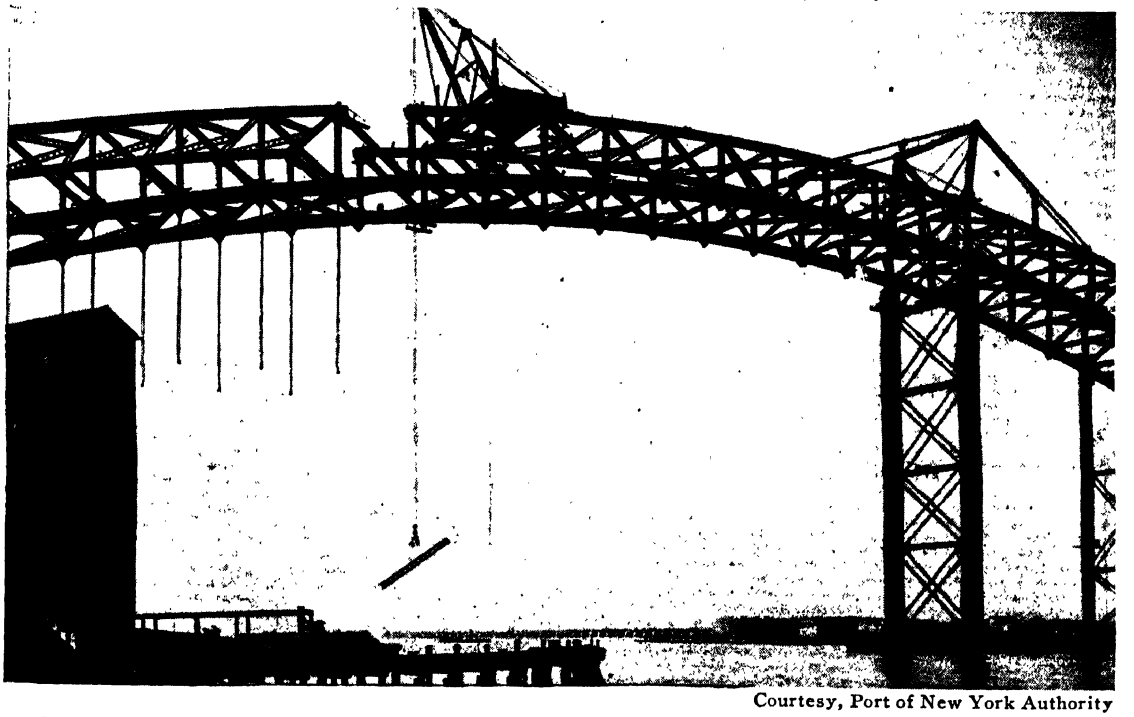
©Ewing Galloway

fifths of a mile! Each of its towers is 746 feet in height. One of them will one day serve as a station of the United States Lighthouse Service; it will carry a beacon to guide ships at sea.

In a number of cases a series of bridges has been built in order to carry traffic over long stretches. We have already mentioned the New York Connecting Railway, that little known system, of which the famous Hell Gate Bridge is only a part. A renowned system of bridges is the Pulaski Skyway, opened to traffic in 1932. This famous aerial highway spans the Jersey Meadows, lying between Jersey City and New York, and crosses the busy Hackensack and Passaic Rivers. The Skyway is about three miles long.

The Triborough Bridge at New York, as the name indicates, connects the three boroughs of Manhattan, Queens and the Bronx. The Triborough is really a series of bridges and viaducts, totaling some three and a half miles in length; included among the bridges is a vertical lift affair over the Harlem River. The Triborough Bridge was completed in 1936.

The same year saw the completion of a far longer bridge system, the San Francisco-

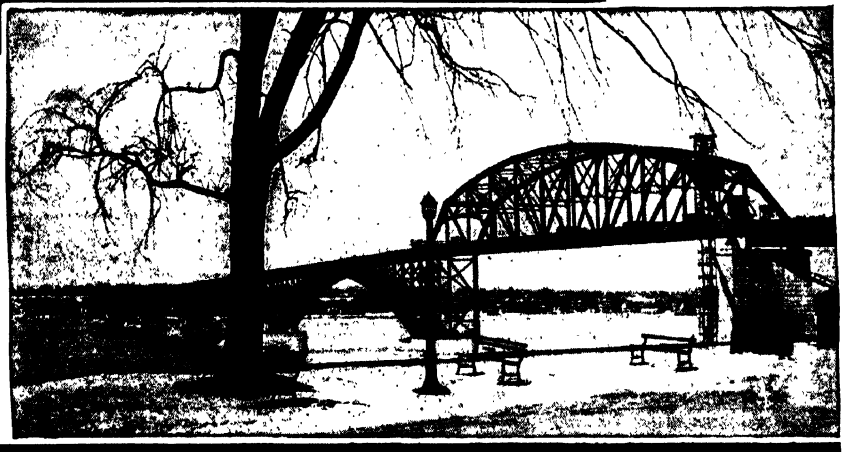


Courtesy, Port of New York Authority

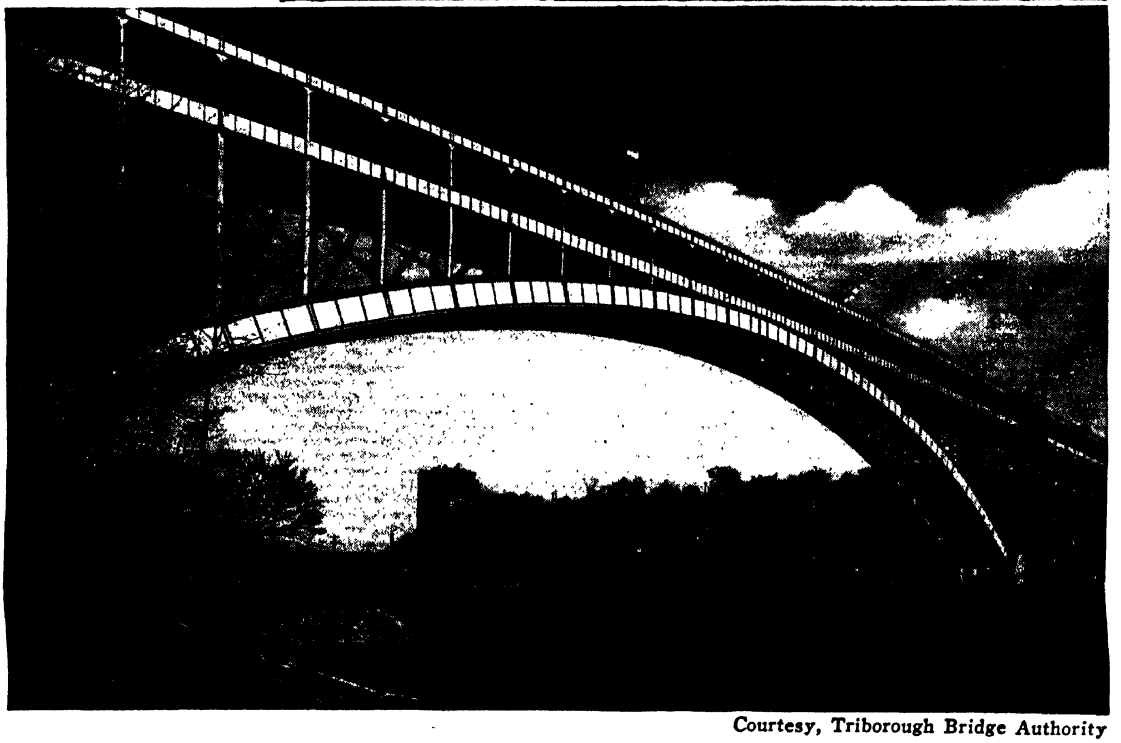
Across the Kill (stream) van Kull, from Bayonne, New Jersey, to Staten Island, is this high arch bridge.

SINGLE SPANS AND MANY SPANS

Bridge across the Rhine at Coblenz, Germany. The arch is shaped like half an egg. Compare the steep arch on page 27.



The Peace Bridge over Niagara River from Fort Porter, Buffalo, New York, to Fort Erie, Ontario, was opened in 1927, commemorating a century of peace between Canada and the United States.



Courtesy, Triborough Bridge Authority

The Henry Hudson toll bridge over the Harlem River, New York City, has an upper and a lower deck.

This concrete and steel viaduct carries a railway across Tunkhannock Creek in Pennsylvania. It is 2,375 feet long.

Oakland Bridge. This amazing project, eight and a half miles in length, crosses San Francisco Bay from San Francisco to Oakland, by way of Yerba Buena Island (commonly called Goat Island). From San Francisco to Yerba Buena Island there are two double-decked suspension bridges placed end to end, with a common anchorage in the centre of the channel. The roadways at the two levels of the suspension bridge plunge into a tunnel, 450 feet long, upon reaching Yerba Buena Island. Finally, from the island to Oakland the bay is spanned by a cantilever bridge, a number of truss bridges and a steel and concrete viaduct.

An important link between the United States and Canada is the Thousand Islands International Bridge, opened in 1938. This, too, is not a bridge but a group of bridges, extending across the St. Lawrence River from Collins Landing in New York to Ivy Lea in Ontario. This bridge system, about eight and a half miles long, passes over a number of the Thousand Islands and includes suspension bridges, truss bridges and a beautiful steel arch.

There is nothing more fascinating than a towering bridge, gracefully spanning a broad stream. Just as fascinating is the construction work that makes the bridge possible.

Bridge construction begins with erection of the piers or abutments upon which the bridge will rest. When these structures are to be below water level, special methods must be employed. One is the open cofferdam system. An area surrounding the proposed foundation is closed off by driving piling, of wood or of steel, all around the area in such a manner as to form a more or less water-tight enclosure. The water is then pumped out and excavation proceeds.

Another method, employed when excavation must go on at a considerable distance below water-level, is the pneumatic caisson system. A pneumatic caisson is a sort of inverted air-tight tub of steel, with a hollow space at its bottom partitioned off from the rest of the caisson. The caisson is towed to the site of the proposed pier; the air trapped at the bottom of the caisson is released and weight is added to the top until the caisson sinks to the bottom of the river. By means

This floating bridge at Seattle, Washington, is on concrete pontoons. One span slides aside to let boats through.

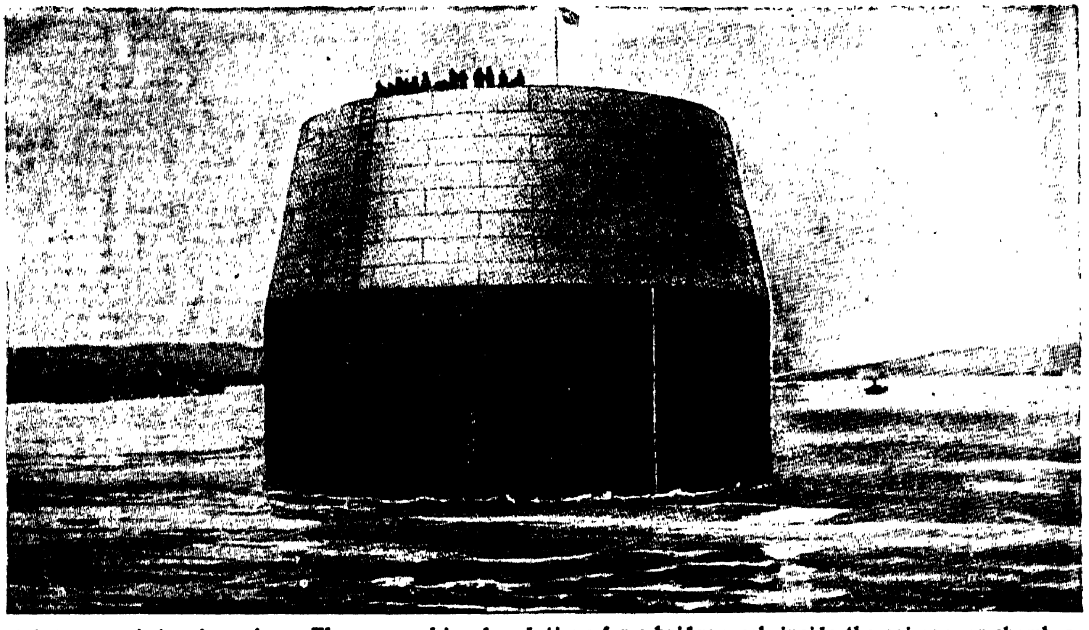
of compressed air the water is forced out of the bottom part of the caisson; this part constitutes the working chamber, where excavation is carried on. As this proceeds, the caisson sinks deeper and deeper until bed rock or some other secure stratum is reached. Then the work chamber is entirely filled with concrete and the caisson remains permanently in place. On top of it is constructed the concrete or masonry pier.

Once the foundations are in place, the construction of the superstructure can proceed. For truss bridges and for some steel arches a temporary framework, called the falsework, is used to support the bridge structure while it is under construction. No falsework is required in the case of cantilever bridges, which are well balanced at any stage in their construction. For concrete bridges a temporary structure of wood or steel is erected between the supports of the bridge. Upon this framework is placed the planking that is to provide a mold for the liquid concrete; the planking is shaped in accordance with the design. When the concrete has hardened the temporary frame-work is removed.

The construction of a suspension bridge is particularly spectacular. First the piers and towers are built and the anchorage blocks, to which the ends of the cables will be fastened, are set in place. Temporary footbridges, borne on steel ropes, are now extended from tower to tower; these footbridges serve as working platforms. Then the spinning of the cable wires begins. A traveling pulley (called a sheave) carries a loop of wire from one anchorage over the two towers and down to the other anchorage, thus bringing two wires into position at the same time. Then another loop is sent across, and many more. These wires are generally spun parallel to each other.

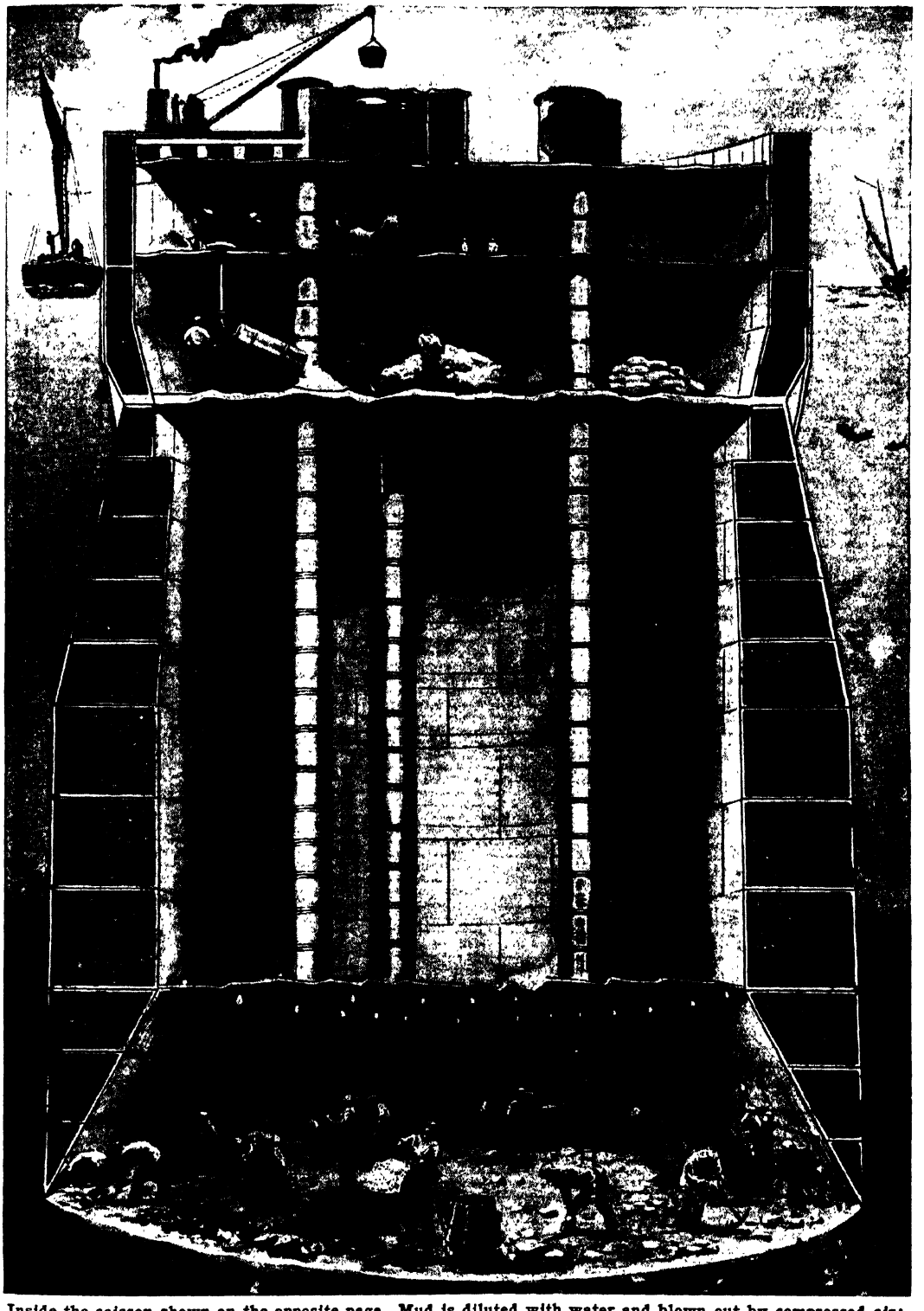
When the spinning is completed, the cable, now consisting of thousands of parallel strands of wire, is pressed into a round shape by a hydraulic squeezer; then clamps are put around the cable at definite intervals. These clamps are to hold the so-called suspender ropes, which drop from the cables and which carry the weight of the bridge. The exposed parts of the suspension cables are now painted with red lead paste and wrapped with steel wire. Next, the steel suspender ropes are put in place. Girders or floor beams are then attached to the lower ends of these suspenders; finally, upon the girders the bridge floor is constructed.

The suspension bridge is now completed. As we admire its airy grace, we wonder how it can be held in position by what seem from a distance to be frail threads strung from tower to tower. A closer examination of these frail threads would reassure us, for the diameter of each cable may measure as much as 36 inches!



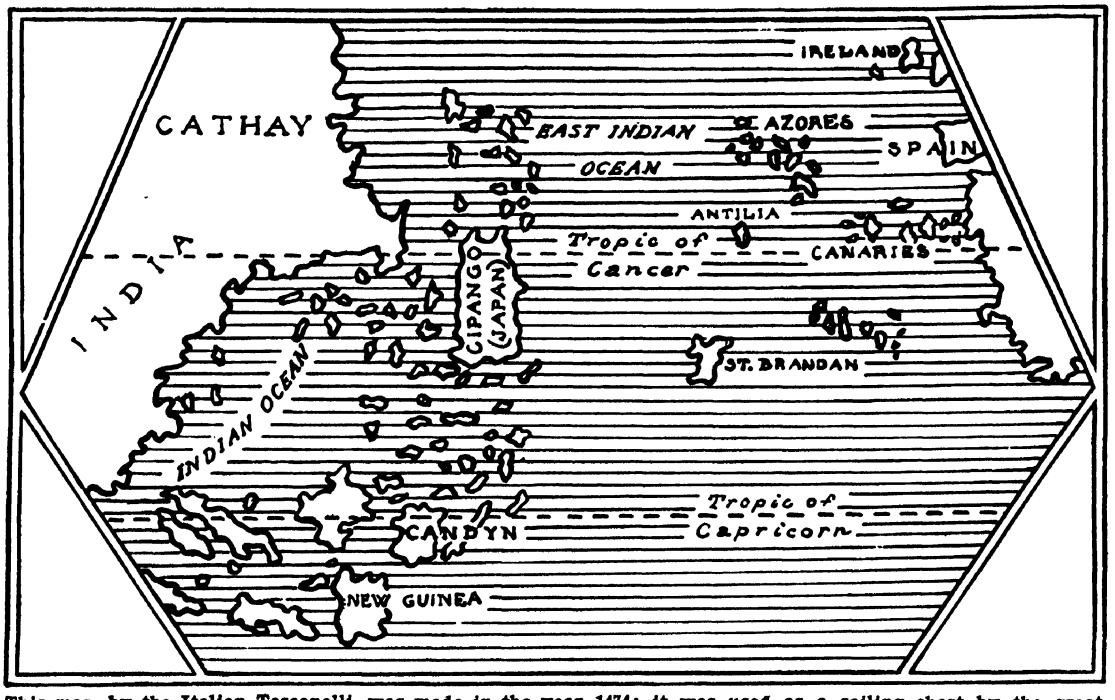
A bridge workshop in a river. The men making foundations for a bridge work inside the caisson, or chamber, sunk in the river. At the bottom is a chamber lighted by electricity and filled with compressed air.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 137.

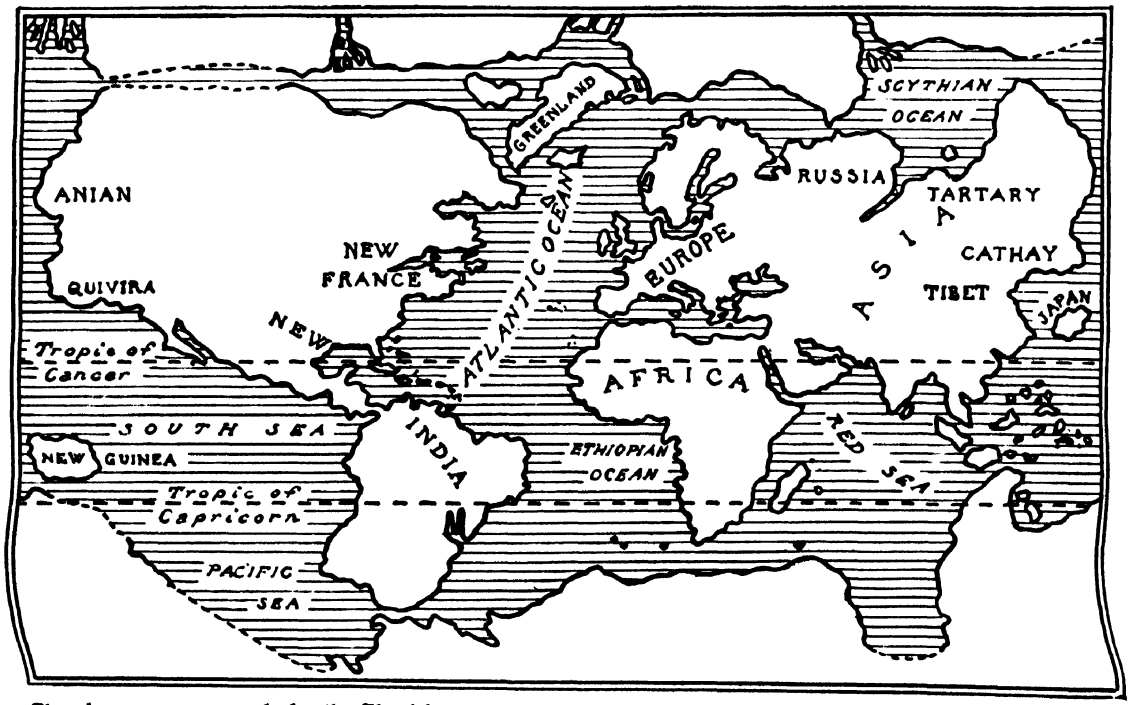


Inside the caisson shown on the opposite page. Mud is diluted with water and blown out by compressed air; clay is hauled out, and when a firm foundation is reached, the caisson is filled with concrete and on this solid base a massive pier can be laid.

MAN GAINS A NEW WORLD



This map, by the Italian Toscanelli, was made in the year 1474; it was used as a sailing chart by the great Christopher Columbus. Toscanelli, as you see, had no idea that the great American continent barred the way to the navigator trying to reach Asia by sailing due west from Europe.



The above map was made by the Flemish geographer Mercator in 1569. By this time the great world to the west had been discovered and explored (see the chapter beginning on page 391). In 1569, therefore, Mercator was able to give an outline of North and South America that we can easily recognize, even though the shape and proportions of the two continents are inaccurate. We have greatly simplified both maps and have given English equivalents for the Latin names used by both Toscanelli and Mercator.

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THIS GREAT WORLD OF OURS

THIS wide world, 8,000 miles in diameter and 25,000 miles round, with over fifty million square miles of land and twice as much water, is the home of two billion people. Some of them are crammed up in great cities; some are scattered here and there with vast spaces all around them. London, with about a hundred square miles to live on, has more people than all Australia, with its five million square miles to live on. There are still deserts and forests that keep back population, but rarely do we find a spot on earth that is not home, sweet home, to somebody. Often people who live in harsh, inhospitable lands are even more devoted to their homeland than are people who live in fertile and beautiful lands.

There are many striking differences between the people of various countries, and even between different groups of people living in the same country. There are, of course, differences in language, in color and size, in customs and in dress, but the strangest difference of all is the remarkable distance in progress that separates the various peoples of the world.

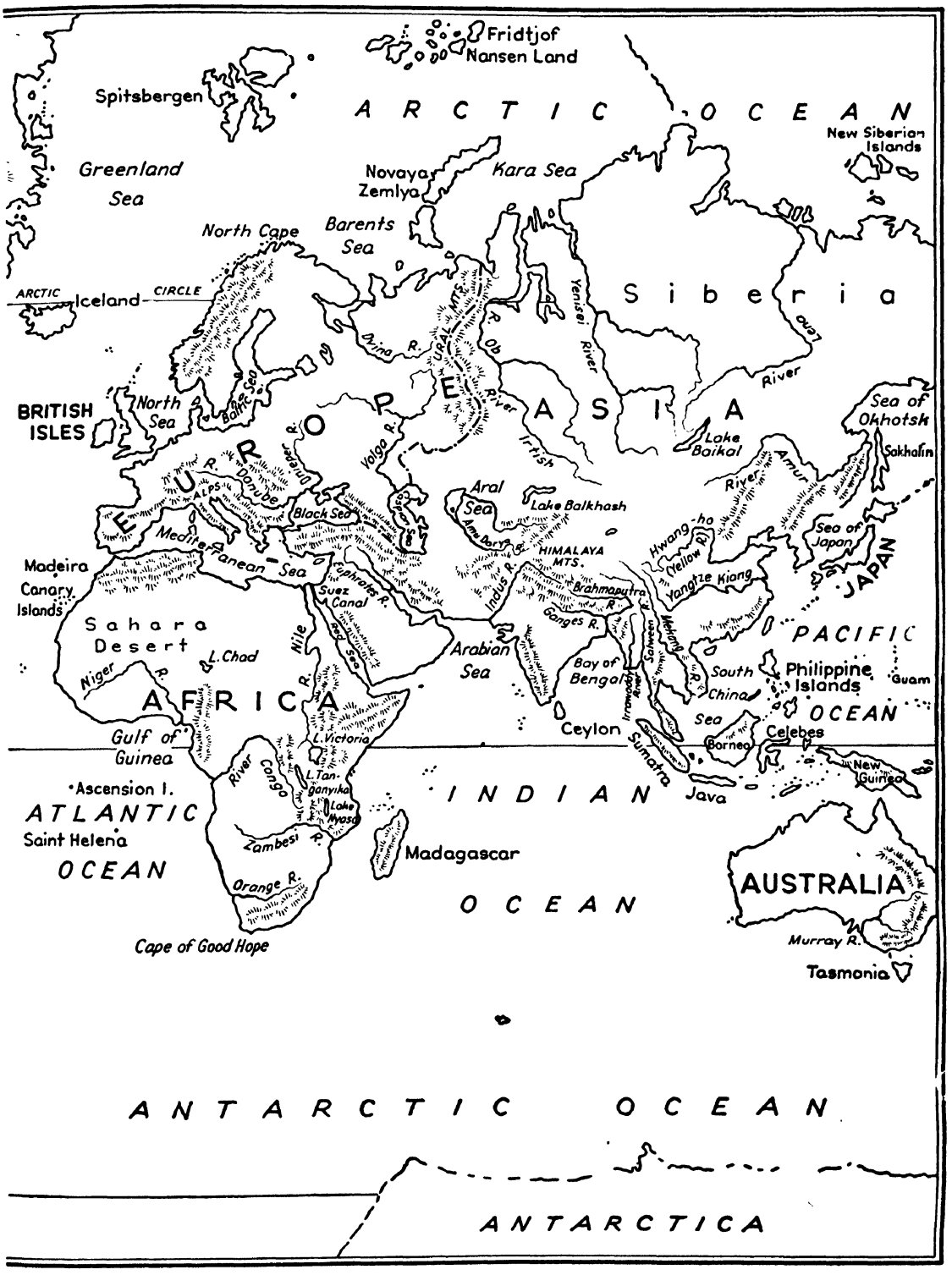
More than twenty centuries have passed over the whole planet since the beginning of the Christian Era, and all of this time civilization has been growing, developing, changing. Yet, to-day there are places in the twentieth century world where time seems to have stood still, and the people live in much the same way that our ancestors did, hundreds, or even thousands, of years ago. We find, in parts of China and in other countries, farmers using wooden plows of a type that was used in Europe eight hundred years ago; yet these same farmers may wear clothing made of cloth woven by the latest type of electric machinery. We find the Laplanders living in tents of reindeer skin, while not far away, in Sweden, people live in houses with all of the most modern conveniences. Australia has a highly developed modern civilization, yet back in the wild interior of the continent there are tribes who are still living in the Stone Age; that is, they have not yet learned to make use of metal, but make their spears and other tools and weapons of stone or wood.

We shall read of the great civilizations which flourished thousands of years ago in Persia and Assyria, Babylonia, Egypt and Ur of the Chaldees. When these countries

THE EARTH—FIFTY MILLION SQUARE MILES

This map shows the surface of the earth and its division into land and water. The polar land boundaries have not been finally mapped, but the whole surface of the earth is about 197 million square miles, of which about 50 millions are land. Europe has 3,750,000 square miles, and a population of 550 millions. Asia is four and a half times as large as Europe, with almost a billion (1,000,000,000) people. Africa is three times the size of Europe, with

OF LAND ON WHICH 2,000,000,000 PEOPLE LIVE



150 million people. North and South America are four times the size of Europe, and have about 270 million people. Oceania, including Australia, is nearly as large as Europe, but has only about 10 million people. The oceans, covering about 147 million square miles, occupy over 80 per cent of the southern half of the world. The Pacific covers about 68 million square miles, and the Atlantic about 41 million square miles.

were at the height of their greatness, western Europe was a land of endless forests, inhabited by a few savage tribes, and America was not even known to exist. As the centuries passed civilization moved westward, and to-day, those ancient lands, after a long period of decay, are receiving new light and new life from the civilization of the once barbarous West.

GREAT CIVILIZATIONS RISE, THEN VANISH INTO TIME

All of life is like this, the old and the middle-aged and the new existing side by side, just as, in human society we have little babies, teen-age boys and girls, grown-up people and very old people, all living at the same time, and each one being an important part of the big family that we call the human race. Thus we see that all of life and all of human history is a great tapestry woven of many threads. The same threads do not all reach the whole length of the tapestry; new ones are continually being drawn into the mesh and interwoven with the old to make an everchanging picture. The tapestry is still being woven, and even as we watch it, more figures and colors are added, and the fabric on the loom of Time grows ever longer. We are so close to its growing end that it is difficult for us to see the far-off beginning of the tapestry.

We are reminded of that old story of a traveler through Time, told in a book which was written seven hundred years ago.

In passing one day by a very ancient and extremely populous city, I asked one of the inhabitants who founded the place. He replied: "I know not; and our ancestors knew no more than we do on this point." Five hundred years afterwards, passing by the same place, I could not perceive a trace of the city. Inquiring of one of the peasants when it was that the city was destroyed, he answered me: "What an odd question! This country has never been other than you see it now." I returned there after another five hundred years and I found a sea. I now asked the fisherman how long it was since their country became a sea, and he replied that I ought to know it had always been a sea. I returned again after five hundred years; the sea had disappeared, and it was now dry land. No one knew what had become of the sea, or if such a thing had ever existed. Finally, I returned once more after five hundred years, and found again a flourishing city. The people told me that the origin of their city was lost in the night of time.

This story shows how Time covers up the history of mankind, so that all that we know of the past is only a small part of what has actually existed. In our story called Digging Up the Past, beginning on page 6763, we tell how some of the buried cities and lost civilizations have been found, and the manners and customs of their people traced through the records they left behind them, carved in stone, or impressed on clay tablets, or painted on the walls of tombs. It is a strange thing to consider, that because so much of the knowledge and history of our own times is recorded only upon perishable paper, or celluloid film, the men of thousands of years from now may know less about our life than we know about the life of the people of ancient Egypt.

NO NATION IS ENTIRELY GOOD OR ENTIRELY BAD

As you read the stories of the different countries and peoples of our world, there is another very important point to remember: that no single country is made up entirely of good people, and that no country is made up entirely of bad people. Wars come and go, whole nations sometimes behave very badly, just as men and women and boys and girls sometimes give way to selfish, greedy or mean impulses, but in the long run, all nations are made up of people with the same hopes and ambitions, fears and responsibilities: sometimes doing noble, unselfish deeds, and sometimes doing evil deeds.

Each country has given something to the sum of beauty and knowledge of the world. Music and art and science do not observe political or geographical boundaries, any more than do the sunshine and the rain. For this, if for no other reason, we should learn all that we can about the other peoples beside ourselves that make up the world. The more we know about the people of other countries, the better we shall be able to understand and appreciate our own country and our own people, for the people of the United States and Canada, and, indeed, of all the American nations, are the inheritors of many national and racial gifts. We must preserve and increase all that is worthwhile of this rich heritage, and discard all that is unworthy, if we are to build a truly great civilization for future ages.

HOW GEOGRAPHY HELPS TO SHAPE THE HISTORY OF NATIONS

As we read about all of these countries, we shall notice many differences as well as similarities, and it is interesting to note how much each country has been influenced and molded by the geographical surroundings of the people, by the climate, and by the kind of plants and animals and minerals that

each contains. The fact that England is on an island, and all of her dealings with the rest of the world have had to be carried on by way of the sea, has had a strong influence on the destiny of her people and on their way of life. Italy's situation in the midst of the great inland sea, with easy access to Asia and Africa, long centuries ago made her cities busy centers of trade, both in goods and in ideas; while the whole of Russian history shows the effort of a landlocked people to reach the shores of the seas, which were for thousands of years the only really convenient highways of trade and communication.

THE MEMBERS OF THE BIG WORLD FAMILY WE SHALL MEET

All of these people, we must remind ourselves, besides being Russians and Swiss and Bolivians and Hollanders and Chinese, are members of the great human race. Most of the differences between them are on the surface, and only serve to make them more interesting to study. In some parts of the world, this human race is so thickly spread over the country that it is difficult to raise enough food for them all. In most of China, and in Japan and parts of India, every square inch of land must be cultivated with painful care. In Australia, on the other hand, every man, woman and child might have a square mile all his, or her, own.

You will visit, by means of the stories and pictures in these books, the prairies of Canada, the tropical forests of the West Indies, the coral islands of the Pacific, the cork forests of Spain, the sandy wastes of Arabia and the frozen peaks of the Caucasus. You will read about the ancient land of China, and picture the children flying their wonderfully shaped and painted kites; the gray industrial cities of northen Germany, and the villages of the Black Forest where, in the days of old, every villager worked at making toys for children all over the world.

YEARS OF PEACE WILL HEAL THE SCARS OF WAR

We shall not take you to many war-torn fields and towns, because war wipes out the things that are worth seeing and learning about. Wars must be fought when nations become dangerous and threaten the life and civilization of other nations, but in a book of this kind it is more important to find out about the normal, peaceful life that the people of the world lead when there is no world conflict to disturb the busy pattern of their activities. And so the scars of war are slowly healing. The children of Holland once more skate happily along the frozen canals to school and to play; the kindly French peasants tend their vines and cultivate their little fields; the fishermen of the warm Mediterranean and those of the North Sea may lay their nets without fear of bringing in among the silvery fish a deadly floating mine.

Over the curve of the earth the great, gleaming planes speed, once more carrying friendly, peaceful cargoes from continent to continent. The Hawaiians watch them come up from the liquid horizon without fear of treachery; the Australian guarding his flocks in the lonely sheep stations "down under" cheerfully waves the friendly planes on their way to China or France or the United States or Canada.

You have read how the wonderful advances of science and invention have brought the peoples of the world closer together, and have done away with the isolation of different continents and islands from the rest of the world. In times of peace this has been an excellent thing, though in wartime it turned out to be anything but pleasant.

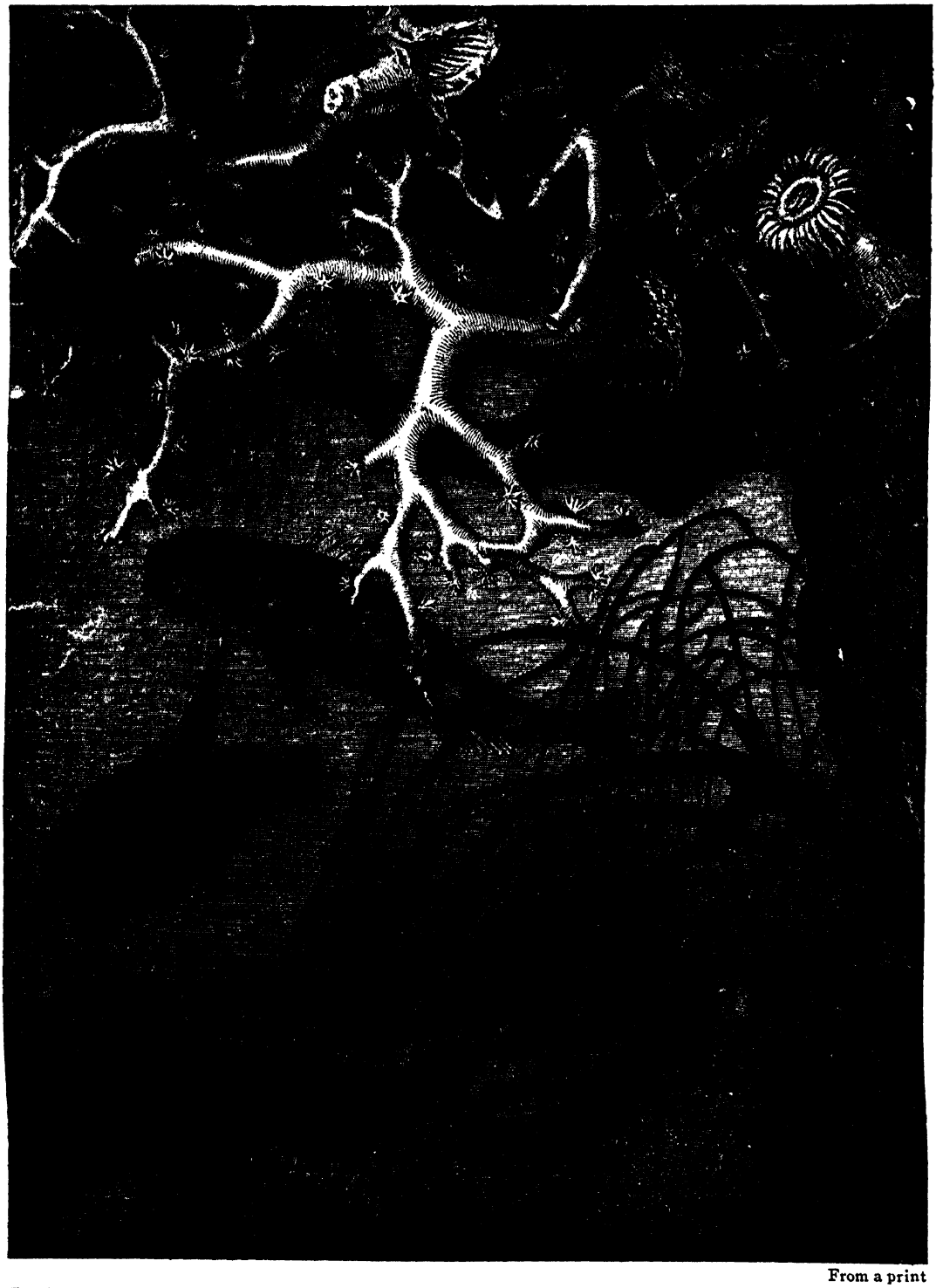
THE NATIONS OF THE WORLD COME CLOSER TOGETHER

As you read the history of the various countries, you will notice that, long ago, when communication between distant parts or the world was more difficult, a great many little wars might be fought in different parts of the world at the same time, but it was very seldom that a single cause would involve a great many countries in one war. You will see that each nation, as its story is brought closer to the present day, becomes more and more involved with other nations, in peaceful affairs as well as in war. Today the nations of the world are so interconnected that if one or two strong nations break the peace, the effect is felt in every country in the world. The world is really one big family now, and the good or evil that befalls one member is shared by the rest.

As you read this book, therefore, try to think of each country you read about as if it were your own. Then you will find that each country will seem more interesting and you will understand the problems of its people more clearly. This understanding will help you, when your turn comes, to promote a brotherly spirit, and to make this world truly a world of good will toward men.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 121.

LIFE THAT FILLS THE WATERS



From a print

In this picture we see various forms of life. The two fish and the octopus are not the only members of the animal family shown here. The "daisies" with thick stems in the upper right-hand corner are really living creatures called sea anemones. The antler-like branches at the top of the picture are coral branches—skeletons of millions of tiny animals called coral polyps. The star-like growths on the branches are clusters of living coral polyps. In the background you see a marine plant, under the branches of which the octopus lurks.

Courtesy, Federal Writers Project

LIFE THAT FILLS THE EARTH

WE all know that the earth is full of living things. We can see with our own eyes the animals that run about on the surface of the earth, the fish that dwell in the sea, the birds that cheer us with their merry song. The great oak tree is also a living thing. So is the waving blade of grass; so are the tiny animals and plants that are too small to be seen by the naked eye. Wherever we turn, there is life.

Yet we know that not all the things that we see are living things. The book that you are now reading is not a living thing. The table upon which you rest your book is not a living thing; neither is the coal in your cellar, nor the metal in your father's automobile, nor the rain that sometimes falls upon your roof.

In certain cases there is a certain relationship between living things and things that are not alive. The paper in your BOOK OF KNOWLEDGE is not a living thing, but it came from a spruce tree which was once very much alive. The coal in your cellar was once a living fern in a great tropical forest. What is the difference, then, between paper and the living tree from which it was made; between coal and the fern tree that flourished hundreds of thousands of years ago?

It is easy enough to say that there is life in the spruce tree and the fern and in all living things, while there is no life in nonliving things, like paper or tables or chairs. However, that would not be a very satisfactory answer.

What of the viruses, those incredibly small bits of matter that cause certain diseases? Scientists find that they sometimes act like living things, and at other times like nonliving things.

In general, however, we can show you how living things differ from things that are not alive.

First of all, they are different because their cells contain protoplasm. You see, all living things, from man himself to the tiny ameba, are made up of cells, which can be seen only through the microscope. Now, every living cell, whether it is one of the billions and billions of cells of a man or the

Pictures, courtesy, National Association of Audubon Societies

The many families of swift birds of the air are among the most interesting of living things.

single cell of the humble ameba, is filled with protoplasm.

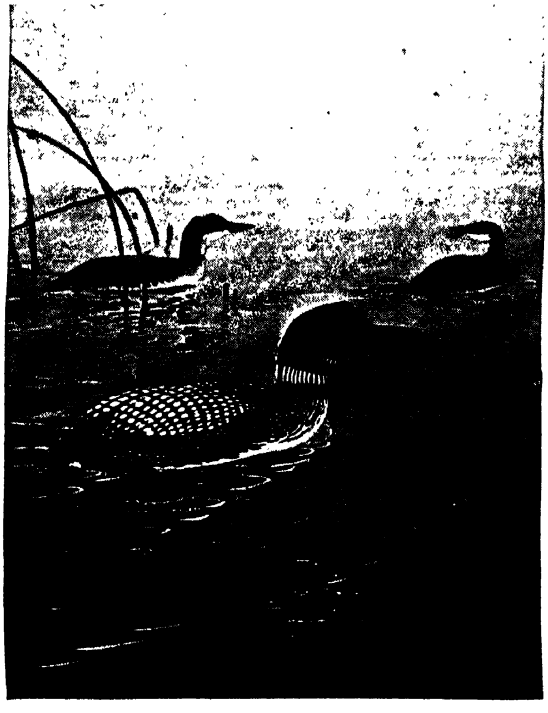
What is protoplasm? It is a jelly-like substance made up of a certain number of chemical elements, including carbon, oxygen, hydrogen, nitrogen and sulphur. Protoplasm, like water bubbling from a spring, is never at rest. All the changes that take place in the bodies of living things are due to its ceaseless activity.

When protoplasm dies, the cell itself dies, though the cell framework may remain unchanged for a very long time and may serve useful purposes. The cell framework of an oak tree, for example, may be made into a fine table. But, though the table may show the same arrangement of cells as the oak tree from which it was made, the table is not a living thing because its cells no longer contain active protoplasm.

Living things, then, differ from non-living things because they contain protoplasm. They also differ from non-living things because of certain activities that take place in the protoplasm. One of these activities is nutrition. It is the process by which an animal or plant takes in certain materials that surround it and changes them into body-building substances. This process must go on constantly if a living thing is to continue to live. We all know that if a man does not receive food for many days, he will surely die. A rose plant, too, will die if it is deprived of the minerals and the water and the sunlight that it requires for nutrition.

There is another wonderful activity that living things take part in. They produce from their own bodies new members of their species (that is, the particular group to which they belong). Men of science call this activity reproduction. The child, the chicken and the colt grow up to look like their parents. The plant produces seeds; if we put these seeds in the ground, they grow up into plants that resemble the original plant. Even the one-celled ameba reproduces its species.

Just think! With the exception, perhaps, of a few great trees, there is no living thing upon the earth that was alive two thousand years ago. All the living things that were alive then—fishes and flies and birds and flowers—are dead now. Yet the earth is still filled with fishes and flies and birds and flowers because of the wonderful activity of reproduction. Non-living things can not take part in this activity. It is too bad, we may think, that caramels and peppermints and lollypops can not give birth to little caramels and peppermints and lolly-



These loons are at home both in the water and in the air. Some birds can swim but can not fly very well. Some others can run but not fly.

pops; but, after all, they are not living things so they cannot reproduce themselves.

We now have some idea of just how a living thing differs from one that is not alive. Its cells are filled with protoplasm. It can draw nourishment from the things that surround it. It can produce new members of its species. If we bear all these things in mind, we shall have no difficulty in recognizing all the members of the great family of living things.

What a vast family it is! It includes over two million different kinds of living creatures. It includes man, the lion, the cow, the ape, the hippopotamus, the whale, the starfish, the fern, the bean, the buttercup and the water lily. The faithful dog, the industrious beaver, the deadly rattlesnake, the restless ant, the mosses and lichens that grow upon rock, the mold that forms on stale bread—all belong to the family of living things.

THE TWO GREAT GROUPS OF LIVING THINGS—ANIMALS AND PLANTS

As we have seen, the members of this family differ from things that are not alive; they also differ from one another. They fall into two great groups—animals and plants. When we speak of animals in this connection, we do not refer only to the four-legged creatures that we generally think of when we hear the word "animal"; we also include birds and fishes and sponges. When we talk of plants, we have in mind not only daffodils and ferns and roses, but also elm trees and yeasts and microbes.

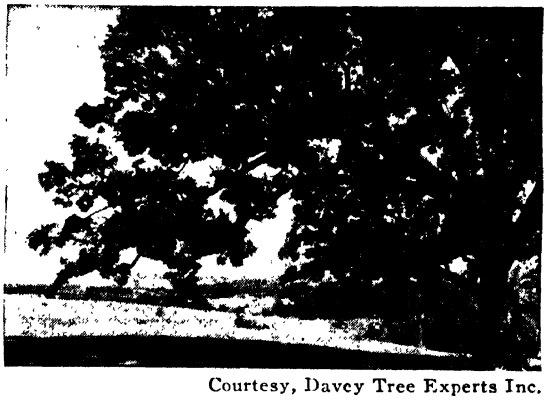
Just what is the difference between an animal and a plant? For one thing, the great majority of plants, including all the more highly developed forms, are fixed in one place, while animals, as a rule, are free to move about from one place to another. Again, animals feed mainly on living things —either other animals or plants. Most plants, however, feed only on non-living food, such as water, carbonic-acid gas, nitrate of ammonia, phosphates and so on. Finally, the cell walls of plants are formed of a vegetable fibre called cellulose; this substance is missing in animals. (On page 2747 we tell you about cellulose and the many ways in which it is used.)

THE DIVIDING LINE BETWEEN ANIMALS AND PLANTS IS NOT ALWAYS CLEAR

It is true, as we shall learn in other chapters of The Book of Knowledge, that some plants do things that we should expect only animals to do, while some animals closely

Courtesy, Quebec Tourist Bureau

A stone or rock is not a living thing.



Courtesy, Davey Tree Experts Inc.

A tree, though it does not move about, is alive.

Picture, Lazarnick

It is easy to see that an active child or playful young animal is alive.

resemble plants in their manner of life.

For example, the Venus's fly-trap, a plant that grows in bogs, actually traps and digests insects. Another plant, the one-celled diatom, often moves about rapidly through the water. On the other hand, such sea animals as the coral and the sponge are firmly attached to one place. They resemble plants so closely that they are sometimes called zoöphytes or animal-plants (*zoion* means animal and *phyton* means plant in Greek).

Living creatures like these, however, are not very common. In general, animals differ from plants in the ways that we have pointed out to you.

In The Book of Knowledge, we shall tell you a great deal about the family of living things. Man will be the central figure of our story. In the chapters of Our Own Life, we shall tell you about man's body, the food he eats and how his mind works. In the Department of Familiar Things, we shall tell you about man's great industries and about the marvelous things that he has invented—the telephone, the telegraph, the radio, the airplane, the microscope and so on. In still other books, we shall tell you about the different countries in which man has lived since the beginning of recorded history. We shall describe the great masterpieces of art and of literature that man has created.

We shall also have much to say about the other members of the family of living things. In the Book of Animal Life, we shall tell you about lions, bears, tigers, cats, camels, dogs, whales and all the rest. In the Book of Plant Life, we shall tell you the fascinating story of the growing things in the great plant world—from the tiny microbe to the huge sequoia tree—and we shall explain how plants serve mankind and the lower forms of animal life.

In the olden days, among their athletic games the ancient Greeks held torch races. A runner would carry a flaming torch as far as possible and as he fell exhausted out of the race another runner on his team would flash forward and grasp it from his hand and carry it onward, passing it to a third, and so on. The runner who first reached the goal-line with his torch still flaming won the prize, not for himself alone, but for the team. So each one of us receives life, and carries it on; and we are responsible for the torch of life we carry.

THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 255.

Saint George and the Dragon*

By HORACE E. SCUDDER

IN the country of Lydda in Asia Minor there was a town called Silene, and near the town was a pond, and this pond was the roving place of a monster dragon. Many times had great armies been sent to slay him, but never had they overcome him.

Whenever this dragon drew near the city walls, his breath was so full of poison that it caused the death of all who were within reach of it; and so, to save the city, it was the custom to throw each day two sheep to satisfy his hunger. So it went on, until not a sheep was left.

Then the people took counsel, and they drew lots, and each day a man or a woman and one of their cattle were given to the dragon, so that he might not destroy the whole city. And their lot spared no one. Rich or poor, high or low, some one must each day be sacrificed.

Now it came to pass one day that the princess herself was drawn by lot. The king was filled with horror. He offered half his realm if she might but be spared. All he could obtain was a respite of eight days, in which to mourn the fate of the girl. At the end of that time, the people came to the palace and said:

"Why do you spare your daughter and kill your subjects? Every day we are slain by the breath of the monster." So the king knew he must part with his daughter. He dressed her in her richest apparel, and kissed her, and said:

"Ah, my dearest daughter! what an end is this! I had thought to die and leave you happy. I hoped to have invited princes to your wedding, and to have had music and dancing. I hoped to see your children, and now I must send you to the dragon."

The princess wept and clung to her father,

*Reprinted from the BOOK OF LEGENDS, by permission of Houghton Mifflin Company, publishers.

and begged him to bless her. So he did, weeping bitterly, and she left him, and went, like those before her, to the lake where the dragon dwelt.

Now these people of Lydda were heathen, but in Cappadocia, not far away, was a Christian named George, a young man of noble bearing. He heard in a vision that he was to go to Lydda, and so he rode his horse toward the city, and he was hard by the lake, when he saw the princess standing alone, weeping bitterly. He asked her why she wept, and she only said:

"Good youth, mount your horse again quickly and fly, lest you perish with me."

But George said to her:

"First tell me why you weep, and why the vast crowd yonder are watching you."

Again she begged him to fly.

"Not so," said George; "I will first hear your tale."

Then she told him all.

"Be of good courage," said he. "It was for this I was sent. In the name of Jesus Christ I will defend you."

"I do not know that name, brave knight," said she. "Do not seek to die with me. You can neither save me nor yourself from this terrible dragon." At that moment, the dragon rose with a great bellowing from the lake. "Fly! fly!" said the trembling princess.

But George, nothing daunted, made the sign of the Cross, and went forward boldly to meet the dragon. He raised his spear, and flung it with all his force at the neck of the monster. So surely did the spear fly that it pierced the neck and pinned the dragon to the ground.

Then he bade the princess take her girdle and pass it round the spear, and fear nothing. She did so, and the dragon rose and followed her like a docile hound, and thus they entered the city. The people began to flee, but George stayed them.

"Fear not," said he. "This monster can no longer harm you"; and so the multitude followed, and they came before the palace, where the king sat sorrowing. And when the king heard the mighty rejoicing, he came forth and saw his beloved daughter, safe, with the dragon at her heels.

Then George took his sword and smote off the dragon's head, and all the people hailed him as their deliverer.

The Story of Beowulf*

ONCE upon a time, in the far north of what is now called Europe, there was a kingdom known as Geatsland, and its ruler was named Hygelac. It was a harsh country, with high mountains and narrow stony valleys, and it had a long seacoast with many harbors and inlets, and the men who lived there were famous for their bravery on both sea and land.

Now, for many years Hygelac ruled over his people with a stern but kind hand. Beside him was his queen, named Hygd, and called the Wise and Fair. About the king and queen were gathered the finest lords of the land. All were valiant warriors whose courage had been proved.

Among the number of youths who were in thrall to Hygelac was Beowulf, the son of the king's sister. As a small boy, Beowulf had shown such strength of body that Hygelac had early named him one of his thanes. So his mother and father gave him up, and young Beowulf went to live with his uncle, to learn the arts of war and the handling of ships.

For several years he led a lonely life, for so great was the strength of his limbs that even among those men of vast vigor he was a youth to be marveled at. As the years slipped by and he grew to manhood, he became more and more sullen in his strength, and his companions dubbed him "The Silent." His movements were clumsy. He tripped over his sword. He broke whatever he touched. The other youths laughed at him for his awkwardness, but in secret they envied the immense spread of his shoulders and the terrible swiftness of his stride.

When Beowulf had at last reached the full tide of his manhood, a feast was held one night in the king's drinking-hall. From all over Geatsland famous warriors and earls gathered at the drinking-benches of their king to hear the songs of the minstrels and take part in games and feats of strength.

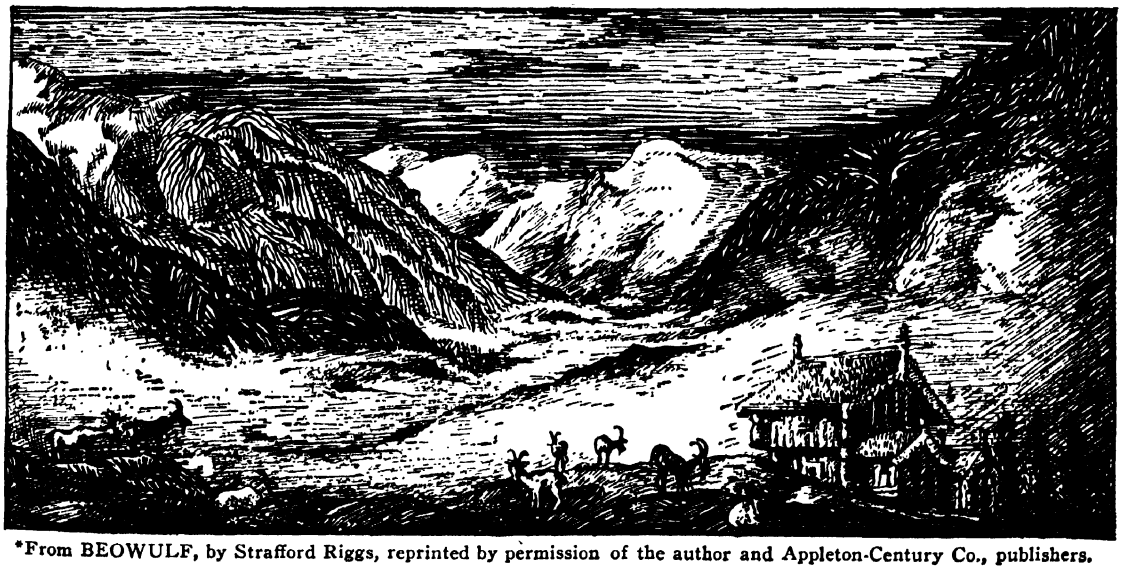
At the feet of the royal couple sat Beowulf, at a table especially prepared for the king's earls. But Beowulf, unmindful of the talk about him, sat in gloomy silence, brooding.

His strength was great, but there was no use for him to put it to, and he longed for wild adventure and the chance to stretch his muscles to the limit of their power.

Then, at a signal from Hygelac, the minstrel came forward with his harp. He was a tall rugged man, with a beard streaked with gray. He had the air of one who had traveled long distances, and his blue eyes were wide and fixed like one used to watching the far horizon.

Around him was wrapped a cloak of deep blue, held together by a curious clasp of gold. Beowulf, noting the clasp, thought it resembled a coiled snake, for there were two green stones set in it which glittered. This man, Beowulf thought, has been in far-away places. He will chant us a good song.

Then the Wanderer (for so he was called) sat down upon a wooden stool, threw back



*From BEOWULF, by Strafford Riggs, reprinted by permission of the author and Appleton-Century Co., publishers.

the cloak from about his arms, and with long thin fingers struck the resounding strings of his harp.

He sang in a sharp voice that was like the crying of birds on the gray sea, but there was a sweetness in it at the same time which held his hearers, and the lords of Geatsland leaned forward on their benches in eagerness to catch every word.

He sang of the vast and frozen North, where winter lay upon the land for many, many months, and men fought in the gloomy light of the night-burning sun.

He sang of endless forests stretching black and forbidding in a sea of snow; of mountains higher and bleaker than the highest mountains of Geatsland; of the strange and fearful demons that inhabited this ghostly region.

Then the tune of the Wanderer changed. His voice fell to a lower note, and he sang of Hrothgar who was king of the Danes, that country not far from Geatsland, across the water.

He told a sad story of desolation and despair in Hrothgar's land, because of a beast which had struck mortal fear into the hearts of the lords of Daneland. For on one cruel night, twelve years before, there had come a monster, part animal, part man, part bird. The lords of Daneland were sleeping soundly, and the monster, who was called Grendel, had forced open the solid doors of the king's hall and carried away in their sleep thirty of the greatest earls of the Danes.

There had been lamentation throughout the land, and many were the attempts to slay Grendel, but none had succeeded. And for twelve long years Grendel repeatedly visited the king's hall and wrought destruction there. Now the land was despoiled of its youthful strength, and there remained to the king only those fighters whose early vigor had long since passed, and Daneland had become a country of old men and defenseless women.

Now, all the while that the Wanderer was singing, Beowulf sat as one bewitched.

He leaned forward upon the table, his arms folded under his still beardless chin, his eyes fixed upon the minstrel. Now and again he lifted his head and shook out the fair hair that hung beneath the golden band encircling his wide white forehead. The huge bracelets that weighted his wrists gleamed like his eyes, and the jeweled collar about his throat was tight because of the swelling veins of his neck. One thought possessed him:

He would seek out this monster, Grendel, and slay him—yes! slay him with bare hands!

He saw himself face to face with the monster Grendel, and suddenly a wild cry broke from his lips and he leaped from his seat.

"Lords of Geatsland and earls of Hygelac," he shouted, as the minstrel finished the song, "I am the son of Ecgtheow and of Hygelac's sister, and in olden times this Hrothgar was a war-brother of my father. Therefore I claim kinship to him, and I will go to the land of the Danes and I will slay this Grendel!"

Then there was great confusion in the hall of Hygelac, and the earls called to one another, and dogs barked. But Hygd the queen stood up amid the turmoil, and holding a jeweled cup in her two hands because of its weight, stepped down to where Beowulf was, and offered him the cup, and smiled at him in affection.

Once again Hygelac commanded silence among the guests in the drinking-hall, and turning to Beowulf said:

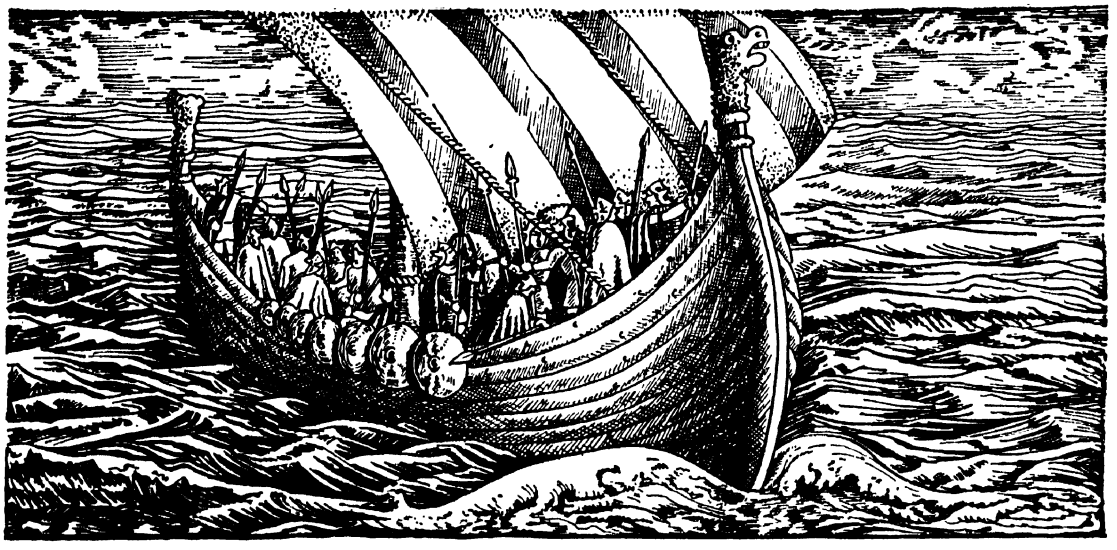
"The time has come, O Beowulf, for you to prove your worth. The gods have gifted you with the strength of thirty men, and this strength you should use to the advantage of your fellows. Our neighbor Hrothgar is in sore need. Go forth, then, from Geatsland to the land of the Danes, and do mortal combat with this Grendel-fiend."

For seven days and seven nights there were great preparations in the halls of Hygelac the Great, that Beowulf might go on his adventure fully equipped for whatever awaited him in Daneland. From the group of companions who had come to manhood at the same time as himself, Beowulf selected fourteen earls to accompany him. He had wished to go alone to the land of the Danes, but his uncle the king had commanded that he be suitably companioned on such a voyage, so that at the court of Hrothgar it could not be said that Hygelac had sent the youth upon a fool's errand and badly equipped.

Special shields were made, of stout wood covered with thick hides and bound with iron and studded with golden nails. Rich cloaks of scarlet and blue there were for the warriors, and massive bracelets of fine gold for their arms and wrists, and collars of gold wire.

When at last they stood ready in the mead-hall of Hygelac, they were a fine company of young men, whose like was not to be seen in all the countries of the North. Each stood well over six feet in height, with broad shoulders and sturdy legs; and each was swift as a deer.

Then came the signal for the journey down to the beach where a ship lay in readiness to



receive Beowulf and his earls, and with torches flaming in the grayness of approaching dawn, they departed.

They came at length to the coast of Daneland and the sea boiled white between them and the land, and the land itself was scarred and pitted with a thousand narrow inlets, which were treacherous to seafarers unfamiliar with them. The forests that clung to the shore line were half hidden in gray mists that moved and twisted like smoke about the trees, but as the storm lessened, they beached their boat on a tiny strip of sand at the edge of a deep forest hung with gray fog and silent as death.

That night, after Beowulf and his companions had rested, for the first time in twelve years there was a great banquet in the hall of Hrothgar. The place was decorated with fine hangings, the gold-bright roof burnished until it shone like the sun, and the benches had been scraped and polished by many willing hands. Huge fires were built on the hearths, and the smell of roasting meats pervaded the hall.

The fires were burnt out on the hearths when the last of Hrothgar's train had departed. Then Beowulf and his companions set themselves to fastening tightly the door of the hall. They secured it with wooden bolts and tied it with leathern thongs, and so strong was it that no mortal could have passed through.

Then the warriors of Geatsland unfolded their cloaks upon the benches and laid themselves down to slumber, and Beowulf stretched his great length upon the dais of the king, and resolved that through the long night he would never once close his eyes. Near the door lay the young Hondscio, Beowulf's favorite earl, who swore that if anyone broke through the door he would be the first to give the intruder battle.

Silence crept over the shrouded forms where they lay upon the floor and benches, and there was no sound save their steady breathing and the faint sighing of the night-wind in the trees about the hall.

Beowulf, upon his couch, lay still as death, but his eyes moved here and there in the deepening gloom of the hall.

Outside, a fog was creeping up from the sea, obscuring the moon in milky eclipse, and at last there was not even the sound of the wind in the trees. To Beowulf the deep silence seemed full of moving things invisible to human eyes.

Gradually there came over him a kind of drowsiness that he fought to ward off. His eyelids fluttered against his eyes, and then he swooned with a sleep that lay upon his limbs like a heavy garment.

But suddenly there was a rustling among the wet trees, and a noise like the deep grunt of a pig, but soft and low, startled the fog-bound night, and the drops of mist-water on the trees fell sharply to the ground like heavy rain. Then the fog parted evenly, and in the wide path it made through the night a Shadow loomed gigantic in all that was left of moonlight.

Slowly, slowly it neared the great hall and

the night shuddered at its coming, and behind it, as it moved, the fog closed again with a sucking sound. And the Shadow stood before the great door of the hall, and swayed hideously in the ghastly light.

Within there was a deep stillness, and Beowulf and the Geatish earls slept soundly, with no knowledge of what stood so evilly beyond the door. For the monstrous Shadow was the fiend Grendel, and standing there in the fog-strewn night he placed a spell upon those who slept to make them sleep more soundly.

But Beowulf hung between sleeping and waking, and while the spell did not completely deaden his senses, it so ensnared his waking dream that he fought desperately against it in his half-sleep and was not quite overpowered.

Little by little the thongs that secured the door gave way, and the huge wooden bolts yielded under the pressure that was strained against them, but no sound broke upon the silent struggle that went on between Grendel and the door.

Beowulf tossed and turned in waking, but the other earls of Geatsland fell deeper and deeper into the swooning sleep.

Then with a rush, the door flew wide, and the fog and salt-smelling night swept in. And in the doorway, swaying this way and that, stood Grendel, huge and dark against the dark night, the fog weaving about him in white veils, and the door of the hall limp on its hinges.

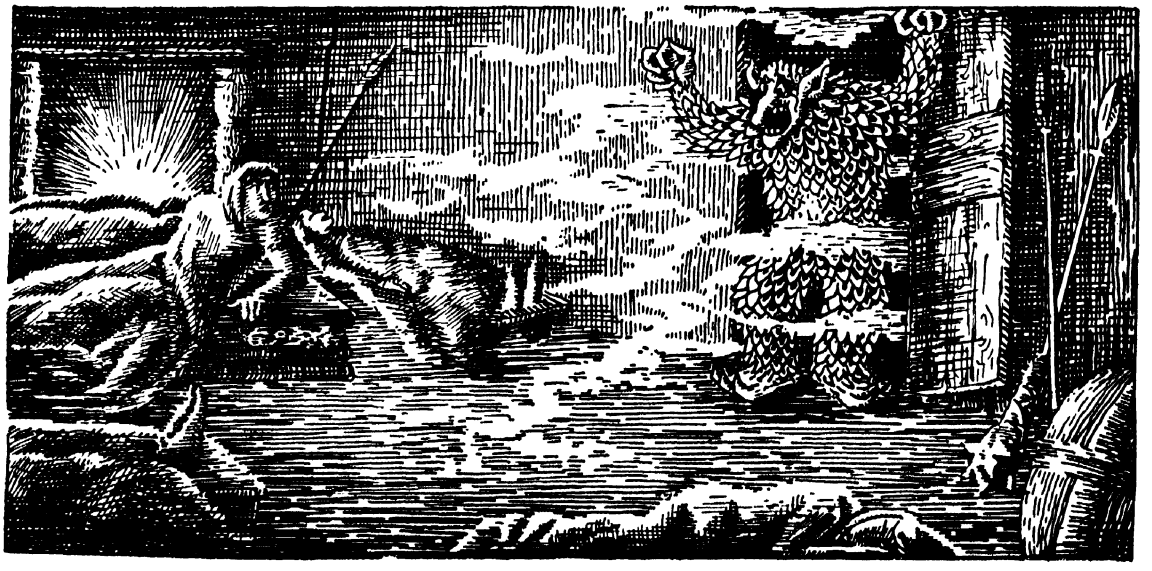
And Beowulf came out of his dream-spell and saw what stood so vast and evil in the doorway. But his eyes were heavy with the spell that clung to him as the wisps of fog clung about the body of Grendel, and only slowly was he able to distinguish the monster. Through his nightmare, now, there came the sense of what had befallen him, and he strove to cast the last remnant of the magic from him as he saw the great form of Grendel swoop down upon the innocent form of young Hondscio, catch him up in enormous hands, and tear him limb from sleeping limb.

And now at last Beowulf saw what manner of thing this Grendel was. His legs were like the trunks of trees and they were covered with a kind of gray dry scale that made a noise like paper as the fiend moved this way and that. The body of the beast was shaped like that of a man, but such a man as no mortal eyes had ever before beheld, and the size and shape of it were something to be marveled at.

The head was the head neither of beast or man, yet had something of the features of both, and the great jaw was filled with blunt fangs that ground the bones of the unhappy Hondscio to pulp. Shaggy matted hair hung over the low forehead, and the eyes in the face of Grendel were the color of milk.

Horror-struck upon his couch, Beowulf felt his limbs in thrall and could move neither leg nor arm to raise himself as Grendel devoured the body of the young Hondscio.

And when Grendel had finished his horrid meal, the beast straightened a little his vast form and looked now to the left, now to the right, until his gaze fell upon the length of Beowulf. Then the milk-white eyes burned with a dull light that was like the light of



the moon, and slowly, slowly Grendel moved toward the dais.

But Beowulf, stung with loathing, leaped from his bed.

Silently they fought in the fog-strewn hall. Silently their bodies twisted and bent, this way and that, and Beowulf kept Grendel's huge hands with their long claws of sharp bone from him, and Grendel in turn sought to tear apart the quick body that slipped so easily through his arms and legs.

Their bodies wove in and out among the sleepers, and Beowulf felt the hot reek of Grendel's breath upon his cheek, and the sweat stood out on Beowulf's broad brow and ran down into his eyes and blinded him. And Grendel's huge hands sought over and over again to clasp his opponent's head, to crush it in their grip.

Then the fight became a deadly struggle in one far corner of the hall, and neither one gained any advantage over the other. Then Beowulf slipped. On the earthen floor they fell together and the force of their fall made the earth tremble.

But Grendel's hold lessened, and fear smote the heart of the fiend. He strove only to free himself from Beowulf's grasp and flee into the night away from this white youth whose strength was the strength of thirty men.

And now Beowulf had the upper hand, and flew at the giant's throat. But here his hands clutched at thick scales upon which he could get no grip. Grendel nearly took the advantage, but before he could seize Beowulf, the lord of Geatsland had fastened both mighty hands upon the monster's arm, and with a sudden twist that forced a groan of agony from Grendel's lips, leaped behind him.

Now came the final struggle, and sweat poured from Beowulf, while from Grendel there oozed a slimy sap that smelled like vinegar, and sickened Beowulf. But he clung to the monster's arm, and slowly, slowly he felt its great muscles and sinews give way, and as his foot found Grendel's neck, he prayed to all the gods for help, and called upon his father Ecgtheow for strength to sustain him in this desperate effort.

And the mighty arm of Grendel gave way in the terrible hands of Beowulf, and, with a piercing shriek that shook the gilded rafters, Grendel stumbled forward, leaving in Beowulf's hands the gory arm.

Beowulf fell back upon the dais, the bleeding arm of Grendel in his hands. And Grendel, with a prolonged and ghastly wail, his blunt fangs gnashing together in dumb fury, stumbled toward the door, and before Beowulf could recover, the fiend was away into the fog which swallowed him as surely and completely as though he had plunged into the everlasting sea.

THE NEXT STORIES ARE ON PAGE 201.

WHAT THIS STORY TELLS US

WHO shall count the treasures of the world that men have made—the lovely things that have come down to us through the ages? Nature has filled the earth with beauty, and in the dark hours of the world it is good to remember that spring and summer have never failed to come, that the violet and the daffodil have never failed to bloom, that June will bring red roses and lift up the hearts of men. And man, too, has made a glory in the world not unworthy to compare with nature in her glory. It is good to think of all the heritage of art that comes to every child alive, of the gems that pack our museums, the glory that enriches our great galleries, the old cathedrals that stand to witness man's faith in his Creator—a faith that has never been lost. Here we shall read of the most beautiful things that men have made—pictures and statues and buildings from all ages and all lands.

THE RICH TREASURE THAT IS OURS

THE art of the world is a glorious inheritance of which we can never be too proud, and it is our very own

The great pictures of a nation may hang on the walls of public galleries, but every time we go and look at them it is as if we stamped them with our own names. They thus become our private collection—a treasure-house of lovely things that time cannot wither nor custom make stale. And, by a beautiful magic, the more miserly we are, the more we gloat upon our treasures and count them over, the richer we become.

Michelangelo.

The world showers these gifts upon us. It is not only in our galleries and museums, in great paintings and sculptures, that we find things to gladden our eyes. Art is with us everywhere. We can scarcely walk by a bookseller's shop or a pottery store or a jeweler's window without being face to face with something we owe to the art of the past. It may be a picture painted and reproduced yesterday, an enamel or china bowl fresh from the maker's hands, but its beginnings lie in the remote civilizations of the world. It may be a beautiful doorway or a pedestal of modern construction, but a stone was first used this way thousands of years before Jesus was born. The art of to-day is the inherited sense in large or small degree of the art of all time.

So that our treasure, our inheritance, is twofold. For centuries upon centuries the nations of the earth have been creating and storing up lovely shapes and colors that are our joy to-day. These are a historic possession. And every year that passes, beautiful things are made which owe their origin consciously or unconsciously to this historic possession; and in these we are again enriched. In art, more than in any other province of the world's history, we are indeed the heirs of all the ages.

Surrounded as we are by innumerable expressions of art, we are apt sometimes to confuse an inspired picture with its imitations, and to take for great what is clever but inferior. We need some standard by which to set our judgment, and we find sooner or later that the Old Masters are the best of all teachers.

A picture or a statue is not necessarily good because it is old. A great deal of ancient art is treasured mainly because it is a living emblem of a dead

civilization, and illustrates for us the story of a race that is gone. But there are certain paintings and sculptures which can be taken as great art, the work of the loftiest genius the world has known, and they hold their proud place, not merely because of their age, but because generations of men have judged them great.

THE THREE CHIEF CLASSES OF THE GREAT ART OF THE WORLD

In the minds of some people there is at first an unwillingness to take the opinion of another, even of generations of men. And often, if some of us were courageous and sincere, we should confess that we preferred some of our familiar little everyday pictures to the paintings of a Titian or a Botticelli. This is, perhaps, because we have never had an opportunity of studying art seriously enough. It takes two to make a picture, one to paint it and the other to look at it. A great picture is the subject the artist painted plus the secret he painted into it. Until we understand something of that secret we cannot fully appreciate our magnificent inheritance.

The great art of the world—the art which has passed the ordeal of centuries of criticism—falls into three chief classes: painting, sculpture and architecture. Architecture, indeed, may be called the parent of all art, because for a long time pictures were made only to decorate spaces on walls, and they were painted on the fabric of the building itself; the framed picture is a comparatively modern adaptation of the colored wall-panel. And statues were chiseled to adorn niches in temples and palaces, or figures cut in low relief to make a long frieze pattern.

THE FEELINGS THAT INSPIRED THE WORLD'S GREAT PICTURES

Whatever it may be, sculpture, painting or architecture, this work of the Old Masters has a kind of family resemblance, in that it owes its birth to an instinct common to its kindred. In almost every case it was inspired by one of the great emotions of the human heart—love, sorrow, reverence or worship—and without some such feeling no great art is ever conceived.

Love has inspired more pictures than any other human emotion, but love bears a very wide interpretation. There is physical love—the love of husband, wife or child; love of the mind—the love of abstract qualities, such as truth, courage; spiritual love—the love of God and of the earth, which poets call the garment of God. The pictures inspired by sorrow are fewer, but stir our feelings intensely, because every one of us has had some experience of sadness, some touch of tragedy.

Love, sorrow, worship—in a way the greatest of these is worship, which holds in itself all three. Worship painted pictures, carved statues, built temples and cathedrals, and made them greater than man because they held a sense of Godhead, of eternity inclosing time as the universe incloses the earth.

If we think seriously of any picture the world calls great, we shall see that its theme is one of these powerful emotions; and any work so conceived, even if poorly executed, has in it the seeds of greatness because it strikes at the heart of the human race. This basic feeling, however, is, so to speak, the foundation, the framework and not the finished edifice. It is the subject the artist painted minus the secret he painted into it, which some of us spend our lives trying to discover. The secret was his own imagination and sense of beauty, and therein lay his final and unapproachable greatness.

THE FEELINGS OF THE SOUL THAT ARE PERFECTLY REAL

We ask what is beauty, what is imagination, and no one can find an answer. We know where beauty and imagination are revealed, in form and color, which satisfy the soul as food satisfies the body; but their nature is hidden deep in the mystery of life. We can think of them as senses of the spirit, as real as are the physical senses of sight, hearing, touch, taste and smell. Just as our ears record the sound of a piece of music, and our eyes register an impression of the shape of a piece of stone, so these spirit-senses "feel" the vision of perfect sound that makes the music beautiful, the vision of perfect contour that makes the stone a lovely statue.

Beauty and imagination reach out beyond the actual to the ideal. For instance, thousands of artists have drawn portraits of old women. Rembrandt drew the portrait of an old woman, and it is one of the greatest things in the world. Why? Because, while through his sense of sight he recorded the features, by his sense of beauty and imagination he re-

corded something infinitely wonderful: not the face of one old woman, but the lovableness, the dignity, sorrow and other-worldliness of old age of all time.

Hundreds of men have painted landscapes and put on to their canvases the glow of the sun and the radiance of the sea. Turner painted that same glowing sun, that same radiant sea, but his sense of beauty, his imagination, reached out to an intangible, heavenly glory, and so he put into his pictures "the light that never was, on land or sea, the consecration, and the poet's dream."

THE PARTHENON, SHAKESPEARE'S PLAYS AND A GREAT SONATA

These spirit-senses of beauty and imagination are powers which the human soul has developed through thousands of years of effort to express itself. All art, poetry and music are forms of self-expression. Next to bodily needs, such as food, shelter, clothing, the need of self-expression is one of the most powerful of human instincts.

Only a few in each generation are born without it. Almost every man is moved by it to the doing of certain kinds of work on which he can stamp his own individuality. It is that which makes a child set up an erection of sand with patience and care, and then say, "*I* have made a house." It is that which built the Parthenon and wrote The Winter's Tale and composed the "Pathetic" sonata. We are told by Indian mystics that it was because of God's desire to express Himself that He created the world—flung from Him a whirling atom. Upon that atom, grown huge and populous, we live and are trying to express the beautiful, which, in the end, is God.

THE GREAT HUNGER OF MEN FOR EXPRESSING THEMSELVES

Art is the very earliest form of this self-expression. Before men could read or write, while yet their clothing was the skins of animals, they could draw. They rendered the objects about them in the simple way a little child would draw its pet kitten on a slate to-day. They drew in their idle moments, when the chase was over and the food had been broiled and eaten by the cave fire. Between those early efforts and the art which to-day is so high a calling there is a great gulf fixed. Thousands of years are needed to span the gulf, and during that time, while whole civilizations rose to power and died, the craving to express himself in beautiful imagery became a spiritual hunger in man's heart.

To look back on the art of the world is, in a way, to see the story of the growing pains of this æsthetic life which is now our pride and our great joy. The early art of the world was centred round the several religions of the human race, and for a long time the sense of beauty was small and stunted, held back by false ideals. Imagination went astray, and the gods men portrayed in their sculpture as high above humans, were often only decorated puppets.

But while his soul was thus struggling in the half-light, man was finding more power in self-expression. In each passing century art was more noble than before, lost more of the things that do not count, and grew to be a very real part of the life of a nation. Soon it came to pass that men were born whose imagination and sense of beauty were of such power as to override all other instincts. These were the men we call geniuses, in whom the inward feeling for self-expression in lovely imagery became a driving force that pushed a wedge, so to speak, through the history of their day.

NATIONS THAT FEEL DEEPLY, AND NATIONS BLIND AND DEAF

To these gifted ones art mattered more than food or clothing; they spent their lives working out their ideals of purity in line and color. These were their secrets, their inner dreams, to which they gave form in their painting and sculpture. But nations, like men, are different one from another; some races have been sensitive to beautiful impressions, and others have been blind and deaf. The spirit of beauty and imagination filled one people—the Greeks—as if they were one man. The soul of Greece was loveliness. There has never been another nation to whom art was so truly a part of life.

Even in Greece there were generations that fell short of the best. A sense of pure beauty comes to a race only in its flowering time; when the soul of a people withers and droops, the art it expresses becomes unlovely and false. Nature is not generous in granting perfection. It is, perhaps, because artists have always dreamed of realizing perfect beauty that genius is called the sorrowful gift, always urging the soul to express the inexpressible, to attain the unattainable.

But it is not only artists who yearn for the vision beautiful. Almost every man, woman and child has inherited, in some degree, the instinct which is the beginning of art. And therein, as soon as we realize it, lies a wonderful happiness. It is because we have in our own souls—we who have never painted a picture or carved a statue—a latent sense of beauty and imagination that we are moved by great art. For this reason, we stand spellbound before a picture and go away haunted by its lines and colors. It is not necessary for us to understand the subject of the picture. We see something beautiful and it calls to something beautiful in us.

WE ARE ALL DESCENDED FROM THE GENIUSES OF THE WORLD

We are all, in a way, descended from the geniuses of the world, and the longer we live, the more we cultivate our sense of beauty, the more shall we show the marks of our breeding. There is scarcely a child born into the world who does not carry in himself the seeds of greatness. And the reason the greatness so rarely flowers is due to the accident of circumstance, upbringing, surroundings. So that we are in the state of knowing in our inmost souls what beautiful sound is, and being unable to express it in music; of realizing dimly what color is, and of being helpless when someone offers us a palette and a canvas.

Art says for us the things we cannot say for ourselves. As our feeling for beauty grows we realize that artists speak for us in other ways than simply presenting shape and color. Art gives speech to the dumb emotions of the soul.

Great happiness or great sorrow seals our lips and keeps us dumb; but as we look on great pictures and sculptures we find that happiness or that sorrow portrayed forever by someone who had the power to speak it out.

ART RUNS THROUGH THE WHOLE WORLD OF THOUGHT AND FEELING

And in little ways as well as greater ones, we owe to lovely things the expression of ourselves. There is not any part of thought or feeling that art does not reveal. It is as if beauty and imagination, like pagan goddesses, immeasurable in their power, had thrown over the world a fine-meshed net, and caught all the outward-flying fragments of human wishes and hopes and held them forever in a golden web. And so we come to see that great statues and pictures are more than lovely shapes and colors: they are beautiful dreams come true, heavenly visions crystallized in stone. They are the sum of all that is best in the mind and heart and soul of the human race. They are a fragment of bygone time and yet a piece of to-day and to-morrow. They are the great fulfillment of all the longings of each man's soul, the ideals and hopes that flit to and fro in the mind, the loveliness we yearn to possess. Once and for all, the senses of beauty and imagination have seized the fleeting raptures of daily life—the dawns that are full of little angels' wings, the sunsets that are full of spring flowers, the hours when earth is very near to heaven.

And we may be quite sure that a picture which does not stir our own imagination, which does not make us conscious of other qualities than color and shape—of the artist's secret, in fact—is not great. It may be a pleasant and attractive subject, but if it ends in itself it will die. It is the secret of art forever to tantalize us with its secret.

THE THRILL OF THE FIRST MAN WHO DREW A BEAUTIFUL THING

Art, we know, has been present as a living force in the world for some sixteen thousand years, but it is still as mysterious a presence as it was to the first man that drew a beautiful thing and thrilled with the thought, "*I* have done that." Art has become, in a way, a great science. It has hundreds of handbooks. And yet it is a fairy tale. Whoever makes it his career must study long and hard; yet he can do nothing without his elusive dreams. For when painters have spent rich years in learning and toil, and have grown great, they are still what the unlearned artists of old were: magicians who make the world a garden.

The work of these inspired ones of yesterday and to-day lies scattered about the world like flowers which bloom forever. We cannot think how bare our lives would be lacking these blossoms. Color, shape and line—finely drawn faces, lovely forms, green fields and tossing seas—are brought within the range of our stay-at-home eyes by means of great art. We should never count an hour wasted that is spent in looking at these treasures, for every time our hearts are moved by beauty, our souls are marching on.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 189.

THE EVERLASTING GLORY OF ART

Art, the expression of the love of beauty in the soul of man, is the glory of the world throughout all ages. Here we give a few examples of the treasures men have created for all mankind to love. They show art in various fields, as: painting, sculpture, mosaic and metal work.

THE VIGOROUS HEAD OF MICHELANGELO'S GIGANTIC STATUE OF DAVID, IN THE ACADEMY IN FLORENCE

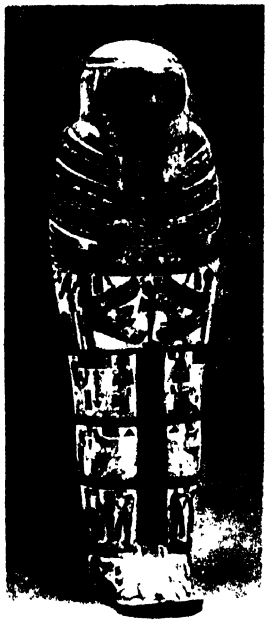
A SILVER MEDAL OF THE SEVENTEENTH CENTURY

BRONZE HEAD FROM HERCULANEUM

A MAJOLICA PLATE FROM ITALY

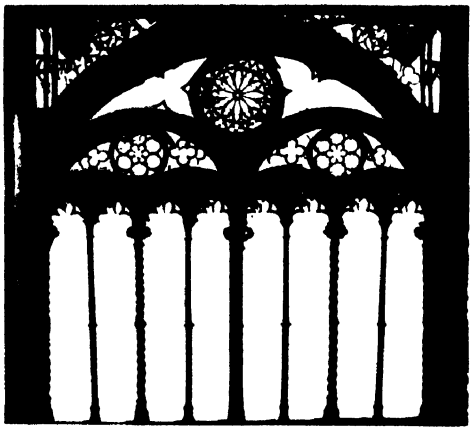
A SIXTH-CENTURY IVORY FROM FLORENCE

A FOURTEENTH CENTURY CAVALRYMAN



THE COFFIN OF AN OLD EGYPTIAN

AN IVORY PANEL A THOUSAND YEARS OLD



A WROUGHT-IRON WINDOW IN THE CHURCH OF SANTA CROCE, FLORENCE

A RARE LANTERN FROM SIENA

A GOLD MEDAL OF CROMWELL'S MINISTER, JOHN THURLOE

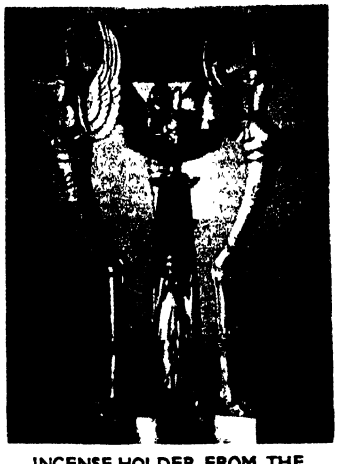
A TURKISH JUG OF THE SIXTEENTH CENTURY

A MEDAL FROM SYRACUSE 25 CENTURIES OLD

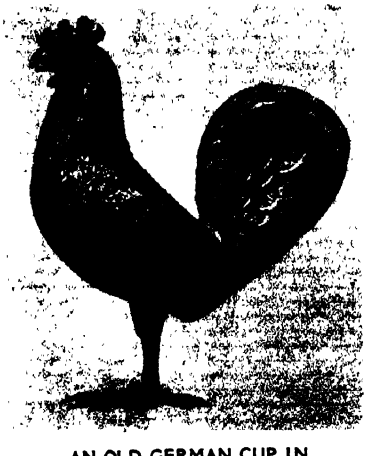
A COLUMN IN A PALACE OF FLORENCE

A MINIATURE OF CROMWELL, BY CHRISTIAN RICHTER

A PERSIAN DOOR IN LACQUER WORK



INCENSE-HOLDER FROM THE PITTI PALACE, FLORENCE



AN OLD GERMAN CUP IN THE FORM OF A COCK

A DECORATED WATER-JUG FROM GREECE

MISS LINLEY & HER BROTHER
BY THOMAS GAINSBOROUGH

A DOGE OF VENICE,
BY GIOVANNI BELLINI

MARCUS AURELIUS

MICHELANGELO'S DAVID

AN OLD LADY, BY REMBRANDT

MISS BOWLES, BY SIR JOSHUA REYNOLDS

MISS HAVERFIELD, BY THOMAS GAINSBOROUGH

A FINE PAINTING OF A WOMAN AND A CHILD, BY FRANS HALS, THE DUTCH ARTIST

AN ETRUSCAN VESSEL IN BRONZE

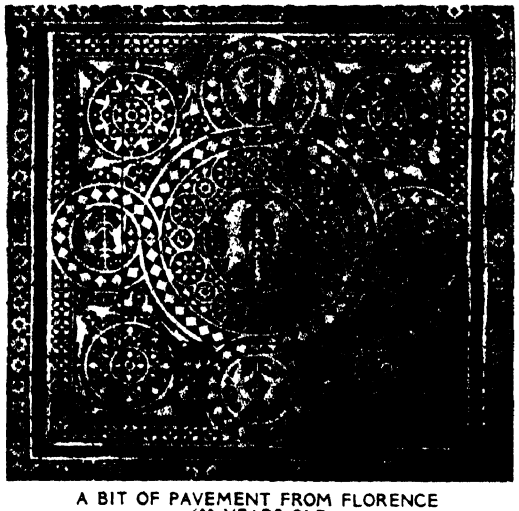
AN ANCIENT BRAZIER FROM ITALY

FOOD-CARRIERS OF OLD EGYPT

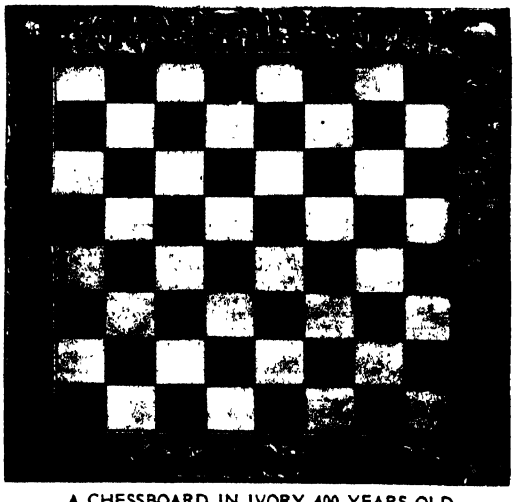
A WOODEN BUST OF THE SIXTEENTH CENTURY

A FOURTH-CENTURY MOSAIC FROM RAVENNA

COPPER MODEL OF A SHIP



A BIT OF PAVEMENT FROM FLORENCE 600 YEARS OLD



A CHESSBOARD IN IVORY 400 YEARS OLD, FROM THE BARGELLO MUSEUM, FLORENCE

FERDINAND OF AUSTRIA, BY VELASQUEZ

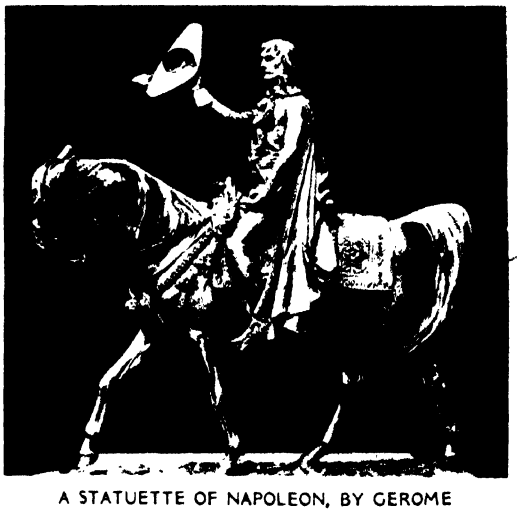
MICHELANGELO'S STATUE OF VICTORY IN FLORENCE

A CHINESE GODDESS IN WHITE PORCELAIN

FORTUNA A SIXTEENTH CENTURY STATUE

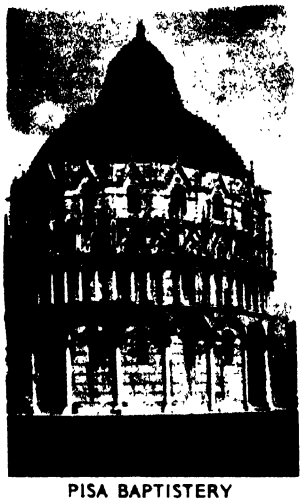
AUGUSTUS CÆSAR IN FULL ARMOR

THE ANGELUS, BY JEAN FRANCOIS MILLET



A STATUETTE OF NAPOLEON, BY GEROME

SALISBURY CATHEDRAL



PISA BAPTISTERY

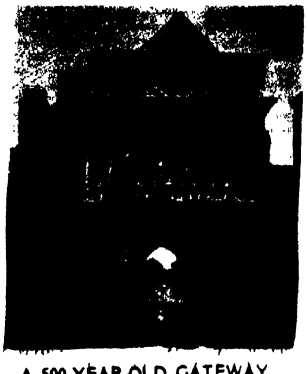
NOTRE DAME, PARIS

ST. GEORGE'S CHAPEL, WINDSOR

A TOWER BUILT BY JULIUS CÆSAR IN PROVENCE

ROMAN ARCH AT ORANGE

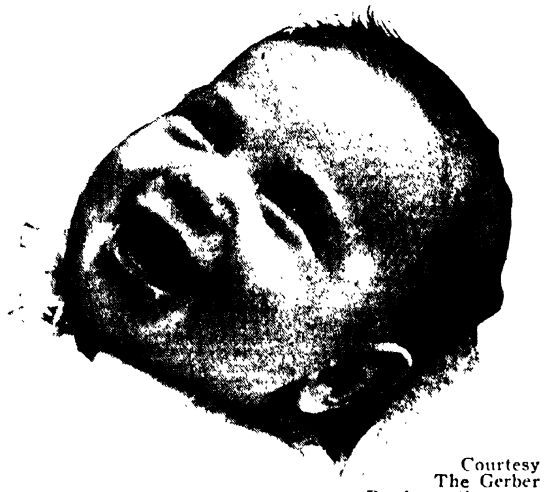
A BEAUTIFUL OLD GATEWAY IN CONSTANTINOPLE



A 500-YEAR-OLD GATEWAY AT NORWICH

THE CARVED INTERIOR OF AN INDIAN TEMPLE

WHY DO I LAUGH AND CRY?



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YOU laugh and you cry because you are "made that way." It depends upon the way in which your body and your brain are built. What we call the lower animals do not laugh because their bodies and brains are different. After all, you laugh when you are tickled, even though you may not be pleased. That is really easier to explain. It is the response the nerves make to what we call a stimulus. If a bright light strikes your eye, you quickly shut down the eyelid because your brain is so made.

That is a simple way of replying, and laughing when you are tickled is really the same, only that, instead of doing one thing, you do a number of things all at once. You move many muscles of your face instead of merely moving the muscles of your eyelids. You also move the muscles you breathe with in an unusual way, and the muscles you make sounds with. It is this particular movement of all these muscles together that we call laughter, and it is really a reply to the tickling, just as drawing your foot is a reply when someone tickles the sole of it.

It is the same with crying as with laughing. We do not know why our brains should be so made, for, though there is much use in tears when we are not crying, there is no use in crying when we are hurt.

When people grow older they find that crying does not do much good, and so most grown people seldom cry. The higher part of the brain is the master of the lower part and can order it to do things or forbid it to do things. Generally the lower part of the brain obeys the orders, though not always. Now, it is the lower part of the brain that replies by crying when we are hurt, so that even the tiniest baby can cry. But when we grow older we usually gain in what we call self-control. We tell the lower part of the brain that it must not do as it feels inclined. So we stop crying.

There is no known reason why tears should come when we cry, but there is a very good and beautiful reason for the tears we are really making all the time we are awake, though we know nothing about it. You know that every few seconds you wink both your eyelids at once. If you did not, your eye would soon cease to work.

Now let us see what winking does for the eye. When the eye is open, the front of it is exposed to dust and dirt, and also the front of it is likely to get dry, and if it got dry we could not see properly. Yet, how is it that, though we never wash the front of our eyes, they are always clean? *It is because we wash them every time we wink.* Up above each eye, rather to the outer side, is a tiny thing called the tear-gland, and all the time we are awake this is slowly making tears. Then when the front of the eye feels itself becoming rather dry, and perhaps a little dusty, it tells the brain and down comes the eyelid with a tear inside it, so washing clean the front of the eye and making it feel more comfortable.

If you look at the inner corner of your lower eyelid you will see a tiny little hole. The tear runs down this and finds itself—where do you think? When you have been crying a great deal, do you not have to blow your nose? The reason is that tears run down into the nose. All the time we are awake this goes on, keeping our eyes moist and clean; but when we cry we make far more tears than we need, and so they get spilled over the edge of the lower eyelid, and run down our cheeks. Let us not shed too many tears in this beautiful world.

WHAT IS A CORN?

A corn is a hard growth which occurs on the toes or some other part of the feet, and is generally the result of wearing shoes which do not fit.

The corn itself is composed of the outer part of the skin. The overgrowth of this skin in a lump, which produces the corn, is caused by the pressure of the shoe at the spot. But the corn would not result unless the pressure were taken off at intervals, and this, of course, is done when we take the shoe off. If the pressure were kept applied to this spot all the time continuously, the skin, instead of overgrowing at that point, would waste away.

WHAT DOES ENCYCLOPEDIA MEAN?

This is quite an easy question to answer. *En* means *in,* and is added to make the word stronger; indeed, the word is often used without the *en,* and just written *cyclopedia.* Then the next part of the word comes from the Greek word *cyclos,* a circle, and tells us that the book is not about one thing only, but goes all the way round knowledge. And the last part of the word is just the English form of the Greek word *paideia,* which means teaching, or instruction, and which comes from another Greek word, *pais,* a child. So an encyclope*dia* is a circle of teaching.

WHAT ARE RHODES SCHOLARS?

Cecil Rhodes was an Englishman who went out to South Africa when only a boy and soon began to dig for diamonds. He was successful, and when twenty years old returned to England and entered Oxford University. His health was delicate, and it was eight years before he took his degree. During these years he spent much time in South Africa seeking health and looking after his business affairs.

After leaving Oxford he returned to South Africa and became very wealthy from mines of gold and diamonds. When he died, in 1902, it was found that he had left most of his wealth to trustees to found scholarships at Oxford University.

Rhodes believed that the world would be helped if all English-speaking people knew more about one another. Therefore the scholars were to be appointed from nearly all parts of the British Empire and from the United States. Germany, too, was allotted five scholars a year, but this was canceled by the British Parliament in 1916.

Each province of Canada appoints a scholar every year and thirty-two come each year from the United States—four each from eight groups of six states. There are about 200 Rhodes scholars in all. They are young men; they receive about $2,000 each year, and the scholarships are for two or three years. At first they were required to study at Oxford, but now they may choose another university for all or part of the time.

WHERE DOES THE TADPOLE'S TAIL GO?

At a certain stage in the life-history of a tadpole some of the cells within the tadpole's body begin to attack and devour the cells that make up the tail. The tail is gradually eaten away and absorbed, until finally, by the action of these cells there is nothing of it left. The material thus disappears by the process which is known as absorption; that is to say, it is used up by something else.

WHAT MAKES THE SEA TASTE OF SALT?

The sun sucks up the water from the sea, but it sucks up nothing else. The salt of the sea has been brought to it by the rivers. These, as they come down from the land, melt away from the land anything that water can melt, and this they carry into the sea. River water contains salt, too, only so very little salt that we notice nothing. Sea water is so much saltier chiefly because it contains the salt that the rivers have been carrying down to it for ages past. One of the commonest kinds of salt in sea water is ordinary salt that we use at table, but there are a great number of other kinds too. We must remember that, though table salt is the only kind of salt we usually think of, yet "salt" is really only a general word for a large number of compounds, like one another to some extent, yet different. It is a mixture of a great number of these that helps to make the sea salt.

WHAT IS A BLUE BOOK? A WHITE PAPER?

Governments often choose a certain color for binding some of their official publications. In the United States, official diplomatic correspondence, when printed, is bound in red. The use of blue, for the covers of British documents, goes back nearly one hundred years, and the documents have long

been known as Blue Books. Since about 1900 the term Blue Book has been applied only to those documents especially prepared for members of Parliament. Only a small proportion of these "Blue Books" are now actually bound in blue. The smaller ones are printed in pamphlet form, without extra covers, and are popularly known as White Papers.

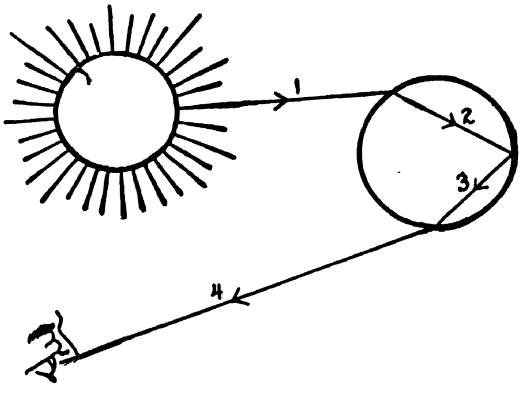
The French generally use yellow, the Belgians gray, the Italians green, etc., for the covers of their official books. Their pamphlet papers are referred to as White Papers.

WHY DO WE SOMETIMES SEE TWO RAINBOWS?

On page 4825 we learned the answer to the question "How does the sun make a rainbow?" Very often, however, we can see two rainbows, one within the other. The inner rainbow is the brighter one and is called the "primary" bow. The outer rainbow is sometimes very faint and is called the "secondary" bow. In the primary rainbow the colors are arranged from violet, on the inner edge to red on the outer edge, but in the secondary rainbow the order of these colors is reversed, the red being inside and the violet on the outside.

Our first drawing shows how the primary bow is formed.

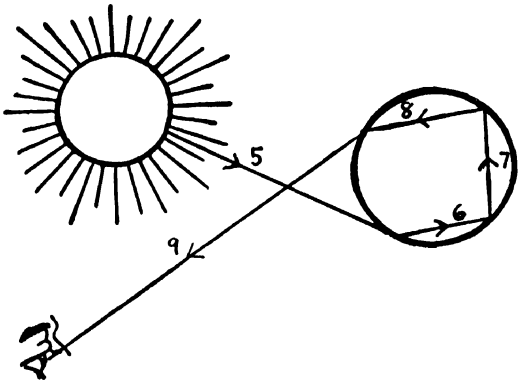
Arrow 1 shows how light from the sun enters the top of a drop of rain and is re-



fracted, or bent, as shown by arrow 2. This light travels to the back of the raindrop and is reflected, as shown by arrow 3, to the bottom. As shown by arrow 4, the light is again bent when it leaves the raindrop. It is this light which reaches the eye. Sunlight is made up of many colors. As it enters and leaves the drop each color undergoes a different amount of bending. Hence when the light reaches the eye the colors have been spread and separated, and we see a rainbow.

Our next drawing shows how the secondary bow is formed by light (arrow 5) which enters the bottom of the drop.

This light, shown by arrow 6, is bent upwards when it enters the drop. It is then



reflected twice as shown by arrows 7 and 8. When it leaves the drop it is again bent. It is this ray, shown by arrow 9, which reaches the eye. This light comes to the eye at an angle different from that of the light shown in our first drawing. Hence there are two images formed. One image is that of the primary bow and the other image is that of the secondary.

WHAT IS THE LONGEST WORD?

In answering this question we must bear in mind that each language contains a certain number of words that form the backbone of the language and that may be used for ordinary purposes, and also a number of technical words that are coined as new developments in science take place. Of the non-technical words in English, the longest is probably antidisestablishmentarianism, which has 28 letters. Even longer words may be formed by adding prefixes such as anti- or non-, or suffixes such as -istical or -ly. Thus the perfectly normal word denomination may become interdenominationalistically and to this curious word we may add the prefix anti-. But the word antiinterdenominationalistically is to be considered as a freak rather than as a typical dictionary word.

As for technical words, there seems to be almost no limit to their length. For example, if you have toothache, your pain may be relieved by the chemical known as dimethylaminophenyldimethylpyrazolondiethylmalonylurea. Sufferers from liver trouble have

often been helped by phenoltetrabromphthaleintetrachlorphalein, another chemical.

Other languages have their unusually long words. Welsh is justly famous for its long place names. We can imagine the plight of a railroad conductor who must call out the railway station of Llanfairpwllgwyngyllgogerychwyrndrobwll-Llantysiliogogogoch!

In German the practice of combining a number of short words to form a long word has brought about some startling combinations. The six-letter English word hyphen becomes in German Zusammenziehungszeichen (literally: together-combining-mark). The American author Mark Twain came upon such interesting specimens as Generalstaatsverordnetenversammlungen (meetings of the legislature; literally: general-states-representatives-gatherings) and Waffenstillstandsunterhandlungen (negotiations for a truce; literally: weapons-motionless-position-negotiations). There is almost no end to the making of compounds in German; many of them are not to be found in any dictionary.

Many Indian words are also extremely long. This is because most of the American Indian languages often compress a whole phrase or even a whole sentence in a single word. Thus, in the Indian language known as Algonkian, yalevolemaktawpokwose means "I am walking about carrying a beautiful black umbrella over my head." Even longer than this is the Algonkian word wutappesittukqussunnoohwehtunkquoh, which means "kneeling down to him." This word occurs in the translation of the Bible into Algonkian by John Eliot, a famous colonial missionary to the Indians.

When the good Indian chief Lepodotemachoselachogaleokranioleipsanodrimupotrimmatosilphioparaomelitokatakeclummenokichlepikossuphophattoperisteralektruonoptegkephalokigklopeleiolagoosiraiobaletraganopterugon died in 1866, in Wisconsin, he bequeathed to posterity what is perhaps the longest word of which there is record: his name! It has no less than 179 letters.

WHAT IS IT THAT MAKES A NETTLE STING?

The leaves of a stinging-nettle are covered with small hairs with sharp, hooked points that will break off when they are lightly touched. But the nettle does not merely prick—it *stings*. This is because the hairs are filled with an acid which gets under our skin, through the hole made by the point of the hair. This makes our skin uncomfortable. *Formis* is Latin for "ant," and this acid is called formic acid because it is found in the bodies of ants. There it probably prevents other animals from eating the ants, because it is not nice to taste. This is one of the thousands of ways in which animals and plants are protected from their enemies —like the poisoned tooth of the serpent, and the inky stuff made by an animal that lives in the sea, which blinds its enemies.

WHY DOES A TREE GROW UPWARD?

The first thing to say in answering this question is that the whole tree does not grow up. Part of the tree grows downward, and that is the root. Each grows to the place where it can do the work for which it was made. In the seed from which the tree grows there are certain cells which are meant to form the part of the tree that is to live in the air and the light. Wherever the light is, they grow toward it. On the other hand, there are other cells which grow best in the dark, and which even seem to be affected by the gravitation of the earth, so that they grow best toward the centre of the earth.

So the tree—and this is true of nearly all plants—has two parts: one that lives in the air, and one that lives in the soil. Neither part could live without the other, and the tree is so made from the first that the right part of it, that which is capable of making leaves, must grow upward into the light and air; while that part of it which can suck up water and salts, and also can hold firm, must grow downward into the earth. So, in whatever position you plant a seed, when it sprouts the young shoot will grow upward and the young root downward.

WHAT LETTER IS MOST COMMONLY USED?

Scholars have found out that the letter most commonly used in English is E. On page 1900 you may read how the knowledge of this fact brought about the solution of a mysterious message in cipher, in Poe's famous story "The Gold-Bug." The other letters of the alphabet, arranged in the order of their frequency, are T, A, I, S, O, N, H, R, D, L, U, C, M, F, W, Y, P, G, B, V, K, J, Q, X and Z. E occurs almost fifty times as often as Z.

If we consider the letters that begin words, the situation is quite different. S is the letter most often used to begin a word: then come C, P, A, T, D, B, M, F, I, E, H, L, R, W, G, U, O, V, N, J, Q, K, Y, Z, X.

HOW DOES THE SPEEDOMETER OF A MOTOR CAR WORK?

We can get an idea of how a speedometer works if we imagine that we hold in our hand a small wheel with a spindle through it, and a fine coil spring attached to the spindle. If we keep tapping the edge of the wheel, it will

The principle of the speedometer is a magnetic force acting on a drum or pointer so as to overcome the tension of a spring. This force can be likened to a finger trying to push round a wheel attached to a spring. When the finger is removed the force diminishes, and the spring pulls the wheel back to the position where it was at first.

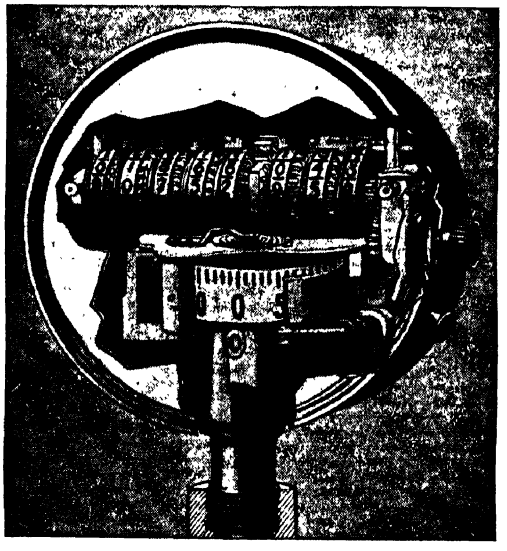
go round and gradually wind the spring up, but as soon as we stop tapping, the pull of the spring will send the wheel back to its original position. If a hand were fitted to the spindle so as to move over a properly numbered disc, a measure of speed would be obtained. Thinking of this, we can look at two popular types of the speedometer, the rotary and the dial types.

From the driving shaft of an automobile a flexible tube runs to the dial box. When the car is moving a flexible cable within the tube is revolved by means of worm gears attached to the driving shaft. At the top of the flexible cable is a circular magnet, and this therefore revolves. Fitting over the magnet, but not touching it, is (in the rotary type) an inverted drum on which are printed figures to show the car's speed. The rotating magnet acts with magnetic force on the drum, and this magnetic influence has the same effect as the finger tapping on the wheel: it causes the drum to revolve. The faster the magnet revolves—that is, the faster the car is moving—the greater the magnetic pull on the drum, and a number is brought to the opening showing the speed of the car.

In the dial type the magnet fits into the centre of the indicator body, but is not in contact with it. As the magnet revolves, a current moves a pointer round a fixed dial. Movement of the drum or pointer is restrained by the counter-tension of a coiled spring. As the magnetic attraction increases with the speed, the resistance of the spring is gradually overcome, and the hand or drum moves round. As the car slows and stops, the magnetic force declines too, and the hand or drum goes back to zero.

The same driving power carried up the flexible tube actuates gears which turn the mileage recorder. This part of the speedometer which registers mileage has its own special name. It is called the odometer (from two Greek words meaning way and measure). One type measures separately the total mileage and the trip mileage. The trip mileage is registered up to 100 or 1000 miles. In this recorder the extreme right-hand figure indicates a fraction of a mile. When the right-hand figure has recorded 9, and 0 is appearing, the disc on which the 0 is engages the disc immediately to the left which thus advances one figure higher, and so on right across. When 99.9 or 999.9 miles are recorded and the final one-tenth of a mile is just completed, the recorder shows zero in all places. At the start of a day's run the trip recorder can be set at zero by turning a knob which advances the figures.

The sum of all these trip mileages is shown on the total mileage recorder. When the total mileage has reached 99,999 miles the addition of another mile sets all these numbers back to zero again.



In a rotary type of speedometer the top of the cable leads to the magnet in the revolving drum, on which are the figures. The magnetic force makes the drum revolve. Total mileage up to 99,999 and trips up to 99.9 miles are recorded by means of gear wheels shown at the side.

WHY DOES A LUMP RISE IN MY THROAT WHEN I CRY?

Your throat is a wide tube with walls of muscle. When you swallow, a wave like a ripple in a pool runs downward through these muscles. When you want to cry, however, your throat muscles contract or tighten up. Then the wave motion may be reversed, from below upward. Either this, or the actual tightening up of the muscles themselves, may cause the uncomfortable feeling that there is a lump in your throat.

HOW CAN A PERSON HAVE LIVED FROM 380 B.C. TO 320 B.C.?

You may think that this would be living backward, as though you were to live your own life from 2000 to 1940 A.D. But this is not true. The farther back we go in time, in the period or era before Christ (B.C.), the bigger the year numbers are. The years of our own era—A.D., or in the year of our Lord—run from the number 1 upward. And so, since you know that a person's birth date is earlier in time than his death, you can see that in B.C. the birth year would have a higher number than the death year. The great Roman emperor, Augustus, was born in 63 B.C. and died in 14 A.D.

WHAT IS CHEWING GUM MADE OF?

If you live in the country, you may have chewed on the little balls of spruce gum which drop off the white or black spruce or balsam fir trees. The gum which comes in packages, however, is really a substance called chicle. This is the milky juice (latex) of a hardwood tree called zapota which grows in the American tropics, especially in Mexico, British Honduras and Guatemala. The latex is collected by tapping the trunk, very much as rubber is collected. Deep zigzag cuts are made in the trunk up to a height of thirty feet, and the thick latex oozes out and runs slowly down into a pan placed at the foot of the tree. The flow lasts about two hours and many quarts may be collected at one time. After the raw gum has been boiled in large kettles, it is poured out on greased canvas and molded into *marquettas* or blocks weighing about twenty-five pounds. The gum is packed into bales of four blocks each for shipping.

To be manufactured into chewing gum, the grayish-brown blocks are re-melted, impurities are removed and sugar and flavoring are added. The finished product is then molded and wrapped into the familiar packages. Millions of people in the United States have the habit of chewing gum—far more than in any other country. Almost $70,000,000 worth of gum is made each year.

WHY DOES SMOKE SOMETIMES RISE AND SOMETIMES FALL?

To answer this question, we must first understand what smoke is. You know that smoke usually results when a substance such as coal, wood or tobacco burns. Smoke is a mixture of gases, mostly water vapor, in which tiny solid particles are held. It is because of these solid particles that we can see smoke. As it leaves a burning log or a cigarette, it is of course quite hot, and this makes it lighter than the surrounding air. So it drifts up, as warm air will rise above cool air. Eventually the gases become mixed with the air and the solid particles fall as dust or soot.

On a damp day, however, when the air already contains as much water vapor as it can hold, the water vapor in the smoke is precipitated, that is, it forms into tiny drops of water and falls just as rain does. As it falls it carries with it the solid particles, and so we see the smoke fall though the amount of water present is too small for us to notice it. We see only the dark particles.

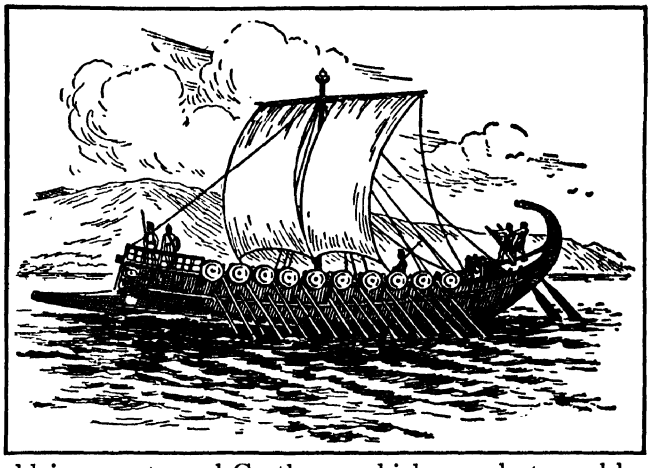
WHY IS IT DARK AT NIGHT?

If you take a ball and hold it near a bright light the half of the ball next to the light is shown upon, and the half of the ball away from the light is dark. If you mark a spot on the ball, and then turn the ball round and round like a top, that spot will be shone upon half the time and will be in the dark the other half of the time. We live on a big ball called the earth, which is always spinning round and round, and it is shone upon all the time, day and night, by the bright light called the sun.

The place where we live is like the spot on the ball, and, as the great earth-ball spins, part of the time we are on the side toward the sun and part of the time we are on the side away from the sun. When we are on that side it is dark at night, but while it is our night it is daytime for the people who live on the other side of the ball. However dark it is where we live, the sun is always shining somewhere. If you think of the ball and the light you will understand that, however dark it is where we are, the spinning of the earth will soon carry us round into the light again.

THE NEXT WONDER QUESTIONS ARE ON PAGE 141.

MEN WHO MADE THE WORLD KNOWN



A Phœnician bireme, or boat with two banks of oars, one above the other. Some use was made of sails.

IT is difficult for us to imagine a world in which, so far as people knew, there were no American continents; no Western Hemisphere. Yet our half of the world was for thousands of years unknown to the people of Europe and Asia. Europe itself was unknown to the early Chinese; and far back in the time of King Solomon and the men who built the pyramids of Egypt, few people in Asia Minor and North Africa knew what lands lay across the Mediterranean Sea.

Little by little, daring adventurers and traders pushed the edges of the map farther back and the known world grew larger. Some of this exploration was done by land, but the most rapid progress was made by sea. People who buy and sell things have always been willing to travel long distances and take great risks to find new markets and new sources of supply. That is why so much of the world has been discovered and explored by merchant-travelers. Even the discovery of America came about because the merchants of Europe wanted to find a safe route to enable them to trade with the East.

The first great explorers of whom we have any record were the people called Phœnicians, who lived on the eastern shore of the Mediterranean Sea, and had colonies on the northern coast of Africa. We read in the Bible of one of their rulers, King Hiram of Tyre, whose sailors brought King Solomon gold from Ophir, ivory, apes and peacocks. The Phœnician traders worked their ships along the coast of the Mediterranean to the Greek isles, to France and Spain and even to England. They found their way overland to India and China and Persia, and in the seventh century B.C. sailed their ships all the way around Africa. The city of Marseilles, in France, was once a Phœnician trading post; and Carthage, which was destroyed by Rome, was a Phœnician city.

After the Phœnicians came the Greeks and then the Romans; and for centuries the Mediterranean Sea was the centre of an ever expanding world. Then Rome began to lose her hold on the lands she had conquered and civilized, and the Empire broke up under the invasions of barbarians from the north and from the east. Still, however, men sailed the seas, and both trade and exploration went on throughout what we call the early Middle Ages. The Mediterranean was still the centre of the civilized world, but men had begun to sail from the northern countries, Ireland, Normandy and Brittany in France, and the Scandinavian countries. Little is known about these mariners, but we do know that at least one of them reached the coast of North America. This was the Icelander, Leif Ericson, who visited the shores of Canada and New England in the year 1,000. You may read more about him in the article Explorers of North America, page 391.

Several hundred years after the time of Leif Ericson, there began the greatest age of maritime exploration and discovery that the world had yet seen. It began when the mariners of the Mediterranean countries started to venture out into the Atlantic—"the sea of darkness"—and the motives that inspired these men were the ancient ones of adventure, trade and conquest.

Always the rich and highly civilized lands of Asia had fascinated the European traders, conquerors and adventurers. Moreover, the East had many products which Europe wanted, such as spices, silks, drugs, and precious woods and gems. For centuries these products had to be brought overland for most of the way, for no sea routes to

Asia were known. Even if such routes had been known, the early ships could hardly have followed them; for in those early days Europeans had no compasses, no navigation instruments, and they had not learned how to make the proper use of sails, but depended to a great extent upon oars. If Columbus had lived 200 years earlier, it is doubtful if he could have even tried to cross the Atlantic.

We will tell you in this chapter about Marco Polo the Venetian, whose account of his travels had so great an effect upon the explorers and navigators who came after his time. Not very many years after the time of Marco Polo, a change came in Asia. The trade routes to India and China, as you can see in this article, went through lands of the Mohammedan Arabs. They were often, in fact, middle-men in the trade between Europe and the East. But as time went on, the fierce Turks who had settled in northwestern Asia Minor conquered most of western Asia and threatened Europe. In 1453 the great European city of Constantinople fell into the hands of the Turks. Now the Turks hated all Christians and would not permit travel through their lands. Nor would they serve as middle-men in trade. The land route to the East was closed.

Of course, this made people even more anxious to find a sea route to Asia, and one idea was to sail around the continent of Africa and up across the Indian Ocean. The Portuguese were the ones who did the most for navigation in this period, and it was from Portugal that the African route was finally opened by Vasco da Gama. We shall tell about him a few pages farther on.

In the first half of the fifteenth century Prince Henry of Portugal lived at Sagres, a place on the Atlantic coast of Portugal. Henry the Navigator, as he is usually called, was a younger son of the King of Portugal and a nephew of Henry IV of England. He was a brave soldier and one of the most famous military leaders of his time, but what he really liked was navigation and exploration. For many years he carried on what has sometimes been called a school of navigation at his palace at Sagres. While he did little traveling himself, he sent out many expeditions to explore the islands and the coast of Africa. Prince Henry's men would enter every bay and river mouth along the coast, make maps and charts and open trade with the natives. At first this trade consisted largely of ivory and gold dust and other such products. Soon, however, they began to add slaves to their cargoes; and this slave trade, besides being a bad thing, in itself slowed up the work of exploration.

Henry the Navigator worked tirelessly to train and equip the men who were to open up the map still farther. His example and his teachings and the results of his expeditions helped to make possible the achievements of many navigators who came after him. In the following pages we tell of some famous navigators of the Age of Exploration, and of Marco Polo whose tales of the East inspired them.

THE ADVENTURES OF MARCO POLO

IN the thirteenth century the city of Venice, in Italy, was an independent republic. It was rich and powerful: its warships ruled the Mediterranean and its merchant ships were seen in many ports. One reason for the great wealth of Venice was the fact that the republic controlled territory at the eastern end of the Mediterranean, in Asia Minor, and also around the Black Sea, and therefore the Venetian merchants gained most of the trade in the silks and spices of the Orient. In those days European seamen had not yet discovered the sea routes to India and the East. Merchandise from these countries was carried hundreds of miles across Asia to the Mediterranean and Black Sea ports by camel caravans. At these ports Venetian ships traded the products of the West for those of the East, and carried their rich cargoes back to Venice, from there to be sent to other European countries.

Although Venice was the gateway through which the wonderful products of the Orient came to Europe, not many Venetians had ever traveled far into Asia. From time to time merchants and adventurers from Europe would make their way into the mysterious continent, and those who returned safely had wonderful things to tell. The most famous of these travelers, and the one who made the strongest impression on his own and later times, was a boy of Venice named Marco Polo.

The Polos were one of the wealthy merchant families that made up the nobility of Venice. While Marco was still a small boy, his father, Nicolo Polo, made a voyage to the Crimea, on the Black Sea. Here he had

a chance to travel farther inland with a returning caravan. He did so, going through one after another of the unknown lands of Asia, until at last he reached Peking, the capital city of the Mongol emperors of Cathay, or China. The Emperor at this time was a great and wise man, Kublai Khan, a grandson of the famous conqueror of most of Asia, Jenghiz Khan. Kublai Khan welcomed foreign visitors, and Nicolo Polo stayed at his court for two years.

When at last Nicolo started on his long homeward journey, the Emperor gave him letters to take to several of the important European kings and to the Pope. Kublai Khan wanted his people to have the benefit of any good ideas that Europe could furnish, and, since he thought the Christian religion might be good for his empire, he asked the Pope to send missionaries to Peking.

When Nicolo Polo reached home Marco was fifteen years old. Nicolo intended to return soon to Cathay, and Marco was eager to go along; but they were not able to set out for two years. Nicolo wished to take some missionaries with him, but the Pope had died and there was a long delay in electing a new pope. The Polos waited until the new pope, Gregory X, was chosen, but he had many problems to solve in Europe and could not spare much time for Asia. Two missionaries did go with the Polos when they started out in 1271, but the missionaries were not able to stand the journey and had to turn back. Along with Marco and his father went Maffeo Polo, brother of Nicolo.

Marco was now seventeen years old and everything that he saw during the four-year journey to Peking interested him. Through Asia Minor, Persia, Tartary, the Pamir Plateau and the Gobi Desert they traveled; through burning sand, fever-filled swamps and frozen plains and up the steep passes of the highest mountain ranges in the world.

When they reached Peking, in 1275, Kublai Khan was glad to see them, and he took a special fancy to young Marco. The young man had an attractive personality. The Emperor found that he was also intelligent and trustworthy, and that he had already learned many of the dialects and languages of the countries that he had passed through. This pleased Kublai, and he gave Marco important positions around the court and sent him on many missions to different parts of the vast empire of the Mongols. Marco noticed that Kublai liked to hear about places and people, and that the emperor was much annoyed with ambassadors who could tell nothing about the countries that they had visited. Marco, therefore, took notes of his travels and delighted the Emperor with the wealth of information that he brought back from each mission.

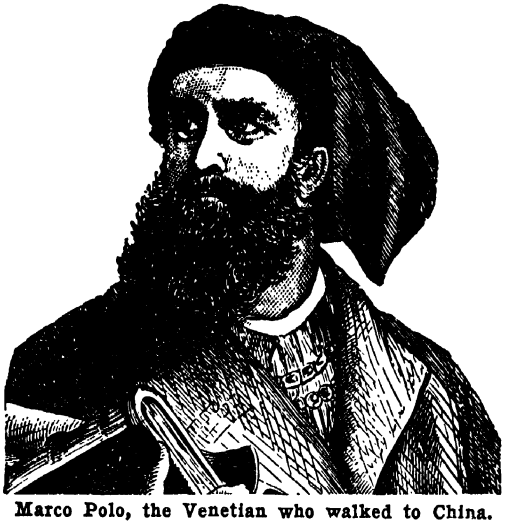
This quaint picture is from an old French book called The Book of Marvels. It shows Marco Polo landing at Ormuz, a once-famous city of Persia. Notice the camels, and the horse and elephant.

The Polos lived for many years in Cathay and grew very wealthy, but always they intended to go back to Venice. Kublai Khan was unwilling for them to leave him, especially Marco, but at last he agreed. One of the young princesses was to be married to the ruler of Persia, and the Persian envoys who had come to escort her to her new home wanted the Polos to guide them back over the dangerous route. Marco and his father and uncle set out for Persia with the princess' caravan in 1292. They traveled to the sea, then went by ship through the islands of the Indian Ocean and round the coast of India into the Persian Gulf. By the time they reached Persia many of the party had been killed or had died of fever, but the princess and the Polos arrived safely. From Persia the Polos went on to Venice, by way of the Black Sea, arriving there in 1295, three years after they had left Peking.

When they reached home their friends did not at first recognize them, for they had been away for twenty years. It is said that they returned in ragged clothing, but with an enormous fortune in precious stones sewed into the lining of their clothes. Marco Polo became famous for his wealth and also for his adventures. Many of the tales that he told about Cathay were not believed until hundreds of years afterward, when other explorers went to Asia and found that the famous Venetian had told the truth about the land and the people.

Marco Polo never went back to Cathay. He was rich—people called him "Marco Millions"—and he became a prominent citizen of Venice, even being made an admiral. During all these years, however, he had never written down his adventures in a book. Perhaps he never had the time, but this was all changed a year or so after he came back to Venice. A war broke out between Venice and Genoa, and Marco Polo was put in command of a fleet. He was captured by the Genoans and put in prison. With him in the prison was a writer named Rusticiano of Pisa. Marco told the story of his travels and Rusticiano wrote them down. After Marco was released from prison and returned to his home, this book became very popular. It was translated into many languages and even to-day you may buy it in a bookshop or borrow it from your library and read the story of the travels of the young Venetian, which took place 650 years ago.

Marco Polo was the first European to see and tell about the wealth and vastness of



Marco Polo, the Venetian who walked to China.

China; the first to travel the whole length and breadth of Asia. He told about the oil springs of the Caucasus, about the dogsleds, reindeer and polar bears of the north, about Siam, Cochin China, Burma, Japan and the islands of the Eastern seas. One of the things he described was the practice of piping natural gas through hollow bamboo poles and using it for cooking purposes. Nobody believed that story, but everyone believed the stories of riches and splendor.

Marco Polo's book, written in a prison in Genoa, was read nearly 200 years later by a Genoese navigator whom we know as Christopher Columbus, and what he read fired his imagination and made him more than ever determined to find a direct sea route to India and China. A few pages farther on we shall tell all about Columbus, and how he failed to find India but found a whole new world instead.

BARTHOLOMEW DIAZ, PORTUGUESE SAILOR

WE have told how the Portuguese seamen sent out by Prince Henry the Navigator explored the west coast of Africa. None of these men, however, had gone all the way down to the end of the continent. It remained for another Portuguese, Bartholomew Diaz, to discover and name the Cape of Good Hope.

We do not know very much about the early life of Diaz. He was probably born about 1460, and started his seafaring life when he was quite young, as boys often did in those days. We know that he made sev-

eral voyages as far as the Guinea coast, bringing back ivory and gold. The King of Portugal was so pleased with the achievements of Diaz that he put him in charge of an expedition to explore and chart the whole west coast of Africa.

In 1487 Diaz left Portugal with three ships, and followed the coast past the desert lands and mountains of Morocco, around the wide bulge of Africa, into the Gulf of Guinea. Here were lands of gold, ivory and gorillas. The many mouths of the Niger River brought the swampy jungle almost to the edge of the sea, for this is near the Equator.

Just above the Equator the coast began to run southward, and Diaz followed it as close to the land as possible, exploring and making maps for later navigators to follow. As the three little ships went farther south the weather began to get colder, but still the long line of the coast stretched ahead toward the southern horizon. Finally the expedition ran into one of the great storms of the South Atlantic and the little ships were blown far out to sea.

When the storm died out, Diaz turned back to find the land again; when he found it, the coast no longer stretched toward the south, but fell away toward the northeast. Diaz had passed the Cape of Good Hope and had also rounded Cape Agulhas, which is the southernmost point of the continent. Diaz sailed on, following the shore as before, and in a few weeks the land began to run north. Then he knew that he had actually passed around the southern end of Africa into the Indian Ocean. He went no farther, but sailed his ships back to Portugal the way he had come, arriving home safely in December, 1488.

The king was delighted with the success of the voyage and with all the charts and maps that Diaz brought back. When the explorer told about the point where he had been blown off his course, he called it the Cape of Storms. The King, however, thought that Cape of Good Hope would be a better name, because it had brought the hope of a route to the East nearer to fulfilment, and that has been its name ever since.

Diaz apparently never made any more voyages past the cape, though he made many trading voyages along the coast. In the year 1500, after the discovery of America, he sailed across the Atlantic to Brazil, but on the way home his ship was lost and he was never seen again.

VASCO DA GAMA SAILS AROUND AFRICA

TEN years after Bartholomew Diaz discovered the Cape of Good Hope, another adventurous Portuguese started out to sail around it and strike northward over the Indian Ocean to India. This was Vasco da Gama, a nobleman who was a skillful navigator and a brave soldier.

It is believed that Vasco da Gama was born in 1460, but this is not certain. He was born in a little town called Sines, on the coast near the seaport of Palos. From his earliest years he loved the sea, and like many of his fellow-countrymen in those days, he longed to explore its mysteries and open new paths for trade and adventure.

Since Diaz had visited the Cape of Good Hope the Portuguese had done very little exploring. But the voyages of Columbus had revived all the old dreams of new routes to the Orient. King Manoel I, therefore, fitted out four ships for an expedition to India by way of the Cape of Good Hope and the Indian Ocean. Da Gama was placed in command of the expedition, and in July, 1497, he set sail.

Around the bulge of Africa and down the long coast they sailed for weeks and months, until they reached the cold winds and stormy waters of the far south. So great were the hardships of the men who were tossed in the frail ships by the storms that some of the men grew frightened and wanted to turn back. Da Gama refused to give up, saying, "I will never go back until I have set foot in India." When they threatened to mutiny he had the leaders put in chains and sailed on, though the seas grew stormier and the little fleet neared the cape.

By Christmas Day they had passed around the cape and were sailing north along the eastern coast of Africa at a point which they called Natal, in honor of Christ's natal day. Near this place they met a vessel from India, and the Indian mariners agreed to pilot Da Gama's ships to their country. Ten months after starting their voyage, Da Gama and his men reached Calicut, the first Europeans to reach the East by sailing around Africa.

The Indian ruler of Calicut was annoyed rather than pleased at receiving these visitors; and after staying long enough to see

how rich the country was, Da Gama started back again on the long journey home.

On September 8, 1499, Vasco da Gama reached Lisbon Harbor. He had only one ship instead of the four he had started with, and only fifty-five were left of the one hundred and sixty men who had sailed from Lisbon more than two years before. Nevertheless they had brought back a rich cargo and had won honor and glory by their venture. Best of all, they had opened a trade route between Europe and the ports of Asia that has never since been closed. When, in the nineteenth century, the Suez Canal was cut through the isthmus that separated the eastern Mediterranean from the Red Sea, northeast of Africa, a much shorter route was opened and most ships used this route. The cape route was never entirely deserted, however, and during World War II, when the fighting closed the Mediterranean route, swift modern ships followed again the route of Da Gama's four tiny sailing vessels.

Vasco da Gama (1450-1524), the Portuguese who first sailed to India by way of the Cape of Good Hope.

Vasco da Gama received great honors and wealth from the King of Portugal, and was made Count of Vidigueira. In 1502 he went again to India and started some trading settlements there—not, unhappily, by peaceful means. For many years after this he remained at home, but in 1524 he was sent to India to be viceroy of the Portuguese colonies there. On the Christmas Eve following his arrival in India he died. He was buried in the Franciscan monastery at Cochin, in India, but a few years later his body was taken back to Portugal to the town of Vidigueira.

COLUMBUS, WHO DISCOVERED AMERICA

CHRISTOPHER Columbus did a greater thing than he knew. He thought that he had discovered the eastern coast of Asia, or the Indies, as India and the islands near it were called. He never knew that between the western shores of Europe and Africa and the eastern shores of Asia a vast land mass blocked the ocean path. To have found a western route to Asia would have been a great achievement, but the discovery of America was a far greater one. It doubled the size of the known world and changed the whole course of the history of mankind.

If this most famous of the world's discoverers were to read any of the stories that are written about him to-day in the English language, he would think at first that they were written about someone else. To begin with, he might not recognize our English version of his name, and he certainly would not recognize the name America. This name was not given to the New World until after his death.

He was born in Italy, in the city of Genoa, probably in 1451, and his name in Italian was Cristoforo Colombo. Later, when he went into the service of the rulers of Spain, he became known by the Spanish form of his name, Cristóbal Colón. In this story, however, we shall call him Christopher Columbus, the form of the name that is most familiar to the people of the United States and Canada.

The father of Columbus was a weaver, and Christopher was carefully trained in that important craft. Not much is known of his early life except that he was poor, and that he began to make sea voyages when he was quite young. For a while he lived in Lisbon, and married the daughter of Perestrello, a navigator who is said to have founded a colony in the Madeira Islands. Perestrello had left his daughter many charts and navigation instruments, and Columbus studied them and read everything he could find about navigation and exploration by sea. Already he had become convinced that India and the other lands of the East could be reached in

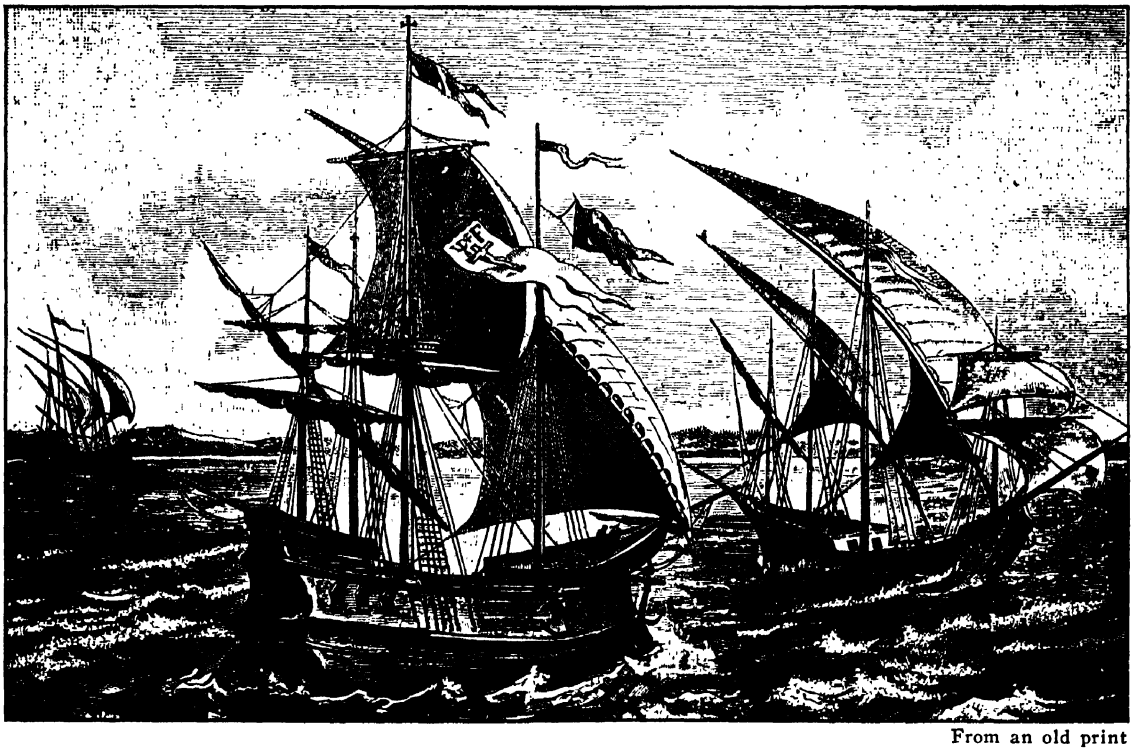
the quickest way by sailing west from Europe. Like most educated people of the time, he knew that the earth was round like a ball and not flat like a plate. He did not know how extremely big around the ball was, however, so that when he later reached land during his famous voyage, he never dreamed that Asia was still thousands of miles farther on.

When Columbus made up his mind to seek a westward route to the East, he had to find someone to give him money for ships and men and supplies for the undertaking. First he tried to interest the city of Genoa in his plans, but the Genoese would have nothing to do with such a wild scheme. Columbus then tried the King of Portugal, who was already sending out men and ships to explore the coast of Africa. The King was interested in the idea, but he would not help Columbus to carry it out. Columbus wrote to the King of England, Henry VII, but Henry did not care to spend the money either. We see now that these people were all very shortsighted, but they thought only of the expense and risk of such an expedition and had little faith in its success.

At last Columbus appealed to King Ferdinand and Queen Isabella of Spain. They were interested; but Spain was busy trying to drive the Moors out of the country, and the plan of Columbus was put off from time to time. Many other difficulties arose. The scarcity of money, the jealousy of courtiers, the timidity or doubt of King Ferdinand, all caused delay. At last, after eight years of struggle, Queen Isabella agreed to send out the expedition. It is said that she offered to pledge her jewels to help pay for it.

Columbus set sail on Friday, August 3, 1492. He was about forty-one years old. He had three ships, the Santa Maria, which he commanded himself, the Pinta, in charge of Alonzo Pinzon, and the Niña, whose captain was Alonzo Pinzon's brother, Vicente Yañez Pinzon. The biggest of these ships, the Santa Maria, was only a hundred tons, while the Pinta was fifty and the Niña forty. There were fewer than a hundred men altogether on the three ships.

A stop of about a month was made at the Canaries to repair one of the ships and take on water and other supplies. Then the little fleet set forth into the strange, unknown reaches of the western sea. It sailed due west until it came into the path of the northeast trade winds, which blow steadily toward the southwest. The wind filled the sails of the little ships and they sped onward through an unknown ocean.



From an old print

The little fleet of Columbus which sailed to America in 1492. The Santa Maria, the largest vessel, was the flagship. Columbus sailed in her. The Pinta, smaller and faster, was commanded by Martin Pinzon and the Niña, the tiniest of all, was commanded by Martin's brother, Vicente. Niña means Baby, or Little One.

COLUMBUS LANDS IN THE NEW WORLD

T. F. Healy Collection

The little fleet drawing near the new world. The men thought they were seeing one of the East Indies. The sailors thanked God for their deliverance from the terrors of the deep.

A great moment in history. The time—October 12, 1492. The place—an island of the West Indies, which Columbus named San Salvador (Holy Savior). After kneeling and thanking God for a safe voyage, Columbus planted the royal standard and claimed the land for Spain.

If you will look at a map of the world you will see that Spain, from which Columbus started, is much closer to Massachusetts, or to Newfoundland than it is to the Caribbean Islands where Columbus finally landed. You may think that if Columbus had kept on straight to the west he would have had a shorter voyage. This is quite true, but there were several reasons why Columbus took the longer way to the southwest. First, he was trying to reach India, not America, and he knew that India was much farther south than Spain. Second, sailing ships had to go in the general direction of the prevailing winds, and "coasting down the Trades," as later seamen called it, to the southwest was the best way that he could have gone to India, had that country been where he believed it to be. There are no winds that blow straight across the Atlantic in the latitude of Spain.

The T. F. Healy Collection

Columbus at the Spanish court explaining to Queen Isabella his belief that he could reach the rich cities of the east by sailing west. Ferdinand and Isabella gave him a fleet of three small ships, to make the experiment.

For twenty-one days Columbus sailed on without finding the slightest sign of land. By this time his sailors had become frightened. Perhaps, they said, there was no land. Perhaps the old tales were true and the sea would suddenly end in a great waterfall over the edge of the earth and they and their ships would be dashed to pieces. They wanted to turn back, and some of the more desperate of the men threatened to throw Columbus overboard if he refused to go back.

Columbus was a strong, fearless man, and he would not give up the goal toward which he had worked for so many years when success might come any day. Pinzon and some of the others were loyal to their commander and the ships sailed on. An American poet, Joaquin Miller, wrote a wonderful story in verse of this voyage of Columbus, and if you will turn to the poem on page 1884 you will feel some of the wonder and terror of the voyage.

As they sailed on, the sea became filled with floating grasses, and many birds were seen. This encouraged the men, and Columbus offered a reward to the man who should first catch sight of land. One night in October Columbus himself saw a wavering light in the distance, and at two o'clock on the following morning, October 12, 1492, a sailor on the Pinta sighted land. A cannon was fired to let the other ships know of the discovery, and there was great joy. The name of the sailor who first saw the land was Rodrigo de Triana.

The land was an island, and to-day we are not quite certain which of several small islands it was. Columbus and his men landed,

and the great navigator knelt down and gave thanks to God before he planted the royal standard of Spain. He named the island San Salvador, which means Holy Savior. He afterward went on and discovered Cuba and the island which we call Hispaniola, but which was named La Isla Española by Columbus. Of course Columbus and his men thought that these islands were

Amerigo Vespucci, for whom the Americas were named.

just off the coast of India, so they called the natives whom they met Indians. That is why, even to-day, the islands of the Caribbean Sea are called the West Indies.

After some further explorations, during which the Santa Maria was wrecked and a little fort was built from her timbers, the other two vessels started back to Spain, leaving about forty volunteers behind at the fort. The Niña and the Pinta sailed in a northerly direction until they got into the winds called the Westerlies, which blow from the west almost straight across the Atlantic toward Spain and Portugal. A terrible storm separated the vessels. On March 15, 1493, Columbus in the Niña entered the harbor of Palos in Spain. Alonzo Pinzon in the Pinta reached Palos later.

For his wonderful achievement, Columbus was made a Grandee of Spain, a member of the highest nobility. He was created Admiral of the Ocean Sea and Viceroy of all the lands in the west that he could claim for Spain. Honors and favors of every kind were heaped upon him.

It was well that Columbus had his hour of glory and triumph then, for he was to have many unhappy hours and many misfortunes later on. Some people became jealous of him and plotted against him. Sometimes he made mistakes which brought trouble upon himself and others. His enemies tried to turn the King and Queen against him. Once, on his third visit to Hispaniola, another man was made governor in his place, and Columbus was actually sent back to Spain in chains. He was quickly cleared of the false charges against him, however, and all his honors were restored. While she lived, Queen Isabella almost always stood by him, but after her death Columbus lost his influence at court.

Altogether Columbus made four voyages to the New World, in 1492, 1493, 1498 and 1502. He discovered many other islands; he sailed along the coast of South America near the mouth of the Orinoco, and on his last voyage sailed along the coast of Central America. He tried at this time to find a passage through the mainland to the Spice Islands near India, which people still believed to be just beyond. Columbus died, poor and unhappy in 1506.

After Columbus showed the way, many other mariners were sent out from Spain to the new colonies. One of the men who made several voyages was a Florentine merchant named Amerigo Vespucci, or in the Latin form of the name, Americus Vespucius. He was a trained navigator as well as a merchant, and in 1501 and 1504 he was sent by the King of Portugal to explore the newly found lands for Portugal. On the first of these two voyages, Americus and his companions explored the coast of Brazil and discovered the Bay of Rio de Janeiro, or River of January. They named the place for the month in which they found the bay, which they thought was the mouth of a great river.

In exploring this coast they saw many things that were not at all like the ancient descriptions of India. When he returned home Americus wrote letters to two of his friends telling about this new land that he had seen, and in the letters he said that this must really be a new world and not the Asiatic land that the ancient writers such as Pliny had described.

One of these letters was published and became what we to-day call a best seller. Many people read it and talked about this New World of Americus Vespucius, until at last the whole of the two western continents came to be called America, the feminine form of Americus. It was a professor of geography named Martin Waldseemüller who, in 1507, first used the name America in a book about Vespucius' discoveries.

THE FIRST VOYAGE ROUND THE WORLD

FERDINAND MAGELLAN AND SEBASTIAN DEL CANO AND HOW THEY FOUND THE PACIFIC OCEAN

THE first man to sail round the world was only a lieutenant. His name was Sebastian del Cano, and when he set sail on the voyage he had for his leader the great Ferdinand Magellan. The ships went out from Spain to the west on September 20, 1519, and returned from the east on September 8, 1522, three years all but twelve days. But instead of the five ships and 270 men which had started out, there came back only one ship and thirty-one men. Del Cano was in command; the brave Magellan was dead. Let us see what had happened.

After the voyages of Columbus the king of Spain still believed that India could be reached by sailing to the west. So he sent Ferdinand Magellan to seek the truth. Magellan was a Portuguese noble, who had left the service of his king because he had not been well treated. He had already gone to India by Da Gama's way, and had seen the famous Spice Islands. Now he set out to do what Columbus had failed to do—to reach India by the western passage.

He struck out boldly for what we now know as South America. Nobody had ever been able to get to the end of it; nobody could tell whether there was a way round or through it. Some of Magellan's men rose in mutiny, and one ship left him because the crew were too frightened to go farther; but he would not give up. He explored all down the coast, and at last came to a great opening into which he sailed, hoping to go right on through. No; it was only a great river. He came back, and went on until at last the coast seemed to break in two. He sailed through heavy waves into a channel which ran between great precipices. He was the only man not afraid. His men almost died of fright when a great storm arose. He managed to calm their fears, and at last they got through the strange channel. And then a magnificent open ocean appeared before them. It was smooth and calm, and he called it the Pacific, which means the "peaceful" ocean.

Ferdinand Magellan who named the Pacific Ocean.

He had come through a strait which he called after his own name. The Magellan Straits had shown him the way past South America. It had taken thirty-eight days to get through, so it is not surprising that his men were afraid. He now sailed halfway round the world, and reached the Philippine Islands, where he was killed in a battle with the natives. After Magellan's death, Del Cano, taking two ships fit to sail, continued the voyage, but one of these ships was abandoned in the Moluccas, and only one little vessel finally reached Europe. Del Cano came back round the Cape of Good Hope, as Da Gama had come from India. When he got home, people saw that, as he had gone out by one way and come back by another, the world really was shaped like a ball, and that Del Cano had been round it. The Straits of Magellan by their name still remind us of the man who found the gateway to the East. Many attempts were made to follow over his adventurous course; and fifty years later Sir Francis Drake sailed round the world from England. There is a fine monument to Magellan at Punta Arenas, in Chile.

You will sometimes see this famous navigator's name written in the Portuguese manner, Fernão de Magalhães; sometimes in Spanish, Fernando Magallanes. Magellan lived from about 1480 to 1521.

Little is known about Sebastian del Cano, who completed Magellan's task. He was born in Spain, around the year 1460, and died in the Pacific, on another voyage of exploration, in 1526.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 588.

FAMOUS MARINERS OF THE AGE OF DISCOVERY, 1400-1800

Henry the Navigator, Prince of Portugal, (1394-1460). From about 1420 until his death he sent out several expeditions each year to explore and chart the west coast of Africa.

Diogo Cam (or Cão) (died in 1486), Portuguese. In 1484 he explored the coast of Africa as far down as Walvis Bay.

Bartholomew Diaz (1460-1500), Portuguese. Discovered the Cape of Good Hope in 1486 and sailed across the Atlantic to Brazil in 1500.

Christopher Columbus (1451-1506), a Genoese employed by Spain. He made the first nonstop transatlantic voyage from the Canary Islands to the West Indies in 1492. He crossed again in 1493, in 1498 and in 1502. On his last voyage he landed on the mainland at Belen on the Isthmus of Panama.

Vasco da Gama (1460-1524), Portuguese. He was the first to reach India by way of the Cape of Good Hope (1497).

John Cabot, or Giovanni Cabotto (1450-1498), a Venetian employed by England who discovered Labrador in 1497, and explored the Atlantic coast in 1498.

Sebastian Cabot (1474-1557). He shared in the voyages of his father, John Cabot, and in 1526 the King of Spain put him in charge of an expedition to the Rio de la Plata.

Amerigo Vespucci (Americus Vespucius) (1452-1512), a citizen of Florence. He is believed to have made four voyages to America, in 1497, 1499, 1501 and 1504; the first two for Spain, the last two for Portugal. He discovered the Bay of Rio de Janeiro.

Alonzo de Ojeda (1468-1515), a Spaniard who was with Columbus on his second voyage. He made three other voyages for Spain: to the Gulf of Venezuela in 1499; to Brazil in 1502; and to Darien (Panama) in 1505.

Vicente Yañez Pinzon (1450-1525), a Spaniard who commanded the Niña on Columbus' first voyage. He made other voyages for Spain, discovering the mouth of the Amazon in 1500.

Gaspar Corte-Real (1450-1502), a Portuguese who reached Newfoundland and Greenland in the year 1500.

Pedro Alvarez de Cabral (1460-1526), a Portuguese. He was sent by the King of Portugal to India, but storms and ocean currents caused him to land in Brazil in 1500.

Ferdinand Magellan (1480-1521), a Portuguese. In 1519 he sailed from Spain with five ships, passed through the Straits of Magellan and sailed across the Pacific. He was killed in the Philippine Islands and one of his men, Sebastian del Cano (of whom little is known) finished the voyage with the one remaining ship, the Victoria. From the Pacific, Del Cano sailed around the Cape of Good Hope and up to Spain. This was the first ship to sail all around the world.

Giovanni da Verazzano (1480-1527), Florentine navigator employed by the King of France. In 1524 he explored the coast of North America, entering New York Harbor.

Jacques Cartier (1491-1557), a Frenchman who discovered the Gaspé Peninsula, sailed up the St. Lawrence to Montreal, which he named, and took possession of Canada for the King of France. He made several voyages, the first in 1534, the second in 1535, the third in 1541. On his second voyage he spent the winter at the mouth of the Charles River.

Sir Francis Drake (1540-1596), English navigator and privateer who, in his ship, the Golden Hind, sailed around the world in 1577-1580. He is believed to have entered San Francisco Harbor.

Sir Humphrey Gilbert (1539-1583), English mariner who took possession of Newfoundland for England in 1583. He was half-brother of Sir Walter Raleigh.

Martin Frobisher (1535-1594), English mariner who in 1576 explored the Coast of Labrador, searching for a northwest passage to the Orient. Two later expeditions, in 1577 and 1578, took him to what is now Hudson Strait.

Henry Hudson (1575-1611), English mariner employed by the Dutch. In 1609 he explored the Hudson River in his ship the Half Moon. Two years later he made another voyage for an English company to Hudson Bay. Here Hudson, his son and eight others were cast adrift in a boat and were never seen again.

Sir Walter Raleigh (1552-1618), an Englishman who sent expeditions to Virginia in 1584, '85, '86, '87 and '89. In 1595 he went himself to South America and explored the Orinoco. In 1616 he went again to South America.

Abel Janszoon Tasman (?1603-1659), a Dutch navigator who was sent by Van Diemen, Governor-General of the Dutch East Indies, to explore the South Seas. In 1642 he discovered Tasmania, New Zealand, the Tonga and Fiji islands.

William Dampier (1652-1715), an English navigator who in 1699 was sent by England to explore the Australian mainland. He discovered the island of New Britain.

James Cook (1728-1779), English naval officer. In 1769 he took possession of Australia for Britain. On later expeditions he discovered New Caledonia, the Isle of Pines and the Hawaiian Islands.

NATURE, a wise man said, is the mother of us all. By "Nature" we really mean the whole of life—everything that is not made by man. But many natural things, such as the sun and the moon, and the earth itself, come into other parts of our book. We are thinking now of the most important things in nature, Animal Life and Plant Life. There were plants on the earth before animals, but in this division we shall treat of animals. Elsewhere you will find the story of flowers and trees. We shall not tell our story as grown-up people do, with big words and strange names, but we shall tell what you need most to know about animals and plants, as discovered by many learned men who have given their lives to the careful study of the many kinds of living things, plant and animal, which are found upon this wonderful world of ours. We shall tell of beasts and birds; of reptiles and fishes; of animals in armor and of molluscs; of the many insects and of other forms of life.

NATURE'S WONDERFUL FAMILY

A MARVELOUS family is Mother Nature's, with thousands of children almost beyond belief. The protozoan is the very simplest form of life. Wrapped up in the single cell which composes it are all the mysteries and magic processes of existence. The crocodile, the oak tree, the elephant, the tiny field-mouse, and man himself—all began as single cells, whether in the egg, the acorn or in the bodies of the parents.

The same power which painted the flowers painted also the butterflies, giving them lustrous wings to make them equally lovely. All the rich colors found in the flowers are repeated in the insects and again in the birds. Reptiles have many strange and often beautiful colors, and there is luxuriant coloring for many of the mammals.

Life is made up of beauty, splendor, wonder, skill, cunning, and also of terrors we can dimly understand. The song of the nightingale and the loveliness of the humming-bird are balanced by the fierceness and deadliness of the flesh-eating animals, such as the tiger and the lion.

Every day and night myriads of herb-eating creatures die to make meals for the eaters of flesh (carnivores). Every day, while the bee is performing her wonders in the hive, multitudes of insects are sentenced to lingering death by ichneumon flies, which make nurseries of them for their eggs. From these eggs will hatch ichneumon grubs to devour the living bodies of the insects in which the eggs are laid. Wasps carry living spiders to their nests, paralyzed but not killed, to await alive the birth and appetite of the grubs yet to be born from the wasp's eggs.

When we are kept awake at night by the noise made by cats, perhaps we wish there were no such things as cats. However, if all the cats were to disappear, our houses would soon be swarming with rats and mice. But something even more strange than that would happen. Because the cats were gone nearly all those beautiful wild flowers called heartsease would be doomed to fade away and die.

Why would the heartsease die if the cats were to vanish? Because, if the cats disappeared, they could not catch the field-mice. Soon there would be so many field-mice that they would eat up all the bumblebee nests in the field. Now, the bumblebees are largely responsible for the growth of the heartsease. The heartsease has a sweet juice which the bumblebees love. They fly into the heartsease to drink this juice, and in doing so they carry in with them from other plants a dust called pollen which the heartsease needs to make its seeds. If it does not get that dust, the flower cannot have seeds. Therefore, if this pretty flower is to continue its race, we must have cats to keep the field-mice from eating all the nests of the bumblebees. The cats do not kill all the field-mice. That would not do. They prevent the mice from becoming too many. Then, although a few mice do eat nests of the bumblebees, there are still enough bees left to bring the pollen to the heartsease.

It took men a long time to learn that nature has to plan so that the world may go on in the best way for us. When we think of the world, we think of a great place where men and women and children live. However, if there were no living creatures but ourselves, there would be a great many empty

places in the world, for there are regions in which we humans find it impossible to live.

But nature does not like empty spaces. She must have living creatures everywhere, in earth and sky and sea. And she does have life everywhere.

Our eyes are not strong enough to see all the tiny things that live. If our eyes were as strong as the strongest microscope, we should see that the air we breathe is full of very tiny creatures. We should see that the soil in the garden swarms with little insects. We should see that the little drops of water which we drink have in them more living creatures than we can count. We know that there is life in the sea, as there is life in the air. We can see the jellyfish floating on top of the waves. We know that there are big fish and little fish beneath the surface. We know that there are monsters in the sea like whales and sharks, and we know that in the dark depths of the sea there are creatures such as nobody has ever seen.

In this diagram we learn how nature packs her box. The earliest beast is stored deepest in the rocks.

NATURE HAS FILLED THIS WORLD TO OVERFLOWING

So there is life everywhere. Besides men, women and children, nature has many workmen, great and small, to carry on the work of the world.

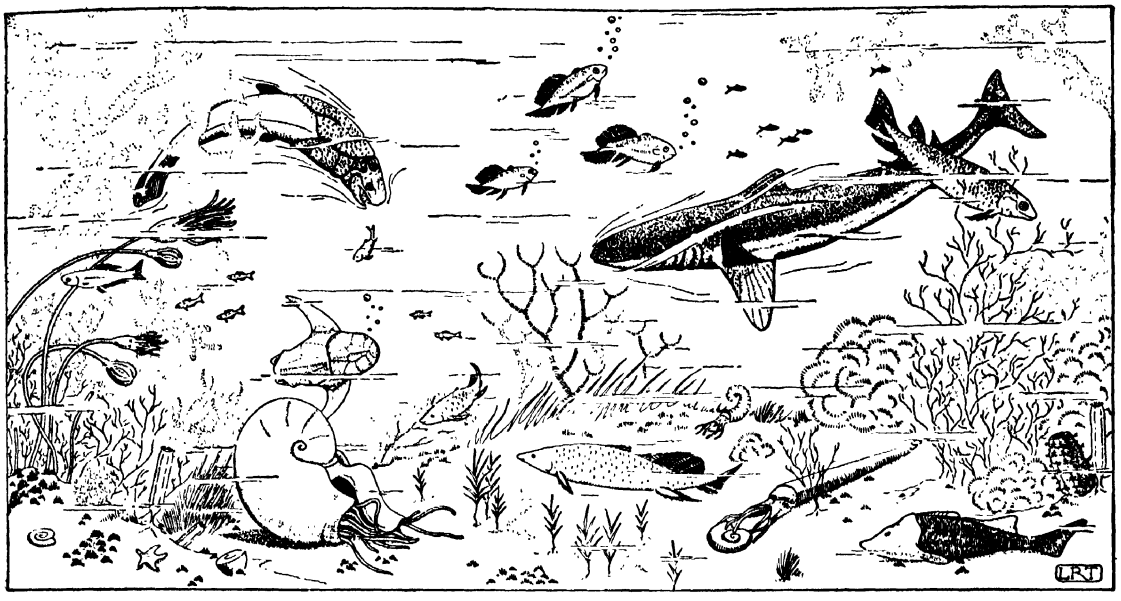
We shall read of their wonderful ways. We shall see that all these animals, reptiles, birds, fishes and insects belong to one great family; and how, though they seem so different, they all resemble one another in some ways.

There have not always been the same sort of animals on the earth as now. Once upon a time, long before human life began, the important living creatures were strange and monstrous ones such as we see in our pictures. Some were so big that they could eat off the top branches of tall trees; some flew and others swam. Eventually, however, these great creatures changed or passed away, and in their places we have the animals of our own times.

CREATURES OF THE PAST WERE STORED IN NATURE'S BOX

No one can accurately say just how much time elapsed while all this changing was happening, but we do know it took millions of years. We know that once certain kinds of creatures lived on the earth or in the waters, and that after these came creatures of a different kind. To-day, deep in the earth and rocks, we find remains of these forms of life. Such remains are known as fossils. The rocks may be likened to a box in which nature has been packing things for millions of years. The things packed away last are near the top of the box. This box, however, was not always of solid rock. At one time it was mud and sand and water. The water dried up, and in time the mud and sand grew harder from heat and pressure, so that it is now rock almost as hard as iron.

How do we find ancient animals in these rocks? When they died, they settled to the

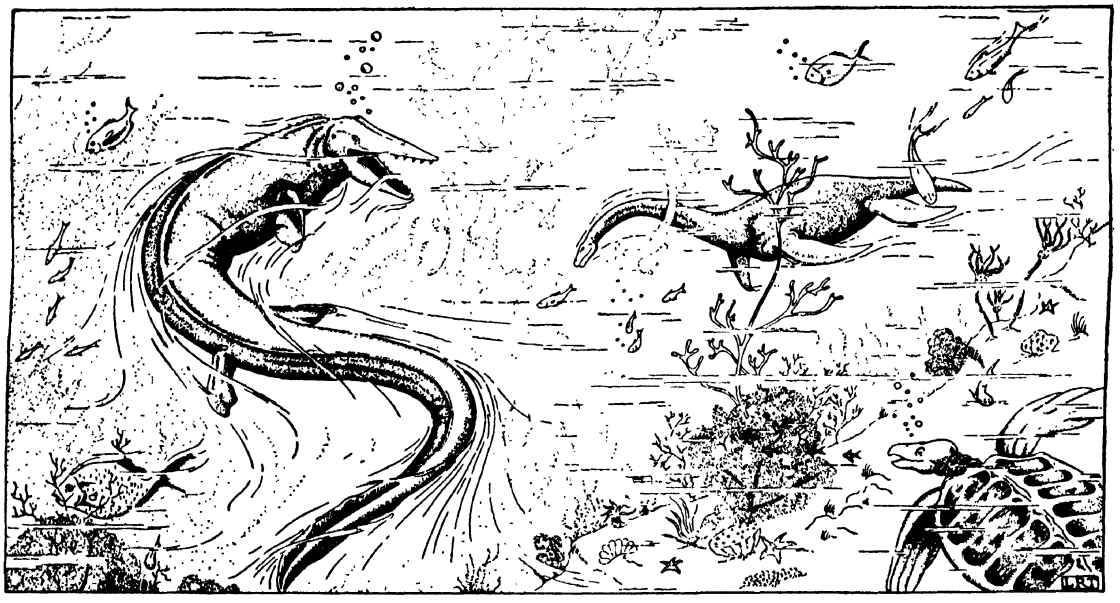


Life began in the sea. From very simple forms, early creatures developed into true fishes. This shows the river and sea life of the Age of Fishes. Then great forests grew on the land, and a new kind of animal life came.

bottoms of rivers, lakes and seas and were covered with layer after layer of mud or sand. As time passed, the rivers, lakes and seas dried up. Pressure within the earth itself forced up these beds of ancient bodies of water and formed them into dry land. The mud or sand in which animal life had been imprisoned became rock above water level.

To-day we find animals, birds, fishes, and even insects, some of them perfectly shaped, in the rock where they have lain for millions of years. The mud or sand which settled about them often did not crush them out of shape but preserved them. Some great beasts were protected by mud which did not turn to stone. The mammoth, a sort of elephant covered with long hair, died many years ago in Siberia and sank into mud which became frozen hard. In this natural icebox mammoths have been so well kept

The age which followed is called the Carboniferous. Animal life began to appear on land. Then the great forests fell, to be buried for millions of years, until they turned to coal. That is how the coal we use to-day began.

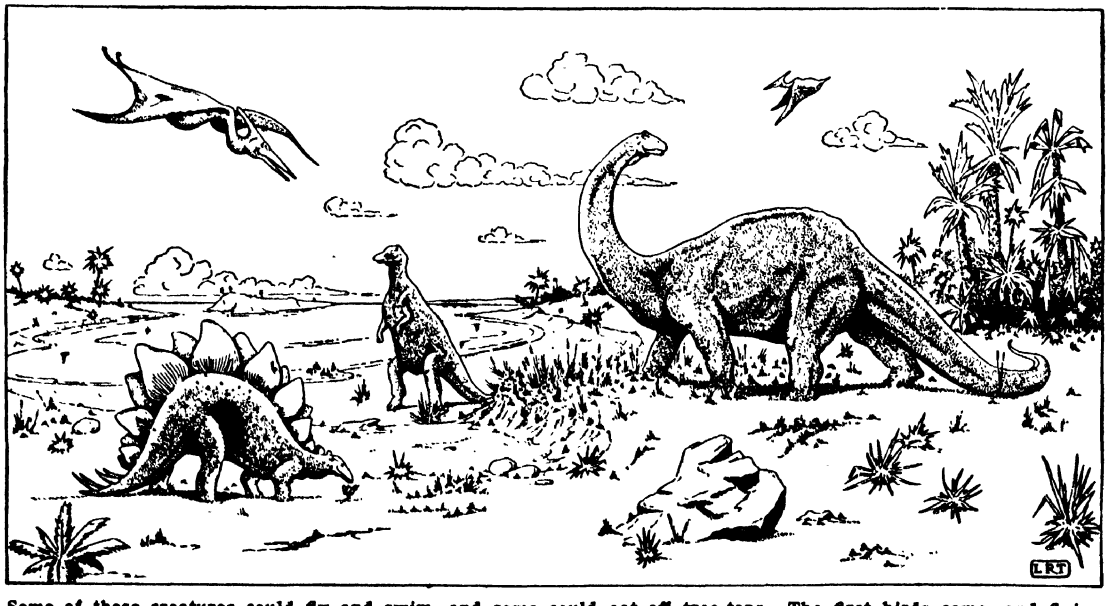


In the seas grew fish-lizards, some as long as 40 feet, some with necks like snakes. This was the beginning of the Age of Reptiles. Some of the fish-lizards were able to live either in the sea or on the land.

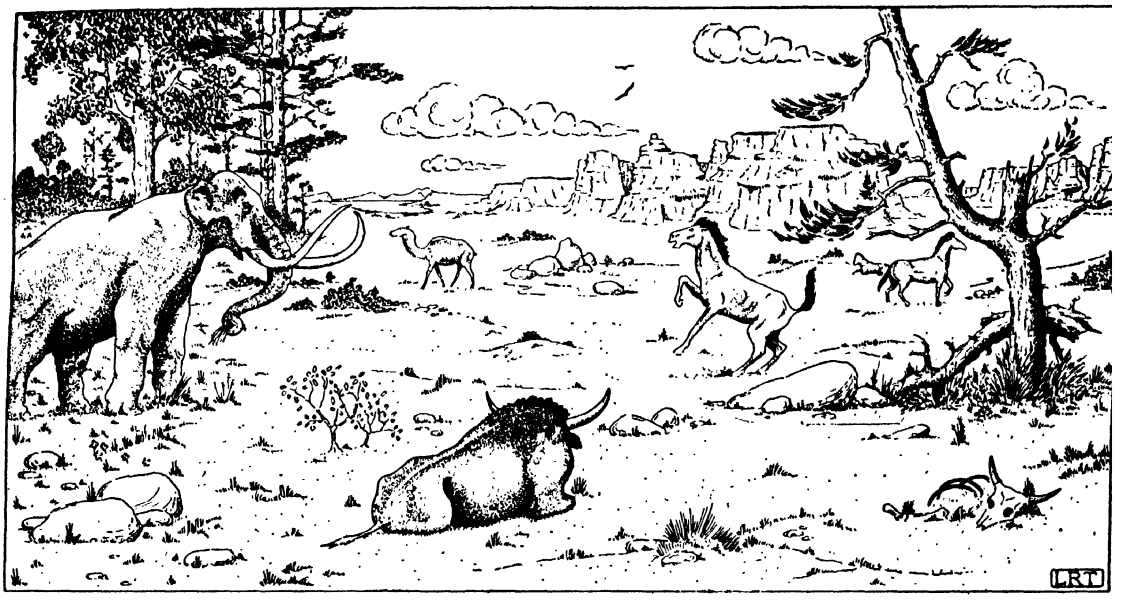
that they are found to-day with the flesh, skin and hair in a state of perfect preservation. For centuries the natives of Siberia have been selling the tusks of mammoths for ivory.

The oldest bird known is called the archæopteryx, a name derived from a Greek word meaning "ancient wing." It was not at all like the birds we know to-day. Its tail was long and lizard-like, with bones and flesh, and with feathers growing from it. It had two legs with which it could walk or perch in the trees, but it had two other limbs with fingers which it probably used for climbing as well as to fly. It had a curious eye fitted with a sort of armor-shield as the reptiles have, and its beak was armed with strong teeth.

No such bird as the archæopteryx exists to-day, having become extinct millions of



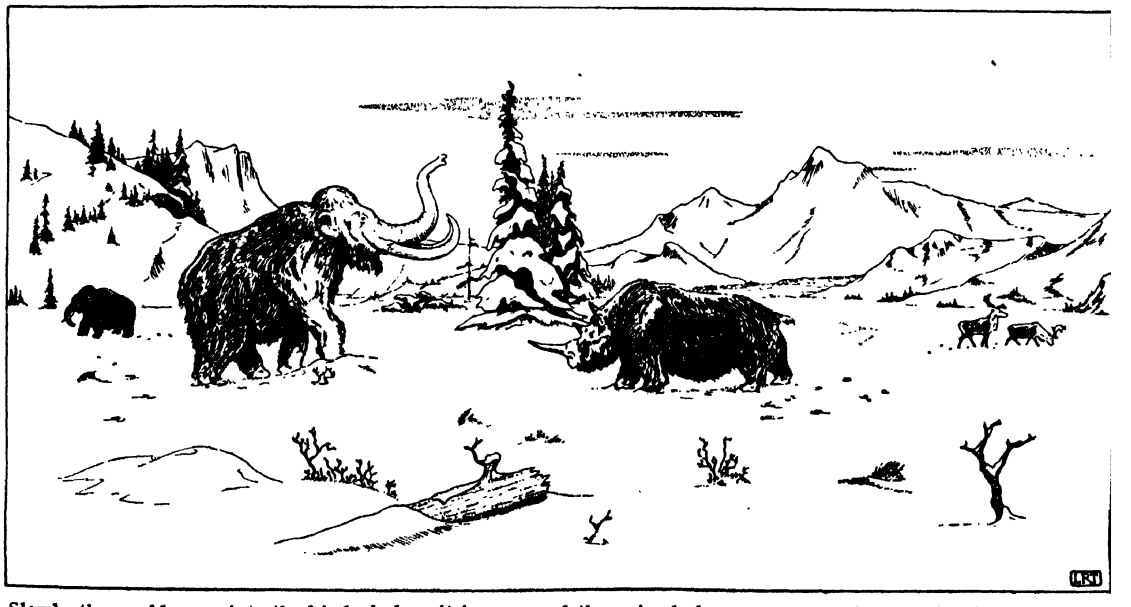
Some of these creatures could fly and swim, and some could eat off tree-tops. The first birds came, and flying reptiles. Millions of years later the earliest birds developed into the birds we are familiar with to-day.



Still later mammals began to replace the reptiles. Here we see a scene in western America, showing the mammoth, wild horse and camel. Then the climate turned very cold, and many of these animals disappeared.

years ago. Even in these days several strange birds have died out. The dodo was quite common in the island of Mauritius not so many years ago, but there is not one alive to-day. It could not fly because its wings were so small, and the dodo family was soon all killed. In New Zealand there used to be vast numbers of birds called moas, which were ten feet high. The great auk, which used to come in thousands to the shores of Newfoundland, is another bird which has died out within the last hundred years or so.

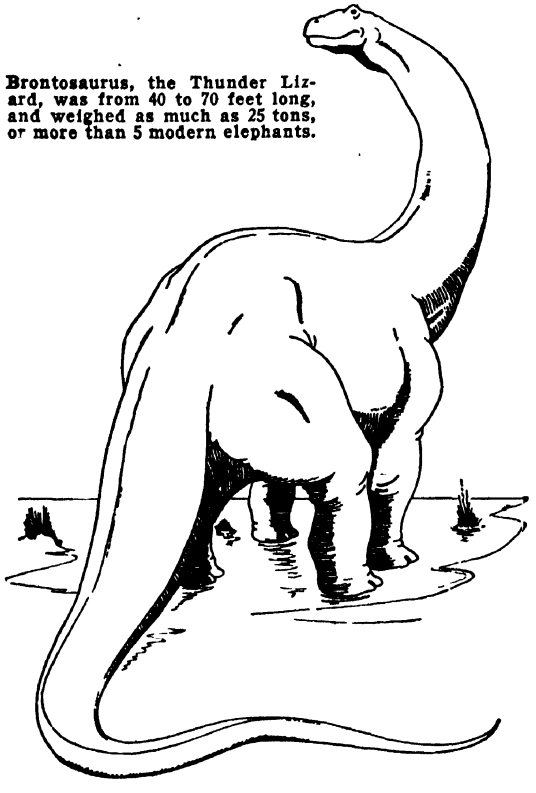
Men have killed many birds and animals, but in making the world what it now is, nature has killed far more. Whole races of animals have been destroyed by earthquakes and floods, by the sinking of land into sea, and by snow and frost and ice descending upon lands where before all was sunshine and rich vegetation. Then again, great fam-



Slowly the world grew into the kind of place it is now, and the animals became more and more like those we know. The mammoth and the wooly rhinoceros wandered over the countryside. The stage was set for the coming of man.

ilies of animals have gradually died out and given place to others better able to fight the battle of life.

Think of the horse, for example. Once upon a time, long before man appeared on the earth, the horse was a little thing, no



Brontosaurus, the Thunder Lizard, was from 40 to 70 feet long, and weighed as much as 25 tons, or more than 5 modern elephants.

bigger than a fox, with five toes on its front feet and three behind. This animal is called eohippus, which means "dawn horse." However, after the passage of much time, the horse has become larger and swifter and more beautiful. Its soft, spreading toes have become hard hoofs.

Think again of the humming-bird, a tiny creature not much bigger than a good-sized bee. Compare it in size and beauty with the iguanodon, a great reptile of the past with a head a yard long. The iguanodon lived long before the five-toed horse. When it reared itself on its hind legs, its head towered fourteen feet above the ground. In many ways its structure resembled that of a bird.

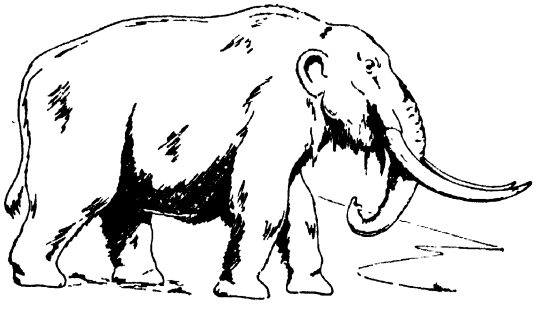
There were others rather like the iguanodon. Brontosaurus, diplodocus and camarasaurus were monsters with bodies bigger than that of the biggest elephant. Some of these creatures were as much as eighty feet in length and fourteen feet high. Many of them were not vicious, however, being vegetable-feeders who lived in the very early swamps.

Some of the great reptiles which lived at the same time were flesh-eaters. Tyrannosaurus rex, "king of the tyrant reptiles," was the most terrible of these. When erect, he stood eighteen feet high. His mouth was armed with dagger-like teeth two or three inches long. All these creatures belonged to a family called the dinosaurs, which means "terrible reptiles."

The sea had wonderful creatures in those far-off days. The waters teemed with what we now call the great fish-lizards. One of these, the ichthyosaurus, was about forty feet long. It had a wonderfully formed eye which it could adjust so as to see things quite near or those far away. Although chiefly a water dweller it could breathe air above the surface of the sea just as the other reptiles could. The ichthyosaurus died out, but the shark lives on as a relic of those times.

Much later than the dinosaurs and the fish-lizards came animal life which began to resemble the life we know. The sloths, small animals to-day, which cling to the branches of trees and live upside down, are descended from creatures which instead of having to climb the trees to eat the tender shoots, were powerful enough to pull the tree down to their mouths! In the western part of the United States the remains of the ancient sloth have been discovered in caves which also contain signs of occupation by early man.

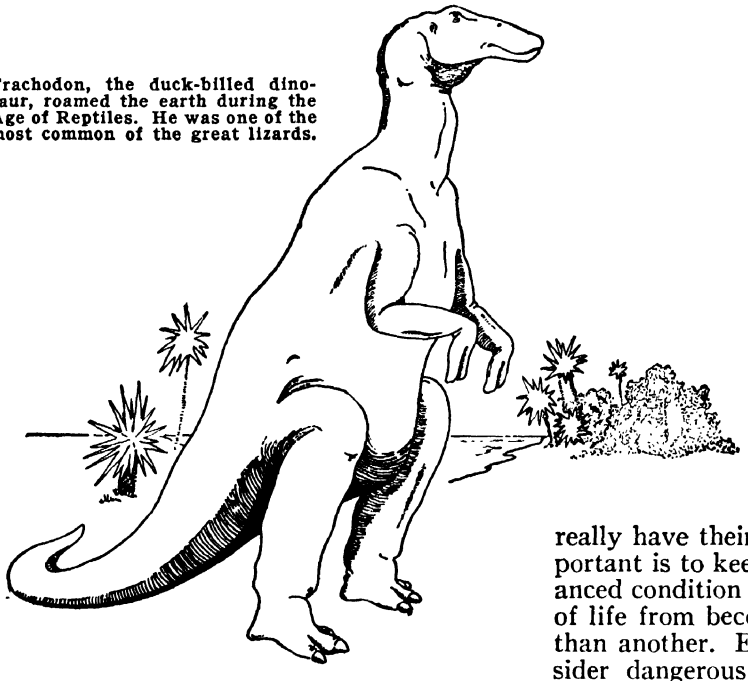
The world of these early days, then, must have appeared quite different from the world we know to-day. The seas covered much of what is now dry land. In them swam huge reptiles and strange fishes. Equally great reptiles roamed the shores or flew in the warm air. At a later date tigers with six-inch tusks, rhinoceroses covered with wooly hair and giant bears took the place of the reptiles.



The mastodon lived long after the great dinosaurs. In many respects he resembled the modern elephant.

Animals which now live only in the coldest parts of the earth once lived in the far south, and animals which can live only in hot climates once were found existing in the north. From this we can see how great have been the changes in climates of the world in bygone ages; and this helps us to understand one way in which animals from time to time have come to their end.

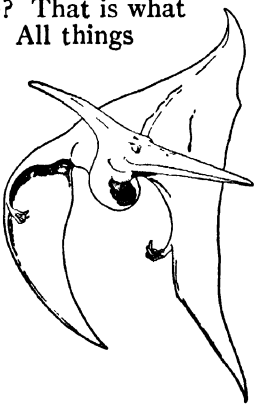
These great animals once upon a time were masters of the earth. They disappeared in the ways we have seen, and in many other ways. Many of them were destroyed by the Great Ice Age, of which we read in the story of North America on another page of our book, when the climate of a great part of the world was suddenly changed, and nearly all living creatures perished from cold.



Trachodon, the duck-billed dinosaur, roamed the earth during the Age of Reptiles. He was one of the most common of the great lizards.

All these things about the early world we learn from nature's own storehouses, the rocks and bogs or the frozen wastes in which the strange monsters of land and sea fell and died, and in which they have been preserved for us. Although these ancient creatures have vanished from the face of the earth, there are still links with the puzzles of those old days. There is a mammal that flies—the bat; and there is another mammal that lays eggs like a bird and has a beak like a duck. It is called the platypus, and it lives in Australia. The great sloth has come down to very small size. The bats, with their wings and claws and mouselike bodies, remind us of the curious things existing millions upon millions of years ago, and the lizards and the armored armadillos tell us something of an earlier day when their ancestors were among the wonders of the world. Unfortunately, not a single living man was on the scene to see them.

What is the use of all these animals? Why were they placed in the forests, on the plains, and in the rivers and seas? What good could such a variety of animal life possibly have in the scheme of nature? That is what we often ask ourselves. All things really have their uses. One of the most important is to keep the world in a sort of balanced condition and to prevent any one form of life from becoming much more numerous than another. Even those creatures we consider dangerous and harmful, such as the poisonous snake and the stealthy leopard, have their place in nature.



The pterodactyl was a flying reptile. Sometimes his wing-spread was as much as 20 feet. Some of his kind were as small as sparrows, but a great deal fiercer.

The alligators and crocodiles are fierce creatures, and have to be killed when caught. Yet we cannot afford to do away with them altogether, for they eat things which destroy the crops, and the dead bodies of animals drowned in the rivers. The hippopotamus also eats the things which grow in the rivers. If he did not, many rivers would become choked with weeds.

Thus we can see by these examples how Nature plans her work. The crocodile and the hippopotamus do their part in preventing the rivers from being choked up, and this prevents them from becoming unfit for human use. There are many such illustrations of the balance of nature. Each proves that Nature creates her creatures for a purpose.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 204.

POEMS OF CHILDHOOD

Illustrated by Helen Sewell

Indian Children*

By ANNETTE WYNNE

WHERE we walk to school each day
Indian children used to play—
All about our native land,
Where the shops and houses stand.

And the trees were very tall,
And there were no streets at all,
Not a church and not a steeple—
Only woods and Indian people.

Only wigwams on the ground,
And at night bears prowling round—
What a different place to-day
Where we live and work and play!

A Mortifying Mistake

By ANNA MARIA PRATT

I STUDIED my tables over and over, and backward and forward, too;
But I couldn't remember six times nine, and I didn't know what to do,
Till sister told me to play with my doll, and not to bother my head.
"If you call her 'Fifty-four' for a while, you'll learn it by heart," she said.

So I took my favorite, Mary Ann (though I thought 'twas a dreadful shame
To give such a perfectly lovely child such a perfectly horrid name),
And I called her my dear little "Fifty-four" a hundred times, till I knew
The answer of six times nine as well as the answer of two times two.

Next day Elizabeth Wigglesworth, who always acts so proud,
Said, "Six times nine is fifty-two," and I nearly laughed aloud!
But I wished I hadn't when teacher said, "Now, Dorothy, tell if you can."
For I thought of my doll and—sakes alive!—I answered, *"Mary Ann!"*

Sea Shell**

By AMY LOWELL (1874-1925)

SEA Shell, Sea Shell,
Sing me a song, O please!
A song of ships, and sailor men,
And parrots, and tropical trees,
Of islands lost in the Spanish Main
Which no man ever may find again,
Of fishes and corals under the waves,
And sea-horses stabled in great green caves.
Sea Shell, Sea Shell,
Sing of the things you know so well.

The Wonderful World

By WILLIAM BRIGHTY RANDS (1823-1882)

GREAT, wide, beautiful, wonderful World,
With the wonderful water round you curled,
And the wonderful grass upon your breast,
World, you are beautifully dressed.

The wonderful air is over me,
And the wonderful wind is shaking the tree—
It walks on the water, and whirls the mills,
And talks to itself on the tops of the hills.

You friendly Earth, how far do you go,
With the wheat-fields that nod and the rivers that flow,
With cities and gardens, and cliffs and isles,
And people upon you for thousands of miles?

Ah! you are so great, and I am so small,
I tremble to think of you, World, at all;
And yet, when I said my prayers to-day,
A whisper inside me seemed to say,
"You are more than the Earth, though you are such a dot:
You can love and think, and the Earth cannot!"

*From For Days and Days, by Annette Wynne. Copyright 1919 by J. B. Lippincott Company. By special permission of the publisher.
**From A Dome of Many Colored Glass, by Amy Lowell: by permission of the publishers, Houghton Mifflin Company.

Thanksgiving Day

By LYDIA MARIA CHILD (1802-1880)

OVER the river and through the wood,
To grandfather's house we go;
The horse knows the way
To carry the sleigh
Through the white and drifted snow.

Over the river and through the wood—
Oh, how the wind does blow!
It stings the toes
And bites the nose,
As over the ground we go.

Over the river and through the wood,
To have a first-rate play;
Hear the bells ring
"Ting-a-ling-ding!"
Hurrah for Thanksgiving Day!

Over the river and through the wood,
Trot fast, my dapple-gray!
Spring over the ground,
Like a hunting hound!
For this is Thanksgiving Day.

Over the river and through the wood,
And straight through the barnyard gate,
We seem to go
Extremely slow—
It is so hard to wait!

Over the river and through the wood—
Now grandmother's cap I spy!
Hurrah for the fun!
Is the pudding done?
Hurrah for the pumpkin pie!

I Saw A Proud Mysterious Cat*

By VACHEL LINDSAY (1879-1931)

I SAW a proud, mysterious cat,
I saw a proud, mysterious cat,
Too proud to catch a mouse or rat—
Mew, mew, mew.

But catnip she would eat, and purr,
But catnip she would eat, and purr.
And goldfish she did much prefer—
Mew, mew, mew.

I saw a cat—'twas but a dream,
I saw a cat—'twas but a dream,
Who scorned the slave that brought her cream—
Mew, mew, mew.

Unless the slave were dressed in style
Unless the slave were dressed in style
And knelt before her all the while—
Mew, mew, mew.

Did you ever hear of a thing like that?
Did you ever hear of a thing like that?
Did you ever hear of a thing like that?
Oh, what a proud, mysterious cat.
Oh, what a proud, mysterious cat.
Mew . . . mew . . . mew.

Grace For A Child

By ROBERT HERRICK (1591-1674)

HERE a little child I stand,
Heaving up my either hand;
Cold as paddocks though they be,
Here I lift them up to Thee,
For a benison to fall
On our meat and on us all.

Note: the word "paddocks" means frogs, and a benison is a blessing.

Seven Times One

By JEAN INGELOW (1820-1897)

THERE's no dew left on the daisies and clover,
There's no rain left in heaven;
I've said my "seven times" over and over,
Seven times one are seven.

I am old, so old, I can write a letter;
My birthday lessons are done;
The lambs play always, they know no better,
They are only one times one.

O moon! in the night I have seen you sailing
And shining so round and low;
You were bright! ah, bright! but your light is failing,—
You are nothing now but a bow.

You moon, have you done something wrong in heaven
That God has hidden your face?
I hope if you have, you will soon be forgiven,
And shine again in your place.

O velvet bee, you're a dusty fellow,
You've powdered your legs with gold!
O brave marsh marybuds, rich and yellow,
Give me your money to hold!

O columbine, open your folded wrapper,
Where two twin turtle-doves dwell;
O cuckoopint, toll me the purple clapper
That hangs in your clear green bell!

And show me your nest with the young ones in it;
I will not steal them away:
I am old! you may trust me, linnet, linnet,—
I am seven times one to-day.

*From Congo and Other Poems, by Vachel Lindsay; by permission of the publishers, The Macmillan Company.

Taxis*

By RACHEL FIELD (1895-1942)

HO, for taxis green or blue,
Hi, for taxis red,
They roll along the Avenue
Like spools of colored thread!

Jack-O'Lantern yellow,
Orange as the moon,
Greener than the greenest grass
Ever grew in June.

Gaily striped or checked in squares,
Wheels that twinkle bright,
Don't you think that taxis make
A very pleasant sight?

Taxis shiny in the rain,
Scudding through the snow,
Taxis flashing back the sun,
Waiting in a row.

Ho, for taxis red and green,
Hi, for taxis blue,
I wouldn't be a private car
In silver blue, would you?

Armies in the Fire**

By ROBERT LOUIS STEVENSON (1850-1894)

THE lamps now glitter down the street;
Faintly sound the falling feet;
And the blue even slowly falls
About the garden trees and walls.

Now in the falling of the gloom
The red fire paints the empty room;
And warmly on the roof it looks,
And flickers on the backs of books.

Armies march by tower and spire
Of cities blazing in the fire—
Till, as I gaze with staring eyes,
The armies fade, the lustre dies.

Then once again the glow returns;
Again the phantom city burns;
And down the red-hot valley, lo!
The phantom armies marching go.

Blinking embers, tell me true,
Where are those armies marching to,
And what the burning city is
That crumbles in your furnaces?

*From Taxis and Toadstools, by Rachel Field; copyright 1926 by Doubleday, Page & Company.
**From A Child's Garden of Verses, by Robert Louis Stevenson: By permission of the publishers, Longmans, Green & Co.

A Boy's Song

By JAMES HOGG (1770-1835)

WHERE the pools are bright and deep,
Where the gray trout lies asleep,
Up the river and over the lea,
That's the way for Billy and me.

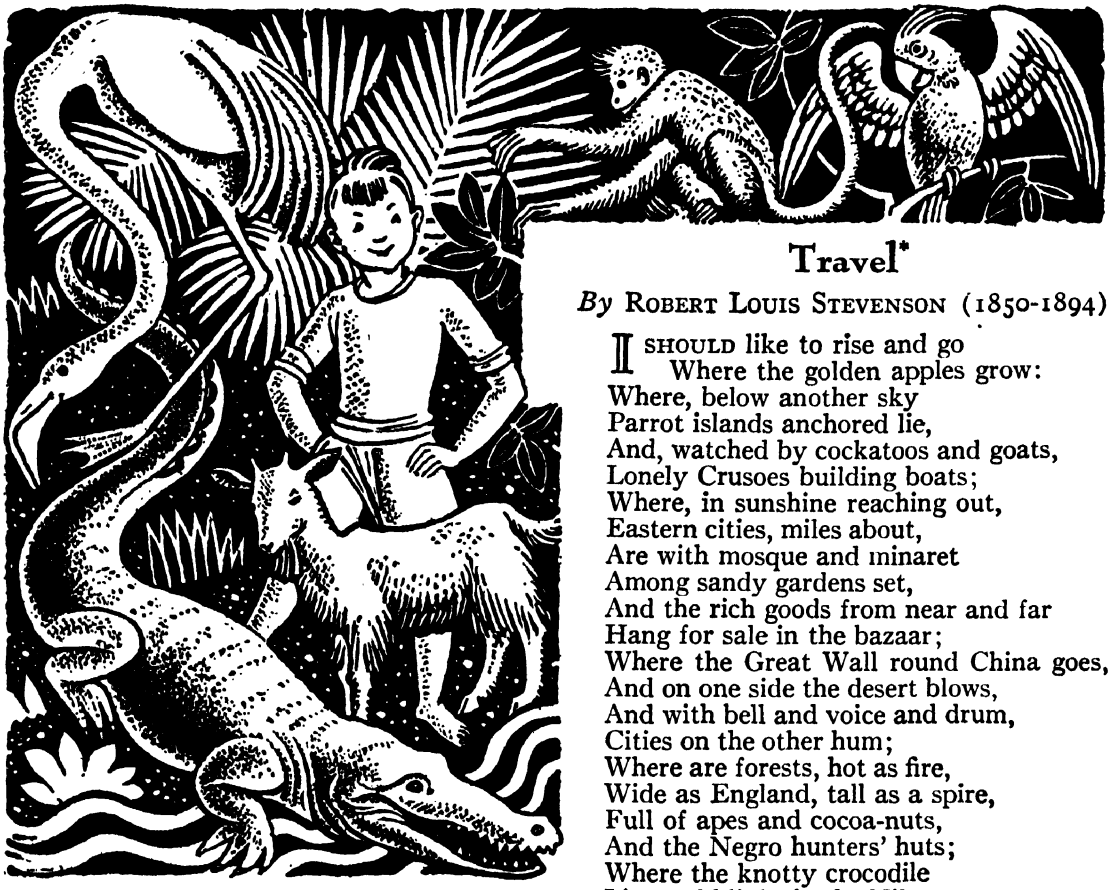
Where the blackbird sings the latest,
Where the hawthorn blooms the sweetest,
Where the nestlings chirp and flee,
That's the way for Billy and me.

Where the mowers mow the cleanest,
Where the hay lies thick and greenest,
There to track the homeward bee,
That's the way for Billy and me.

Where the hazel bank is steepest,
Where the shadow falls the deepest,
Where the clustering nuts fall free,
That's the way for Billy and me.

Why the boys should drive away
Little sweet maidens from the play,
Or love to banter and fight so well,
That's the thing I never could tell.

But this I know, I love to play
Through the meadow, among the hay;
Up the water and over the lea,
That's the way for Billy and me.



A Child's Thought of God

By ELIZABETH BARRETT BROWNING
(1809-1861)

THEY say that God lives very high!
But if you look above the pines
You cannot see our God. And Why?

And if you dig down in the mines
You never see Him in the gold,
Though from Him all that's glory shines.

God is so good, He wears a fold
Of heaven and earth across His face—
Like secrets kept, for love untold.

But still I feel that His embrace
Slides down by thrills, through all
things made,
Through sight and sound of every place:

As if my tender mother laid
On my shut lids her kisses' pressure,
Half waking me at night and said:
"Who kissed you through the dark, dear
guesser?"

Travel*

By ROBERT LOUIS STEVENSON (1850-1894)

I SHOULD like to rise and go
Where the golden apples grow:
Where, below another sky
Parrot islands anchored lie,
And, watched by cockatoos and goats,
Lonely Crusoes building boats;
Where, in sunshine reaching out,
Eastern cities, miles about,
Are with mosque and minaret
Among sandy gardens set,
And the rich goods from near and far
Hang for sale in the bazaar;
Where the Great Wall round China goes,
And on one side the desert blows,
And with bell and voice and drum,
Cities on the other hum;
Where are forests, hot as fire,
Wide as England, tall as a spire,
Full of apes and cocoa-nuts,
And the Negro hunters' huts;
Where the knotty crocodile
Lies and blinks in the Nile,
And the red flamingo flies
Hunting fish before his eyes;
Where in jungles near and far,
Man-devouring tigers are,
Lying close and giving ear
Lest the hunt be drawing near,
Or a comer-by be seen
Swinging in a palanquin;
Where, among the desert sands,
Some deserted city stands,
All its children—sweep and prince—
Grown to manhood ages since,
Not a foot in street or house,
Not a stir of child or mouse,
And, when kindly falls the night,
In all the town no spark of light.
There I'll come when I'm a man
With a camel caravan;
Light a fire in the gloom
Of some dusty dining-room;
See the pictures on the walls—
Heroes, fights, and festivals;
And in a corner find the toys
Of the old Egyptian boys.

*By permission of the publishers, Longmans, Green & Company.

A Swing Song

By WILLIAM ALLINGHAM (1824-1889)

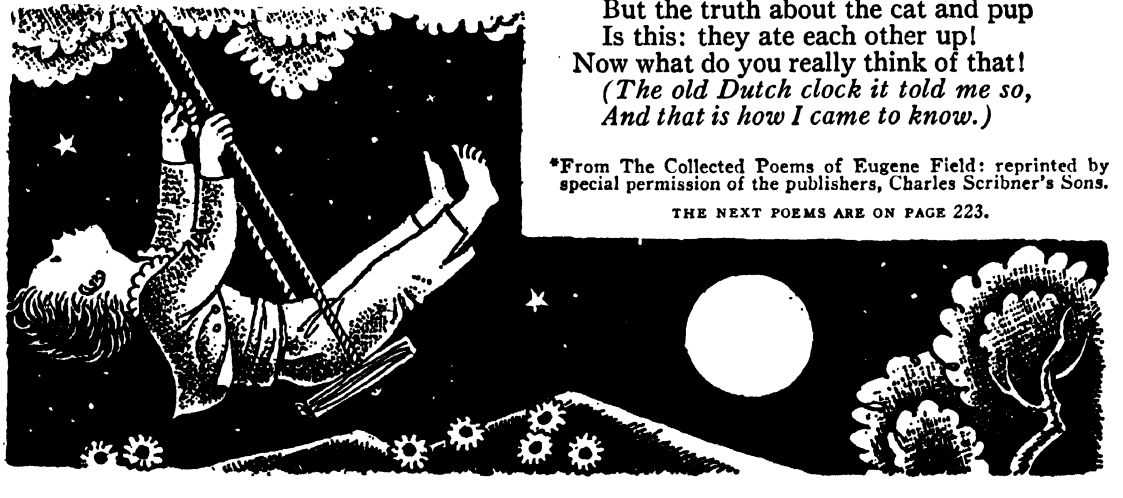
SWING, swing,
Sing, sing,
Here! my throne and I am a king!
Swing, sing,
Swing, sing,
Farewell, earth, for I'm on the wing!

Low, high
Here I fly,
Like a bird through sunny sky;
Free, free,
Over the lea,
Over the mountain, over the sea!

Up, down,
Up and down,
Which is the way to London Town?
Where? Where?
Up in the air,
Close your eyes, and now you are there!

Soon, soon,
Afternoon,
Over the sunset, over the moon;
Far, far,
Over all bar,
Sweeping on from star to star!

No, no,
Low, low,
Sweeping daisies with my toe.
Slow, slow,
To and fro,
slow—
slow—
slow—
slow.



The Duel*

By EUGENE FIELD (1850-1895)

THE gingham dog and the calico cat
Side by side on the table sat;
'Twas half past twelve, and (what do you think!)
Nor one nor t'other had slept a wink!
The old Dutch clock and the Chinese plate
Appeared to know as sure as fate
There was going to be a terrible spat.
(I wasn't there: I simply state
What was told to me by the Chinese plate!)

The gingham dog went, "Bow-wow-wow!"
And the calico cat replied, "Mee-ow!"
The air was littered, an hour or so,
With bits of gingham and calico,
While the old Dutch clock in the chimney-place
Up with its hands before its face,
For it always dreaded a family row!
(Now mind; I'm only telling you
What the old Dutch clock declares is true!)

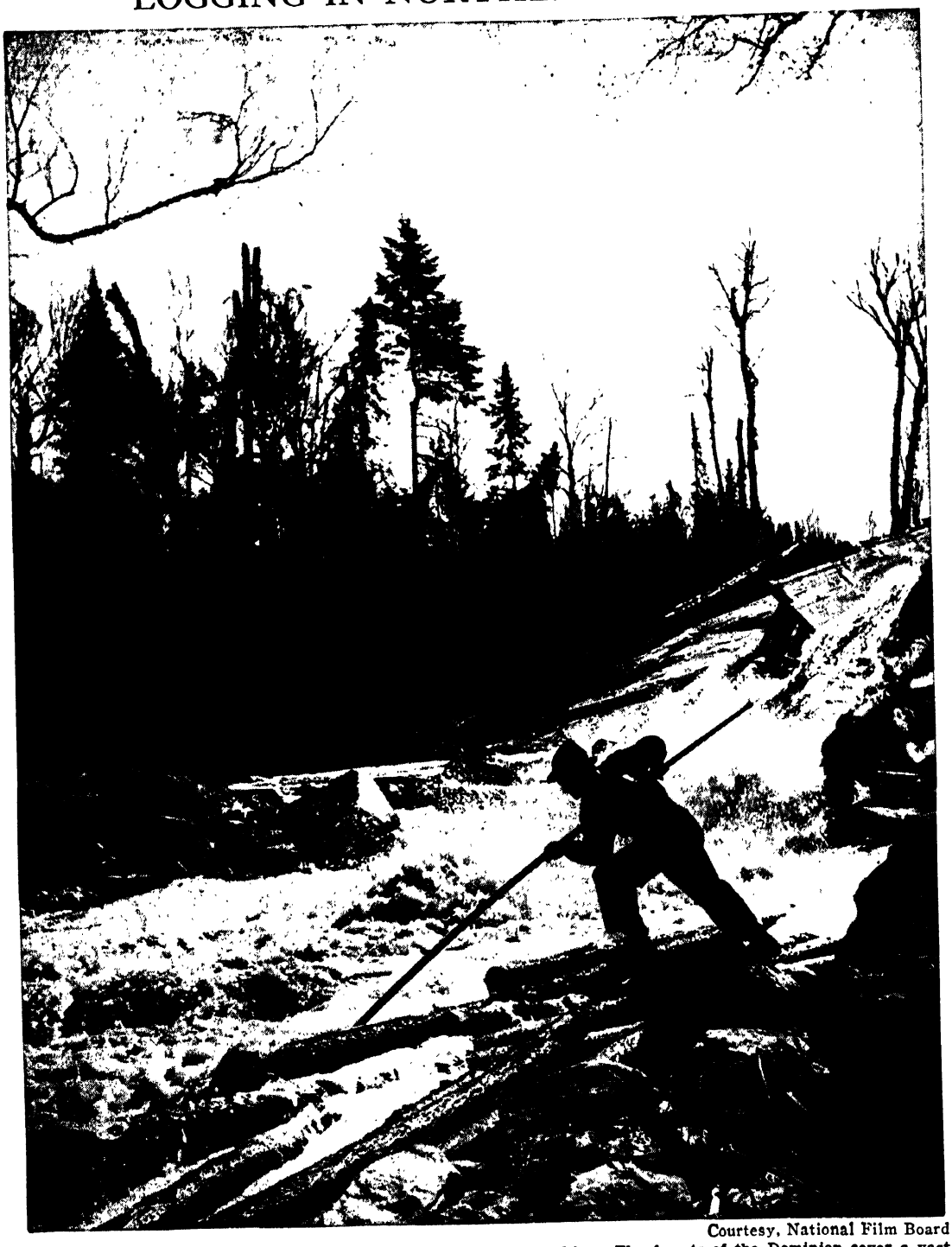
The Chinese plate looked very blue,
And wailed, "Oh, dear! what shall we do!"
But the gingham dog and the calico cat
Wallowed this way and tumbled that,
Employing every tooth and claw
In the awfullest way you ever saw—
And, oh! how the gingham and calico flew!
(Don't fancy I exaggerate—
I got my news from the Chinese plate!)

Next morning, where the two had sat
They found no trace of dog or cat:
And some folks think unto this day
That burglars stole that pair away!
But the truth about the cat and pup
Is this: they ate each other up!
Now what do you really think of that!
(The old Dutch clock it told me so,
And that is how I came to know.)

*From The Collected Poems of Eugene Field: reprinted by special permission of the publishers, Charles Scribner's Sons.

THE NEXT POEMS ARE ON PAGE 223.

LOGGING IN NORTHERN CANADA



Courtesy, National Film Board

Two very important industries in Canada are pulp- and paper-making. The forests of the Dominion cover a vast area; and they contain a great variety of trees useful for building materials, furniture, railroad ties, plastics, and pulp for paper and many other things. Canada's many swift streams aid the forest industries enormously. The woodmen cut the trees, transport the logs to a near-by stream and float them downstream to a mill. This seems to be a very simple operation, but sometimes difficulties come up, particularly when there is a "jam." A jam takes place when a number of logs floating downstream tangle together, barring the movement of logs down the river. A man armed with a long pole (as in the picture) goes out upon the jam and loosens the tangle. This is a dangerous operation, calling for skill and agility. The men who work in the forests spend the winter there, living in groups in camps usually far from any town. The life appeals to men with a taste for adventure.

A pleasant country scene, Cap Noir, Quebec.

THE DOMINION OF CANADA

THE Dominion of Canada, reaching from ocean to ocean across the northern half of North America, covers a territory so large and so varied that few people who live there really know it all. Four thousand miles lie between its eastern and its western limits. From south to north it stretches from the temperate regions of the Great Lakes to the coldest Arctic.

In the long process by which the surface of the earth has been molded, almost all the changes known to geologists have taken place in Canada. An Ice Age, when glaciers carved out great valleys and piled up rocky moraines; a time of volcanoes and earthquakes, when mountain ranges were hurled up; times during which the beds of lakes were quietly filled in—all such changes have left their marks upon this country. As a result, there are five great divisions which nature has marked out in Canada.

The most easterly of the five regions is the Maritime or Appalachian area. It includes the Atlantic provinces of Prince Edward Island, Nova Scotia, New Brunswick and part of eastern Quebec. It is really a northern extension of the Appalachian mountain chains of eastern United States. In Canada the mountains are nowhere high, but they are rugged, and the country is wooded and rocky. There are many rivers and in their rich valleys fertile soil covers the farm lands and orchards of prosperous districts. Lumbering, fishing and mining are also carried on in this region. Prince Edward Island is the least rugged of these eastern areas; it is a province of many farms, and, in fact, agriculture is the main occupation of the people.

Canadians inherit a seafaring tradition from their provinces by the Atlantic. In the days of wooden ships, some of the world's finest sailing vessels were made in the shipyards of Nova Scotia and New Brunswick. There are many good harbors where vessels great and small may make their calls. Two of these harbors, Halifax and Saint John, are Canada's largest Atlantic ports, and they are also the eastern starting-points for her two great railroads. There are lesser harbors, too, from which the fishing fleets now sail, and where the sea provides the chief means of earning a living.

A second great region of Canada lies in the Upper St. Lawrence valley. The St. Lawrence River is one of the greatest of the world, a waterway leading into the heart of the continent. Large ocean vessels may sail along its course inland for almost a thousand miles to Montreal. Westward from that city, canals have been built around rapids and waterfalls; they open the river system to smaller vessels. Freighters large enough to cross the Atlantic have sailed inland up the St. Lawrence and across the Great Lakes.

Courtesy, Travel and Publicity Bureau, Toronto

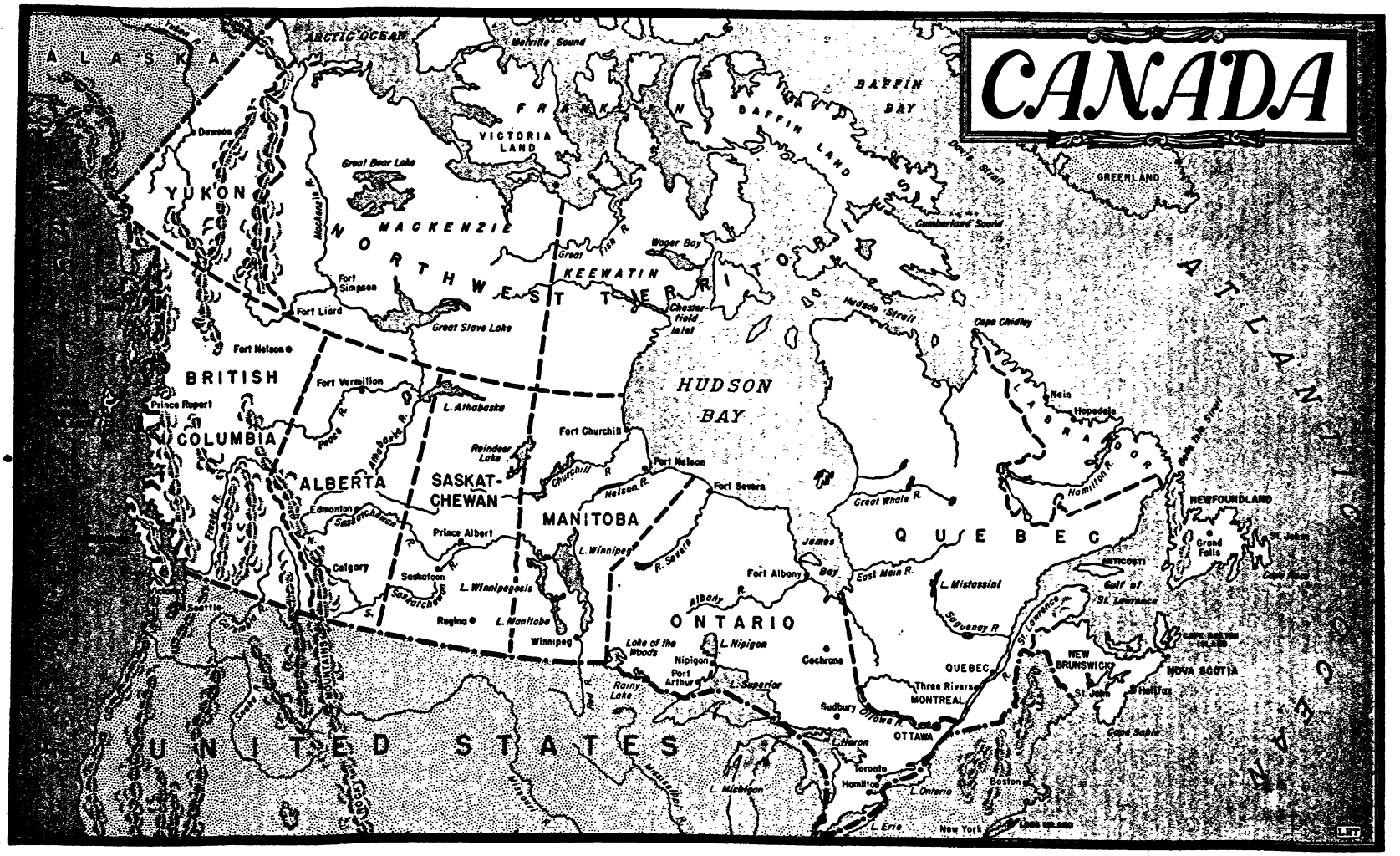
An apple orchard in bloom in Ontario. Canada produces about $10,000,000 worth of apples each year.

There is a continuous water highway from Montreal to such distant inland ports as Fort William on Lake Superior and Chicago on Lake Michigan.

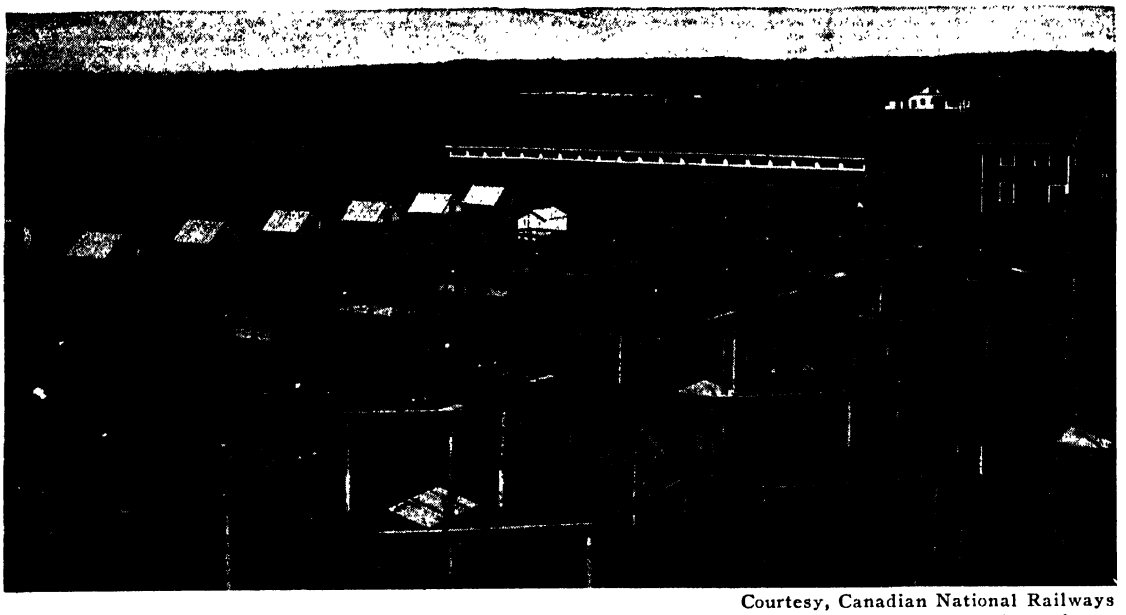
Above Quebec City the St. Lawrence Valley gradually widens into a fertile plain. At first the Laurentian Hills, marking the edge of the valley to the north, may be clearly seen from the river, then the mountains recede and the area of farm land grows larger. It reaches westward through Ontario to the United States boundary at Windsor and Sarnia, and northward along the Ottawa River and to Georgian Bay.

Canada's first farm lands were cleared and cultivated in the eastern part of this region, and it was in the St. Lawrence Valley that prosperous agricultural communities, both French and English, grew up in the eighteenth and nineteenth centuries. The pioneers found the region thickly covered with heavy forests of hardwood—elm, ash, walnut and maple. Lumbering has been an important Canadian industry since the early days of settlement, and at one time, over a century ago, hundreds of ships a year called at Quebec to carry timber to Europe.

The St. Lawrence Valley is the most thickly populated part of Canada. Most of the fertile land is cultivated in this area, and there are many prosperous farming districts. Commerce and industry have also developed here. Because the valley is a highway into the interior of the continent, the cities of Montreal and Toronto have become important centres of trade. Factories and mills have been built here, too. One reason for this growth of industry has been the cheapness of electric power. The St. Lawrence River system drops 602 feet between Lake Superior and the sea. This drop does not take place all at once, of course, although there is one enormous fall at Niagara, where the river plunges down more than 300 feet between Lake Erie and Lake Ontario. In the rivers and streams to the north also there are waterfalls, which have been made to produce electric power. Though there is no coal in the



The vast Dominion of Canada covers an area of almost 3,750,000 square miles. It stretches from the Atlantic Ocean to the Pacific, and from the Arctic Ocean to the northern border of the United States. More than 12,000,000 people dwell within its boundaries, about half of whom live in the provinces of Ontario and Quebec. Canada is a well-watered land, with many broad rivers and a number of large lakes, in addition to the Great Lakes which it shares with the United States. With the discovery of valuable ores and the development of air transportation, the northwest has become Canada's new frontier.



Courtesy, Canadian National Railways

A farm in Prince Edward Island where silver foxes are raised. Fur-farming is important in several provinces.

region, it can be brought cheaply by water from the United States. It is easy, therefore, to find the power for industry, and the area has naturally grown into a centre for manufacturing.

Geologists tell us that some of the oldest rocks in the world underlie Canada. This very old rock is located in the third, and largest, of the great regions of Canada. The Pre-Cambrian Shield, the name by which it is known, because it surrounds Hudson's Bay, is in the form of a gigantic shield. Sometimes it is called the Canadian Shield.

Elsewhere in our book you may read that some of the oldest rocks in the world are called Cambrian. Much of America is on a

Courtesy, National Film Board

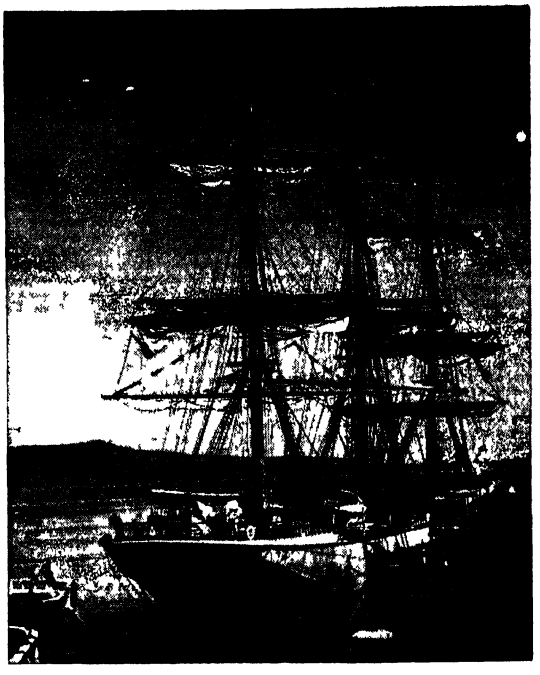
A gold mine in British Columbia. Canada is second in the world's production of gold. All the provinces produce some gold, Ontario the most, then Quebec, British Columbia, and Manitoba; the others, smaller amounts.

foundation of Cambrian stone. The name comes from Cambria, the Latin name for Wales, where the rocks of this era are abundant. The Canadian Shield was formed in a still earlier era so we call the shield Pre-Cambrian, which means before the Cambrian.

From Labrador in the northeast the boundaries of this area sweep southward until they almost touch the St. Lawrence River near Kingston, and then northward again cutting across western Ontario up through eastern Manitoba, across the northern part of Saskatchewan and Alberta and along the line of the Mackenzie River to the Arctic Ocean. Within these boundaries is a gigantic wasteland of rock and forest. There are occasional small areas of land suitable for cultivation, and one quite good-sized area, called the Clay Belt, south of James Bay. But the climate is cold, and for the most part the shield is unsuited to farming.

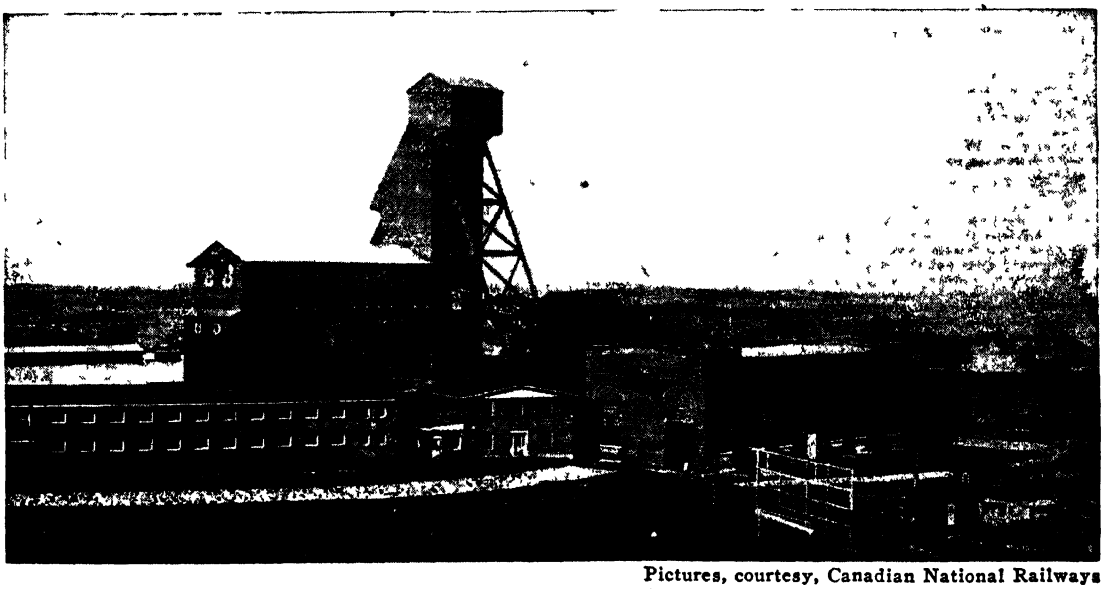
The wealth of the Pre-Cambrian Shield is to be found in its furs, its minerals, its forests and its water power. From the earliest days of Canada, the forests of the rocky northland have been rich in fur-bearing animals. Along the canoe routes on a network of lakes and rivers, traders have been bringing down the furs for more than three hundred years.

The canoe routes have carried prospectors, too, and in more recent times the shield has become important for its many minerals. Most precious of all metals is radium, and large radium ore deposits have been found at Great Bear Lake in the Northwest. Gold, silver, nickel, iron, copper and many other metals and stones too are found in the Pre-Cambrian Shield.



A fishing ship at Campbellton, New Brunswick.

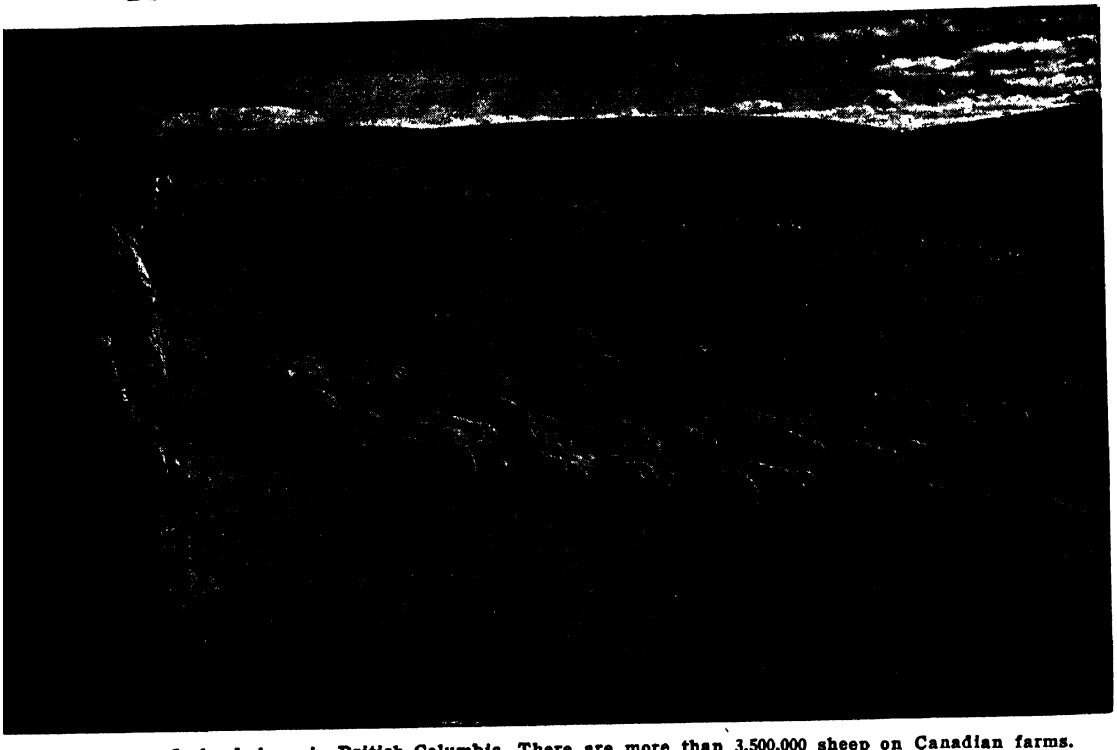
Another source of wealth is its forests. Thousands of acres of trees are cut each winter to feed the pulp mills where newsprint is made. When spring comes, the logs are floated down the rivers, and sent in rafts



Pictures, courtesy, Canadian National Railways

A nickel mine in the Sudbury district, Ontario. The ores in this region contain several metals.

RICH FARMS IN WESTERN CANADA



A prosperous flock of sheep in British Columbia. There are more than 3,500,000 sheep on Canadian farms.

Pictures, courtesy, National Film Board

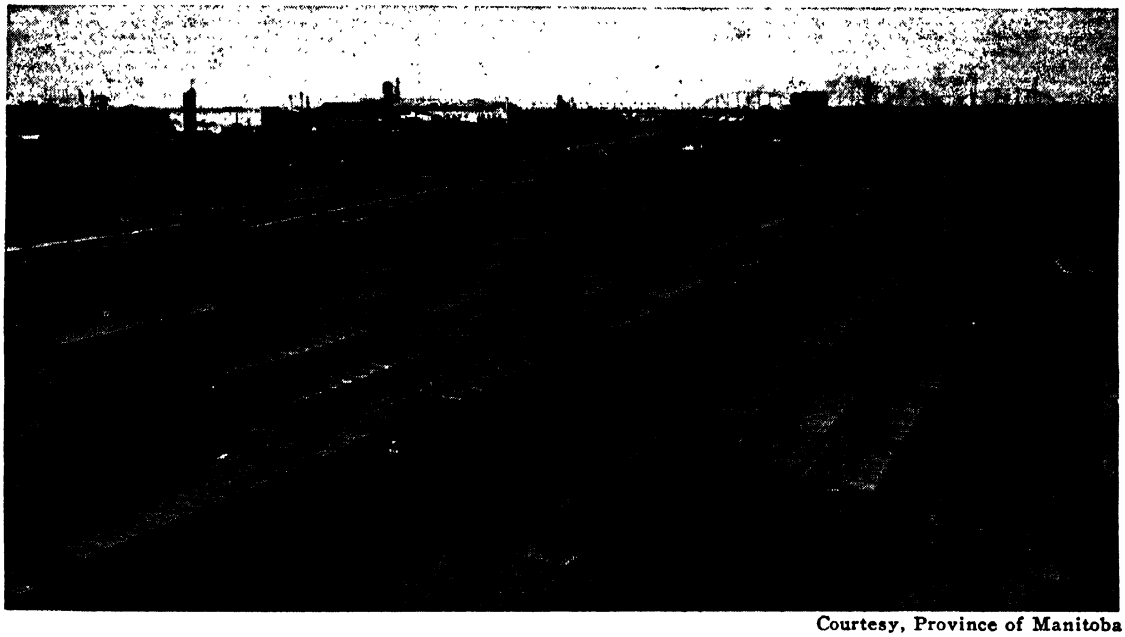
Harvesting wheat on one of western Canada's great modern farms. The threshing machine pours the grain into a truck.

across lakes to the mills where they are made into pulp and paper.

A fourth distinct region of Canada is the Prairie or the great central plain. From the borders of the Pre-Cambrian Shield in eastern Manitoba to the foothills of the Rockies in Alberta stretch a thousand miles of prairie. In the Red River Valley near Winnipeg the plain is low and very flat. Westward it rises in great steps through three prairie levels, and in the land near the Rockies there is farm land 3,000 feet above sea level. The more westerly parts of the Prairie have low rolling hills, and the northern farm lands are wooded.

The great central plain is Canada's wheat and cattle country. The settler did not have try. Thousands of head of cattle graze in the open fields where once great herds of buffalo passed. Each year large shipments of livestock are made to the markets of the East. The city of Calgary, in the centre of the ranching country, holds a stampede each summer which has now become famous. Ranchers and cowboys from hundreds of miles around come to take part in the riding contests, the chuck wagon races and the steer-roping competitions which are held at the stampede.

The Prairies have other resources besides the wealth of the farm lands. In the north there are gold and water power, and coal deposits are found in all three Prairie Provinces. In the Turner Valley, near Calgary,



Courtesy, Province of Manitoba

A large share of western Canada's grain moves eastward through these freight yards of the Canadian Pacific Railway.

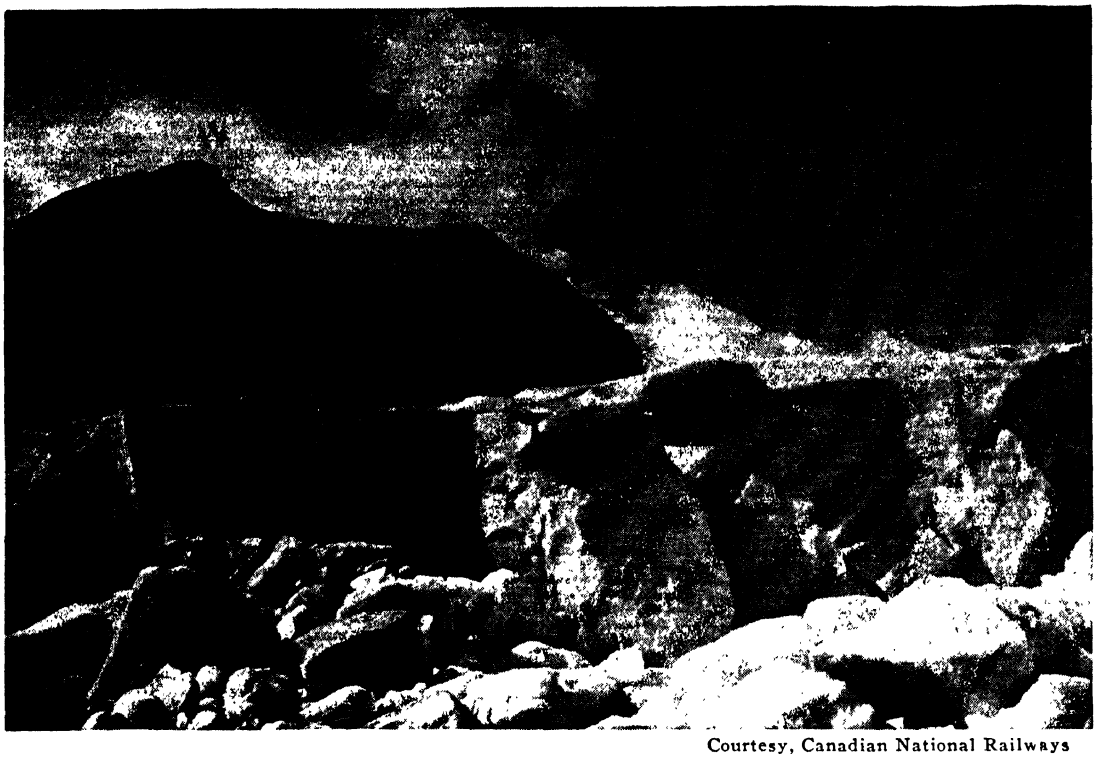
any forest to clear away from the Prairies, and when he had broken the grass cover, or prairie wool as it was called, he found rich earth beneath. The growing season is short and there are years when the rainfall is dangerously little. Frost and drought have caused many reverses. But the scientists and the farmers together, the one group working in the laboratories, the other in the fields, have found ways to grow good grain on the Prairies. In the best years as many as 400,000,000 bushels of wheat alone can be produced on prairie farms.

The high rolling prairies of southwestern Saskatchewan and southern Alberta have been the centre of Canada's ranching country. Thousands of head of cattle graze in the open fields where once great herds of buffalo passed. Each year large shipments of livestock are made to the markets of the East. The city of Calgary, in the centre of the ranching country, holds a stampede each summer which has now become famous. Ranchers and cowboys from hundreds of miles around come to take part in the riding contests, the chuck wagon races and the steer-roping competitions which are held at the stampede.

The Prairies have other resources besides the wealth of the farm lands. In the north there are gold and water power, and coal deposits are found in all three Prairie Provinces. In the Turner Valley, near Calgary, is a rich oil-field. Far to the north of Edmonton there is a fertile valley where the Peace River flows. The mountains shelter this region from the cold winds of the north Pacific, and the soil produces good crops in spite of its northern location. It is Canada's last pioneer farming district. The second World War has given it new importance, for it is the starting point of the Alaska Highway.

Canada's most westerly region is a land of high mountains and heavy forests. The mountains rise abruptly on the western plains in Alberta. They are the northerly extension of the great chains of mountains that form the backbone of both North and South

SCENES OF GRANDEUR AND BEAUTY

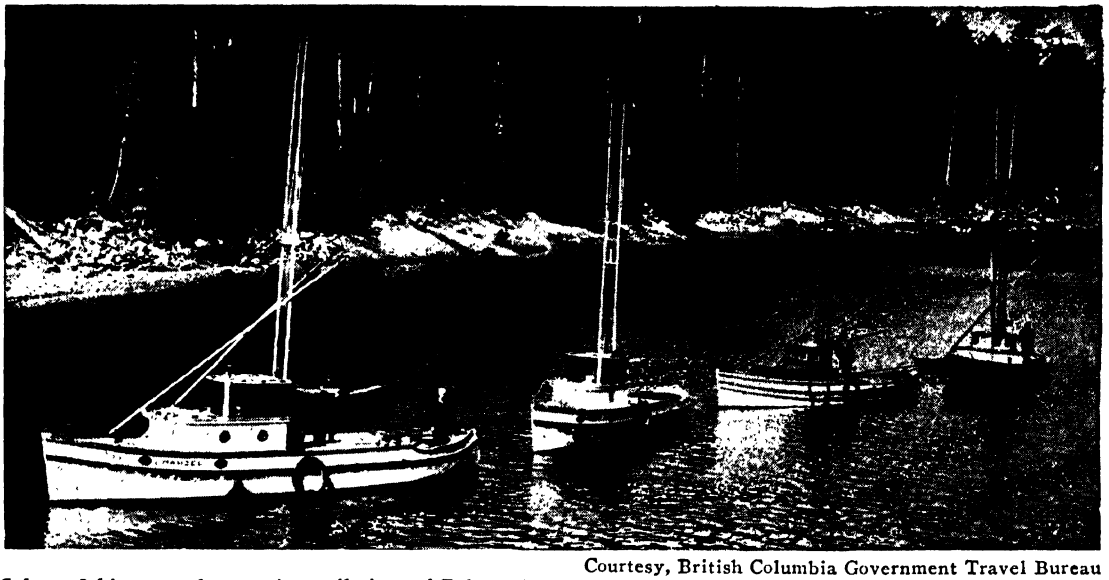


Courtesy, Canadian National Railways

From Columbia Ice Field, Alberta, rivers flow to Hudson Bay, the Arctic Ocean, and the Pacific Ocean.

Photo by T. J. Hileman, Kalispell, Montana

The mountains that form a ring around Waterton Lake, in Waterton Lakes National Park, southern Alberta



Courtesy, British Columbia Government Travel Bureau

Salmon-fishing vessels on a tranquil river of British Columbia. Salmon has first place among Canada's fish, and British Columbia produces far more wealth from its fisheries than any other province of the Dominion.

America. The Canadian ranges are high and massive. Snow glistens on their summits the year round. In a series of great parallel chains these massive ranges stand between the Prairie and the sea. The Rockies, most rugged of all, the Selkirks and the Coast Range—these are the names of the most important ranges. Between them lie deep valleys in which great rivers rise—the Fraser, the Columbia, the Thompson and the Peace. In some of the valleys are farm lands and orchards. There are important mineral deposits, too, in British Columbia—especially the copper ores in Trail.

Beyond the mountains is a narrow coastal plain where Canada's great Pacific port, Vancouver, is situated. Off the coast lies a series of islands, once peaks of a mountain range. Of these, the largest is Vancouver Island on the southern shore of which the provincial capital, Victoria, stands. On the steep slopes of the Pacific Mountains are great forests of Douglas fir, immense trees sometimes ten feet in diameter. Here, too, is to be found a thriving fishing industry. The famous salmon catch of the British Columbia rivers provides labor for many men, both in the boats and in the fishing canneries.

There is yet another great region of Canada —the Arctic Northland. This country was little known until recent times. Brave explorers have traced its outlines during the past two centuries, finding their way down the rivers of the north to the Arctic Ocean and probing the dangerous channel through the ice across the top of North America. It was not until our own day, however, that the country became known in any detail. The airplane has made simpler the mapping of remote areas, and new sources of mineral wealth have been found in the Arctic regions.

In this great country, the Dominion of Canada, more than 11,000,000 people live. That is not a large population for so big a territory, but it is a varied one. People have come from many parts of the world to make their home in this new land. The French were the first. They came from western France, especially Normandy, and they settled in Nova Scotia, which they called Acadia, and in the valley of the St. Lawrence. In Canada their way of life, their language and their religion have been kept throughout 300 years, in spite of their separation from France in 1763.

The people whose origins are in the British Isles—English, Scotch, Welsh and Irish—form the largest group in Canada. English settlements were made in Nova Scotia as early as 1750, and the English settlement of central Canada began after 1763. Since that time, settlers have come continuously, but there have been some periods when large numbers came at one time.

The first important group were the United Empire Loyalists, who came from the United States during and after the Revolution. A further wave of settlement took place during the 1820's and 1830's, when thousands

of newcomers came to Canada from the British Isles. The stream of settlers kept flowing during the years after 1840 and became a tide again between 1900 and 1914. Those were the years during which farmers began to go in great numbers to the prairie regions, which had been opened to settlement after 1870. Land was free, transportation was cheap, and the promise of new wealth attracted thousands. Many of them came from the farm lands of Ontario, many from the United States and others from the British Isles. During this period, too, great numbers of immigrants began to come from the continent of Europe.

European groups, apart from Anglo-Saxons and French, have formed a part of the Canadian population since the earliest days. German-speaking people settled in Lunenburg in Nova Scotia in the 1750's and established a flourishing fishing industry. Other German-speaking settlers were among the groups who came to Canada during the American Revolution. Icelandic and Mennonite immigrants were among the first to take up land on the Prairies.

In the settlement which took place after 1900 almost all parts of Europe were represented. People came from Denmark, Sweden, Norway and Finland, from Holland and Belgium, from Germany and Italy and from eastern Europe. Ukrainians, Poles, Russians, Czechs, Serbs and Bulgarians were among the many national groups in this migration. After the first World War, the stream of European settlement was renewed, and for more than ten years thousands of people came each year to make their home in Canada. Oriental people, too, have come, though not in great numbers. Japanese, Chinese and even settlers from India make up the group from the Far East.

MOST OF CANADA'S POPULATION IS NOW CANADIAN-BORN

To-day in Canada one may watch the interesting process by which groups of European people, gradually becoming Canadian, are nevertheless keeping many of the customs and skills which they brought with them from their homeland. Though the people of Canada have many different origins, the majority of the population is now Canadian-born. They think of their country as a nation—a young one, but an important one.

Canada is a self-governing member of the British Commonwealth of Nations. This means that she is part of the family of states which make up the British Empire, but she is a grown-up member of the family and she now manages her own affairs. Canada is a kingdom, and her king is the sovereign who sits upon the British throne. His representative in Canada is called the governor-general.

As in England, however, so also in Canada the people govern themselves through their own democratic Parliament. The prime minister is the real leader of the country's government. Neither he nor any of his cabinet ministers can hold office unless Parliament approves. The House of Commons, the more important part of Parliament, is chosen by the electors of the country as a whole. The prime minister is a member of the House of Commons, and so are most of the members of his cabinet.

There is also a Senate, the members of which are appointed for life. All bills must pass both houses of Parliament and receive the assent of the governor-general before they become part of the law of the land. The House of Commons, as we have said, is the more important law-making body. It is only in very extraordinary cases that the Senate will refuse its approval, and it is difficult to imagine a governor-general refusing to give his assent to a law which had passed both houses.

CANADA IS A FEDERATION, OR UNION, OF TEN PROVINCES

Canada is not only a parliamentary democracy; she is also a federation. There are ten provinces in Canada, and each has a government of its own which controls certain parts of the life of the people. Federation came fairly recently in Canadian history. The Dominion began as a series of widely scattered British colonies, each with a separate government and tradition of its own. The Maritime colonies formed one group. The French and English settlements in the St. Lawrence Valley were another. A tiny settlement grew up on the edge of the Prairies at Red River, and still other colonial settlements were founded on the Pacific Coast. Many men had written and spoken about the day when these colonies might be joined together; but union was only a dream until it was possible to connect the British colonies by railway lines stretching from east to west across the continent.

The union, or Confederation, was established in 1867. Four provinces, Nova Scotia, New Brunswick, Quebec and Ontario, then entered the new Dominion. The great Northwest Territories were taken over in 1870 and the province of Manitoba entered Confederation at that time. Prince Edward Island and British Columbia were soon added, and in

Courtesy, Canadian National Railways

One of the entrances to Stanley Park, Vancouver, British Columbia. Vancouver is an important trade centre.

1905 Alberta and Saskatchewan became provinces, and in 1949 Newfoundland was added.

The Dominion and the provinces divide responsibility for government in Canada. Matters concerning the life of the country as a whole, such as defense, foreign affairs, foreign trade, banking, currency, the postal system, railroads and river transport, all belong to the Dominion government. To the provinces belong matters of more local interest, such as education, the construction and care of roads, the control of companies doing business within provincial boundaries, the sale of public lands and social services.

One reason for this division of power is to be found in the fact that both French- and English-speaking people live together in Canada. The people of Quebec, most of whom are French Canadians, were willing to enter Confederation because the agreement left them in control of matters in which they were especially interested. Education, for example, has a special interest for the people of Quebec, because they wish to have French taught in the schools. Civil law, too, is decided by the provincial governments, because Quebec prefers its own system which goes back to ancient French law. Criminal law, on the other hand, is the same throughout the whole Dominion, and is controlled by the federal government.

In the same way that the government of the Dominion is controlled democratically by the people through Parliament, so also the people of each province control their government through a provincial parliament or legislative assembly. There is a cabinet of ministers in each province, and the head of the government is a premier. There are political parties in the provinces, and the premier is the leader of that party which has the largest number of members in the legislative assembly. The premier chooses the members of the cabinet, who are also members of the legislative assembly. There is also in each province a lieutenant-governor, who represents the king. He is the formal head of the government, and his official approval must be given to provincial laws. All the provinces have equal powers of government.

The ten provinces of Canada are bound together, not only by their federal government, but also by strong commercial interests. The growth of business in the Dominion has been helped by communications which have been built from east to west across the country. The first great highways of Canada were the rivers and lakes. The explorers made their way inland by water, and the fur traders followed them, in turn becoming explorers themselves and finding new routes into the interior. Gradually a great river-system was revealed, by which men could travel in canoes from one side of the continent to the other. (In a few places the canoes had to be carried overland for short distances.) Many of the rivers and lakes are still important as means of communication. The St. Lawrence and the Great Lakes form a mighty highway of commerce. The Saguenay River and the Ottawa are both traveled by steamboats. The fish caught in the north-

Courtesy, National Film Board
A strip on the great Alaska military highway.

ern waters of Lake Winnipeg are brought south to market in steamers. A steamship goes down the Mackenzie River to the Arctic each year, and some of the lakes in the interior of British Columbia have steamer service. The waterways, which were the first important channels of communication in Canada, continue to carry a share of the country's trade.

Within the last century a modern system of railroads has been added to the water routes. There are two great transcontinental railroads in Canada, the Canadian Pacific Railway and the Canadian National Railway. The latter is owned by the government of Canada, and its lines reach from Atlantic to Pacific, and also north to the shores of Hudson Bay. A journey across Canada on either of these railroads is an exciting experience, because many kinds of country will be seen. Four days and five nights of continuous travel are necessary for going by train from Halifax to Vancouver.

There are good highways, too, in Canada. Each province has built its own system of roads, and many thousands of miles are paved. Not long ago a road was built through the difficult country north of Lake Superior. For many years this was the one unfinished link in a transcontinental highway. This part of the road lies through country where few people live and there was little local need for a highway. With support from the Dominion Government, however, the work went forward. Now it is possible to travel by road from coast to coast on Canadian soil.

The Alaska Highway is another exciting addition to the network of roads in the Dominion. It was built by the Government of the United States as a wartime emergency measure, in agreement with the Canadian Government. Much of the highway lies through unsettled country in British Columbia and the Yukon Territory.

Airways are Canada's newest means of transportation. Canada's air-transport system began with commercial flying in the far northern stretches, beyond the railroads and roads. The famous bush pilots of that northern country established for Canada a tremendous business in commercial flying in the days when air freight in other parts of the world was still in its infancy. Passenger travel by air has also been rapidly developed. The Trans-Canada Airways, a publicly owned company, now provides a regular service across the continent, and the lines of other air services reach out into every remote corner of the country. As world aviation becomes more important, so does the air over Canada. The short "great circle" routes from America to Europe and to Asia lie across the Canadian northland.

In recent years, all the wealth and all the strength of the Dominion of Canada has been tested by the part she has played in the second World War. As a united country she has had a short history, but she has in that time taken part in three wars outside her borders. Canada's contribution to the South African War in 1900 was not great, but the record of her soldiers was a good one. In 1914 and 1939 Canada became involved in wars of world-wide importance. Thousands of Canadians served in both conflicts, on land, at sea and in the air. A great munitions industry grew up to help supply the armies in the field; ships were built, armored vehicles were manufactured, and, in the second World War, airplanes, too, were made in Canada.

Although she was one of the earliest discovered and also one of the earliest settled lands of North America, Canada has still the character of a young country. Many areas are little known, and this is especially true of the whole of the north country, which is only now being opened. These are days in which the northern parts of the world are becoming more important. Men are finding ways to live and prosper in Arctic and sub-Arctic regions, and Canada has an important share of the Arctic within her boundaries.

Soil Conservation Service

Cows in clover—the beginning of the cycle that provides us with milk and butter and beef.

THE PLANT WORLD

IF a scientist from another planet were to explore the earth, he might well decide that the plants were more important than the animals, even more important than man. For most of the life on this earth is plant life. If you were to weigh all the plants in a meadow—grasses, daisies, buttercups, tiny mosses, molds, mushrooms, bacteria, etc.—and then weighed all of the animals that lived there naturally, from the woodchucks to the microscopic amebas that crawl between moist grains of soil (including the meadow mice, grasshoppers, crickets, earthworms, etc.), you would find that the plants weighed a great deal more than the animals.

The same thing would be true if you compared all of the plant life in a tropical forest with all of the forest's animal life. It would even be true if you could construct gigantic scales to weigh the plant life of the oceans against their animal life. The plants would weigh much more than the animal forms. This seems strange when you consider that you can cruise for days without seeing any plants in the ocean while schools of porpoises are playing tag with your ship and flying fish glide lightly over the waves.

What do the whales and the sharks live on? The general rule is, of course, the whales and the big fishes eat the medium-sized fish, the medium-sized ones eat the small ones, until the smallest fishes have to eat small wriggling worms, or tiny crustaceans, or the babies of other fish or whatever living things are small enough for them to swallow. Finally the smallest sea animals (and many of the larger ones, too) devour the one-celled plants that float or swim, millions of them, from the surface down as far as there is enough light for them to manufacture sugar and other foods. Many sea animals eat the larger seaweeds that grow along the coasts or, in some cases, in the open sea. And so you see that most of the animals of the ocean are supported, directly or indirectly, by the ocean plants. Sometimes these plants are so abundant that they give the water a green or red tint. Some authorities believe that the Red Sea got its name from the billions of microscopic red plants that color its waters.

On earth, too, all of the animals, including man, depend on the plants for food. The lion eats the antelope, but the antelope lives on grass and other plants. You may eat beef or lamb, but the animals made the meat by eating plants. If the plants were all to die, both the antelope and the lion would starve. The milk you drink in the morning was made from the food the cow ate—grass, clover and other plant products.

The *green* plants have a wonderful secret which the animals do not have. It is called photosynthesis. All the green plant has to do in order to manufacture food is to stand in the light and take in water and minerals through its roots and air through its leaves. Using the energy of sunlight, the plant's green coloring matter (called chlorophyl) changes the water and the carbon dioxide

American Museum of Natural History
Luxuriant plant life growing in a shallow sea.

U. S. Forest Service
Desert vegetation is scanty and widely scattered.

of the air into sugar and the invisible gas, oxygen. From the sugar the plant makes all of the other foods it needs. By shuffling the atoms that make the sugar, or by combining sugar with minerals from the soil, the plant makes starch, fats and oils, proteins, vitamins and everything that it requires. Mankind and all of the animal kingdom live on the food produced by green plants. The plants that lack chlorophyl (the fungi, such as mushrooms, molds and bacteria, and a few higher plants like Indian pipe and dodder) also have to depend on the food produced by the plants with chlorophyl.

The green plants give to us (and to the animals and the non-green plants) something else which is just as important as food. This something is oxygen. All living things breathe in oxygen and breathe out water and carbon dioxide (another transparent gas). But only green plants in sunlight perform the reverse process, taking in carbon dioxide and giving off oxygen. Hence, if all of the green plants were to go on strike, the animals would suffocate very soon.

There is a sort of partnership between the green plants on one side and the animals and the fungi on the other. We have just learned that the green plants contribute food and oxygen. But the animals do a great deal for the green plants. Insects and humming-birds pollinate flowers, and many animals distribute the seeds of plants so that they can find new places to grow. When animals die, bacteria and other fungi decay their bodies until the materials the bodies were made of are changed to substances the green plants can absorb and use. Thus, the same chemical elements, carbon, hydrogen, nitrogen and others, are used over and over again. Also, the green plants must have a constant supply of carbon dioxide and they get this from the respiration of the animals and fungi.

In some cases plants have turned the tables, so to speak, and get their food from animals. There are millions of bacteria (which are plants) in the intestines of every higher animal. Many diseases are caused by bacteria and a number by molds and other fungi. Here it is the man or lower animal that supplies the food and shelter and the plants that benefit. The most curious cases of all are plants like the sundew and the Venus's-flytrap which capture and digest insects. Many plants carry on partnerships with other plants or animals. Many of the mushrooms you see in forests are produced by fungi which gather water and minerals for the trees in return for sugar. The billions of bacteria in our own intestines sometimes cause serious infections, but it has been found that they produce useful vitamins.

We have shown how meat, milk and other animal foods are derived from plant products that some animal ate. Actually, much of our food is produced directly by plants. What a list we could make! Sugar, from sugar-cane, sugar-beets, sorghum, corn plants, maple trees. Starch, from corn, wheat, the other grains, potatoes, cassava.

Plant foods rich in protein include most nuts, dry peas and beans, especially soy beans, and the avocado. The yeast used to make bread rise contains a very large amount of protein as well as an excellent supply of several vitamins. The olive, the coconut, and the peanut are rich sources of edible oil. Today most of the shortening you see on

New Zealand Government
Jungles teem with plant life, often gigantic in size.

display at the grocer's is made from vegetable oils—peanut, cottonseed, or corn. Plants supply the starches and minerals that we need, and most of the vitamins. In some plants it is the seed or fruit of the plant that we eat; in others, the stem or the root. Actually, most seeds can be eaten either raw or cooked. Among the most important seeds are the grains, peas, many beans and various nuts. Among the most delicious of plant foods are the fruits, from the cherries, peaches and apples of temperate countries to the mangoes, custard apples and durians of the tropics. Such common "vegetables" as tomatoes, squash, pumpkins and cucumbers are really the fruits of these plants.

Often the root is the part where the plant stores most of its food, as in the carrot, the beet and the sweet potato. (The white potato is an underground stem.) We eat the stem of the asparagus, the growing buds of the Brussels sprouts, the leaves of cabbage, lettuce and spinach, and the leaf stalks of celery and rhubarb. In the case of cauliflower, the principal edible part is the white cluster of unopened flowers. Some day in the future, perhaps, we may live largely on wood, for chemists have discovered how to make nutritious and digestible foods from wood.

Just as plants are the primary sources of vitamins, they also supply us with many of our most valuable drugs and medicines. Quinine, which cures malaria, is extracted from the bark of a South American tree. Cascara, used as a laxative, comes from the bark of the western buckthorn of British Columbia and the Pacific coast states. Ephedrine, used to reduce the swollen membranes of the nose in colds, comes from a leafless shrub that looks like a bunch of switches. The Chinese have used this plant medicinally for more than 5,000 years. Some other important drugs obtained from plants are digitalis (for the heart), belladonna, cocaine (local anesthetic), opium (from the opium poppy), and ergot. In some cases chemists can make the same drug artificially.

Since Sir Alexander Fleming discovered that a common green mold produces the marvelous penicillin, scientists have investigated many molds and other lowly plants and have found many other antibiotics, as these germ-killers are called.

Many of the deadliest poisons are produced by plants. Some of them, such as aconite, from monkshood, are extracted from delicate plants with beautiful flowers. Strychnine, opium, cocaine and belladonna are dangerous poisons as well as useful drugs.

Spices and nearly all flavoring materials are obtained from plants. Black and white pepper are the fruits of a climbing shrub. Red peppers are fruits of much smaller plants. Nutmeg comes from an evergreen tree of the East Indies. Mustard is the ground-up seeds of the mustard plant, whose leaves are cooked as greens. Chocolate and cocoa are prepared from the seeds of the cocoa tree, while vanilla is extracted from the pods of a Mexican orchid. Most of the beverages that people drink, except milk and water, are made from plants.

The most delicate and valuable perfumes are still obtained from plants, even though many perfumes are made nowadays by chemical processes. In southern France, millions of pounds of flowers are gathered every year for perfume. The hillsides are covered with orange blossoms, roses, jasmine and violets.

THE SOURCES OF COTTON, LINEN, SILK AND MAN-MADE FABRICS

What else do we owe to plants? For clothing we use cotton, linen and some less well-known plant fibers, such as ramie and pineapple. The silkworm feeds on the leaves of the mulberry. In various tropical countries there are trees whose bark can be pounded until there is nothing left but a kind of cloth. The natives of many Pacific islands used to dress themselves in such a material. They called it tapa. Today many fabrics are made by chemical means from wood pulp.

Wood is still one of the most important materials for building houses and for furniture. In Japan and in other countries where bamboo is abundant, the natives make the

tough stems of this giant grass serve for all of the purposes for which ordinary wood is used elsewhere. Even water pipes are made from bamboo.

It is true that many synthetic products are just as good as the natural ones made by plants, and the synthetic products are often much cheaper. Natural vegetable dyes have been almost supplanted by synthetic dyes made from coal tar. Sometimes the natural product is better in some respects while the synthetic one is better in others. This is the case with rubber. Natural rubber is made from the milky juice (latex) which flows from wounds in various plants. The commercially important source is the Para rubber tree. Chewing gum is made from the latex of another tropical tree.

Though science replaces some plant products in our daily lives with synthetic products, science creates an even greater demand for plant products. All paper used to be made from old rags. Now most of it is made from wood pulp. Sawdust is now transformed into hard wallboard, soft woods are made hard by chemical means and also resistant to fire and decay.

Some day we may keep warm by the use of atomic energy, or by harnessing the sun's rays. But for some time to come, we shall continue to use fuel produced by plants. Coal and peat were formed from the trunks and leaves of plants that flourished long ago. When coal is burned the heat comes from energy stored by strange green trees millions of years ago. Petroleum (from which we get gasoline) is believed to have been formed from the partial decay of one-celled plants, and possibly also from primitive animals.

NEITHER HEAT NOR COLD CAN DAUNT THE PLANT KINGDOM

Plants surprise us sometimes by their ability to grow under unfavorable conditions. You frequently see large trees growing on mountain sides and amid rocks where there hardly seems to be enough soil to cover their roots. Some bacteria can live in hot springs at a temperature not far below boiling (175° F.), and spores of bacteria have survived after being exposed to the temperature of liquid air (—310° F.). Some flowers push their way up through the snow.

Many plants (called annuals) die as soon as they have flowered and produced their seeds. Some of the big trees of California are more than 2,000 years old and still in good health. The smallest plants are the bacteria, which average about 25,000 to the inch. On the other hand the redwoods grow 360 feet tall, and some tropical vines may become a thousand feet in length.

The great water lily of the Amazon has leaf blades five feet in diameter. Some palms have leaves twenty feet long. The cactus, on the other hand, has lost its leaves altogether, and carries on photosynthesis in its green stems. It is difficult to say which leaves are the most beautiful, but it would be hard to surpass the finely cut fronds of our native ferns. Some plants, like the long-leaf pine and most cactuses, require full sunshine; others, like most of our woodland flowers and ferns, do best in the shade of trees. Some seaweeds grow in the dim light 450 feet below the surface of the ocean. Some plants take on a different appearance according to where they grow. Many pines and spruces grow as tall straight trees in most places, but crawl along the ground, forming dense tangles, near the timber line.

EGGS OF PLANTS, FROM WHICH THE SEEDS COME

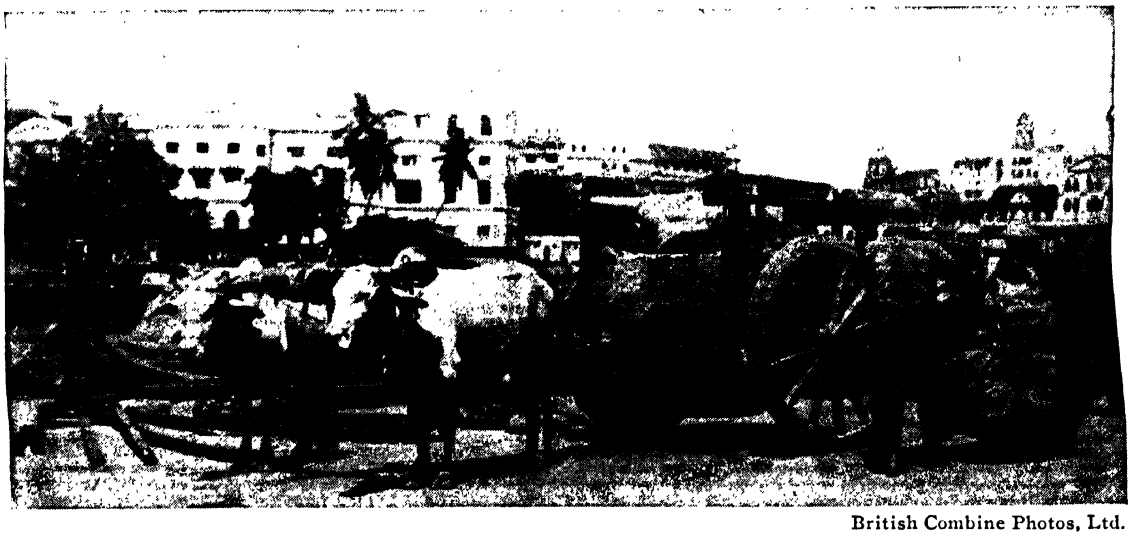
How do plants come into the world? Most people are not familiar with the fact that plants produce eggs, and that the eggs develop into embryos which become the young plants. All of our common plants—apples, dandelions, grasses — produce microscopic eggs. No, the seed is not the egg. The seed is the embryo plant with its food supply and protective coverings. Plants have other ways to reproduce, however. Potato tubers, onions, lily bulbs, the runners of strawberry plants are all structures for producing new plants. Sometimes all one has to do is to cut off a piece of leaf or stem and plant it in damp sand, and a new plant will grow.

The oldest and the largest living things now on earth are plants. So are the smallest living things (unless the viruses are actually alive). Plants could get along without animals, since the fungi could supply the green plants with carbon dioxide. But animals could not live without plants.

In our Department of Plant Life we survey the great world of plants. We tell you something of the families of plants, what they are noted for and where they live. We tell you how plants are born, grow up and spread their seeds; how man has changed some of the plants to serve his own use. Scientists all over the world are studying plant life—a study with rich rewards.

By THOMAS GORDON LAWRENCE.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 218.



British Combine Photos, Ltd.

On an island at the tip of the Malay Peninsula is the city of Singapore, with many fine modern buildings and just as many features of Oriental life, such as this two-wheeled bullock cart.

THE GREAT CONTINENT OF ASIA

ASIA is by far the largest of the continents; its area is estimated at from sixteen to seventeen millions of square miles. It is more than four times as large as Europe; it has more territory than North and South America combined. It extends some 6,900 miles from east to west and 5,300 miles from north to south. Its northern coast is well within the Arctic Circle; the islands to the southeast touch the equator. Within this vast area there are lofty mountains, great plateaus, barren deserts, dense jungles, broad rivers and great lakes.

Western Asia is really a continuation of Europe. The two continents form a single land mass, which is sometimes called Eurasia. Asia is set apart from Europe by the Ural Mountains, the Caspian Sea, the Caucasus Mountains and the Black Sea. At the southwest corner of the Black Sea the Strait of Bosporus separates the two continents; from here the boundary line passes through the Sea of Marmora and the strait called the Dardanelles.

Asia is connected with Africa by the Isthmus of Suez, across which runs the great Suez Canal, nearly a hundred miles long. The Isthmus of Suez is at the northern end of the Red Sea. Asia almost touches Africa again at the southern end of the Red Sea, at the Strait of Bab-el-Mandeb.

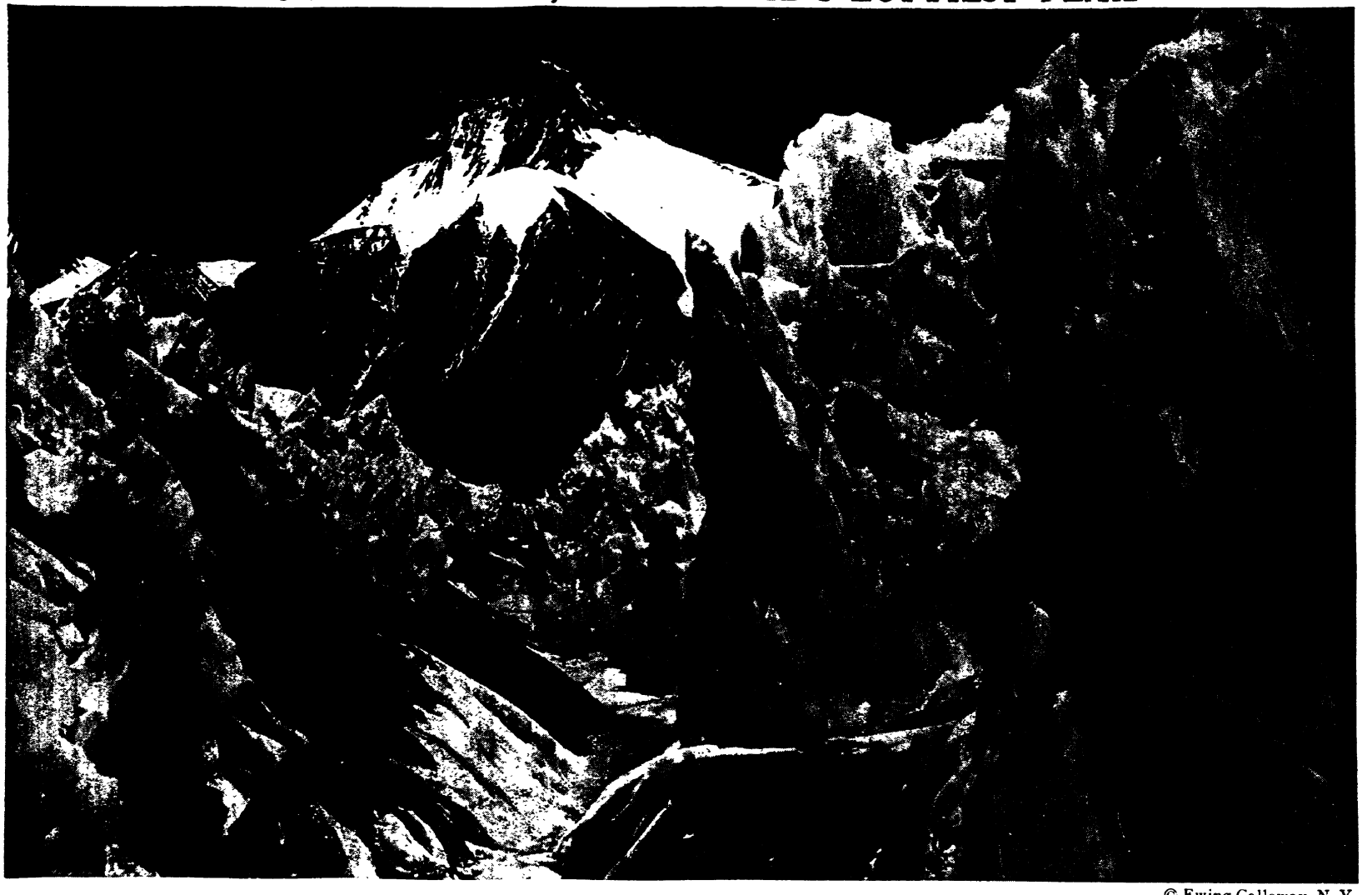
The mighty Pacific Ocean separates Asia from North America, to the east. At most points the continents are thousands of miles apart. However, the extreme northeastern tip of Asia is only about sixty miles from the North American land of Alaska.

Asia has about 35,000 miles of coastline. The ports of the northern coast, which lies, as we have seen, within the Arctic Circle, are useless for navigation for eight months or so in the year because of the great cold that freezes up the harbors. The eastern coast of the continent has many islands and peninsulas, which form a series of sheltered seas and bays. Chief among these peninsulas are Kamchatka and Korea; the most important island groups of the east are the islands of Japan and the Philippine Islands. There are hundreds of smaller islands farther to the east.

In the southeast there are a number of large islands, including Borneo, Celebes, Sumatra and Java, which form a sort of bridge leading to Australia. Standing out boldly from the southern coastline are the great peninsulas of Indo-China, Malaya, India and Arabia. At the southern tip of the Indian Peninsula is the large island of Ceylon. In the Mediterranean Sea, the principal islands belonging to Asia are Cyprus and Rhodes.

Within Asia are to be found the mightiest

MOUNT EVEREST, THE WORLD'S LOFTIEST PEAK



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mountains in the world. Most of Asia's mountain systems are contained within a triangle which has one point at the extreme northeast of the continent, another at the Malay Peninsula and a third at the southern end of the Caspian Sea.

THE GREAT MOUNTAIN RANGES, PEAKS AND PLATEAUS

Included in this triangle are the greatest ranges of all—those that meet at the Pamir Plateau, at the crossroads between Turkestan, Afghanistan and India. The northernmost of these ranges, the Tien Shan, extends to the plateau of Mongolia. The Kunlun and the Himalayas follow a more or less parallel course east from the Pamir. The Hindu Kush runs west from the Pamir, crossing Afghanistan and forming the northern boundary of the Persian Desert. The mountains that meet at the Pamir Plateau contain the loftiest peaks in the world. The highest, Mountain Everest, in the Himalayas, towers to a height of 29,141 feet; there are several other peaks topped only by Mount Everest.

Of the mountain ranges outside the triangle that we have described, the most important are the Ural Mountains in the northwest of the continent and the mountains that run along the western border of the Arabian Peninsula.

We think of the Alps in Europe as a mighty range; yet parts of the Pamir Plateau are higher than Mount Blanc, the loftiest peak of the Alps. The average height of the Pamir Plateau is some 13,000 feet. The average height of the plateau of Tibet, to the east, is greater still (about 15,000 feet). Even the river beds of this great tableland are thousands of feet above sea level. There are other extensive plateaus in Asia—the plateau of Iran (Persia), the Mongolian Plateau and the Deccan Plateau in Southern India.

THE RICH PASTURE LANDS OF THE GRASSY STEPPES

Asia has many boundless plains. In the northern part of Asiatic Russia one finds the tundras—moss-covered plains, which are sometimes very swampy. Stretching eastward from the Caspian Sea to the Tien Shan Mountains and extending hundreds of miles to the north are great grassy areas called steppes, which form rich pasture land. The alluvial plain of China, which has an area of about 200,000 square miles, is among the most fertile in the world. (When a river overflows and then goes back into its bed, particles of soil carried in the water are often left behind. A plain in which these particles form a definite upper layer is called an alluvial plain.)

One of the most desolate areas in the world is the great desert called the Gobi (or Shamo) in the central part of Mongolia. This barren land is not all sandy desert; it also has gravel plains and thinly covered steppes. There are other great desert areas in Turkestan, Arabia, Iran and India. One can trace an almost continuous desert region from the Sahara, in Africa, through Arabia and Iran to the Indus River, in the western part of India.

ASIA'S MIGHTY RIVERS ARE AMONG THE LARGEST IN THE WORLD

Asia's rivers are among the largest in the world. The chief rivers of the north are the Obi (or Ob), the Yenisei (or Enisei) and the Lena; they flow through Asiatic Russia and empty their waters in the Arctic Ocean. The river Amur, rising in Mongolia, makes a great turn about the north of Manchukuo and then flows into the Sea of Okhotsk, in the northeast of Asia. The other great streams of the east are the Hoang Ho (Yellow River) and the Yangtze Kiang, both in China.

Next we find the Mekong River, which flows through French Indo-China and enters the China Sea. As we proceed along the southern coastline, we meet the Salween (or Salwin) and the Irrawaddy, rivers of Burma that empty their waters in the Bay of Bengal. Two mighty rivers of India also flow into this bay—the Brahmaputra and the Ganges. Still further to the west there is the Indus, which flows through Northwestern India and falls into the Arabian Sea. The Tigris and the Euphrates, in the southwest of the continent, make their way to the Persian Gulf.

THE RIVERS THAT NEVER FIND THEIR WAY TO THE SEA

Asia has other rivers that never find their way to the ocean but that are lost in the sands of the desert or flow into lakes that have no outlet to the sea. The largest of these are the Amu Darya (*darya* is a Persian word, meaning river) and the Syr Darya, which flow into the inland Aral Sea. Perhaps the most interesting river of all is the Tarim, which, after a winding course through the desert plain of Turkestan, finally loses itself in a group of lakes and salt marshes known as Lob Nor (or Lake Nor).

The largest lake in Asia and in the world is the Caspian Sea, which is partly in Europe.

THE COUNTRIES AND CAPITAL CITIES

ON THE SPACIOUS CONTINENT OF ASIA

This great lake, which has an area of about 170,000 square miles, is over five times as large as Lake Superior, in North America. The Caspian Sea has no outlet. It is in the midst of a great hollow in the earth; the surface of the lake is eighty-three feet below sea level. To the east there is the Aral Sea, which covers about 27,000 square miles. In Asiatic Russia, to the north of Mongolia, we find Lake Baikal, set in the mountains. From this beautiful body of water, the area of which is about 13,200 square miles, the Yenisei River draws a part of its waters.

THE DEAD SEA WHERE NO FISH ARE ABLE TO LIVE

The most picturesque of Asia's lakes is the Dead Sea, on the southeastern border of Palestine. The surface of this lake is almost 1,300 feet below sea level—the lowest point of the earth's surface. So full of salt is the water that fish can not live in it, therefore it is called the Dead Sea. The specific gravity of the water is so great that it is almost impossible for a bather to sink in it, no matter how hard he tries. The vicinity of the Dead Sea is a barren waste, where no bird life is to be found.

There are startling contrasts in climate in the various regions of Asia. The tundras of Asiatic Russia are bitterly cold in winter, the temperature reaching almost 100 degrees below zero in some places. On the other hand, Southern India, Siam, French Indo-China, Malaya and the near-by islands have a tropical climate; temperatures of over 110 degrees have been recorded. There are many variations of temperature between these extremes.

The rainfall is great in Asia where the high mountains trap the moisture borne by the winds from the southern seas. The mountains force the air up to cooler heights; the chilling of the air which results produces rain. The heaviest rainfall in the world takes place in the district of Assam, in Northeastern India; here the average fall in the course of a year is some 550 inches. (The average rainfall in the United States is less than fifty inches.) On the other hand these same mountains keep moisture from great areas of Central and Western Asia, where the rainfall averages less than ten inches a year.

ASIA'S WEALTH IN IRON, COAL, GOLD AND OTHER MINERALS

Asia is almost fabulously rich in minerals; practically all the minerals are represented. The Ural Mountains have great deposits of iron; this mineral is also produced abundantly in China and Manchuria. The coal fields of China are among the largest anywhere in the world.

The Caucasus Mountains have rich deposits of gold; this valuable mineral is also abundant in northern India, Siam, Borneo and Tibet. Diamonds and other precious stones are found in various countries of Asia, particularly in India, Afghanistan, Borneo and Ceylon.

Much of the world's tin comes from the Malay Peninsula, Sumatra, Borneo and near-by islands. Asia has rich oil wells in the Caucasus, in Burma, and on Sumatra, Java and Borneo. China produces more than half of the world's supply of antimony, and much of the world's tungsten.

THE PLANT LIFE RANGES FROM SIBERIAN TO TROPICAL VEGETATION

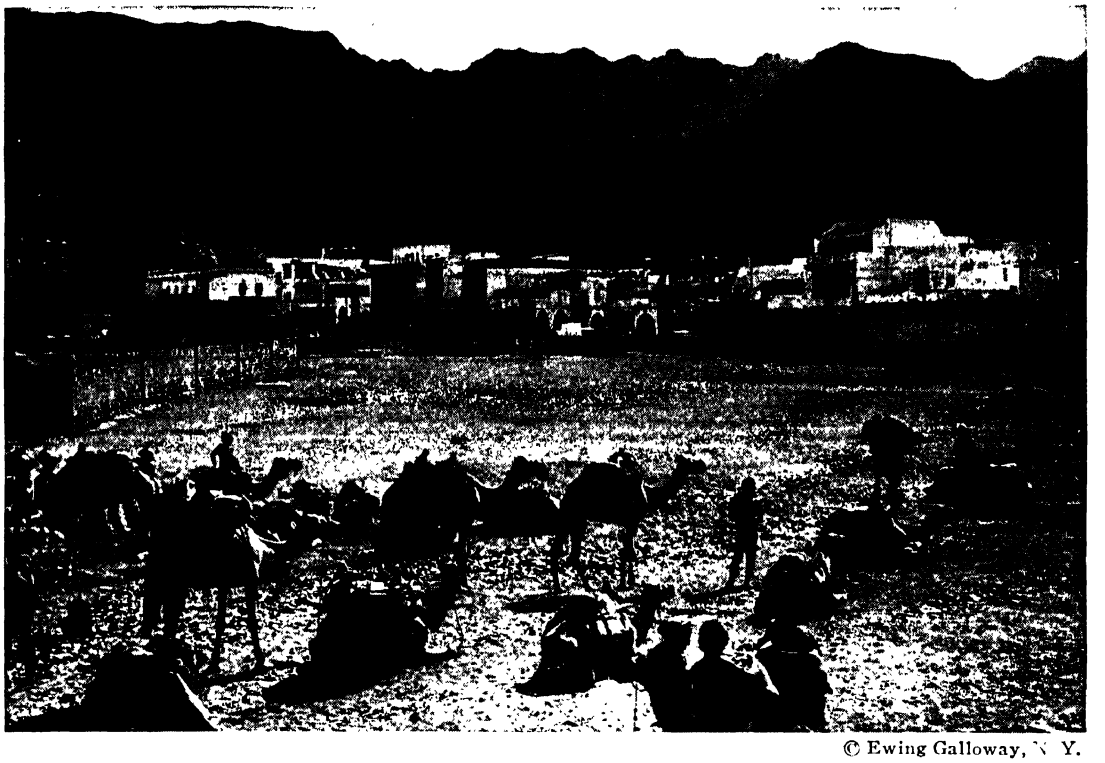
The vegetation of Asia varies according to the latitude and climate. In the great region of Asiatic Russia formerly called Siberia one finds great numbers of birches, pines, willows and poplars but no oaks. The oak is well represented, however, in North China and Japan; there are also a great many maples, walnuts and poplars. Vines, olives, figs and various European fruit trees are found in many districts of Central Asia.

In the southern regions of Asia, from India to French Indo-China, one finds a great variety of plants growing wild that have become very important to mankind—sugar-cane, rice, cotton, pepper, cinnamon, clove, nutmeg, bananas and coconut palms. Many of the plants are now cultivated in these regions. In the forests of India we find oaks, teak, sandalwood and laurel; bamboos and palms also grow here in great numbers. Similar plants are to be found in the jungles of the Malay Peninsula. The great bulk of the world's rubber supply comes from the plantations of Malaya, Sumatra, Java, Borneo and Celebes.

The Arabian Peninsula is renowned for its gum-producing acacia trees and the date palms that flourish in the oases of the Arabian Desert. The coffee plant is cultivated extensively in the fertile regions in the west of the peninsula.

WHERE LIONS, LEOPARDS AND TIGERS ARE FOUND, AND ELEPHANTS ARE TRAINED

Most of the mammals of Europe—horses, sheep, antelope, deer, bears, wolves, weasels and so on—are to be found in Northern Asia. Of the larger flesh-eating animals the tiger is the most widely distributed. It is



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Camels enjoying a rest in the main square in Aden, the city that is built inside the crater of a dead volcano.

to be found in many different parts of Asia, particularly in the regions from Armenia to the Indo-Chinese Peninsula and in the great islands of Sumatra, Java and Bali. The leopard also roams over many different parts of the continent. The lion inhabits Arabia, Persia and Asia Minor and is to be found as far east as India.

The elephant is particularly numerous in India and in the countries of the southeast. The Asiatic elephant is shorter than his African cousin and he is considered more intelligent; he is also a more faithful servant of man. The one-humped camel or dromedary is to be found in Arabia; the two-humped or Bactrian camel, in the desert lands and steppes of Central Asia. That homely but good-natured and useful animal, the yak, is a native of Tibet. The monkey tribe dwells chiefly in the southern part of the continent. One comes upon almost every variety of bird life in Asia.

Crocodiles lurk in great numbers in the Ganges River of India and in other large rivers. There are many different species of snakes in Asia. The deadliest, perhaps, are the cobra, found chiefly in India, and the Russell's viper, or chain-viper, which is found not only in India but also in Ceylon, Burma and Siam. The largest of the Asiatic snakes is the python, which is found in India, Ceylon, French Indo-China and Malaya. Some pythons are thirty feet long. These monsters are the largest snakes in the world.

The seas and rivers of Asia produce a great variety of fish. Salmon is found in large numbers in the rivers flowing into the Arctic Ocean and the northern part of the Pacific Ocean. Trout and sturgeon are very numerous in many of the rivers that flow into the Caspian Sea.

The remarkable dugong, a mammal that lives in the sea, is to be found along the shores of Australia and the Indian Ocean and around the Red Sea. The dugong holds its young to its breast with its flippers almost like a human mother. It is said that sailors who first beheld this strange sight started the legend of the mermaid, that beautiful creature supposed to be half woman, half fish.

Another unusual creature that lives in Asia is the climbing-perch. This fish, which frequents the shore waters of India, Burma and the islands off the Malay Peninsula, can not only climb out of the water but can live on dry land for several days.

The population of Asia includes about

half the inhabitants of the world; estimates of the population range from 900,000,000 to over 1,000,000,000. The inhabitants are not evenly distributed over the length and breadth of the continent. There are many regions where only a few people live—such as the great desert areas of Turkestan, Iran, Arabia and Mongolia, the steppes of Central Asia, the forest regions of Asiatic Russia and the jungles of Malaya.

Other regions of Asia are among the most densely populated in the world. Humanity swarms in the river valleys of the Ganges and the Brahmaputra in India and the Hwang Ho and Yangtze Kiang in China. There are also great numbers of inhabitants in certain regions where the rainfall is heavy, as in Japan and Java.

RACES IN ASIA INCLUDE YELLOW, WHITE, BROWN AND BLACK

The yellow, or Mongolian, race is the most numerous in Asia; it includes about two-thirds of the population. It occupies the Japanese islands, China, including Manchuria, most of Central Asia and the Indo-Chinese peninsula. Many of the Turks show a strong Mongolian strain, though there has been intermarriage with other races also.

The white, or Caucasian, race is next in numbers to the yellow race. It prevails in India and in most of the lands to the west of India; it is becoming increasingly important in Asiatic Russia. The brown, or Malay, race dominates in the Philippine Islands, in the Malay Peninsula and in many of the islands of the South Seas.

The black race has comparatively few representatives in Asia. There are the Negritos of the Philippines, the Papuans of New Guinea and several tribes of the Malay Peninsula. Certain peoples of Asia—particularly the Dravidian race of Southern India and the Ainus or Ainos of Japan—have no definite relation to the larger race groups that we have mentioned.

ASIA MAY WELL BE CONSIDERED THE MOTHER OF OUR CIVILIZATION

Some people are apt to think of Asia as a backward continent, with foolish or even wicked superstitions which are gradually disappearing through the influence of Western civilization. We must not forget however, the debt that our civilization owes to Asia. For one thing, the men of Europe and their sons who settled in America are descended from the Asiatic peoples who made their way to Europe from Asia many thousands of years ago. Again, almost all the languages of Europe—English, French, Polish, German, Italian, Spanish, Portuguese and so on—are members of the Indo-European family of languages, which originated in Asia.

Only in Egypt are there older relics of civilization than in Asia. At a time when barbarian tribes were moving restlessly over the face of Europe, the wise men of Asia—the men of Babylonia, Assyria, India and China—were making wonderful contributions in the art of writing, in literature, in the arts, in the sciences, in religion. Asia is the birthplace of practically all the great religions of the world—Christianity, Judaism, Mohammedanism, Hinduism, Confucianism and Buddhism.

There came a time when Asiatic civilization seemed to stand still, while in the West a new civilization was being built up. By the end of the Middle Ages the peoples of Europe were forging ahead of their Asiatic neighbors in their knowledge of the world about them.

HOW THE STRONG YOUNG NATIONS OF EUROPE CARVED OUT COLONIES IN ASIA

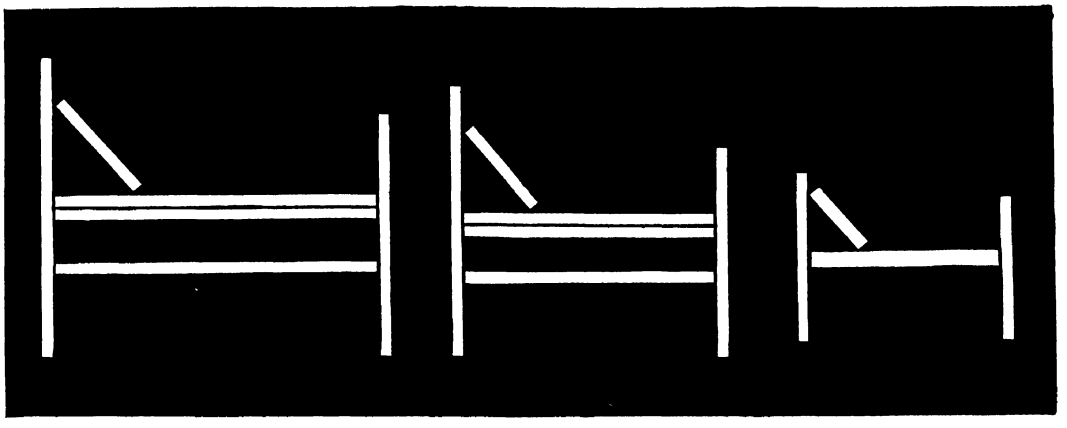
In the sixteenth century strong nations in Europe began to carve out great colonies for themselves in Asia. By the beginning of the twentieth century a large part of Asia was divided up among the Russians, the British, the French and the Dutch; other European nations had footholds there. Before the century was half over, startling changes had come to most of Asia. Europeans were being pushed out of their strongholds. India's millions, in two great commonwealths, were governing themselves. Burma was an independent republic. French Indo-China had a large measure of freedom. Other sections had broken some, or all, of the European ties.

The two world wars sapped the power of most European countries. That is why they lost control of far-flung territories.

Truly, Asia, the geography of one-third of the earth and two-thirds of its peoples, is a land of extremes. In elevation Asia is the highest of the inhabited continents, yet it has the lowest inhabited region on earth! The temperatures drop to ninety degrees below zero Fahrenheit in Siberia while the hottest spot on the earth is Aden.

So ends our brief survey of the great continent of Asia. You will find a detailed account of the various countries of the continent in other chapters of our book. (See the Index.)

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 420.



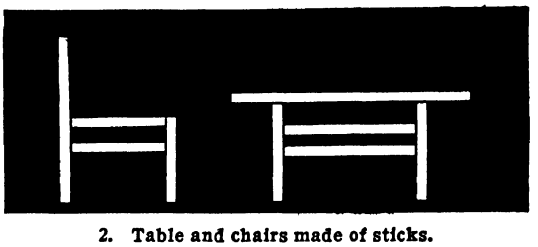
1. The beds in the home of the Three Bears.

TELLING STORIES BY MEANS OF STICKS

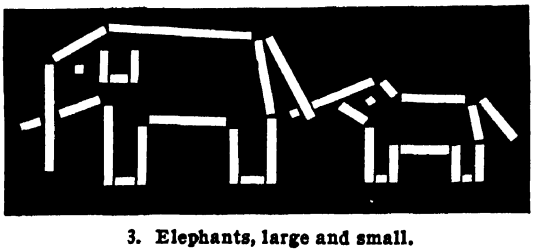
PERHAPS you have heard or read Indian stories which explained how the red men told their tales by means of sticks. You will find that making your own stick-pictures will provide you with much entertainment and will give you a good chance to show your ingenuity. You may make pictures out-of-doors with straight twigs and sticks that you have collected, just as the Indians did. It is possible, however, to have just as much fun making smaller stick-pictures on the table or floor, particularly when you are unable to go outside because of stormy weather or because of illness.

Any straight, long sticks will do for your stick-pictures. You may use burnt matches or toothpicks for this purpose. These sticks are to be cut to the appropriate lengths. For example, you will note that the top of the table is made up of a fairly long stick, while the elephant's eye is made of a very short one.

One little boy who was recovering from a cold spent several hours making stick-furniture for his stick-house. Pictures of his chair and table are shown in picture 2. Then his sister became so interested in what he was doing that she too decided to make stick-pictures, but hers were to illustrate the stories that she had been reading. After each one was finished she would ask her brother if he could guess what story she had represented in her stick-pictures. A part of one picture which she made is shown in picture 1. As you probably have guessed, she was illustrating the story of The Three Bears. Can you make the chairs and other furniture that the three bears used? What other stories can you tell with stick-pictures?



2. Table and chairs made of sticks.



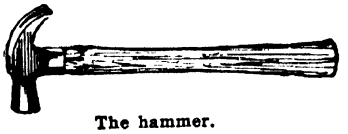
3. Elephants, large and small.

You will find that you can make a number of animals with sticks. In picture 3 we show you how simple it is to make a mother elephant with her little son holding on to her tail with his trunk. Other objects also lend themselves to this sort of picture-writing: houses, even little cities, boats, trees and the like.

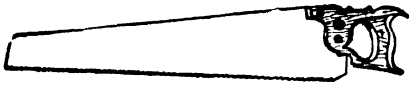
THE BOY CARPENTER'S BOX OF TOOLS

EVERY boy should have a box of tools and know how to use them. With practice you will be able to make a number of things that will be both useful and ornamental.

While you will not be able to have as many tools as a real carpenter, you may, with careful saving and wise spending, have enough to do many useful things about the house. There are of course different qualities of tools and you should buy the best that you can afford. You may buy your tools one by one, or you may find it better to purchase a little carpenter set which will include all the tools that you need.



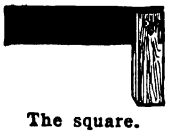
The hammer.



The saw.

The plane.

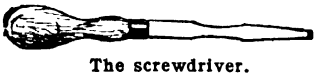
The ax.



The square.

The chisel.

The gimlet.



The screwdriver.

The tools you must have are: an ax, a hammer, a saw, chisels, planes, a screwdriver and a gimlet. Let us look at these tools and see how they are used. The first is the ax or hatchet, which is used for splitting wood. Wood has what is called a *grain,* which always is up the way the tree has grown; the wood can be split up the way of the grain but not across the grain. When you wish to cut wood across the grain you must use a saw. When the grain of the wood is very regular you can split the wood evenly with an ax, but if the grain is twisted you cannot do so. Therefore, even when you want to have the wood cut the way of the grain, it may be necessary to use the saw instead of the ax.

There are many different kinds of saws. The kind that you want is a handsaw, say about 14 or 16 inches long. You can use this both for sawing the long way of the grain and across the grain.

There are many ways of sawing but only one right way. You must work the saw backward and forward regularly, not rocking it from side to side, or you will cut unevenly. Nor must you jerk it in and out, or you will blunt the saw and tire yourself. Before beginning to saw, make a pencil line on the wood where you want to cut it, and make the saw follow the line very carefully. You should provide yourself with a carpenter's square in order to make accurate lines.

The hammer is a very useful tool. Its chief use is for driving in nails. Get what is called a claw-hammer. By using the two claws you will be able to draw nails out of wood without difficulty. When you have drawn them out you may want to use them again. If they are bent you must straighten them. Put the nail on a piece of iron or stone, or on a block of hard wood—not upon anything that can be damaged—and place the point downward. Then strike the high place with the hammer until the nail is straight.

Chisels are used to cut the wood where an ax or saw would not be suitable. We use a chisel, for example, to cut away the wood to make room for a lock on a door, and sometimes before putting on hinges.

We use a gimlet to make holes chiefly when we are going to put in screws. For ordinary nails it is not necessary to make holes with the gimlet unless the wood is very hard and likely to split.

The screwdriver is for putting in screws. It is pressed against the head of the screw

with its point in the slot of the screw head, and then it is turned.

Now we come to the plane. If you look at an ordinary wooden fence and then at a door in a house you will notice a great difference in the surface of the wood. The fence will probably be rough or almost hairy, whereas the door will be very smooth. The reason is that the door has been planed and the fence has not. Most wood to which we want to give a smooth surface must be planed. Another reason for planing is that if we paint wood that has not been planed we use much more paint than we should use if the wood had been planed. Wood not planed absorbs paint as blotting-paper absorbs ink.

In using the plane, push it forward on the wood steadily, and press upon it evenly all the time. The edge of the plane-iron, which does the actual cutting, must stick out below the bottom of the plane, but not too far.

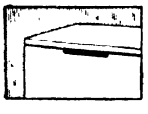
The plane-iron and the chisels must be kept sharp at all times by means of an oil-stone. The stone is called an oil-stone because it is used with a little oil in rubbing the edge of a tool upon it.

The first thing you might make with your tools is a box in which to keep them. Your grocer will be glad to supply you with a wooden box suitable for your purpose. First you must take the sides apart by pulling out the nails. Now measure off two pieces 18 inches long and 6 inches wide. These are for the two sides of your tool-box. Then measure off two other pieces 6 inches by 7 inches to make the ends. Cut out these pieces, plane them until they are smooth enough and nail them together so that they look like the box in the picture, with the end pieces fitted inside the sides.

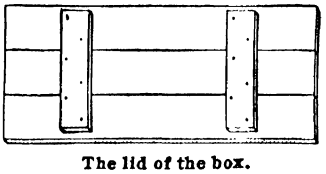
The total length when nailed up is 13 inches, and the width will now be more than 7 inches—it will be 8 inches if the wood of the sides is ½ inch thick. Now nail on pieces of wood to make the bottom, having cut them out as you did the sides. You may get the bottom in one piece, but if the wood is not wide enough you must nail pieces together.

Now you must make the lid. This may be made of one piece of wood, or else you may use several pieces, the combined width of which is equal to the width of the bottom of the box. Nail across the board or boards two pieces that do not quite reach the edge of the lid. The lid is now ready. If you wish, you may put on hinges, which you may buy at any hardware store. Screw the hinges to the edge of the lid first. Chisel away a little of the wood from the back of the box so as to make room for the hinges, which you are then to screw onto the box itself.

You may put a lock on the box if you like; this too you may buy at a hardware store or at a five-and-ten cent store. It would be well too to fit a tray inside the box; this will hold nails and other small things. When putting your tools away in the box, be sure that each is in its proper place. You will find that neatness in arranging your tools, nails and so on will save you a good deal of time.

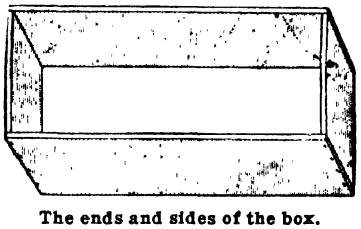


The position of a hinge.

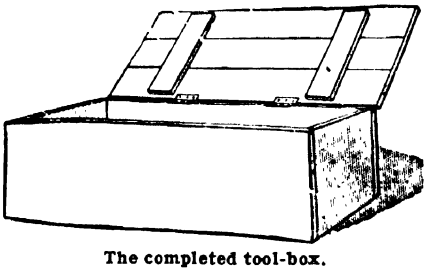


The lid of the box.

Box end and position of bottom.



The ends and sides of the box.

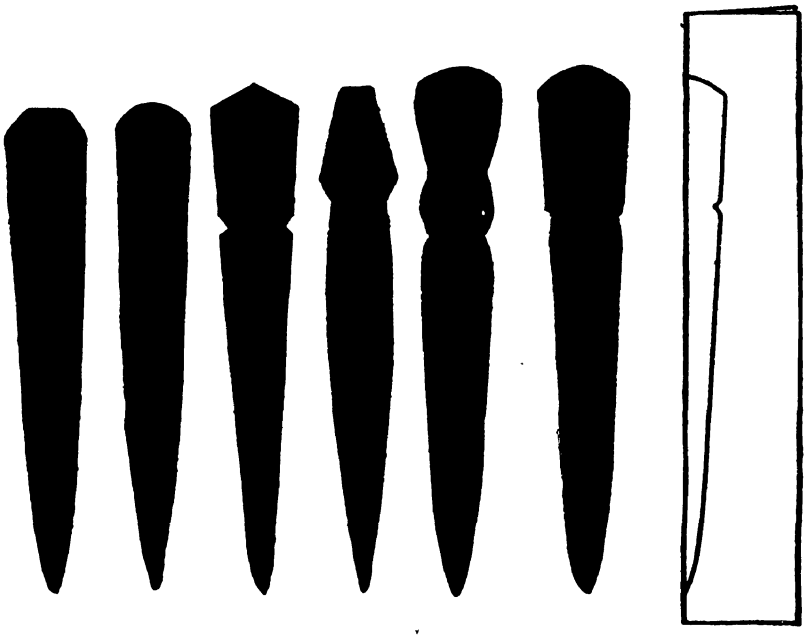


The completed tool-box.

A USEFUL PAPER-KNIFE MADE OF WOOD

WOULD you like to make a handy paper-knife to open your letters and also to cut the pages of new magazines and books? Perhaps you would prefer making this knife for father or for some other member of the family. In either case you may have lots of fun by designing it and making it to suit your own taste.

The paper-knife may be of any soft wood about ⅛ or $\frac{3}{16}$ of an inch in thickness.



You will find that old cigar boxes will serve the purpose very well.

The designing of the paper-knife will be quite easy if you keep in mind what uses are to be made of it when finished. If you desire a knife that will open letters as well as cut paper, it is important that you provide for a point, as shown in the accompanying designs. A convenient length, including a handle, is found to range from 6 to 7 inches, depending somewhat upon the type of design chosen. A satisfactory width for the handle will range from ⅝ to ⅞ of an inch, while the thickness will be determined largely by the material used. Although a handle is not necessary, it will be found that even the suggestion of a handle adds much to the general attractiveness of your knife. If the handle is decorated, the design should be made quite small and suitable to its form.

When you have decided upon the size and shape, the actual method of designing the paper-knife is merely to draw one-half of the pattern or design on a sheet of stiff paper, which can be folded as shown above. This design may be transferred to the wood either by cutting and tracing the outlines of the pattern or by using carbon paper.

The wood may be cut by a jig-saw, if one is available, or else it may be whittled with a sharp knife. The edges of the knife, from the handle to the point, should be beveled so that the knife will cut paper properly. When you have finished the cutting process, sandpaper the knife all over until it is smooth.

The whole surface should then be rubbed over with a dark wood-stain of the desired color. If the handle has been decorated, the design will be most effective if painted with bright water-colors, which must dry before the wood-stain is applied. These colors should be put on with a brush which is not too full of paint, in order to prevent the colors from spreading. When these are quite dry, rub on the wood-stain as explained above. Finally rub on a coat of floor or furniture wax with a soft cloth.

You can make paper-knives which are odd in shape, yet useful and beautiful. For example, the blade may be curved like a scimitar or like the oar of a gondola.

THE NEXT THINGS TO MAKE AND DO ARE ON PAGE 231.

HOW DID THE EARTH BEGIN?

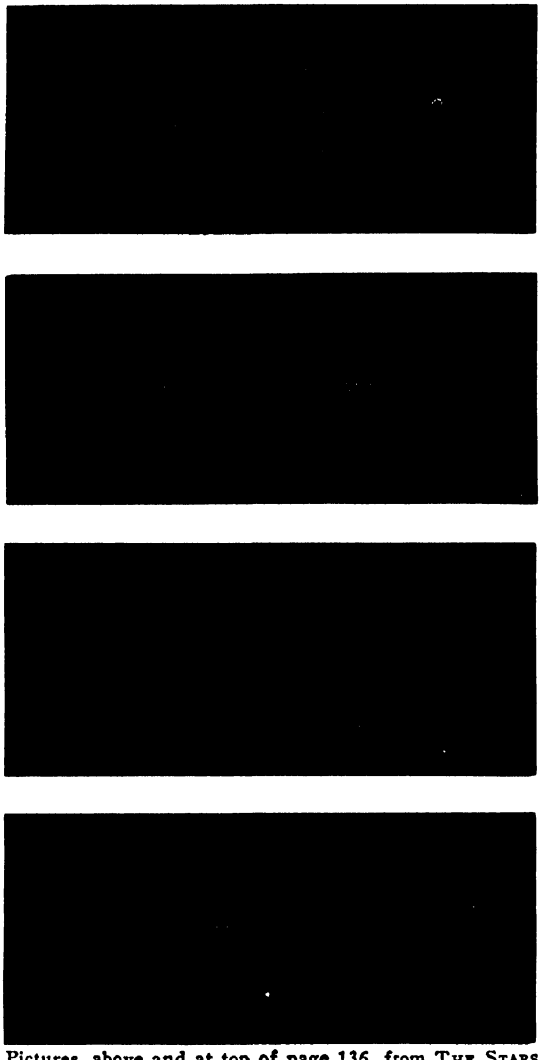
HOW our world came into being, where it came from, and when it all happened, these are age-old questions which human beings have tried to answer ever since they began to think. Before men knew much about the sun, the other planets and the stars, they could not even begin to puzzle out the answers, however.

But as men began to look through their telescopes at the sun, the planets and the distant stars; and as they saw how the heavenly bodies moved across the sky; and as they learned here on earth what happens when gases are heated up and compressed, they came gradually to realize that wherever we look there is order in the universe. The planets move in an orderly fashion around the sun, in paths that are nearly circular and that lie nearly in the same plane, or level. They saw that many planets have one or more moons, and that most of these moons move in paths that lie in or near the same plane. The laws that make them all move are so simple, and the whole solar system, as we call it, shows so much regularity that scientists gradually began to hope that from this regularity they could reason out how the earth and the other planets had come into being. In other words, scientists began to set up theories, which are guesses based on carefully observed facts.

Astronomy showing the starry skies to a child.

One of the first of these theories, and perhaps the best-known of them all, was the one which the great French astronomer Laplace brought forward. This is known as the Nebular Hypothesis. Here theory and hypothesis mean much the same thing. Laplace saw our solar system beginning with a huge "nebula"—which is simply the Latin word for cloud—of gas and dust. We know that the universe is full of such clouds. Laplace thought that if such a nebula, a globe of luminous gas, were slowly spinning around, as it got older it would not only shrink in size, and become denser, but it would also begin to spin faster. This would flatten out the globe into a biscuit, or disc. Finally, at the outer edge of the disc a ring might be thrown off. This ring would break up into pieces, and perhaps many of these pieces might come together again and form a small lump of matter—a planet. The force of gravitation, Laplace thought, would bring the little pieces together into a lump. Meanwhile, the disc would go on shrinking and spinning faster, and would throw off more rings, many of which might become planets in the end. This explanation made such a nice picture that for a while everyone believed he had found the answer to the riddle of the origin of the world.

But in Laplace's day we did not know as much about physics as we do now. Since his time we have found out that a ring such as he described would not be formed and



Pictures, above and at top of page 136, from THE STARS IN THEIR COURSES, by Sir James Jeans, reproduced with permission of The Macmillan Company, publishers.

The birth of a star-city. The first picture shows nebula, a ball of glowing gas. In the next picture the ball has begun to flatten out. Then it becomes still more flat and stars begin to show. Last, it has become a flat disc made up of millions of stars.

thrown off the disc. We know that even if a ring did somehow form, it would have to break up into a great number of very small pieces, and these could never come together and join into making a planet. Instead, that ring would just dissolve in space. Finally, if the planets really had been born that way, then today the sun should be what is left of the original cloud of gas, and it should be the fastest spinning object in the whole solar system. Actually it is the slowest.

When we found all this out, we had to start over again, and Thomas Chamberlin and F. R. Moulton, at Chicago, and later Sir James Jeans and Harold Jeffreys, in England, worked out an entirely different idea. They called it the Planetesimal Theory. That means the Theory of Little Planets. While there are some differences in details between their theories, the main idea of these men was the same. This was that ages ago the sun must have met with a rare accident, it must have come very close to another star, or perhaps even have been hit by it. If they came very close, without hitting, the two stars must have attracted each other so much that each of them raised a huge tidal wave of gas on the other. At the same time their speeds increased as they got closer, and they must have whirled around each other at a terrific rate—more than a million miles per hour—and because of this the tidal waves may have rolled over, as a breaker does on the beach. As the tidal waves dashed to pieces in this way, puffs of hot gases were strewn over the space in the neighborhood. But these puffs of gas still followed some of the whirling motion of the two stars. They cooled off and first became drops of liquid, then chunks of solid rock, or planetesimals. Gravitation drew little planets together into bigger planets. These bodies continued to move around one or the other of the two stars. Some stayed with the sun, and became our planets. Others went off with the other star, to some far distant corner of the universe, to make up the planetary system of that other sun.

WHAT WOULD HAPPEN IF TWO STARS ACTUALLY COLLIDED

If our sun and the other star actually hit each other, as in a collision, there would be no breakers. Two stars, that is, two enormous balls of gas, would not crash as two billiard balls do. They would not bounce off, not at all. Instead, as they hit each other with terrific speed, they would fuse together, or melt into one for a short time. But the great speed at which they were traveling would drive them apart again; and, as they parted, a thin strand of hot gases would stream out between them. Finally this would break into pieces, and the pieces would be the planets, some staying with the sun, others moving off with the other star.

AFTER THE COLLISION, EACH STAR WOULD HAVE A FAMILY OF PLANETS

This, too, looked like a very good theory. Imagine the scene—the sun and another star

with their huge tidal waves swirling around them, or hitting each other in the greatest traffic accident in our universe. Then they move off, each going its own way, and looking none the worse for the accident, but each of them now having a little family of planets.

Unfortunately, the astronomers and physicists have had to discard this theory, too. First of all, we find it impossible to explain by the Planetesimal Theory how the planets got so far away from the sun. They should all have been much closer than the earth is, if the theory were true. There is a more serious difficulty, for we can not figure out how those tidal waves and those threads of hot gases could ever have liquefied and later become solid rock. These clouds of gas would have been so enormously hot (a million degrees or more) that their gases would almost immediately have run off into space, and they would never have had a chance to turn into drops of liquid or solid rock.

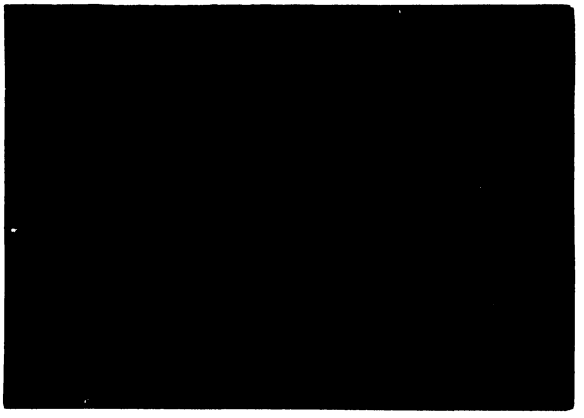
There is one important difference between the two theories that we want to point out to you. As Laplace thought of it, any spinning globe of gas would get smaller, spin faster and throw off little planets. If he had been right, we could expect that nearly all stars would have planets whirling around them. The men who put forward the Planetesimal Theory guessed at a collision between the sun and another star, or a "near-miss" as we would now call such a close approach of two stars. Now all such happenings are very, very rare, so rare indeed that an accident of the sort would not happen even once in a million years. That means, you see, that it could not have happened very often; and therefore there could not be very many other planetary systems in the universe. If there are not many other planetary systems in the universe then there can not be very many "earths" besides our own. That means there is not much chance that somewhere there might be another world with living beings on it. Not humans, of course, but life of some kind or other.

We had hoped that by solving the riddle

Yerkes Observatory

Saturn and its three rings, as seen when the planet is slightly tilted toward us. It is believed that these rings are made of many moon-like particles. The inner ring of the three seems to be the least dense.

of how the earth came to be here we might also learn whether there may be life on other worlds, or whether the earth is likely to have the only living beings in this universe. But today we know that the riddle has not been solved.



Another stage in the formation of a star-city. This picture shows how the stars are first formed on the rim of the nebula. The gas in the center is the last to form stars.

In recent years many new theories and ideas on this very interesting and very important subject have been published. Some have tried to see what would happen if we had the sun moving into and through a large cloud of gas and dust, and they have made calculations taking into account the sun's magnetism and electricity. All the modern thinking is very complicated. So far the scientists do not agree on any of the ideas that have been suggested. We must honestly admit that we do not know how the earth and the other planets came into being. Nevertheless we do know a great deal about the starry skies, about light and heat and energy which we get from our sun, and about many universal laws which the heavenly bodies—stars, planets, comets—obey.

As you read the other articles in this department of THE BOOK OF KNOWLEDGE, keep in mind the following facts:

Our earth is a planet whirling around a great star which we call the sun. The sun has nine planets and some other bodies whirling around it. Together the sun, planets and other bodies form the solar system.

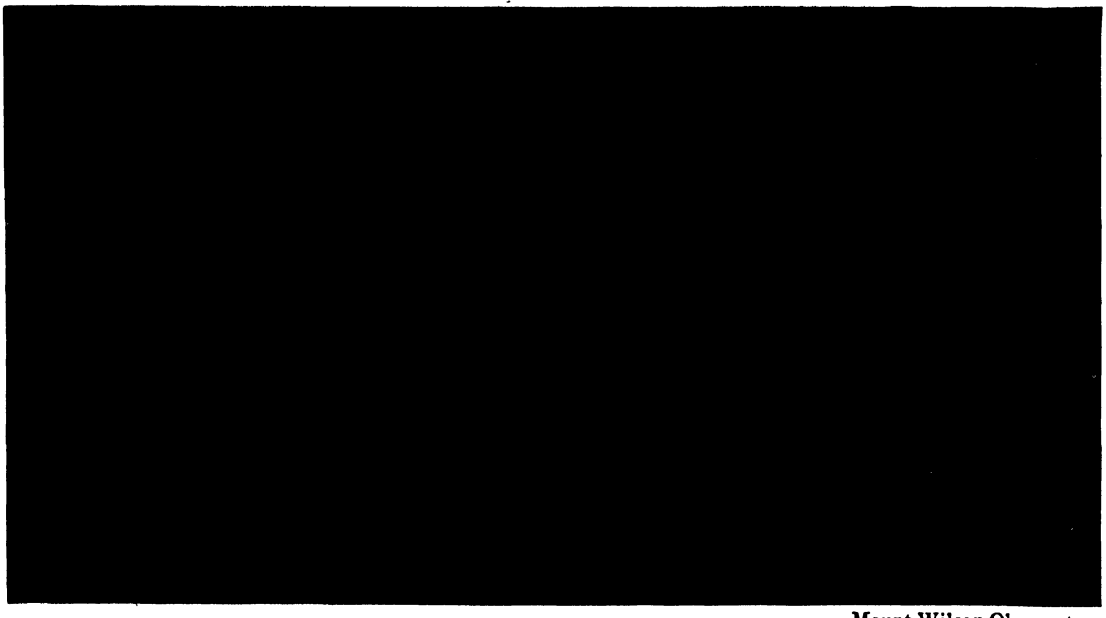
The solar system is just a very small part of an enormous city of stars. We can see some of this star-city in the sky at night, and we call it the Milky Way.

Our star-city is only one of a very great number of star-cities that are scattered through vast space. Peering through the telescope we can see the misty gleam of some of those distant cities of stars.

Let us learn all we can about our earth, and the solar system; and about our own star-city; and about those other star-cities in space.

By WILLEM J. LUYTEN.

THE NEXT STORY OF THE EARTH IS ON PAGE 235.



Mount Wilson Observatory

Gas being drawn from one heavenly body by the approach of another, at top of wisp. This is called tidal action.

Pictures, courtesy, Aluminum Company of America

The compound mineral known as bauxite is a rich source of aluminum. In this picture we see bauxite being loaded into cars in an open-pit mine.

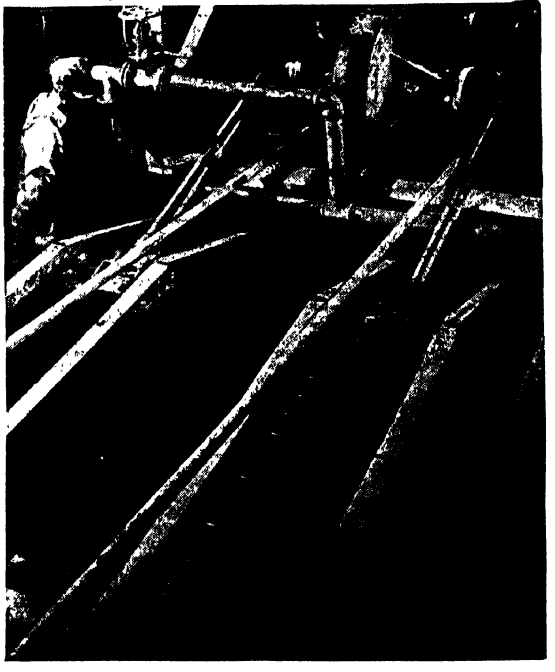
HOW WE GET ALUMINUM

ALUMINUM is truly a wonder metal, with hundreds of different uses in the world of to-day. It is the most abundant of all the metals; it forms something like 8 per cent of the earth's crust. It is never found in nature in pure form; it is always mixed with a number of other elements.

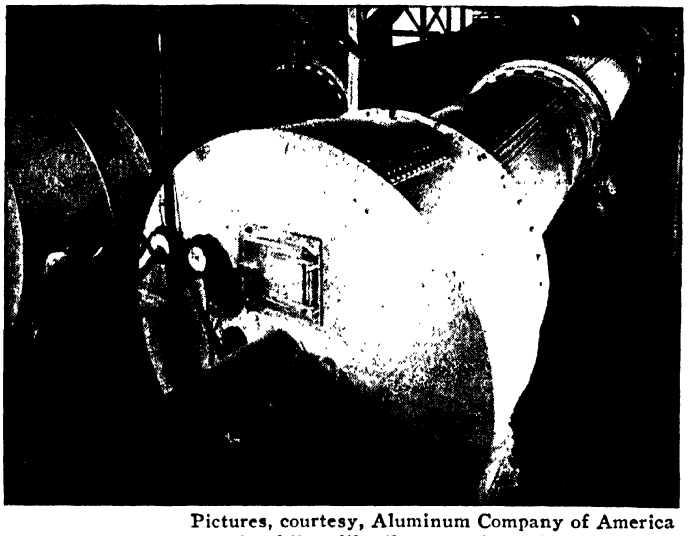
Nearly all rocks (but not sandstone and limestone) contain at least some aluminum. Practically all the aluminum used by man, however, comes from the ore known as bauxite (pronounced bohks'-ite; from the French town of Baux). Bauxite is found in many parts of the world. There are particularly large deposits in France, Dutch and British Guiana, Hungary, Italy, Yugoslavia, the United States and the Netherlands Indies.

Bauxite contains not only aluminum but also a number of other substances, including oxides of iron, titanium and silicon. (An oxide is a combination of oxygen with another element.) These substances are extracted

Powerful crushers break up the lumps of bauxite into small pieces. Conveyors carry these to a washing screen. Then they are broken still smaller.



The crushed bauxite is carried to a classifier, like that shown above. Here it is washed again. From the classifier it goes to the rotating kilns.



Pictures, courtesy, Aluminum Company of America

The ore is dried in rotating kilns, like the ones shown in the picture. The ore is then cleansed of impurities in another series of operations and at last emerges as alumina, a powdery white chemical.

from the bauxite by what is known as the Bayer process. Bauxite, finely ground, is put in large pressure tanks together with caustic soda. This process causes the oxides of iron, titanium and silicon to form a muddy mass, which is removed by means of filtering. The liquid that remains is put through several other processes and finally yields a powdery white chemical, which is called alumina. It is a mixture of aluminum and oxygen.

The aluminum is separated from the oxygen by means of a process which is described in the explanation under the diagram on this page. A great deal of electricity is used in this process. Therefore cheap electric power must be available if the aluminum is to be produced profitably. It is for this reason that most aluminum plants are located near places where hydroelectric power is produced.

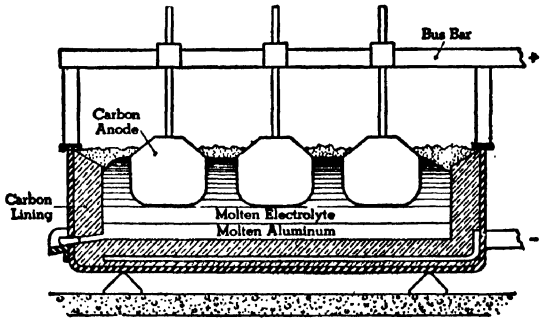
The finished product is a light metal with a bright, silvery luster. It comes in various forms —ingots, sheets, plates, rods, wires and so on. A good deal of the aluminum in use to-day is alloyed—that is, mixed with other metals—in order to make it harder and tougher. The metals most often used for this purpose are copper, magnesium, manganese, silicon, iron, nickel and zinc. Duralumin is one of the best known of all these alloys; it is an alloy of aluminum with copper, manganese and magnesium.

Aluminum combines lightness and strength. It is often used for the framework of airplanes, as well as for the bodies of streamlined railway cars, streetcars and buses. Aluminum-alloy castings are used for cylinder heads, crank-cases, water jackets, pistons and other parts of internal-combustion engines. Aluminum forgings are employed for airplane propellers and fittings and for the side rods of locomotives. Aluminum cable, with a steel core to give added strength, is used for transmitting electric power.

Aluminum is a popular material for machines and electrical equipment used in the home; the vacuum cleaner, the washing machine and the iron are familiar examples. Since aluminum is a good conductor of heat, it is an excellent material for cooking-pots and pans, as well as for the big kettles and tanks used in processing food. It resists attack by various strong chemicals; therefore it is used in tanks, stills, pipes and fittings which serve for the production and storage of these chemicals.

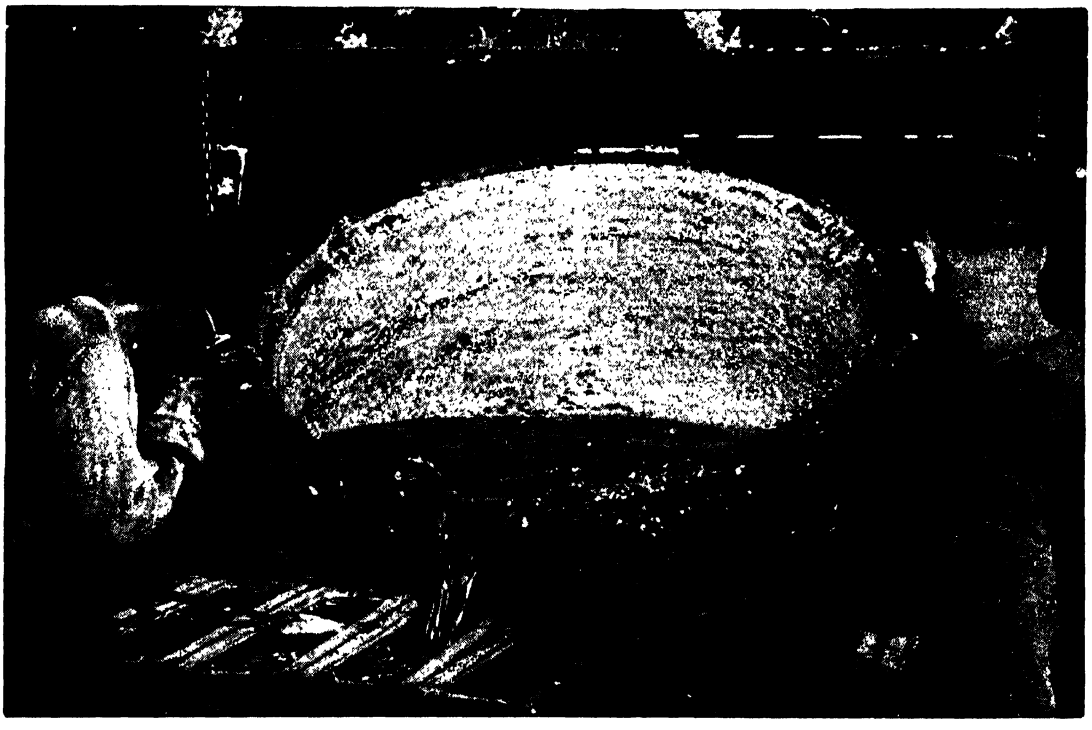
We have mentioned here only a few of the uses of aluminum; and new ones are constantly being found. That is why aluminum is the metal of to-day and to-morrow.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 166.



This diagram shows how aluminum is produced from alumina. The process takes place in an open box, serving as an electric cell. Like all electric cells it has a positive and a negative terminal. It is also provided with electrolyte—that is, a liquid that conducts electric current. The sides and bottom of the box are lined with carbon; this serves as the negative terminal, called the cathode. Suspended from an overhead bar—the bus bar—are several blocks of carbon, which serve as the positive terminals, or anodes. The box contains molten cryolite (a metal), and into this the carbon anodes dip. The powdered alumina is then stirred into the cryolite. The alumina-cryolite mixture serves as the electrolyte, or conductor of electricity. An electric current is passed through the box. It goes down through the anodes and the electrolyte to the carbon lining of the box. The current is very powerful; it causes the dissolved alumina to be split into oxygen and aluminum. The oxygen combines with the carbon anodes to form various gases. The aluminum settles to the bottom in molten form and is drawn off from time to time. Big ladles then pour the molten metal into molds.

FROM MOLTEN MASS TO SOLID BAR

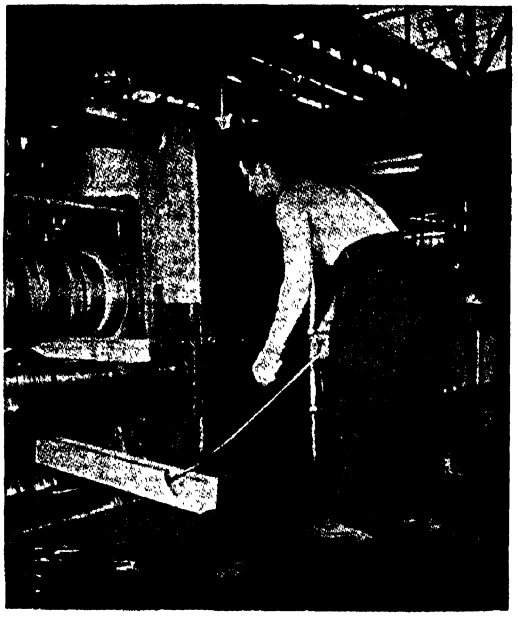


After aluminum has been produced from alumina (see the explanation under the diagram on page 138), it passes into big ladles, like the one shown in this picture. The ladles pour the molten aluminum into pigs, or molds.

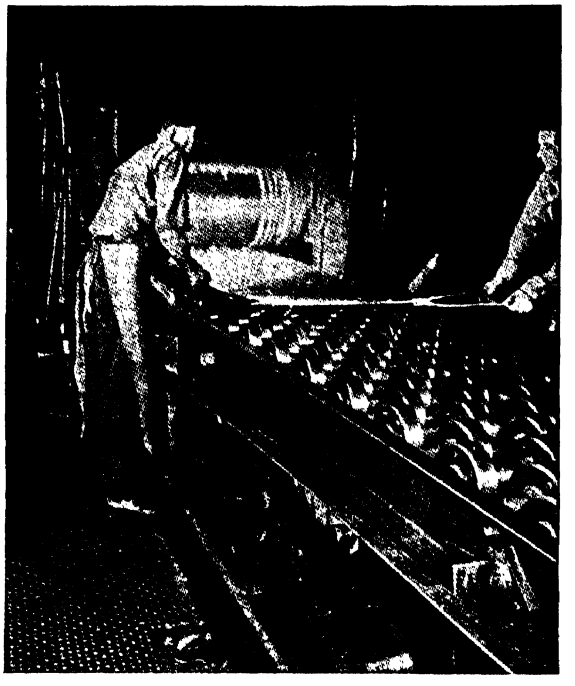
OEM Defense photos

In the pigs the molten aluminum hardens in the form of bars. Later these bars must be melted again and the aluminum must be purified before it is ready for use. If alloys are wanted, the alloy is added at this time.

CLOSE-UPS OF ALUMINUM IN INDUSTRY



After remelting and adding the alloy (that is, if one is wanted), the metal is cast into ingots, or long bars. Above is an ingot of aluminum alloy. Aluminum is alloyed with various other metals in order to make it harder and tougher. Duralumin is one of the best known of these alloys.



Rolling a sheet of aluminum alloy for use in airplane manufacture. Aluminum comes in many different forms.

OEM Defense photos

High-speed tools cut parts for aircraft from aluminum. Aluminum is a vitally important material in making airplanes, since it combines lightness with great strength. It is used for the wings and the fuselage. The pistons, cylinder heads, crank-cases, water jackets and other parts of airplane engines are often made from aluminum-alloy castings. Aluminum forgings are used to make airplane propellers and fittings of different kinds. One reason for the wide range of the uses of aluminum in airplanes, streamlined trains, buses and so on is the fact that it can be worked in so many different ways. The metal can be forged, stamped and spun with equal effectiveness. As for the alloys, they can be cast by the sand, permanent-mold or die-casting processes.

What is the Fastest Living Thing?

MAN is the most intelligent of living things, but he certainly is not the fastest. At his absolute best, as represented by a trained athlete making a world record, a man runs a little less than 22 miles an hour and this only for a short distance. It is true that the pig can run at the rate of about 11 miles an hour, yet a dog (greyhound) can run 36 miles per hour and horses have attained speeds as high as 40 miles per hour.

Horses are not, however, the fastest four-footed animals. The buck deer has been clocked at a speed of nearly 50 miles an hour, a very good speed for an automobile. A still more surprising pace is possible for the cheetah, a species of hunting leopard, built to get its prey in one tremendously swift and silent dash. This wonderful creature is credited with a top speed, for a distance of one hundred yards, of 70 miles an hour. By virtue of this speed, it is quite probably the fastest animal in existence.

It is the birds that must be looked to for speeds in excess of 70 miles per hour. However, estimates of flight speed can not always be accurate, and most figures should be treated as approximations. The vulture is assigned a top speed of 89 miles an hour; golden eagles can touch 120 miles an hour; the duck hawk, a species of falcon, is rated between 160 and 180 miles an hour. This hawk preys on ducks, themselves fast in flight, so its vertical dive upon its victim must be exceedingly fast to be successful. Even if the figures established for the duck hawk are exaggerated, it remains by a safe margin not only the fastest bird of which there is record, but also the fastest living thing now known.

Some observers would bring forward an insect, the deer fly, as a candidate for the speed championship of the world, claiming for it the incredible velocity in flight of 818 miles per hour. At least one student of insects, the entomologist, Dr. C. H. T. Townsend, supports this claim, but the probable facts are against his opinion.

Dr. Irving Langmuir, holder of a Nobel Prize in science, can not agree with Dr. Townsend for several reasons. One of them is the fact that a tiny deer fly would be invisible at a speed of 60 miles per hour, yet

The Bettmann Collection

Hunting with falcons, or duck hawks. From a painting by Holbein.

Dr. Townsend speaks of seeing them as a brownish blur when they were supposedly moving past him at more than ten times 60 miles per hour. Again, at such an enormous speed the wind pressure against the fly's head would be 8 pounds per square inch, probably enough to crush it instantly. Then there is the question of the energy necessary for the fly to reach these great speeds. In all living things, movement of this sort requires energy and energy requires food. To achieve its supposed top speed the deer fly would have to eat twice its own weight in food every second. This is not the case, hence, if for no other reason, its great speed of flight is impossible.

WHY HAVE WE LINES ON OUR HANDS?

If you will look at your palm as you double up your hand, you will notice that the lines across the palm occur at the places where your hand bends. The skin of your palm is very thick, and the lines are so placed that the skin can bend with the bending hand.

The lines on our palms help us to grasp things more firmly and to get a better hold on them. Without these lines the flesh of the palm would be very loose and would slip around. This would make it much more difficult to take hold of things and keep a firm grasp upon them.

It is possible, also, that these lines help the sense of touch in our hands and fingers, where touch is so very important. By making little valleys and ridges they increase the surface of the skin on the palm. The little endings of the nerves of touch are placed to the greatest advantage by means of these lines.

WHY DOES A GLOW-WORM GLOW?

Glow-worm is a name which is given to any kind of insect that gives off light. You have probably often seen—for they are very common in North America—the beautiful little fireflies or lightning-bugs which flit through the summer evenings like tiny spirits. You may have noticed this same kind of "cold light" in fungi in the woods at night, or in fish swimming through the dark ocean.

The light given off by these living things is indeed cold light. It is caused by a chemical process which depends upon the presence of oxygen. If the oxygen were taken away, the light would cease to shine. A chemical substance called luciferin is present in luminous animals and combines with the oxygen to form cold light.

WHAT IS MEANT BY ETAOIN SHRDLU?

While reading printed material such as a newspaper, have you ever lowered your eyes in order to read the next line and met with etaoin shrdlu etaoin shrdlu etaoin shrdlu? The reason for the occasional appearance of these strange words is because of the way a linotype machine works. Three of its most important parts are the keyboard, the magazine and the distributor-bar.

The keys in the leftmost column of the linotype's keyboard, from top to bottom, control the letters e-t-a-o-i-n, and the next column of keys, in the same order, controls the letters s-h-r-d-l-u. The keys are arranged in this manner because, according to one survey, in the order in which they are given these letters are the most frequently used in the English language. (If you turn to Edgar Allan Poe's story, The Gold-Bug, on page 1901, you will find a different arrangement of the letters which are believed to be used most frequently.)

The linotype's magazine contains only a certain number of the matrices or molds for each letter. This makes it necessary that the molds most often used be returned to the magazine as quickly as possible so that they may be used again. After a line of type has been cast, the letter molds travel along the distributor-bar until they fall into their proper places in the magazine. Since the "e" compartment is the first one reached, the "e" mold falls into it without the need for this busy letter to waste its time in travel along the distributor-bar. In the same way, the molds for the other letters of etaoin shrdlu reach their places in the magazine in less time than is taken by the mold for a letter, such as "z," which is not used so frequently.

When the linotyper wishes to test his machine, or to set it for a line of some given length, or to fill out a line in which a mistake appears, he will often run his finger down the keys which spell etaoin shrdlu. If through an oversight on the part of the linotyper or proof reader, the letters thus cast get among the lines of type cast for the printed text, we shall find the smooth course of our reading interrupted by the repetitions of etaoin shrdlu.

ARE ANIMALS IN THE ZOO CONTENTED?

The zoo is a fascinating place to us, where we may see wonders gathered from the four

corners of the earth. But what of the animals of the zoo? Do they pine in captivity and long for the freedom of the wilds? Is the zoo a place where dumb beasts are tortured in spirit if not in body, to amuse humans who come to the zoo to gratify mere curiosity?

Some good people maintain that this is indeed the case. They point out that many animals are forced to live in a climate for which they were never intended; that hunting animals are unable to gratify their instincts; that birds have little space in which to fly; that the inmates of the zoo one and all long for their freedom, as is shown, for example, by the restless pacing of certain animals.

It is true that many of the zoo animals live in climates to which they have not been accustomed. But most animals have an astonishing power of adaptation to all sorts of climates. The aoudad, the wild mountain sheep from the sun-baked crags of northern Africa, thrives in winter at the New York zoo. On the other hand, such inhabitants of colder climates as polar bears, penguins, and musk-oxen endure summer heat astonishingly well. Other animals are not so adaptable, but every effort is made to cater to their needs. The giant panda is kept in a specially cooled room when the weather is unbearably hot. Tropical animals, on the other hand, are kept in carefully heated houses in winter, and in some zoos specially constructed vitaglass and heated floors contribute to their comfort.

As for lost hunting opportunities, we must remember that most animals hunt through sheer necessity. Only a few, like the cougar or the wolverine, take delight in killing for its own sake. Careful observers have noted that when lions, in their native haunts, have fed, they will romp and rest and sleep for hours on end, with no thought of seeking prey. At the zoo it has been noted that the larger animals, when not hungry, will not molest smaller creatures that invade their cages. At Whipsnade, in England, rabbits boldly venture almost to the very paws of the lions, who quite ignore them. At the Edinburgh Zoo, a bantam hen, accompanied by several chicks, used to enter the brown bear's cage and gobble up crumbs in safety. As long as the zoo supplies food, the hunting instinct is a luxury of which most animals do not care to avail themselves.

It is true that caged birds have not all the great out-of-doors in which to fly. Yet the larger aviaries afford ample flying space, and even the smallest of the bird cages at the zoo is very much larger than those very small cages in which people keep pet birds. Those of us who have kept canaries and parrots know how contented they often become in captivity. Are we to suppose that the birds of the zoo, whose quarters are so much more spacious and who are provided with so much lively company, are less contented?

As for the restless pacing of the animals, it is not so much evidence of a desire to escape as it is a rhythmic series of movements that seem to give the animal pleasure and that enable it to work off its superfluous energy. We can note this same sort of rhythmic movement among many animals in freedom and captivity. Curiously enough, some of the animals who indulge most freely in this endless pacing are the most loath to take advantage of their freedom when through some chance it is offered them. The little kinkajou is a very restless little animal, who is forever marching to and fro in the front of his cage. Yet two little kinkajous of the Regent's Park Zoo, in London, who succeeded in opening the door of their compartment, went on a wild spree, overturned boxes, pulled parrots' feathers and then, returning of their own free will to their cage, shut the door after them and fell asleep!

The crowning argument against the captivity of animals at the zoo is that they have lost their liberty. But liberty in a wild state is not exactly heaven for most animals; it is very often the reverse. In the natural state animals are constantly seeking to flee from dangerous enemies. Life becomes a rather monotonous round of animals and birds and insects devouring and being devoured. Again, animals in their natural haunts are constantly exposed to hunger and thirst, and there are no attendants to see that these needs are supplied at a given time. Furthermore, disease is quite common among animals in the wilds, as veterinary doctors discover when they examine new arrivals at the zoo.

It is true that a few animals fail to thrive in captivity. The Komodo dragon, the giant lizard from the island of Komodo, in the Dutch East Indies, cannot adapt itself to changed surroundings. It is difficult to rear gorillas successfully in the zoo, though other large apes are quite hardy. The giant panda finds it hard to accustom himself to the extremes of hot and cold of the temperate

zone. But these are exceptional cases. Most animals that reach a zoo in sound health continue to thrive and live to a ripe old age. Lions, for example, do so well in captivity that they outlive their normal span of life. Furthermore their physical condition is sometimes superior to that of their brothers in the wilds. It is a significant fact that when a certain zoo in South Africa wanted some lions for exhibition purposes, it spurned its native species and sent for its lions to the zoo at Dublin, where the animals had been bred for many generations.

We are fairly safe, then, in concluding that not only do most of the animals in the zoo thrive in captivity, but that they lead as contented lives as they would in their native haunts. That is the opinion of the great majority of trained zoologists and zoo attendants the world over.

WHO ARE LLOYD'S OF LONDON?

The name of Lloyd's of London is often heard in connection with all kinds of odd insurance policies. Lloyd's, we hear, will insure dancers against becoming fat and the fat ladies of the circus against becoming thin. It will insure against colds, bad weather and vermin. It is true that Lloyd's will insure against anything but death. But there is nothing freakish about this famous company; it is the largest insurance organization in the world.

It began when a group of insurance men started to meet and transact business at Edward Lloyd's coffee house in London, toward the end of the 18th century. Each of these men carried on his own business, but they combined in a group in order to obtain shipping information. In the course of the long history of Lloyd's, its underwriters became more closely associated, and a company was finally formed in 1871. Yet even at the present time insurance is issued, not by Lloyd's as a corporation, but by the individual members of Lloyd's, who take all the risks.

As a corporation Lloyd's watches over the interests of its members and gives out shipping news and general commercial information. Lloyd's maintains many agents and correspondents all over the world. It also issues a number of publications, including a Register of the world's shipping. An interesting feature of Lloyd's headquarters in London is the ship's bell of the old frigate Lutine; this is rung once to indicate good news, twice to indicate bad.

WHAT IS VENEERED FURNITURE?

The beauty of much wood furniture is only veneer deep. In such furniture the surface wood is no more than a thin sheet which has been applied to a core usually made of cheaper materials. Though veneers can be used to hide shoddy work and wood, properly veneered wood offers several advantages, in addition to permitting the use of cheaper material in unseen places.

In practically all built-up panels alternate plies of wood are laid with their grains running across each other at right angles; that is, in three-ply veneer, the face veneers are glued at right angles to the core, and in five-ply material the face veneers and the core are parallel and the layers between, known as crossbands, are laid at right angles.

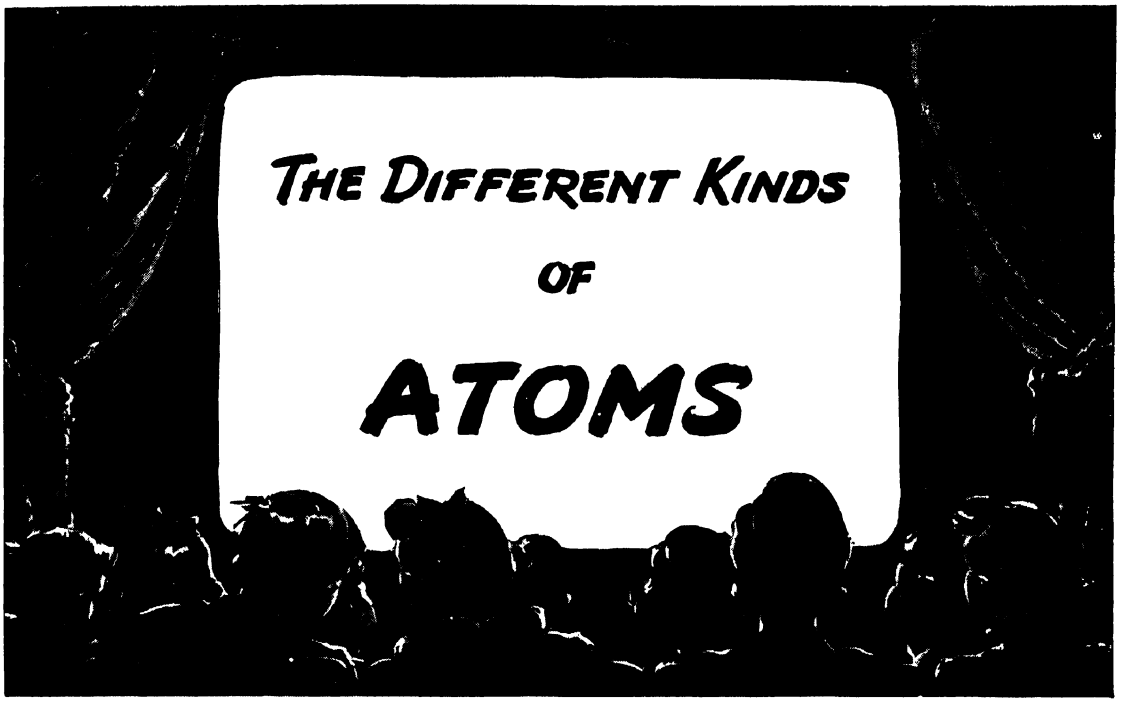
A panel of such construction has the advantages that it is more nearly of the same strength in all directions, and that as it absorbs or gives up moisture it shrinks or swells about as much one way as another. Thus, splitting along the grain in one set of plies is made impossible by the cross grain of the alternate plies, and rapid shrinkage across the grain in the face veneers is offset by slow shrinkage along the grain in the core.

Veneered panels do not change dimensions as much as solid wood. Warping is largely eliminated in thick panels by plywood construction. More care can be taken in the selection of surface wood in veneered furniture than can be taken in solid furniture. The manufacturer can dry veneer stock quickly and cheaply, and he can utilize all of his wood to the best advantage.

Most veneers are produced by slicing. In this operation a long heavy knife cuts the thin panels from a log which has been boiled or steamed. Many cheaper veneers are made by rotary cutting. The log is held in a lathe and is turned against a knife which slices off a continuous ribbon of veneer. In a variation of this method, known as half-round, the log is placed off centre in the lathe. Some veneers are produced by sawing, a method not often used because much of the wood is wasted. Sawed veneers are best as the wood fibre is undisturbed.

Until recently only animal glues were available, but to-day new binders made from casein, which is a milk product, from soy beans and from synthetic resin plastics, make possible a sandwich of wood which is stronger than steel of equal weight.

THE NEXT WONDER QUESTIONS ARE ON PAGE 284.



WHAT ARE THINGS MADE OF?

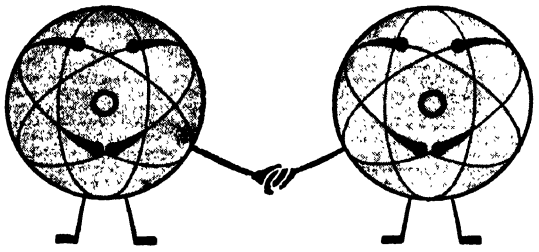
WHEN the first warm days of summer come, we all enjoy seeing flowers and vegetables growing in our gardens and fields. They grow so fast that the difference in size can be noticed almost from day to day. They all started from tiny seeds, so we naturally believe that most of the stuff in the fruits and leaves must have come out of the ground, or out of the air, or out of the rain, or out of the fertilizer which was used. Later on we eat the vegetables—the tomatoes, the carrots, the corn, and the beans. By eating these and other things children grow heavier and taller; their bones grow stronger, their hair grows longer. So we must also believe that most of the stuff of which children, and adults, are made must have been contained in the food they ate, or in the air they breathed, or in the water they drank. If you think about this a little you will want to ask "Are there the same ingredients in the soil, in the vegetables and in ourselves?"

Men have sought the answer to this question for centuries. They have learned how to take the carrot to pieces, and the soil also, and wood and coal and sugar and salt and all other kinds of matter that we see around us. They have found out what *we* are made of, also.

Yes, it is true that you will find some of the same ingredients in the soil, the air, the rain, the carrots and other vegetables, and ourselves. Now here is a very wonderful thing. Cut a carrot up, and keep cutting until you have the smallest possible piece of carrot, and you have a tiny, tiny piece of matter. You have such a tiny piece of matter that you can not see it—you can not see it with any microscope, though you might see an enlarged image of it by the wonderful electron microscope.

We call this tiny piece of anything a molecule, which means "small piece." Now a molecule itself, though it is so tiny, is made up of even tinier parts. In most cases, however, the parts are not the same as the matter we started with. The parts of a carrot molecule are not carrot, for instance.

These parts that combine to form molecules are called atoms. The molecules of some things (water, for instance) have just two kinds of atoms locked together. Other



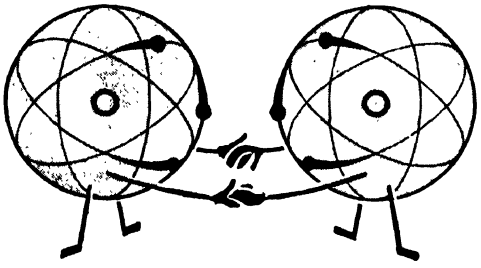
How some atoms join together to form a molecule. Each individual of this tribe possesses only one arm with which to hold on to another atom.

materials have many different kinds of atoms. Some molecules are rather simple; others are complex, with hundreds of atoms of various kinds, combined according to rules of nature. We have not yet discovered all these rules, but we know some of them.

New molecules are continually being discovered by chemists to add to the thousands we already know. But in all the world—and in the sun, the moon and the stars—there are only ninety-odd different kinds of atoms. It is the way in which these atoms form into groups that make the great, wide, varied world we see, and everything in it.

You can understand this if you think of a piano. It has keys enough to produce only eighty-eight different tones. However, it is possible to produce countless tunes by combining this definite number of sounds.

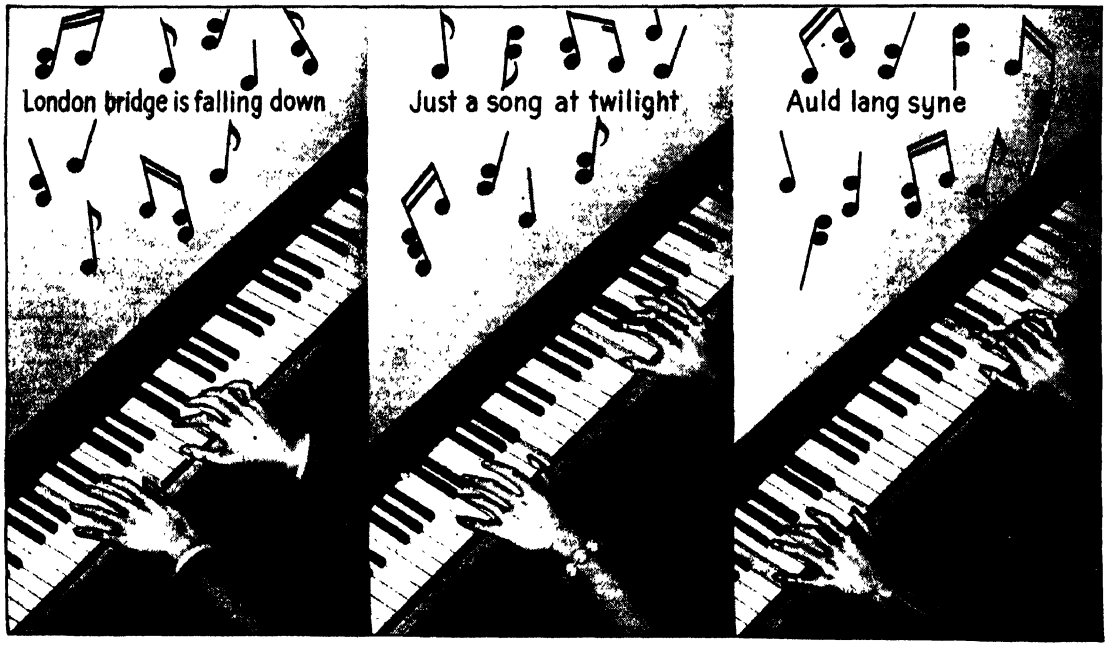
Now let us consider the ninety-odd different kinds of atoms. Some are very familiar to us. Every day we see materials made of only one kind of atom. Iron, for example, contains atoms of only one kind, and therefore one of them is called an iron atom. The atoms of mercury in your mother's fever thermometer are all of one kind; they are mercury atoms. Silver, gold and lead are each made of only one kind of atom; though we often mix them with other materials to



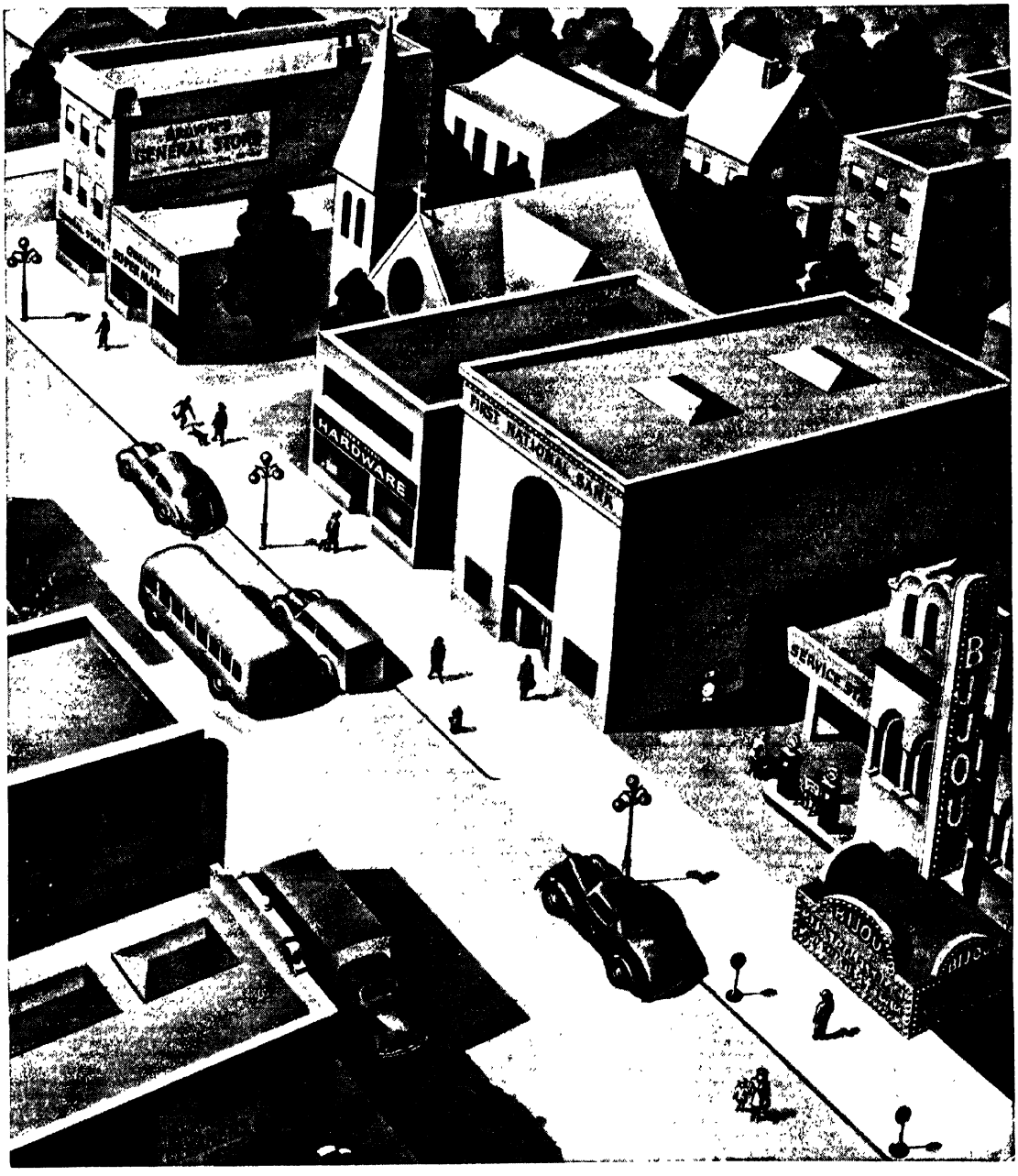
Other atoms combine to form molecules by "double bond," as this union is called. Each individual of this tribe possesses two arms.

make them stronger metals, called alloys, for daily use.

When a substance is made up of atoms of one kind only it is called a chemical element. Familiar chemical elements are iron, copper and aluminum, which are metals; oxygen, hydrogen and helium, which are gases; car-



A piano's eighty-eight keys produce eighty-eight different musical tones, which may be combined into a countless number of tunes. In somewhat the same way, the ninety-odd elements combine to form many different substances.



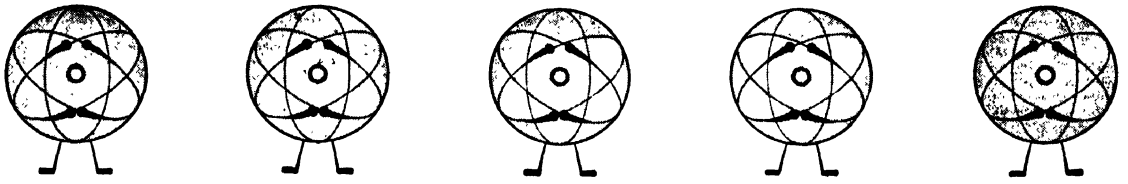
If you were making a cardboard village, you could arrange all the different buildings in any order that you liked. They might be arranged in order of value, for example. In Column 3 of Table I, on the next page, the atoms are arranged according to weight. Hydrogen, the lightest, is in first place.

bon, sulphur and phosphorus, which are solids, but not metals; mercury is a liquid. Some chemical elements can be told by their appearance, although appearance alone is not reliable as a final test. Copper is reddish, aluminum is greyish, sulphur is yellow, carbon is sometimes black, sometimes colorless. These special colors of some of the chemical elements must not, however, be thought of as the colors of the individual atoms of which they are composed. The particular reddish color of a chunk of copper is not due to any color of the individual copper atoms, but is caused by the special way in which the atoms are put together to make the solid piece.

TABLE I. THE ELEMENTS

Column 1. Name of element
Column 2. Chemical symbol or abbreviation
Column 3. Atomic number
Column 4. Approximate atomic weight
Column 5. Form when pure: G, gas; M, metal; L, liquid; N, non-metal; V, various.

Hydrogen	H	1	1	G	Indium	In	49	115	M
Helium	He	2	4	G	Tin	Sn	50	119	M
Lithium	Li	3	7	M	Antimony	Sb	51	122	V
Beryllium	Be	4	9	M	Tellurium	Te	52	128	V
Boron	B	5	11	N	Iodine	I	53	127	N
Carbon	C	6	12	V	Xenon	Xe	54	131	G
Nitrogen	N	7	14	G	Cesium	Cs	55	133	M
Oxygen	O	8	16	G	Barium	Ba	56	137	M
Fluorine	F	9	19	G	Lanthanum	La	57	139	M
Neon	Ne	10	20	G	Cerium	Ce	58	140	M
Sodium	Na	11	23	M	Praseodymium	Pr	59	141	M
Magnesium	Mg	12	24	M	Neodymium	Nd	60	144	M
Aluminum	Al	13	27	M	Promethium	Pm	61	147	M
Silicon	Si	14	28	V	Samarium	Sm	62	150	M
Phosphorus	P	15	31	N	Europium	Eu	63	152	M
Sulfur	S	16	32	N	Gadolinium	Gd	64	157	M
Chlorine	Cl	17	35	G	Terbium	Tb	65	159	M
Argon	A	18	40	G	Dysprosium	Dy	66	162	M
Potassium	K	19	39	M	Holmium	Ho	67	165	M
Calcium	Ca	20	40	M	Erbium	Er	68	167	M
Scandium	Sc	21	45	M	Thulium	Tm	69	169	M
Titanium	Ti	22	48	M	Ytterbium	Yb	70	173	M
Vanadium	V	23	51	M	Lutecium	Lu	71	175	M
Chromium	Cr	24	52	M	Hafnium	Hf	72	179	M
Manganese	Mn	25	55	M	Tantalum	Ta	73	181	M
Iron	Fe	26	56	M	Tungsten	W	74	184	M
Cobalt	Co	27	59	M	Rhenium	Re	75	186	M
Nickel	Ni	28	59	M	Osmium	Os	76	190	M
Copper	Cu	29	64	M	Iridium	Ir	77	193	M
Zinc	Zn	30	65	M	Platinum	Pt	78	195	M
Gallium	Ga	31	70	M	Gold	Au	79	197	M
Germanium	Ge	32	73	M	Mercury	Hg	80	201	ML
Arsenic	As	33	75	V	Thallium	Tl	81	204	M
Selenium	Se	34	79	V	Lead	Pb	82	207	M
Bromine	Br	35	80	NL	Bismuth	Bi	83	209	M
Krypton	Kr	36	84	G	Polonium	Po	84	210	M
Rubidium	Rb	37	85	M	Astatine	At	85	211	M
Strontium	Sr	38	88	M	Radon	Rn	86	222	G
Yttrium	Y	39	89	M	Francium	Fa	87	223	M
Zirconium	Zr	40	91	M	Radium	Ra	88	226	M
Columbium	Cb	41	93	M	Actinium	Ac	89	227	M
Molybdenum	Mo	42	96	M	Thorium	Th	90	232	M
Technetium	Tc	43	99	M	Protoactinium	Pa	91	231	M
Ruthenium	Ru	44	102	M	Uranium	U	92	238	M
Rhodium	Rh	45	103	M	Neptunium	Np	93	237	M
Palladium	Pd	46	107	M	Plutonium	Pu	94	239	M
Silver	Ag	47	108	M	Americium	Am	95	241	M
Cadmium	Cd	48	112	M	Curium	Cm	96	242	M



The noble gases, as they are called, will not combine with other elements, but stay aloof. Helium, neon, argon, krypton and xenon are noble gases. Helium, the lightest of them, is the best gas to use in balloons.

As we have said, *there are only ninety-odd different kinds of atoms, or chemical elements.* Every bit of matter in the world is made up of some combination of these ninety-odd. Although we say that they are all different, nevertheless some show a sort of family relationship. To understand this, think first of the buildings in a village. They could be listed in order of size, starting at the smallest and ending with the largest. A number could be assigned to each one of these, starting with 1 for the smallest and going on through the town until all the buildings were numbered.

Another number could also be put opposite each building on the list, representing, let us say, the value of the building. Usually, but not always, the value would be greater, the larger the building. And finally, some descriptive term could be added to each entry on the list, such as garage, shop, or dwelling.

When atoms are listed in this way, Table I is obtained. The first column of Table I tells the name of the atom: hydrogen, or nitrogen, or another. The next column gives the usual abbreviation of the name, or its chemical symbol, often the first two letters of its name in Latin. Then follows a number, called the atomic number, which ranks the atom in order of size, or weight. Next the atomic weight of the atom is given, using as a basis the hydrogen atom with weight 1. And finally a letter is given to tell whether the atom ordinarily joins with other identical atoms to form a metal, a non-metal, a gas, or a liquid. Thus we read Copper, Cu, 29, 64, M—which tells us that the chemical symbol for copper is Cu, that it is 29th from being the lightest atom, that a copper atom is 64 times as heavy as a hydrogen atom, and that the material copper is a metal under ordinary conditions.

We would think it a very strange village if every eighth building in the list starting with No. 2 was a garage, and every eighth building starting with No. 3 was a drugstore, and every eighth building starting with No. 4 was a residence, and every eighth building starting with No. 5 was a bakery. Yet this is just the kind of thing we find in the table of atoms.

When applied to atoms and chemical elements, this strange regularity is known as the periodic law. To make the meaning clearer, some of the atoms from Table I have been set down in crossed columns in Table II, which is part of the Periodic Table used by chemists.

Reading the atomic numbers across, you have 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, then some jumps, then 33 to 40, then more jumps, then 51 to 56. We can forget the jumps until a later chapter.

The atomic numbers, remember, tell the way the elements rank in weight, beginning with the lightest, hydrogen.

Now read down, beginning with number 2, Helium. 2-10-18; 3-11-19; 4-12-20; 5-13-21; 6-14-22; 7-15; 8-16; 9-17.

The pattern is not absolutely perfect, but again and again you are able to see the atomic groupings themselves, eight atomic numbers apart.

Is this all just a matter of chance? The answer is no. The

TABLE II. PERIODIC TABLE

O	I	II	III	IV	V	VI	VII
2He Helium	3Li	4Be	5B	6C	7N	8O	9F
10Ne Neon	11Na	12Mg	13Al	14Si	15P	16S	17Cl
18A Argon	19K	20Ca	21Sc	22Ti			
					33As	34Se	35Br
36Kr Krypton	37Rb	38Sr	39Y	40Zr			
					51Sb	52Te	53I
54Xe Xenon	55Cs	56Ba					

It would be a strange sort of village if every eighth building were a garage, with a church next in line, then

atoms in the columns really are related. Numbers 4, 12, 20, 38 and 56 (beryllium, magnesium, calcium, strontium and barium), which fall into the same column, have very similar properties. They are all metals, they look somewhat alike and they behave very much alike, so much so that chemists often have difficulty in telling from their behavior which is which.

Again as a result of this grouping by eights, five elements, helium, neon, argon, krypton and xenon find themselves in one column. These elements are all gases; their chemical behavior is identical, in that they will not enter into chemical combination with any other elements. Thus they are called inert, or noble, gases, because they stand aloof. It is this nobility which makes helium so valuable for airships and blimps.

A helium atom is four times as heavy as a hydrogen atom. Therefore a balloon filled with hydrogen rises more readily than one filled with helium. But hydrogen can explode, while helium can not combine with oxygen or any other element to burn or explode.

A story of relationship can be told about the elements in any other column of this Periodic Table. Similar elements fall into the same column, but elements in one column, say IV, are quite different from those in, say VII.

The whole study of chemistry, part of the study of physics and some of astronomy is based on what you have just learned about these ninety-odd elements. The next step is to see how they combine to form molecules, and so build the vast number of different materials in our world. Remember this—whether it is simple or complex, natural or man-made, all matter is made of molecules; and most molecules have two or more atoms. Some molecules have hundreds of atoms.

Atoms do not combine helter-skelter, but according to strict rules, beautiful rules of harmony. We spoke earlier of the eighty-eight piano keys. You can not make chords just by striking any keys together. You must learn the rules. You must learn what tones can be sounded together to make beautiful new sound-patterns.

It is the same with combinations of atoms. Some, as we have said, will not combine at all. Those we call the noble, or inert, gases. Different atoms do not always combine one and one, but sometimes one and two, or one and three, or two and three. This orderly and regular behavior is governed by a number called valence. Different atoms have valence 0, 1, 2, 3 or 4. You would not be far wrong in thinking of an atom as having hooks by which it could attach itself to other atoms. There is one strict rule,

a house, then a bank, then a school and so on. The different elements do show this type of arrangement.

however. Every hook must be used. The number of hooks is the valence of the atom. The noble gases have valence 0. They do not combine with other atoms. Magnesium has valence 2, chlorine 1. Therefore one atom of magnesium hooks on to 2 atoms of chlorine, leaving no hooks unused. The compound is magnesium chloride, written $MgCl_2$.

Oxygen, however, also has valence 2, so one atom of magnesium can combine with one of oxygen, each atom using its two hooks, like two children each holding both the other's hands. The compound is magnesium oxide, written MgO.

Turning once more to the Periodic Table, we see that the atoms are classified also according to valence. In column I all the elements have valence 1. In column II, the valence is 2. Other valence numbers are: column III, 3; column IV, 4; column V, 3; column VI, 2; column VII, 1; and, of course, column O, 0. Thus, by looking at the Periodic Table carefully, one can predict how different atoms will combine, if they combine at all. For example, Ca(2) and F(1) make calcium fluoride, CaF_2. Na(1) and Cl(1) make sodium chloride, NaCl, which is the chemical name for common salt. The rules which govern chemical combination are more fully described in The Building Blocks of Matter, on page 609.

A brick wall is made of bricks; so is a pile of bricks dumped from a truck. The one is much neater and better looking than the other. This difference in appearance depends on how the bricks are put together to make the wall or to make the rough pile. There are several kinds of atoms which can be put together in different ways, for example, carbon and selenium, to take only two which are marked with V (for various) in Table I. Carbon atoms joined in one way make diamonds; in another way, they make graphite. Both these substances are pure carbon, but the atoms are put together in different ways. Diamond is very hard; graphite is very soft.

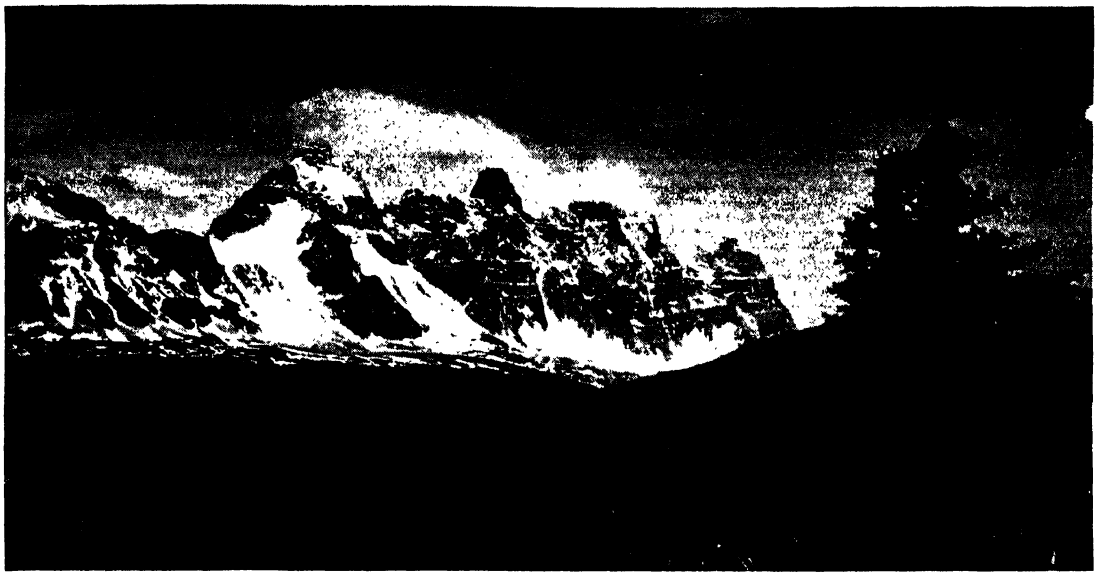
Selenium can be made, when pure, in three forms, (a) red crystals, (b) red, but not crystalline and (c) gray metallic crystals. Only the third variety conducts electricity at all well. Different forms of pure chemical elements such as these are called allotropic modifications, or allotropes. Not all elements which occur in different allotropic forms are so indicated in Table I. Many elements are so rare that they can not be obtained pure enough or in sufficient quantity to provide material for conducting experiments.

By THOMAS H. OSGOOD.

THE NEXT STORY OF SCIENCE IS ON PAGE 307.

THE SURFACE OF NORTH AMERICA

This map of North America shows the land itself with its streams and mountains. You can notice the gentle mountain ranges of the East, the great trough in the middle of the continent and the lofty Rocky Mountains of the West. Still farther west is a great highland, then more mountains, the Coast Ranges. Notice how most of the rivers of the United States flow south, while the river systems of Canada and Alaska drain northward. You can understand from this map how far down the ice sheet came, and how far up into the land the Gulf of Mexico once reached. You can also see how like and yet how unlike the United States is the surface of Canada and of Mexico. A study of the surfaces of a country helps one very much in understanding its settlement and its history.



A part of the great continental divide, in Jasper National Park, Alberta, Canada.

THE CONTINENT OF NORTH AMERICA

NORTH America is one of the great land divisions of the world, with an area of about 8,500,000 square miles. Its northern regions lie well beyond the Arctic Circle; its southernmost tip is less than 500 miles from the Equator. It is separated from South America by the narrow Isthmus of Panama, across which runs the great Panama Canal. At one place the North American land of Alaska is only about sixty miles from the northeastern tip of Asia; at most points, however, the two continents are thousands of miles apart.

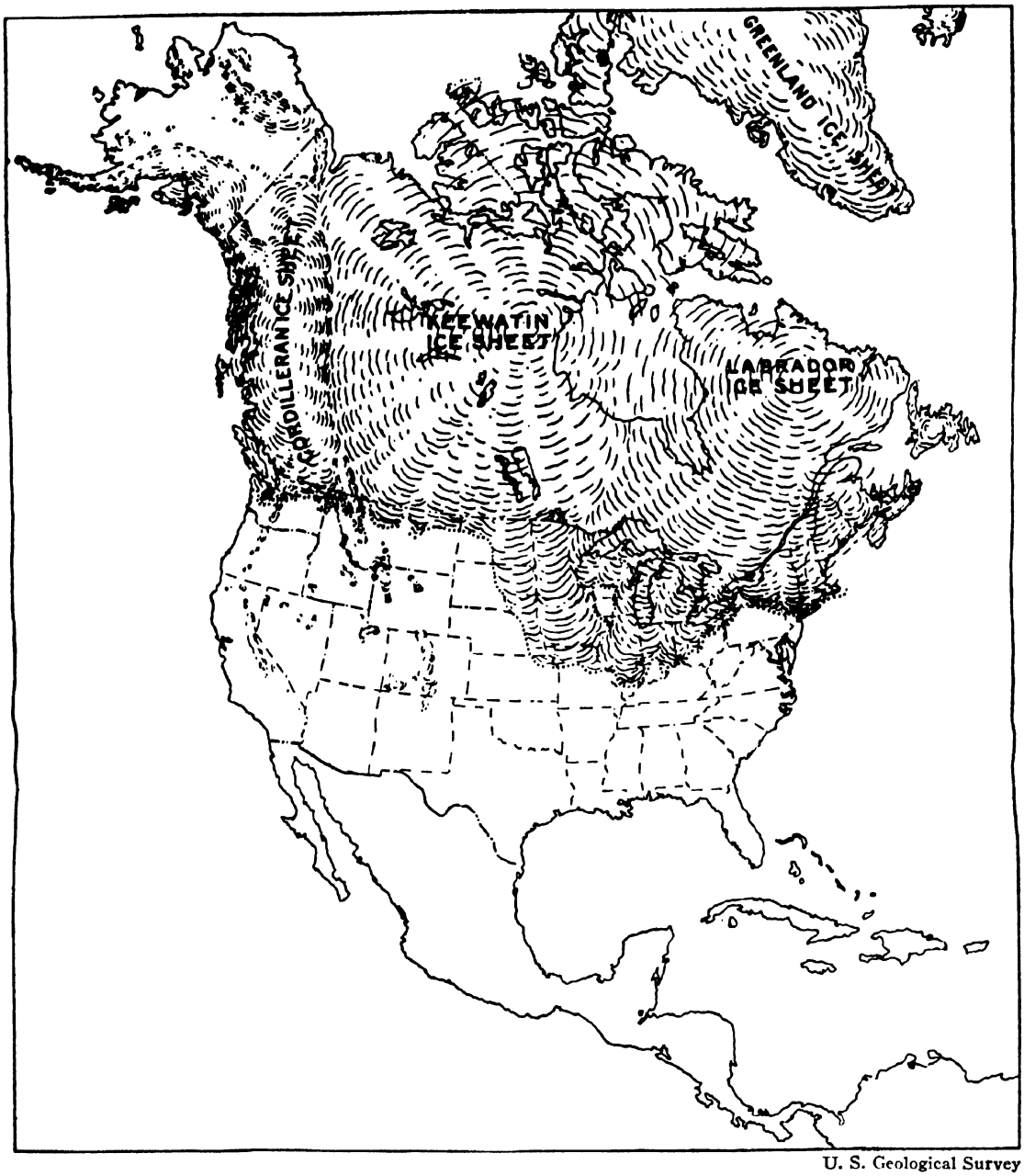
There are numerous islands off the mainland of North America. In the north they form a tangled archipelago in the Arctic Ocean. (The word archipelago refers either to a sea abounding with islands or to the islands themselves.) Some of the islands of the northern archipelago are very large; one of them, Greenland, is almost a continent in itself.

Off the eastern coast of Canada one finds the island of Newfoundland, which almost closes up the entrance to the great Gulf of St. Lawrence. The group of islands known as the Bahamas lie off the eastern coast of Florida. Further to the south there are the West Indies, which include Cuba, Hispaniola, Puerto Rico, Jamaica and a great number of smaller islands spreading southeast.

The most striking islands of the western coast of North America are the Aleutians, which stretch from the southwestern tip of Alaska toward Asia in a sweeping curve. As we go southward, along the western coast of Canada, we come upon the Alexander Archipelago, the Queen Charlotte Islands and Vancouver Island. There are practically no islands of importance south of Vancouver.

The coastline of North America is irregular, particularly in the north and east. There are a number of large peninsulas that jut out into the sea—Alaska, in the northwest, Labrador in the northeast, Nova Scotia in the east, Florida and Yucatan in the southeast and Lower California in the southwest. There are also innumerable bays and gulfs and sounds. The eastern coast is particularly irregular; it has a great number of excellent harbors.

A vast mountain system, known as the Cordilleras, runs more or less parallel to the western coast of North America. This system extends from Alaska to the Isthmus of Panama; from here it crosses over into South America. In the Alaskan Cordillera one finds mighty glaciers, as well as the loftiest peak in North America, Mount McKinley, which towers to 20,300 feet.



U. S. Geological Survey

This map shows how far the great ice sheets, or glaciers, crept down from the north.

The Cordilleras broaden as they sweep through Canada. There is a great range called the Rocky Mountains, a central belt made up of mountains and plateaus, and, farthest west, the Coast Range. In the Canadian Cordillera, near the Alaskan frontier, we find Mount Logan, which is 19,500 feet high.

In the United States the Cordilleras reach their greatest width. Here, as in Canada, we find the Rocky Mountains and the Coast Range. The Sierra Nevada, running from northwest to southeast, is in between. Extending from the Coast Range to the Rockies there is a great plateau, a thousand miles wide in some places and from 5,000 to 10,000 feet high. Some of the peaks of the American Cordillera reach a height of from 14,000 to

15,000 feet; they include Mount Shasta and Mount Whitney, in California, and Mount Rainier, in the state of Washington.

THE GREAT DEPRESSION IN THE CENTER OF THE CONTINENT

East of the Cordilleras, in Canada and the United States, is an immense lowland that some people call the great depression (sunken place). This extends almost across the continent. It is bounded on the north by Hudson Bay; it includes the lands lying on both sides of the bay. It extends south to the Gulf of Mexico.

The great depression does not quite extend to the Atlantic Ocean. Not far from the coast it meets the wall of the Appalachian Mountains, which run north and south from the Gaspé Peninsula, in Canada, to Alabama, in the United States. The Appalachians consist chiefly of a plateau, from fifty to two hundred miles wide. The mountains that rise at intervals from the plateau are much lower than those of the Cordilleras; the highest peak is Mount Mitchell, North Carolina, 6,684 feet. East of the Appalachians, the land slopes gently to the Atlantic.

In Mexico the Cordilleras have two main branches, one following the Atlantic coastline, the other the Pacific coastline. The great plateau of Mexico lies between the two. Towering from the plateau are a number of volcanic peaks, some still active. The loftiest are Orizaba, 18,250 feet; Popocatepetl, 17,520 feet; and Ixtacihuatl, 16,960 feet.

In the Isthmus of Tehuantepec, in southern Mexico, there is a great gap in the Cordilleras system; the mountains give place to a broad plain. Further to the south, in Central America, the Cordilleras consist of a range of foothills, with frequent gaps. There is a steep slope from these foothills to the Pacific Ocean and a much more gradual slope to the Atlantic.

THE MIGHTY RIVER-SYSTEMS THAT DRAIN NORTH AMERICA

The waters that arise in the highlands of North America are drained off into the great oceans and bays that surround the continent by an imposing network of waterways. The Colorado, the Sacramento, the San Joaquin, the Columbia and the Fraser rivers flow into the Pacific. Farther to the north, the mighty Yukon empties into Bering Sea.

The Coppermine and Mackenzie rivers carry to the Arctic Ocean the waters that flow through the northern part of the great depression. Somewhat farther to the south the waters of the depression are drained into Hudson Bay by the Nelson River and into the Atlantic Ocean by the Great Lakes and the St. Lawrence River. East of the Appalachians, the St. John, the Kennebec, the Connecticut, the Hudson, the Delaware, the James and the Savannah rivers flow into the Atlantic Ocean.

In the southern part of the great central lowland we find a great river system which empties its waters into the Gulf of Mexico. This system consists of the Mississippi River and its tributaries, of which the most important are the Missouri, the Ohio, the Arkansas and the Red rivers. The Mississippi and Missouri combined form the second longest river course in the world, with a total length of about 3,988 miles. The Mississippi and its tributaries drain a vast area of over 1,200,000 square miles. Farther south, the Rio Grande, which also flows into the Gulf of Mexico, marks the boundary between the United States and Mexico.

THE GREAT LAKES, LARGEST BODY OF FRESH WATER IN THE WORLD

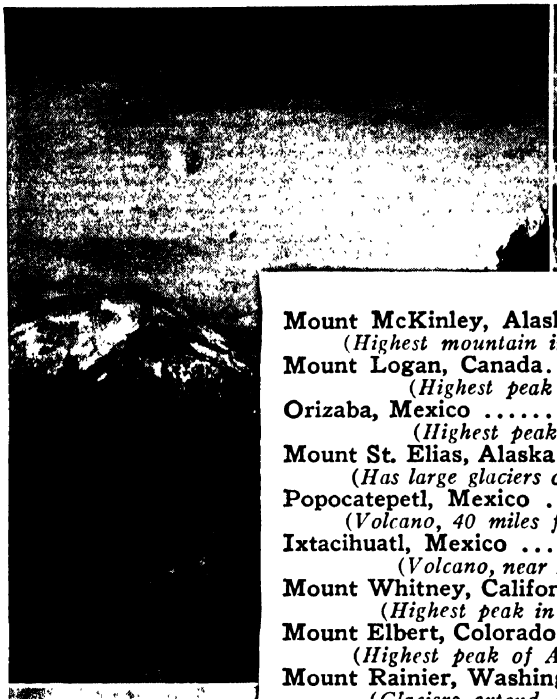
Five inland seas—Lake Superior, Lake Michigan, Lake Huron, Lake Erie and Lake Ontario—are linked together to form the Great Lakes. They make up the largest body of fresh water in the world with a combined area of over 94,000 square miles. Lake Michigan lies wholly within the United States. The rest of the Great Lakes serve as a natural boundary between the Canadian province of Ontario and the American states to the south—New York, Pennsylvania, Ohio, Michigan and Wisconsin.

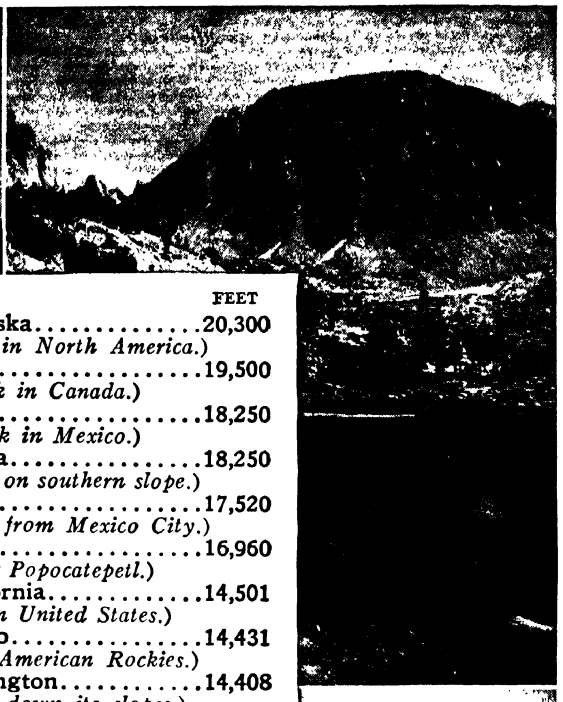
There are a number of large lakes wholly within Canadian territory; these include Great Bear, Great Slave, Athabaska, Reindeer, Winnipeg and Manitoba. Lake Michigan is by far the largest lake in the United States. There are thousands of smaller lakes. The most interesting of all, perhaps, is Great Salt Lake, in a desert valley of Utah. Its waters are so salty that it is almost impossible for a bather to sink in that lake. In the southwest of Nicaragua (Central America) we find Lake Nicaragua, 110 miles long and about 40 miles wide. It lies on the route of the proposed Nicaragua Canal.

CLIMATE AND RAINFALL VARY GREATLY IN DIFFERENT SECTIONS

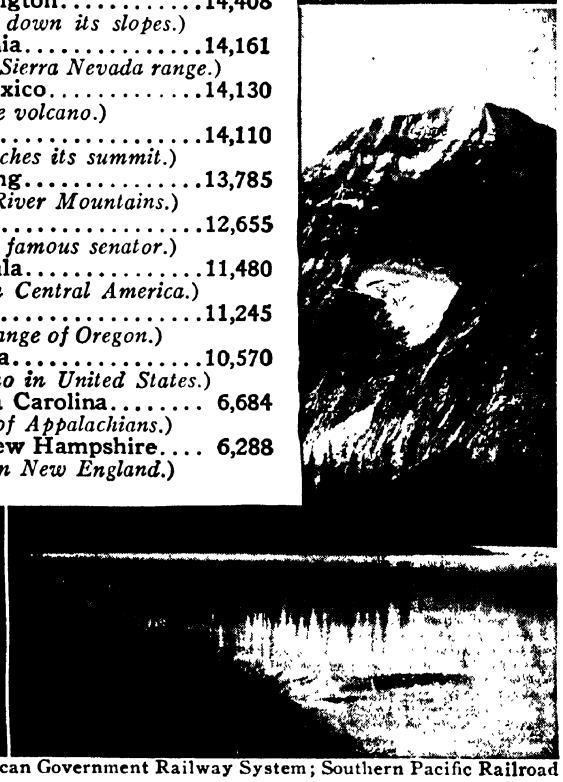
There are great extremes of climate in North America. In southern Arizona the thermometer sometimes rises to 120 degrees; it is also very hot in the steaming coastal

SOME FAMOUS NORTH AMERICAN MOUNTAINS





	FEET
Mount McKinley, Alaska	20,300
(Highest mountain in North America.)	
Mount Logan, Canada	19,500
(Highest peak in Canada.)	
Orizaba, Mexico	18,250
(Highest peak in Mexico.)	
Mount St. Elias, Alaska	18,250
(Has large glaciers on southern slope.)	
Popocatepetl, Mexico	17,520
(Volcano, 40 miles from Mexico City.)	
Ixtacihuatl, Mexico	16,960
(Volcano, near Popocatepetl.)	
Mount Whitney, California	14,501
(Highest peak in United States.)	
Mount Elbert, Colorado	14,431
(Highest peak of American Rockies.)	
Mount Rainier, Washington	14,408
(Glaciers extend down its slopes.)	
Mount Shasta, California	14,161
(Inactive volcano in Sierra Nevada range.)	
Nevado de Colima, Mexico	14,130
(An active volcano.)	
Pike's Peak, Colorado	14,110
(A highway reaches its summit.)	
Gannett Peak, Wyoming	13,785
(Peak of Wind River Mountains.)	
Borah Peak, Idaho	12,655
(Named after a famous senator.)	
Santa Maria, Guatemala	11,480
(Active volcano in Central America.)	
Mount Hood, Oregon	11,245
(In Cascade Range of Oregon.)	
Lassen Peak, California	10,570
(Only active volcano in United States.)	
Mount Mitchell, North Carolina	6,684
(Highest Peak of Appalachians.)	
Mount Washington, New Hampshire	6,288
(Highest peak in New England.)	



Pictures courtesy, Canadian Government; Mexican Government Railway System; Southern Pacific Railroad

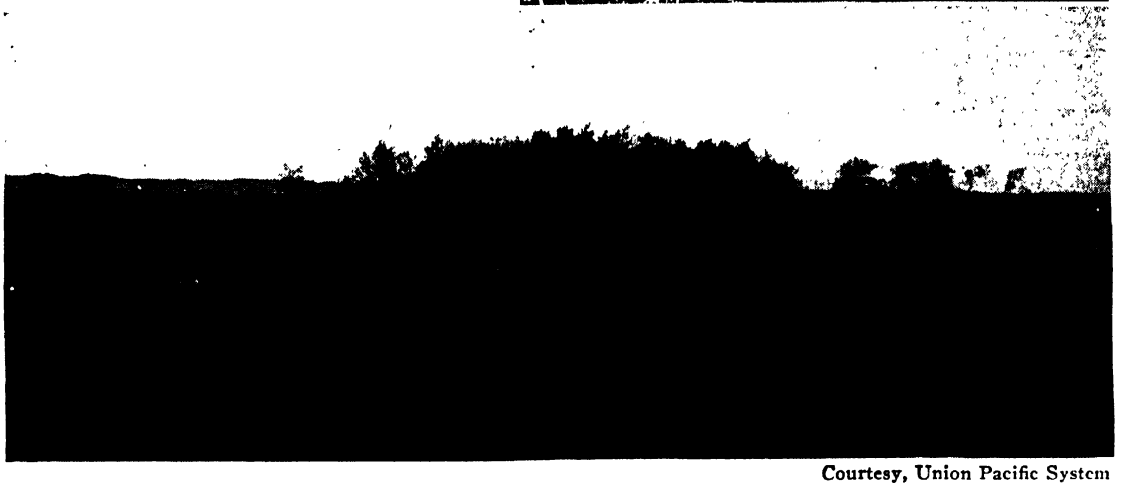
TOP LEFT, Popocatepetl volcano, named from the Aztec words meaning "smoking mountain." Plumes of smoke continually stream from the crater, but there have been no serious eruptions for centuries. BOTTOM LEFT, Mount Kerkeslin and Athabaska Falls, in the Canadian Rockies, solemn majesty and the roar of rushing water combined. TOP RIGHT, Mount Whitney, in the Sierra Nevada range. The mighty peak does not look so high here because the view has been taken from a lake not far below the summit. BOTTOM RIGHT, Mount Edith Cavell and Lake Cavell, in Jasper National Park, Canada, eternal tributes to the martyred British nurse.

SOME ANIMALS OF NORTH AMERICA

A herd of wild elk, in Elk Island National Park, Alberta. This is the largest member of the deer family now living. In America the elk is often called moose.

Courtesy, Canadian National Railways

Two young American black bears. The first white men found black bears in most parts of the continent. Polar bears, grizzly bears and Alaskan brown bears are also native to this continent.



Courtesy, Union Pacific System

The picture at the right, above, shows beavers in a stream, building a dam. Below, a herd of bison (American buffalo). Beavers and buffalo were very numerous in America three hundred years ago.

regions of Mexico and Central America. On the other hand, temperatures of 50 degrees below zero are common in the icy wastes of the Far North. In general, one finds less extreme ranges of temperature in the western coastal regions of Canada and the United States than in the great central depression and in the east.

Rainfall is heaviest in Central America. In Panama the average yearly rainfall is 200 inches (it is about 45 inches in New York City). There is also heavy rainfall on the Pacific Coast. The reason is that the winds heavy with moisture that blow inland from the Pacific are stopped by the Coast Range. As they are brought up against this mountain wall their burden of moisture falls in the form of rain. The mountains force the air up to the cooler heights; the chilling of the air which results causes rain. Since most of the moisture brought by the west winds is trapped by the Coast Range, there is little rain in the plateau land of the Cordilleras and the territories just east of these mountains. These lands are among the most arid (dry) regions of the continent.

The vegetation (plant life) of North America shows great variety. In Alaska and in northern Canada, where the frozen ground thaws only in summer, one finds chiefly grasses, mosses and Arctic willows. Below the Arctic Circle, in Canada, there are great forests of spruce and birch; farther to the south, firs, pines and hemlocks appear in great numbers.

The region from the Rocky Mountains to the Pacific coast, which includes much arid land, also contains magnificent forests. These are particularly dense along the well-watered coast of northern California and Oregon. Here we find the giant redwood trees which sometimes reach a height of 350 feet.

In the east of the continent there are forest areas from Newfoundland to the Gulf of Mexico. In the northeast there are sturdy growths of cone-bearing trees, elms, maples, oaks, poplars and other trees. Southward from North Carolina the yellow pine is particularly common. The cypress is found everywhere in the swamps.

The part of the great central depression that extends westward from the Appalachian Mountains to well beyond the Mississippi River and northward into the border provinces of Canada, is very fertile. When the first settlers came to this region from Europe, they generally found wooded country along the rivers and a thick carpet of grass elsewhere. Now we see cultivated crops throughout the area.

Farther to the west, the vegetation becomes more scanty. The soil becomes more and more barren as one goes southwest into

A scene in Yellowstone Park, Wyoming, where hot water and steam gush up from the ground in many places.

California and southward into northern Mexico. Here one finds such dry-climate plants as the cactus, the sage-brush and the agave. A good deal of the plateau land of Mexico is very fertile. Along the eastern coast of Mexico and Central America there is much rich tropical growth; there are magnificent forests of mahogany and boxwood.

Lumbering on a great scale is carried on in North America, particularly in the United States and Canada. Agricultural crops also contribute greatly to the wealth of the continent. In normal times North America produces about half of the world's corn and cotton and a good deal of its wheat, oats, barley, potatoes, peas, beet-sugar, cane-sugar, bananas and tobacco.

There are certain areas in the continent where the soil and climate are particularly favorable for the growth of certain crops. We call these favored areas "belts." The spring-wheat belt (where wheat is planted in the spring) includes the Canadian border provinces of Manitoba, Saskatchewan and Alberta and the American states of Minnesota, North Dakota, South Dakota and Montana. The winter-wheat belt, farther south, extends from Illinois to Kansas; the corn belt, from eastern Ohio to eastern Nebraska; the cotton belt, from North Carolina to Texas.

North America is immensely rich in minerals, particularly in gold, silver, petroleum, iron, lead, copper, nickel, zinc, building stone, phosphorus and mercury. These mineral resources have been highly developed in many parts of the continent. The Sudbury district in Ontario, Canada, alone produces some 85 per cent of the world's nickel. Most of the world's silver comes from the silver mines of Mexico and the United States. The oil-fields of the United States supply the world with over half its oil; the oil deposits of Mexico and Canada are also very rich. Certain minerals, such as tin and tungsten, are not produced in quantity in North America; but these are comparatively few.

The animals of North America correspond more or less to those found in Europe. There are bears, wolves, lynxes, bison, reindeer, deer, beavers, bats, cats, rats, mice and so on. A certain number of species, however, are to be found only in North America; these include the raccoon, the skunk, the gopher, the musk-ox and the pronghorn (an antelope-like creature). The birds, on the whole, resemble their European cousins; the humming bird is related to a South American form. Snakes are numerous in the less widely settled districts. Poisonous species include the rattlesnake, the water moccasin and the copperhead.

None of the common domestic animals,

© J. E. Haynes, St. Paul

There are nearly one hundred hot springs and geysers in Yellowstone Park. See the article beginning on page 728.

with the exception of the dog, were originally natives of North America. The wild horses that used to be numerous on the western plains were not natives of North America. They were descended from the steeds that escaped from the early Spanish explorers and that afterward ran wild. Our domestic cattle, sheep, hogs and chickens were brought over to this continent from Europe.

The seas and rivers of North America abound in fish of many different kinds. Along the Atlantic coast we find haddock, cod, mackerel, flounders, clams, lobsters, crabs, oysters, mullet, tuna and red snappers. Salmon is plentiful along the Pacific coast; so are mullet, tuna, flounders, halibut and crabs. The rivers of the continent yield trout, bass, catfish, carp, perch, mullet, mussels and other kinds of fish. The fisheries of North America especially those of the United States and Canada, rank with the most important of the world.

We know very little about the earliest inhabitants of North America. It is generally believed that they came over from Asia through Alaska. We do know, however, that the earliest European explorers in North America found the continent inhabited by the race that we call the Indians—a people with copper-colored skin, high cheek bones, black eyes and straight black hair. The Indians were scattered over the length and breadth of the continent. (See the article on Indians, page 241, and the article on the Eskimos, page 2563.)

The article on Explorers, page 391, tells you of the bold men of the fifteenth and sixteenth centuries who sailed from Europe in frail ships that took weeks to cross the ocean. Yet, for two hundred years they came, exploring the eastern coast, and pushing far inland. After the explorers came men and women resolved to make a new life for themselves on this strange new continent. They came in larger and larger numbers, until a vast wave of colonization was flooding across from the old world to the new. There was a time when it seemed that North America would be divided up among the nations of Europe — particularly the English, the French and the Spaniards. This has not come to pass; instead, a number of inde-

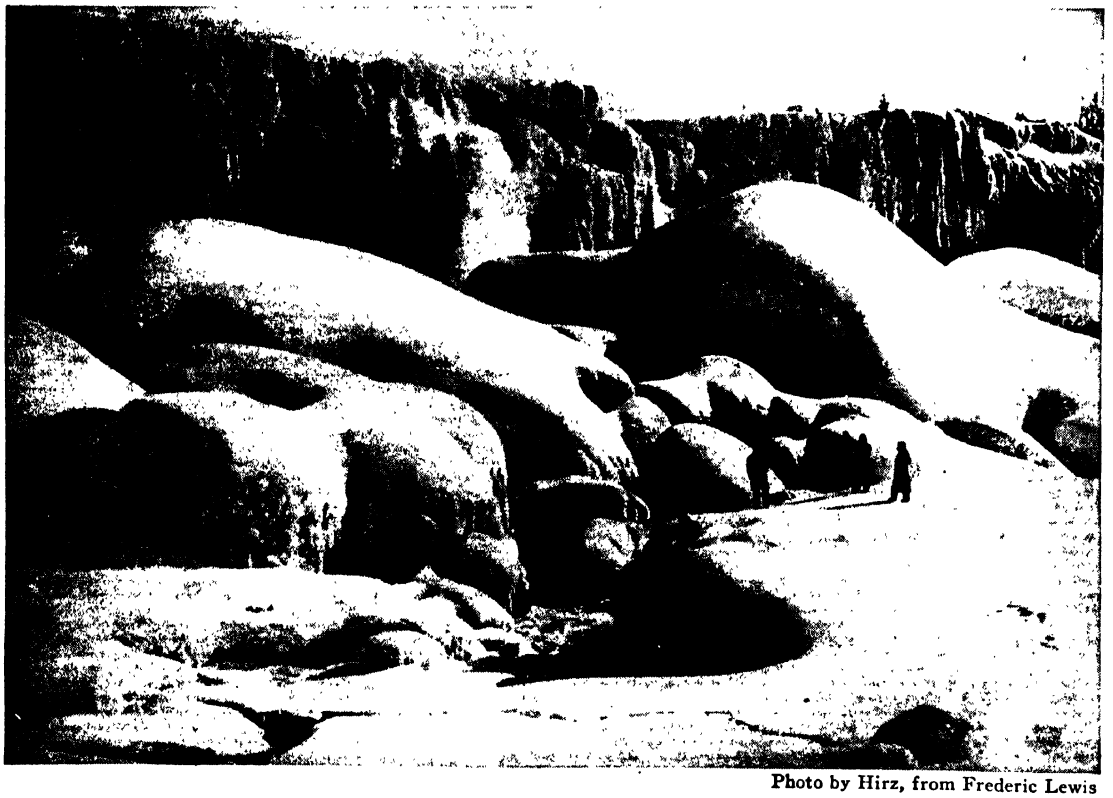


Photo by Hirz, from Frederic Lewis

Niagara Falls, its tumbling waters held fast in winter's icy grip. The mighty cataract is made by the Niagara River which suddenly plunges with a roar over the brink of a deep chasm. The falls are in two sections—the American Falls, 167 feet high, and the Canadian, or Horseshoe, Falls, 158 feet high. The American Falls, though higher, carries only about one-tenth of the water. Niagara is an Indian name. It means Thundering Waters.

Courtesy, Chamber of Commerce, Charleston, South Carolina

In sharp contrast to the winter scene on the previous page is this view of a road near Charleston, South Carolina, where fine old live oak trees festooned with Spanish moss make a luxuriant landscape. The southeastern coast of the United States is warmed by the gentle waters of the Gulf Stream which, between the southern tip of Florida and Cape Hatteras in North Carolina, is never more than 100 miles away.

pendent nations are now firmly established on the continent.

The largest and most populous of these nations is the United States, which includes Alaska and several islands in the West Indies among its possessions. The other independent countries of North America are Mexico, the six small countries of Central America—Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica and Panama—and the countries of Cuba, Haiti and the Dominican Republic, in the West Indies.

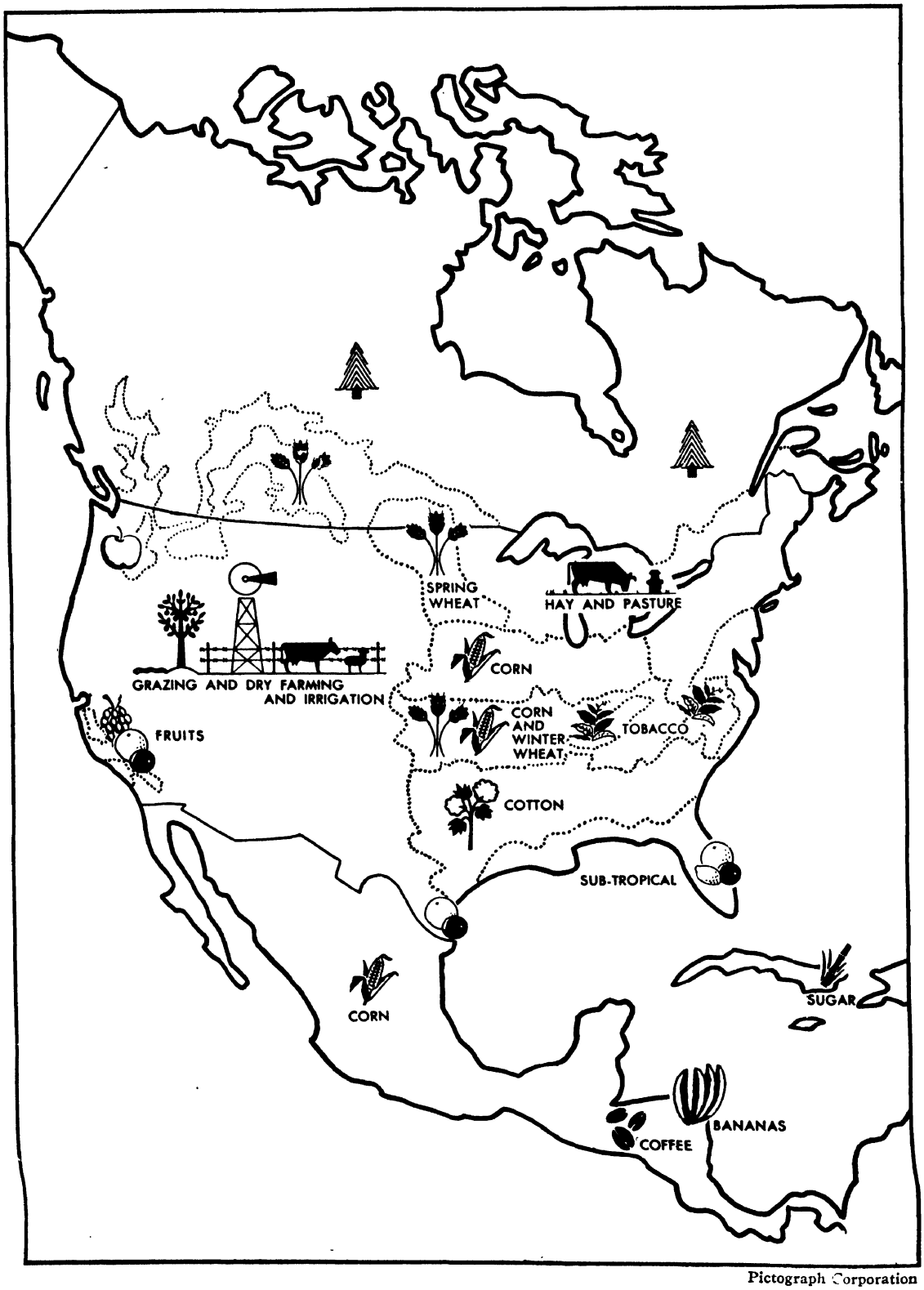
Britain still is represented in America. Canada is a member of the Commonwealth of Nations. British Honduras in Central America is a British colony; and Great Britain controls a number of islands in the West Indies. The rule of the French is now limited to the tiny islands of St. Pierre and Miquelon, just outside the Gulf of St. Lawrence, and the small West Indian islands of Martinique and Guadeloupe. Since 1946 Martinique and Guadeloupe have been French departments. The Dutch have only Curaçao, Aruba and Bonaire, also in the West Indies, and these are so near South America that they might be considered as part of that continent. Little Denmark holds Greenland, which, for the most part, is a barren waste. The Spanish flag, which once flew over great areas in the south and southwest of the continent, has now disappeared entirely from North America.

The inhabitants of North America number about 183,000,000. Among them are found all the races of mankind. The white race is by far the most numerous; there are also many Negroes, particularly in the United States. The Indians are especially numerous in Mexico and Central America; there has been much intermarriage between Indians and whites in these places. Indians form a comparatively small part of the population in the United States and Canada. The yellow and brown races are to be found chiefly in the United States.

In the course of the few centuries that have passed since North America was first colonized by Europeans, the continent has made amazing progress. From a state of barbarism, it has come to challenge the age-old civilizations of Europe and Asia. Its population has increased by leaps and bounds; it has built up vast industries.

There are various reasons for this wonderful progress. For one thing, most of the continent lies within the temperate zone;

THE CHIEF CROPS OF NORTH AMERICA



Pictograph Corporation

the climate is much like that of Europe. The early settlers felt at home in it. The progress of European colonists in Africa has been far slower because most of that continent is included in the torrid zone. It is very hard to put forth one's best efforts in the heat of the tropics.

North America has forged ahead, too, because of her rich store of natural resources. The early colonists found food and raw materials of all kinds in plenty. Furthermore, there were many magnificent harbors in the part of the continent that faced Europe. There were also many navigable rivers that led to the interior of the continent. Cities grew up around the harbors and along the rivers. These cities became trade centres, where men brought the products of the forest and the soil and of the boundless seas and, later, the products of industry.

Progress has been particularly rapid in the United States and Canada. There has also been a great awakening in recent years in Mexico and, to a certain extent, in the small countries of Central America and the West Indies. North America, which has already accomplished so much, stands on the threshold of an even greater development.

Such is North America to-day, with its mountains and its plains, its rivers and its lakes, its boundless forests and its broad plains, its varied animal life, its flourishing industries and its proud civilization. It is hard to realize that, millions of years ago, the waters covered all of what is now the North American continent. Then the crust of the earth, lying under the sea, crumpled, and certain portions of the land rose above the waters. It is generally believed that the northeastern part of Canada, from Labrador to the Arctic Ocean, was the first land to appear. As time went on, other land was raised above the sea.

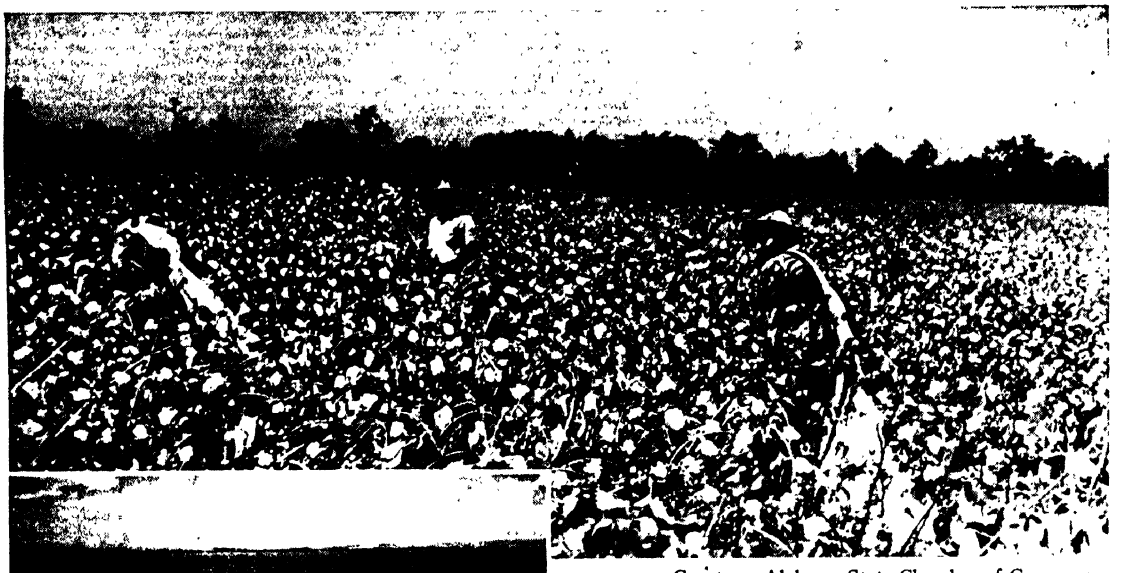
Some of the earth's crust, pushed far above the surface of the waters, became great mountains. They were affected by the action of water and air, heat and cold. In many parts of the continent the mountains have worn away until there is not much left of them. It is estimated, for example, that some parts of the Appalachians were once five miles higher than they are now.

For a long time the Gulf of Mexico extended to the Ohio River and, farther west, well up into Canada. At last land appeared. Fossil remains of sea animals have been

Photo, Extension Service, U. S. Department of Agriculture

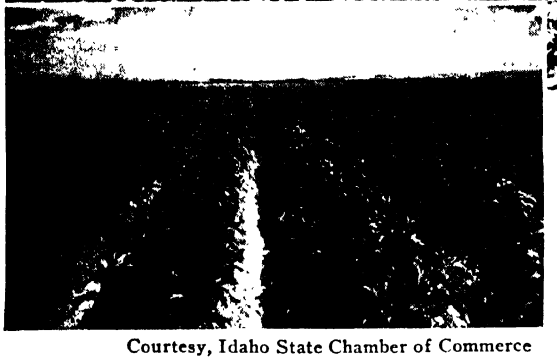
Preparing the ground for planting, on a vast wheat farm of the prairies in the centre of the continent.

A FEW OF THE IMPORTANT CROPS



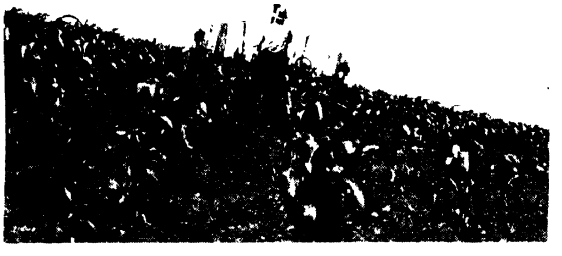
Courtesy, Alabama State Chamber of Commerce

Picking cotton in Alabama. A machine to do this work has been invented.



Courtesy, Idaho State Chamber of Commerce

A fine field of potatoes near Idaho Falls, Idaho.



Courtesy, Des Moines, Iowa, Chamber of Commerce and Virginia State Chamber of Commerce

The picture-map on page 162 shows the chief agricultural crops of North America. We see the wide belt where cotton grows, from South Carolina westward into Texas. The tobacco, corn and wheat belts are clearly marked. "Winter wheat" is planted in the fall. Farther north, where winters are cold, wheat must be planted in the spring. The tobacco field just above, on this page, is in Virginia. The smaller picture is of a cornfield in Iowa.

found in the limestone rock of this land—a striking reminder of the far-off ages when some of the most fertile stretches of the Mississippi Basin lay under the sea.

HOW THE GREAT BEDS OF COAL WERE FORMED, IN PAST AGES

In what is called the Coal Age, the climate of North America was very hot. Plants grew and died in great swamps in different parts of the continent. In time their decay made beds of vegetable matter many feet thick. When the level of the land changed, in the course of the centuries, these beds of dead trees and ferns sank into the seas or great inland lakes and were covered with mud many feet thick.

When the land rose above the sea again, other trees and ferns flourished and then died in the mud. In time there were a number of layers of dead vegetation. Lying deep in the ground, they were pressed together and subjected to great heat. They became coal; the layers of mud became rock. At about this time, too, Mother Nature laid down rich deposits of gold, silver, copper, iron and many other minerals.

In the early days of the continent, queer animals roamed in the land; their remains have been discovered in many different parts of the continent. There were flying lizards and lizards that walked. Much later, there were great mammals that were more like the animals of to-day. The mammoth and the mastodon, great elephant-like animals, towered above all the rest. There were also fierce tigers, with fearfully long, sharp teeth, and huge buffalo and elk.

THE SHEETS OF ICE, SEVERAL MILES THICK, THAT MOVED DOWN FROM THE NORTH

There now came a period of terrible cold. Great ice sheets, called glaciers, appeared in the northern part of the continent and began to move slowly southward. These ice sheets, which were several miles thick in some places, covered almost all of Alaska and Canada and much of the northern part of the United States.

It is hard to imagine the destructive force of these glaciers. They cut off the tops of mountains and scooped up the soil in their slow but steady advance. They ground up the softer rock into a fine dust that afterwards became the soil of fertile plains. The harder rock was sometimes not ground up into fine particles but was left in the form of huge boulders, such as are still to be seen in many parts of New England.

The glaciers brought about many changes in the face of the earth. For one thing, they caused the formation of most of the lakes in the northern part of the continent. Sometimes the glaciers dumped great masses of rock dust upon the land, leaving hollow places alternating with ridges. Sometimes they scooped out great holes in the softer stone over which they passed. In either case the hollow places were later filled with water flowing from the little streams in the neighborhood, and so we have lakes.

HOW THE GLACIERS FORMED LAKES BY DAMMING UP VALLEYS

In some places a glacier moved slowly down a valley, carrying a great mass of clay and gravel with it. When the ice sheet finally melted and disappeared, the valley was left with a dam across it, and water collected behind this dam. In much the same way man now builds some of his great reservoirs. He dams up valleys with huge structures of concrete and steel. Then the valleys are filled with water, which remains imprisoned behind the dam.

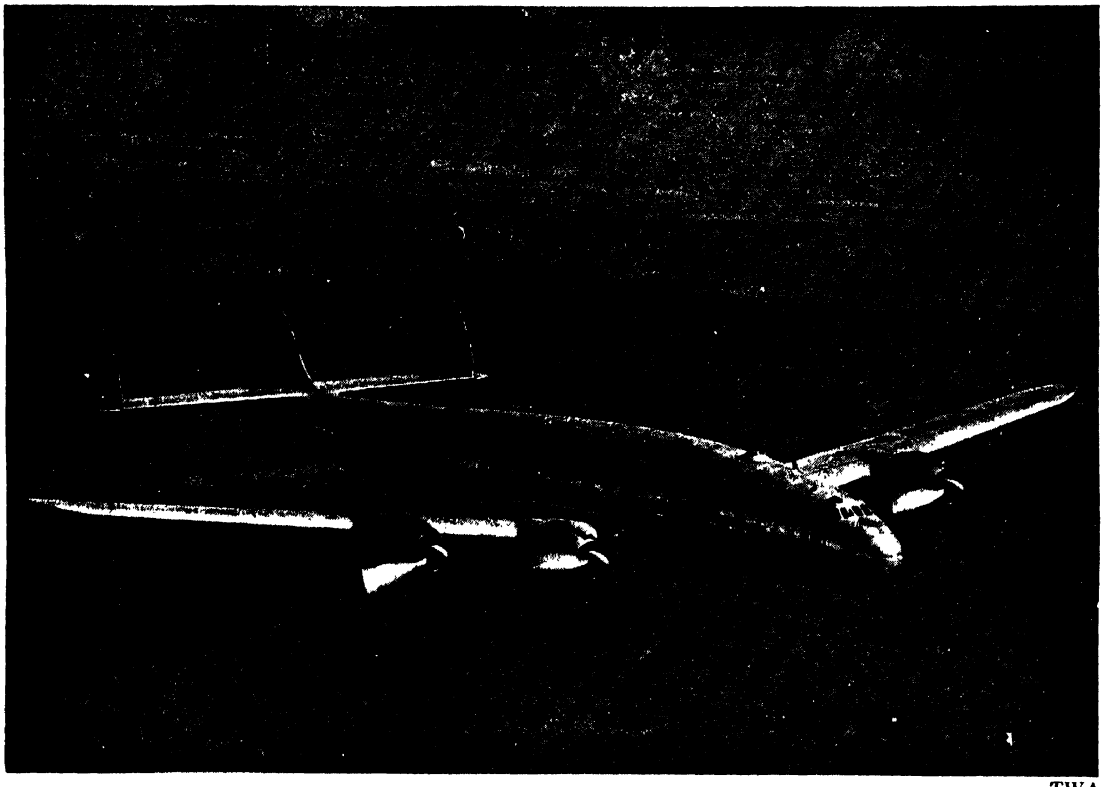
Many streams were forced to change their courses as a result of the glaciers' steady advance. Some of the streams carved out new beds for themselves by wearing away the rocks over which they flowed. If these rocks were very hard, the river would sometimes leap over them, instead of carving a road through them. This explains the formation of Niagara Falls, one of the great wonders of North America.

MOST OF GREENLAND STILL LIES UNDER AN IMMENSE SHEET OF ICE

The glaciers have not disappeared entirely. Almost all of Greenland (705,000 square miles out of a total area of 736,000) lies under an immense sheet of ice. Smaller glaciers are to be found in Alaska, in British Columbia and in the western part of the United States. However, in most places the glaciers withdrew, some 10,000 years ago, leaving the North American continent much as it is to-day.

To be sure, changes are still taking place in the earth's surface and will continue to take place throughout the ages. The sea tears down some coasts and builds up others. In some places the mountains are worn away by the action of the weather; in other places, portions of the earth's crust are still being heaved up. Such changes are so gradual, however, that it generally takes hundreds and sometimes thousands of years before they become plainly evident.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 240.



A Lockheed Constellation flying above a lofty mountain range. TWA

RIDERS ON THE WIND

THE STORY OF AIRPLANES

IT would be impossible to say definitely where or when men first felt the desire to soar like the birds. We can be sure that the urge to fly is one of the oldest ambitions of men and women. Yet flight as we know it is so new that the first successful flight in a powered airplane took place in the present century. So it is easy to see why flying is often referred to as "man's oldest dream and youngest reality."

The artists of ancient Egypt pictured men and animals with wings in the striking paintings that today tell us so much about ancient life and people. Some of these pictures of flying men go back to 3,000 years before the birth of Christ. The scribes of Assyria, another ancient land, told their people about men who could soar with the birds. Many hundred years later, wandering story-tellers spoke about a fabulous magic carpet which carried Bagdad's princes through the Asiatic skies, a story which remains popular today.

In Greece the wandering Homer spoke of man's efforts to fly. To escape from Crete, Daedalus and his son Icarus were said to have flown aloft on wings fastened to their shoulders with wax. Daedalus, so the story goes, landed safely in Sicily. Icarus, however, flew so high that the heat of the sun melted the wax, his wings dropped off and he fell into the sea.

Today we know that such aerial travels were flights of pure fancy. They are still important to us, however, because they prove that human beings have long considered flying as a real possibility.

In fact, men have actually been trying to fly for almost a thousand years. In what is now Great Britain, King Bladud perished when he attempted to soar from the chalky cliffs of Dover in imitation of the gulls. A Saxon Monk, Oliver of Malmesbury, was

killed after leaping from a church tower with wings on his hands and feet. Such efforts as these were not based on any logical approach to the problem of flight.

In the thirteenth century Roger Bacon, an English monk who was a scientist, suggested a flying machine modeled on the flying mechanism of birds. No one seems to have taken the idea seriously until the great Italian artist and scientist, Leonardo da Vinci (1452-1519), tried to build such a bird-machine—an ornithopter, as it was called. But Da Vinci failed. Neither he nor Bacon before him realized the enormous strength of the muscles that give the wings of birds their power. Any machine strong enough to fly as birds fly would be too heavy for man's poor muscles to work.

Though Leonardo da Vinci's ornithopter was a failure, he contributed much to the science of aeronautics—the science which deals with the operation of aircraft. He left a treasure of drawings and reports on this subject when he died in 1519, and this material gave other men much information for study.

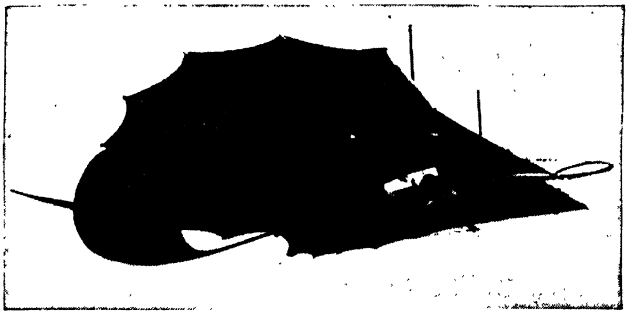
Man did not succeed in flying until the eighteenth century. Two brothers, Jacques-Etienne and Joseph-Michel Montgolfier, who lived in France, had long been impressed by the manner in which scraps of paper soared up the chimney over an open household fire. Fashioning a number of bags from paper, they placed these toy balloons over small dishes filled with burning charcoal. They noted that these paper bags rose to the ceiling, then dropped slowly to the floor as the air inside them grew cool. The brothers decided to make large balloons and fill them with hot air.

On June 5, 1783, the Montgolfier brothers' first large balloon ascended from Versailles, France, after they had filled the bag with warm air. Later on, the Montgolfiers sent chickens, sheep and other barnyard friends aloft in their balloons. Finally, on November 21, 1783, Pilâtre de Rozier and the Marquis d'Arlandes ascended in a Montgolfier balloon that was fastened to the ground by a long rope. Such a balloon is called a captive balloon. The two brothers Montgolfier continued their experiments and made many exhibition flights with great success. We tell you about the further development of lighter-than-air craft in the article on page 345.

Across the English Channel, Sir George Cayley, another pioneer, was beginning his experiments with the glider at about the same time. He had noticed that birds remain aloft for long periods of time without moving their wings. He fashioned a spider-like glider with wings shaped like those of birds. Cayley gave the world a really sound basis for successful flight. By building gliders, he gave later scientists an actual pattern for their experiments.

Launched from hilltops, the Cayley gliders soared skyward with perfect balance, then settled on the grassy meadows below. No pilots were carried on these early flights, but the men who ran against the wind to get the gliders off the ground were frequently lifted into the air and held aloft for several seconds. From this record we can be quite sure that Cayley would have been quite capable of producing a man-carrying glider. However, his belief that a successful flying machine required some mechanical means for motion kept Sir George Cayley from everlasting fame as the father of gliding.

In this regard, Cayley's ideas were shared by most of the other men who experimented with gliders during the eighteenth century. One man, however, saw a future in motorless flight. That man, Jean-Marie Le Bris, was a French sailor. Using the soaring albatross, nature's greatest flyer, as his inspiration, this famous seaman built a man-size glider which, in 1855, carried him into the sky.



Otto Lilienthal, possibly the first to understand heavier-than-air flight, made many successful glides with his brother in this weird-looking glider.

Twelve years later, Le Bris flew again in a much larger glider which he called The Albatross. Unfortunately, the French sailor was a very poor man. He spent so much money repairing his glider after landing accidents that he became discouraged and gave up the experiments.

So it remained for Otto Lilienthal to

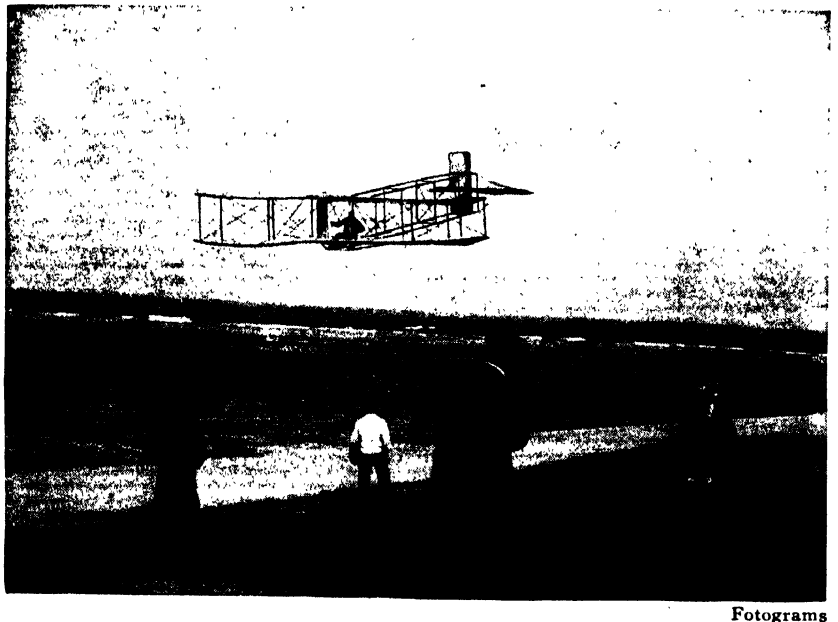
become the first man to understand heavier-than-air flight, to master the art himself and to pass the knowledge along to future generations. Impressed by the graceful flight of storks, which were common at his boyhood home in Pomerania, Otto and his brother, Gustav, worked for three years to prepare the world's first complete record of the theory of flight. From this study came the first Lilienthal glider. Fashioned from the limbs of willow trees and covered with a special waxed cloth, the glider combined bat-like wings with a strap arrangement which permitted Otto to hang from the center in flight. This strange plane represented a milestone in the history of aviation. It was the first of twenty Lilienthal gliders, given to the world within a period of five years—years of research as well as of actual glider construction.

In all these gliders, the pilot thrust his arms through padded openings in the middle of the wing, then controlled the plane in flight by swinging legs and body to and fro. A master of this art himself, Lilienthal was quick to realize that less active men would need better means for control of the glider, so he added a movable tail to one of his last ships.

If he had deserted the crude glider a few years earlier, Lilienthal might have lived to produce the world's first powered airplane. Instead, while piloting a "hang glider," he lost his balance and fell to his death on April 9, 1896. His work with the glider had lasted only five years, but his neighbors at Rhinow had seen him make flights of nearly 900 feet. What was more important, his efforts had impressed men in other countries. These men—Pilcher in England and Chanute and the Wright brothers in America, among others—were destined to carry on far beyond the wildest dreams of the great Otto Lilienthal.

A very hard worker, Percy S. Pilcher devoted most of his time to improvement of the Lilienthal glider. As a result, he made few advances in the science of aviation. He did, however, use boys or horses to pull the rope which snapped his glider into the air. This simple idea opened entirely new opportunities for human flight, because all earlier flying had been limited by the strength and speed of pilots who ran down a hill to take off. Pilcher lost his life after a short flying career when he took off in bad weather to please a few intimate friends.

While Pilcher was building gliders in England, Octave Chanute was beginning the most important American work with gliders at a camp on the Indiana dunes in 1896. Chanute was too old to fly the dangerous hang gliders, so he employed A. M. Herring to pilot a Lilienthal glider. After fewer than a dozen flights, "the old man of the dunes" realized that the German glider was too hard to fly and too full of danger for average people to handle without great risk.

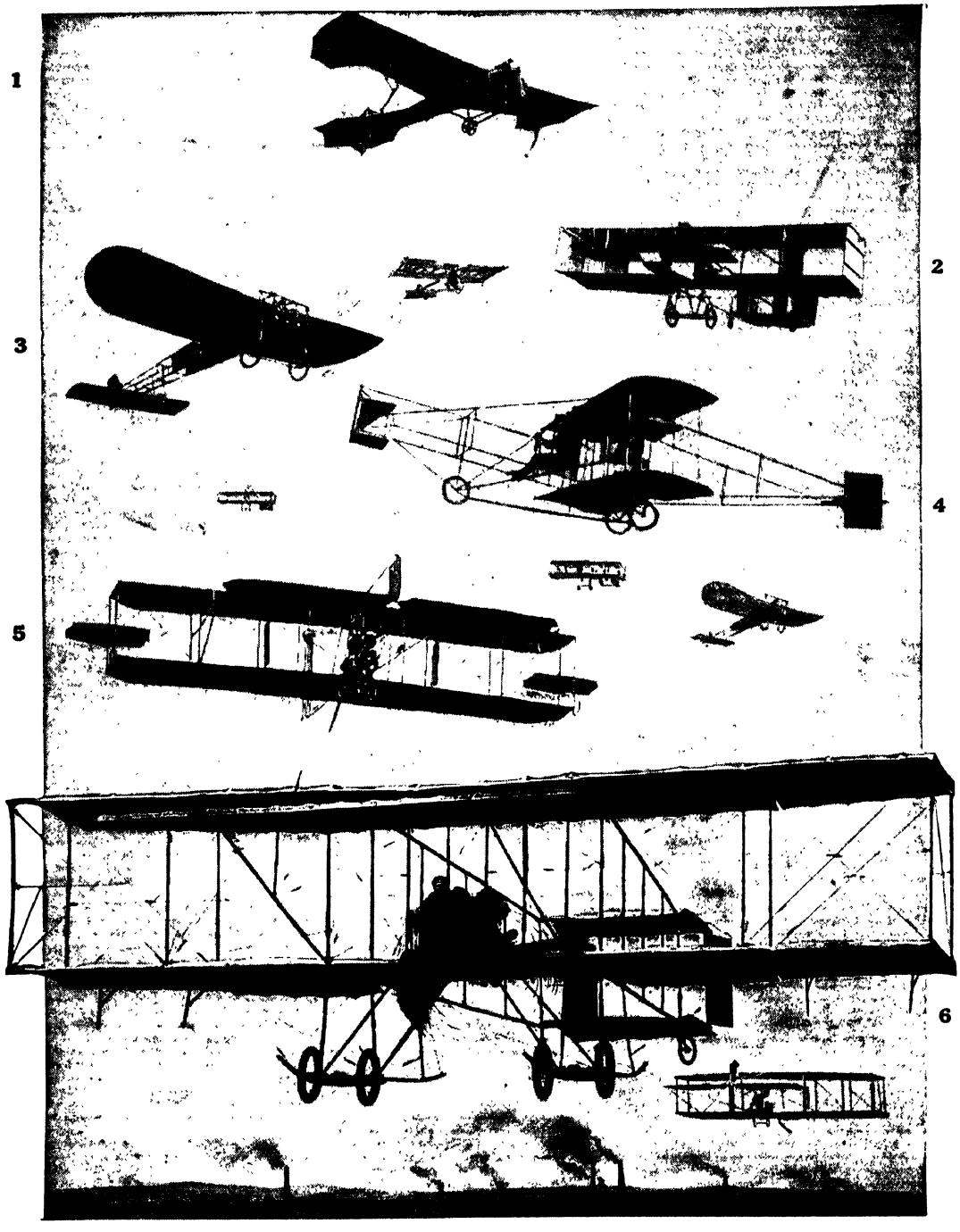


Fotograms

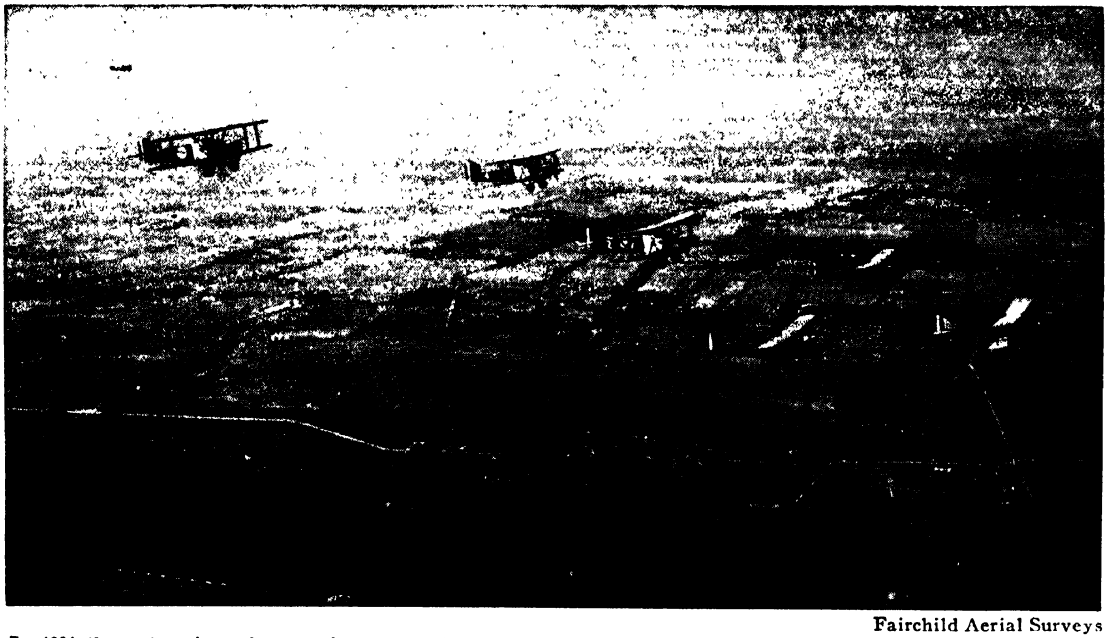
This early glider, designed by Orville Wright, remained aloft for five minutes.

So Chanute designed a glider of his own, with an arrangement of wings which could be twisted in flight. Meanwhile, A. M. Herring had suggested a vertical tail, which stabilized the glider, and kept it flying in a straight line. Most of the Chanute flights were made over Lake Michigan's hot white sand dunes; but several flights carried the glider higher than its point of take-off after the pilot learned to turn lengthwise across the hillsides. In October, 1896, the Cha-

SOME EARLY TYPES OF AIRPLANES



Thousands of years ago man conquered land and sea, but the conquest of the air has been largely a matter of the twentieth century. Your own father and mother will probably remember the time when airplanes first began to be flown. Those first airplanes were hardly more substantial than the kite you fly from your backyard, and we can scarcely understand how men ever found the courage to entrust their lives to such flimsy machines. But they did; and because they did we have today airplanes carrying ourselves, our messages and goods across great distances in incredibly short times. Above we show some of the pioneer types of airplanes which made successful flights. No. 1 is the Antoinette airplane with which Hubert Latham nearly crossed the English Channel. No. 2 is an early Voisin biplane. No. 3 is the monoplane with which Blériot flew from France to England in 1909. No. 4 is an early Curtiss biplane. No. 5 is Colonel Cody's airplane; and No. 6 an early Farman biplane.



Fairchild Aerial Surveys

In 1924 three American Army aviators completed a record-breaking air journey of 27,000 miles around the world. They are shown here accompanied by three small escort planes upon their return.

nute glider, with Herring at the controls, flew 927 feet while remaining in the air for 48 seconds.

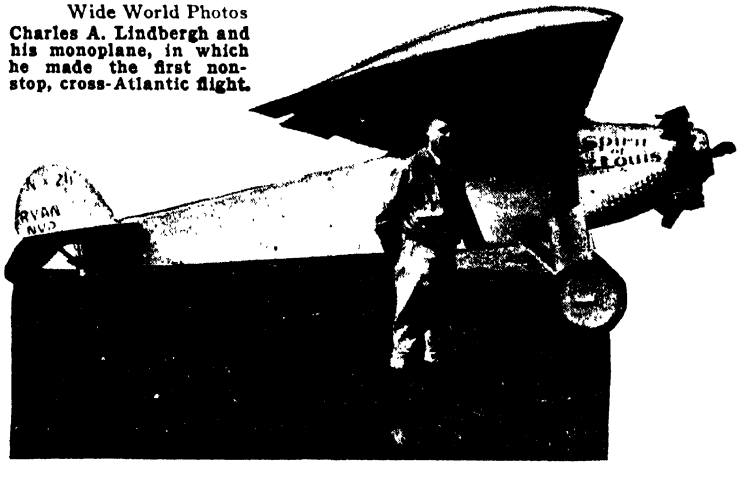
In the meantime, news of Lilienthal's experiments attracted other brilliant Americans to motorless flight. Two sons of a Dayton, Ohio, minister—Orville and Wilbur Wright—took time out from their work as bicycle-builders and began experiments with gliders. Discarding most of the Lilienthal and Chanute ideas, they built a medium-size glider which flew successfully at Kitty Hawk, North Carolina, in 1900. In 1901, they returned to North Carolina with a larger and much improved glider which was praised for its construction by Octave Chanute.

The Wright brothers, however, were not satisfied. Returning to Ohio, they built a quite modern wind tunnel in which they could test each part of the plane separately. They went back to the Kitty Hawk dunes the following spring with the largest glider ever built. Measuring 32 feet across the wing, and weighing 116 pounds, this plane was flown successfully on more than one thousand flights during September and October, 1902.

During the winter that followed, Orville and Wilbur Wright worked on an engine for their plane and, in September, 1903, they returned to Kitty Hawk to divide their time between work on the powered "Wright Flyer" and flights with the previous year's glider. When they finally flew the powered plane—on December 17, 1903—the Wright brothers realized a dream which men of all nations had shared for so many centuries.

Wide World Photos

Charles A. Lindbergh and his monoplane, in which he made the first non-stop, cross-Atlantic flight.



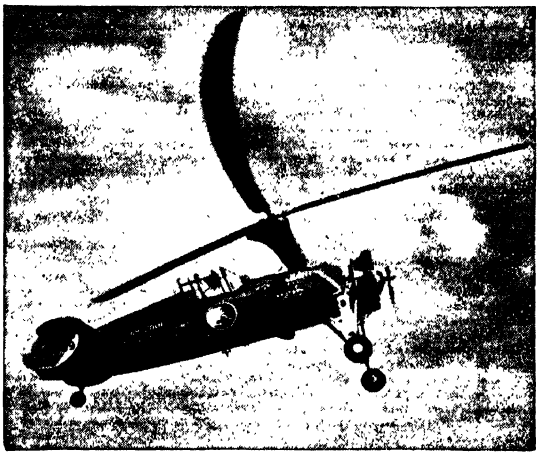
Earlier experiments with powered airplanes followed the invention of the steam engine; so the success of the Wright brothers, whose plane slid down the launching rails with Orville Wright

lying prone on the lower wing, was not an accident. In 1842, shortly after the steam engine was invented, William S. Henson of England built a model airplane powered by steam. Although this little plane never flew, it did show enough promise to inspire another English inventor, John Stringfellow, to build a steam airplane in 1848. If the experiments of Henson and Stringfellow met with little success, it was only because the steam engines of their day were much too heavy. Moreover, in point of efficiency, steam power can never compare with the gasoline engine in the ability to keep planes in the air.

In the United States, Professor Samuel P. Langley, then secretary of the Smithsonian Institution at Washington, D. C., began experiments in 1891 with plane models powered by rubber bands. Impressed by his success with small planes, Professor Langley built a full-scale airplane ten years later, and attempted a flight on December 8, 1903. Unfortunately, the plane crashed into the Potomac River immediately after take-off. And so it was the Wright brothers who won fame as the founders of modern aviation.

Lincoln Ellsworth

J. H. Lynburger and Lincoln Ellsworth, who explored Antarctica. Their plane is on skis to permit landing on ice and frozen snow.



Eastern Air Lines

This autogiro is shown carrying the mail from a Philadelphia airport to the rooftop airport of the Philadelphia General Post Office. It was the first flight of this type.

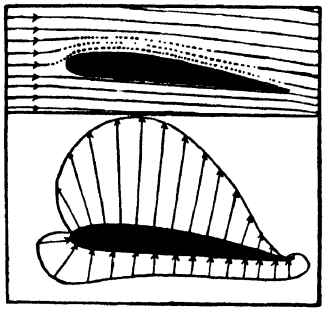
In the beginning few people believed reports of the Kitty Hawk flight. It remained for the Wrights to make a number of flights in England before any real interest in heavier-than-air flying machines gripped the world. In 1905 the Wright plane remained aloft for more than a half-hour while covering 24½ miles. By 1908 the great new invention had demonstrated its ability to stay in the air for two hours and more. A year later, the United States Army purchased a Wright biplane—and this marked the birth of military air power.

When World War I broke out in 1914, the airplane was still something quite new and wonderful. Little had been done to put the airplane to practical use. To be sure, planes had been used to carry mail in 1911 in both the United States and England. These were mere demonstrations, however, and no regular mail service was established. A few military services used planes for scouting purposes, but the total number of airplanes in the world was still comparatively small.

All that was changed almost overnight. In the beginning of World War I planes were used only as scouts and observers. Occasionally the aviators shot at each other with revolvers or hurled hand grenades at each other. Soon, however, planes began to be equipped with machine guns. At first the guns could fire only sideways and backward, but not forward through the whirling propeller. The Dutchman, Anthony Fokker, a great airplane designer, cleverly geared the machine gun to the airplane motor so that shots might be fired through the propeller blades. From that time on the airplane played a vital part in the war. There were

swift little fighting planes, larger and slower observation planes and still larger heavy bombers.

Behind the lines airplanes were built and flyers were trained as rapidly as possible. The production of airplanes soared in all the warring countries that had the necessary industrial facilities, and also in such countries as the United States, which did not enter the war until 1917. New models were constantly developed; and even these new models soon became old-fashioned. The result of all this was that airplane progress was unbelievably rapid in the course of the four years that the war lasted.



Top: How air flows around a moving wing-shape or "airfoil" shown here in cross section. The arrows show the direction of the air. The dotted lines indicate how the air is thinned out when traveling the longer path over the top of the wing.
Bottom: The forces resulting from the airflow, indicated by direction and length of arrows. Most of the force acts upward; this is the "lift." A small force, however, pushes the wing backward; this is the "drag." A good airfoil must have much lift and little drag. As may be seen, most of the lift comes from above the wing.

Shortly after the war three amazing flights showed the great progress that had been made in airplane construction. In May, 1919, three United States Navy flying boats set out from New York for Plymouth, England. Their course took them first to the coast of Newfoundland, thence to the Azores, and on to England by way of Lisbon, Portugal. Only one of the planes, the NC-4, completed the entire trip. Although this plane left Newfoundland on May 16 and did not arrive at Lisbon until May 27, it actually spent only 26 hours, 51 minutes in the air.

A month later, Captain John Alcock and Lieutenant Arthur Brown made the first flight across the Atlantic without a stop, flying from Newfoundland to Ireland in 16 hours, 12 minutes. Later in the same year a British captain, Ross Smith, captured a $50,000 award offered by the Commonwealth of Australia by flying from London to Melbourne in 29 days. The flight covered 11,500 miles. Before World War I a flight of a hundred miles was an outstanding event and a transatlantic flight would have seemed to most people a fantastic dream. The dream had now come true.

Airplane progress was steady after World War I. The various governments disposed of their surplus war planes at very low prices. Many former war pilots bought these planes and used them for exhibition purposes and also to take passengers for short flights. Soon transportation companies were formed in various countries and regular passenger

National Advisory Committee for Aeronautics

This NACA wind tunnel tests model-airplane performance at varying speeds and in air of varying densities.

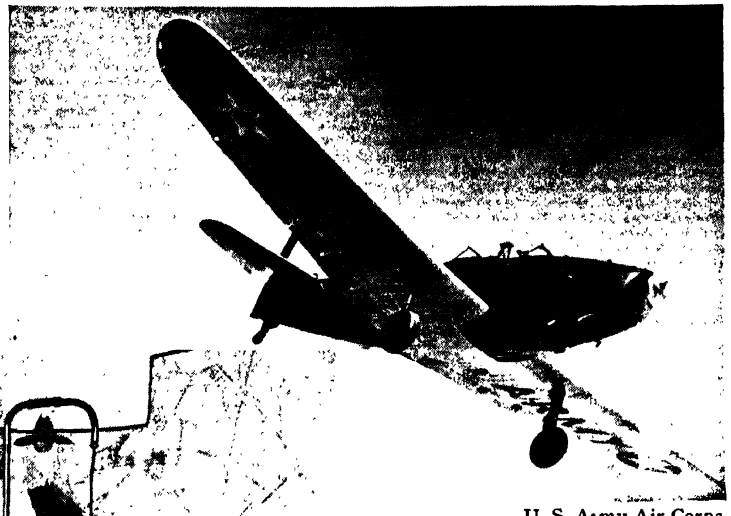
service was established. Regular air-mail service was set on a firm basis.

The years 1927 and 1928 saw an amazing series of brilliant flights. Competing for a $25,000 prize which had been offered by Raymond Orteig, a New York man, an obscure air-mail pilot named Charles A. Lindbergh flew a specially built Ryan monoplane from San Diego to New York, then calmly set out alone on a flight to Paris. Prominent pilots, including Richard E. Byrd and Clarence D. Chamberlin, had entered the same contest, and so neither the public nor the newspapers paid much attention to the tall stranger from the Middle West.

The better-known flyers were still tuning up their engines when Lindbergh lifted his heavily loaded cabin plane from the Roosevelt Field runway on May 20, 1927. Flying through fog and sleet most of the way, taking meager refreshment from hot chocolate and cold sandwiches, Lindbergh and his silvery Spirit of St. Louis moved eastward to land at Le Bourget Field, near Paris, just before ten o'clock on the evening of May 21.

Although Lindbergh had won the cash prize, the other pilots continued their preparations. On June 4, Chamberlin and a passenger, Charles A. Levine, took off from Roosevelt Field in the Bellanca monoplane Columbia. They landed 42 hours, 31 minutes later at Eisleben, Germany, falling 110 miles short of their goal, which was Berlin; but they had traveled 3,911 miles without a single stop.

Twenty-four days later, Commander Byrd and four companions left New York in the America, a Ford tri-motor. Battling bad weather until their fuel was exhausted, they landed in the surf off Ver-sur-Mer, France, approximately 46 hours after take-off. The year's transatlantic flying ended on August 27, when W. S. Brock and E. F. Schlee flew from Newfoundland to London, covering a distance of 2,400 miles in 23 hours, 9 minutes.



U. S. Army Air Corps

The Fairchild PT-19A; this United States Army Air Forces training plane has been used extensively in flying schools for instruction work.

U. S. Army Air Corps

Cadets receive training in "blind" or instrument flying in Link trainers like the one shown at left. Almost all conditions of actual flight may be simulated in the Link trainer, which is both safe and convenient.

In all of these flights, and in the earlier transocean crossings, pilots and planes had been aided by the fact that prevailing winds blow from west to east across the North Atlantic. Pilots who attempted to fly against the wind from Europe to North America were unsuccessful. During 1927 and 1928, eight east-west flights were attempted without success, and seven famous pilots were lost in the Atlantic. Then, in April, 1928, Captain Hermann Koehl of Germany and

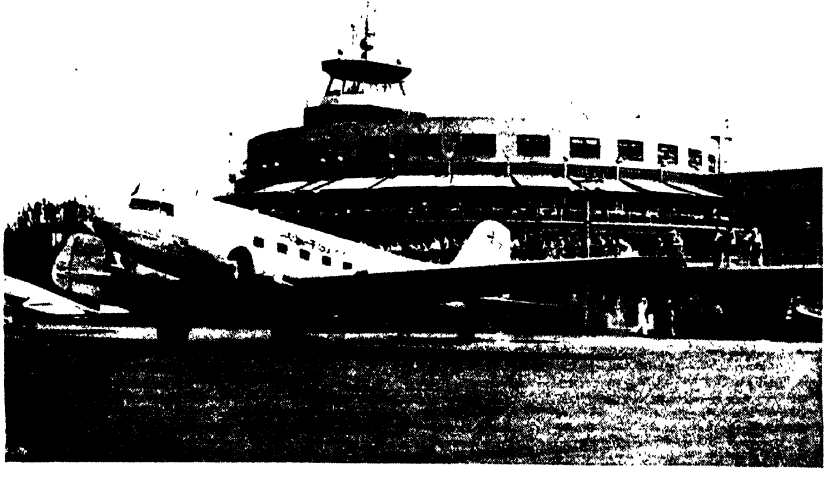
VARIOUS TYPES OF LANDING FIELDS

The Northern Miner

This snow-covered Canadian airfield is typical of northern outposts of aviation. Building this field was a matter of clearing the wilderness; note the heavy forest of evergreens in the background. Landing aircraft in snow takes rare skill.

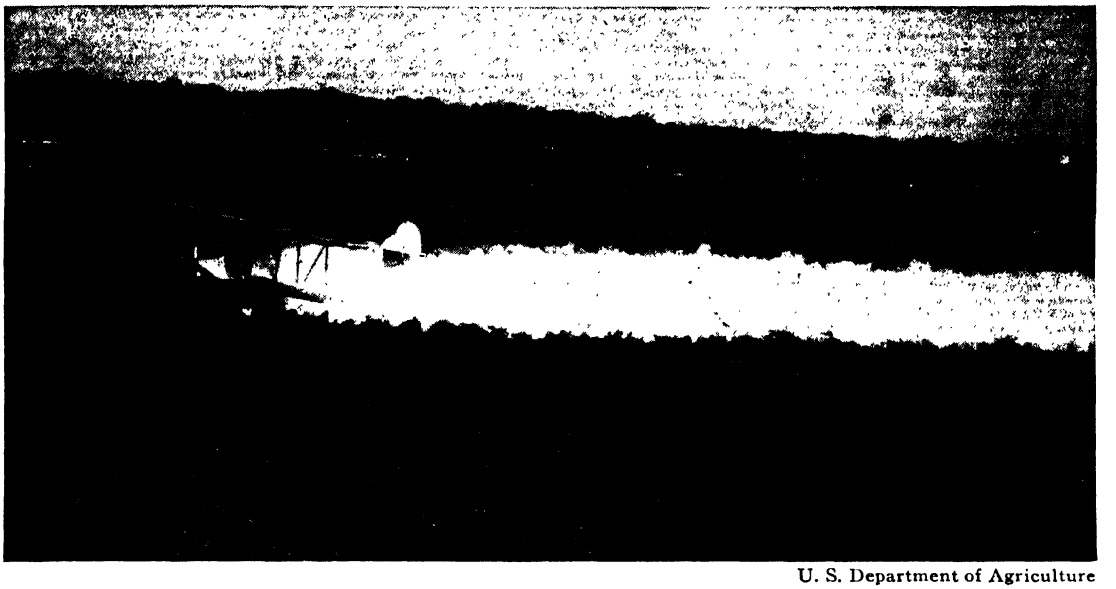
U. S. Navy

The landing deck of a United States naval aircraft carrier. The prop-spinning Navy Hellcats are preparing for take-off from their big flat-tops, ready for a strike. Carrier task forces were a decisive factor in the Pacific war.



American Airlines

La Guardia Field, on Long Island, New York, one of the largest airports in the world. The building shown is a passenger station.



U. S. Department of Agriculture

Agriculture has found use for the airplane in the control of pests. Here a plane is shown flying low, dusting a cotton field with calcium arsenate, found to be effective against the boll-weevil.

Major James Fitzmaurice of Ireland took off from the Emerald Isle with a passenger, Baron von Huenefeld. Flying into the teeth of the wind all of the time, their Junkers monoplane Bremen was blown far off its course and finally landed on Greenly Isle, a remote little spit of land off the coast of Labrador.

Meanwhile, the Pacific Ocean was also seeing man's conquest of the air. On June 28, 1927, Lieutenants Lester J. Maitland and Albert F. Hegenberger flew from Oakland, California, to Honolulu, Hawaii. Their flight covered a distance of 2,400 miles and lasted 25 hours, 49 minutes. A few weeks later, Arthur C. Goebel and Lieutenant W. V. Davis won the $25,000 Dole Race by flying from San Francisco to Honolulu in 26 hours, 17 minutes, 33 seconds. Ten pilots were killed and two planes were lost before and during this competition.

In 1927, too, W. S. Brock and E. F. Schlee started a round-the-world speed flight that was planned to bring them across the Pacific from west to east. But they stopped at Tokyo after flying 12,995 miles of their proposed flight. In May, 1928, the noted Australian pilot, Sir Charles Kingsford-Smith and four companions flew from Oakland, California, to Brisbane, Australia in the Southern Cross. A month later, John Henry Mears and Captain Charles B. D. Collyer circled the world in 23 days, 15 hours, 21 minutes in a Fairchild monoplane called the City of New York.

There were many notable flights in the years that followed, and many a bold aviator

American Export Lines

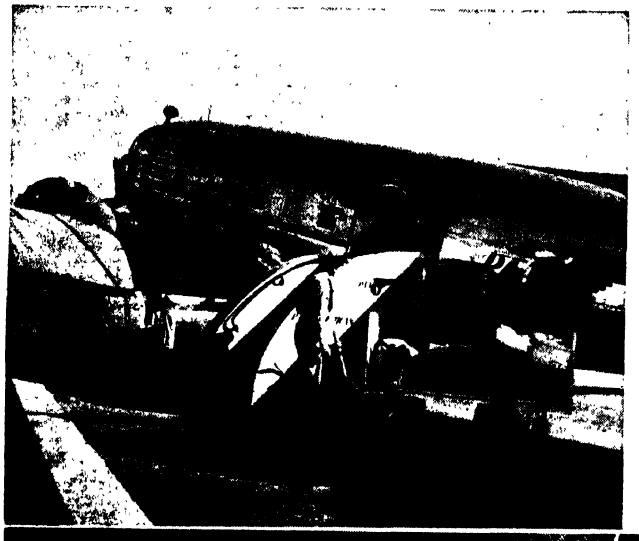
A huge four-engine ship is taking on its load of air mail for a distant point.

and aviatrix (woman aviator) had a more or less brief day of popularity. The one-eyed flyer, Wiley Post, made two remarkable flights around the world (in 1931 and 1933) in the monoplane Winnie Mae. The first was made with Howard Gatty; the second was a solo performance. The brilliant young American aviatrix, Amelia Earhart, made a number of outstanding flights, including solo flights from Newfoundland to Ireland (1932) and from Hawaii to California (1935). In 1937 she was lost at sea while bound on an eastward flight around the world, with Fred J. Noonan as her navigator.

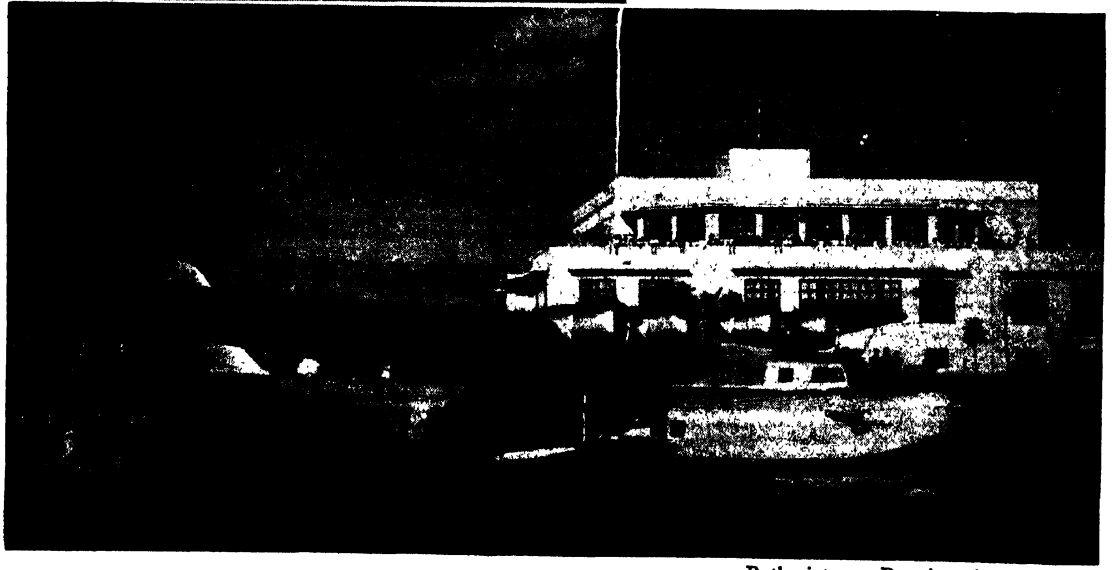
Other renowned flights were made by General Italo Balbo, Captain James Mollison, Amy Johnson and Howard Hughes. The world records for speed, for altitude, for endurance, for round-the-world flight and so on were broken again and again by daring flyers.

There was now a great boom in the airplane industry. The airplane forged ahead with giant strides. It became a factor of importance in the world's transportation. Freight planes opened up new areas to commercial enterprise. Large-scale mapping was done photographically from the air. Forest rangers used planes to maintain fire patrols. Insect pests were fought by dusting fields with poison spread by low-flying planes.

In World War II it became clear, likewise, that the airplane was now an all-important factor in war. The early successes of Germany in the war were due in large part to her powerful air fleets, which the Allies at first could not match. When Germany lost this superiority to the Allies, her doom was sealed. It was because the Allies ruled the skies that both Germany and Japan were finally forced to yield. Without the fighters, bombers, transports and scouting planes of the Allies, no ground forces could have landed on Africa or Normandy, no tanks or troops could have crossed the Rhine, no atomic bombs would have fallen on Japan.

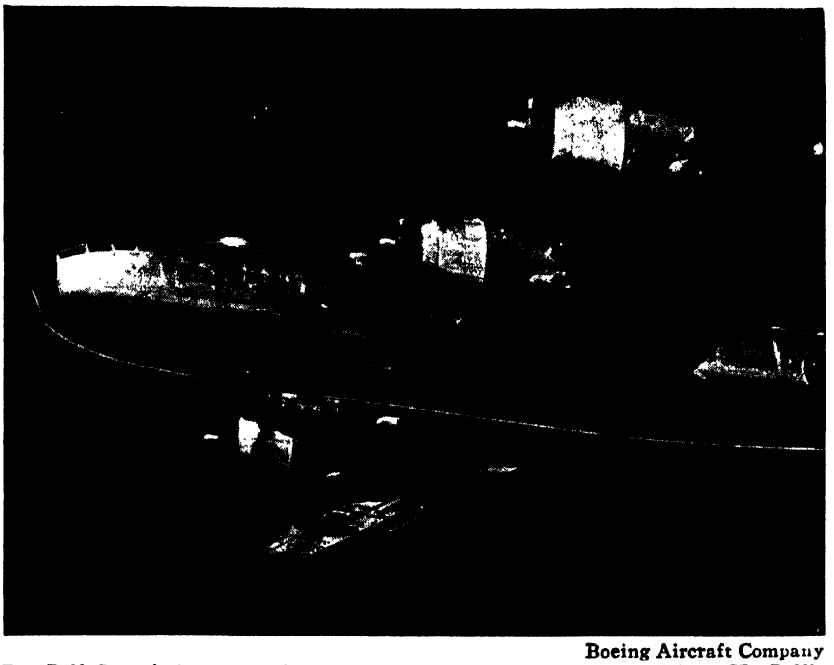


Freight planes open up remote and undeveloped areas. Canada has been the world leader in carrying freight in "flying boxcars."



Both pictures, Pan American Airways

All distances on earth can be measured in hours and days, instead of weeks, in our Age of Wings.



Boeing Aircraft Company

The B-29 Superfortress was the largest and fastest bomber of World War II. B-29's dropped bombs over an area of 8,000,000 square miles in the Pacific.

To show how powerfully the airplane contributed to the final defeat of the enemy, let us review certain records. During the single nine-day period in March, 1945, the Allies sent 62,873 planes into the air over the western front. Dropping 122,000,000 pounds of explosives, these planes destroyed 9,371 German railroad cars and damaged 10,117 others; shattered 7,998 motor-transport vehicles and damaged 5,864; demolished 769 locomotives and damaged 475; knocked out 509 tanks and armored vehicles and halted 473 more for repairs.

Meanwhile, Allied airmen destroyed 595 enemy airplanes, with 80 "probables," and damaged 601 other planes. We paid for all these conquests with only 389 planes. During another period in the drive toward Berlin, Allied flyers lost 220 planes while destroying 584 locomotives, 7,700 railroad cars, 6,800 motor vehicles and 370 German planes. No other war can show such enormous damage inflicted at such comparatively slight cost.

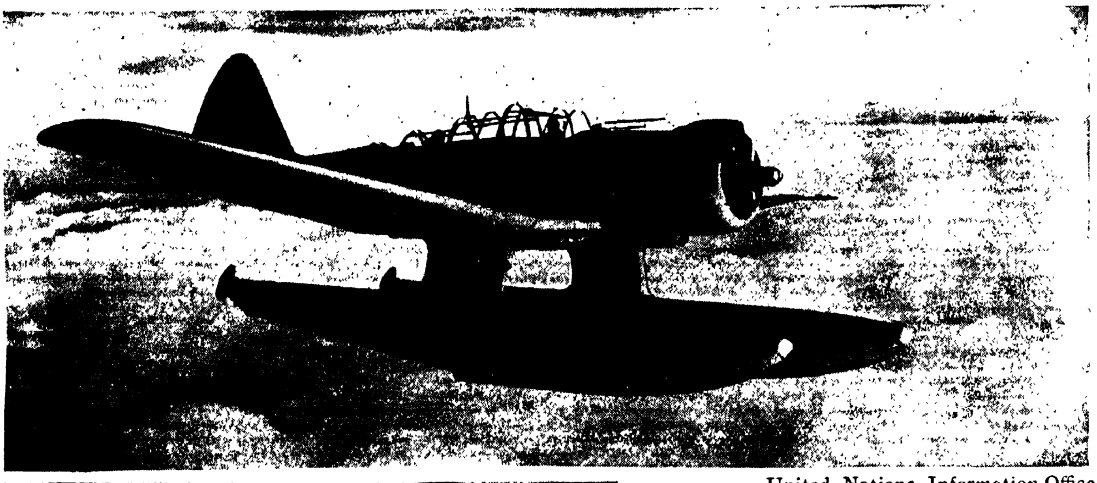
Victory over Japan was not achieved by two raids with atomic bombs. Operating from bases in China, India and the mid-Pacific islands, American Superfortresses (Boeing B-29's) spread devastation over an area of 8,000,000 square miles during thirteen months of action against Japan. When they first entered the Pacific fight, B-29's made their raids at ten-day intervals with fifty planes participating in each mission. Twelve months later, they were going out every four days with 750 planes in each raiding party.

When Japan surrendered on August 14, 1945, daily raids by two hundred Superfortresses were possible. B-29's had destroyed more than half of the total area of Japan's ten most important cities—even before atomic bombs blasted Hiroshima and Nagasaki.

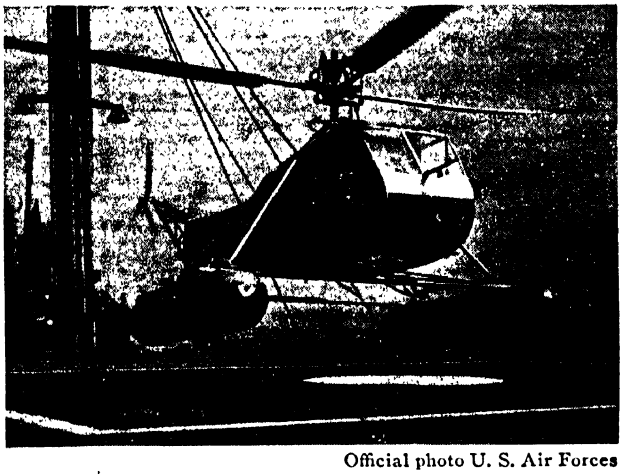
Such, briefly, is the history of the airplane. Today heavier-than-air craft vary greatly in their characteristics and uses. Gliders, which were first developed about 150 years ago, are still very important to aviation. The simple primary glider, which is launched from a high place and allowed to settle earthward like a small boy's sled moving downward on an ice slope, is the best vehicle for teaching young boys and girls the rudiments of flying.

The most efficient of all men's airborne inventions is the sailplane. This craft can travel for several hundred miles, rising far above the point of take-off because of currents which move skyward from the earth, water and certain types of clouds. During the sunny daytime hours, lakes, forests and fields soak up a great deal of heat. After the sun sets, this stored-up heat is released and because the air near the earth is warmer than the cool night skies, it moves upward until cooled by the higher reaches of the atmosphere. Because plowed fields, lakes and wooded areas will hold heat longer than ordinary earth, currents are still rising from these areas long after sunrise each day. So sailplane pilots ride these bubbles of rising air which we call thermals.

Long-distance flights in sailplanes would be impossible, however, if additional upcurrents were not available. Hence, glider pilots watch for cumulus clouds, the bell-



United Nations Information Office
A Norwegian plane used for patrol and convoy.



Official photo U. S. Air Forces
A rotor provides lift and forward motion to the wingless helicopter, which can land and take off from a lawn.

shaped cloud heaps which spell fair weather to most of us; and they ride on the up-currents which are present with these clouds until the wind begins to break the cloud masses up into long white streamers. There are other cloud currents also which serve the motorless plane. However, it should be remembered that only the most skillful men can travel safely in the sensitive, high-performance sailplanes.

The finest sailplane in the world must depend upon nature for success. Until the Wright brothers added a successful engine to their glider, human flight was only a sport, with little value as a means of transportation. The forty-odd years since Kitty Hawk have brought great advances, however, in power for airplanes. In fact, powered planes can now hardly be considered as companions to the glider, even though both vehicles are heavier than air.

When the Wright brothers flew over North Carolina, their engine weighed 170 pounds and developed 12 horse-power. Thus every unit of power weighed more than 14 pounds. Today, radial engines which power the great war planes develop more than 3,000 horse-power and weigh only 3,000 pounds. From this it is apparent that modern engines are enormously more efficient than anything available forty years ago. Moreover, modern manufacturers of airplanes can choose either the air-cooled engine or the liquid-cooled type; and they can obtain enough power to operate airplanes carrying as much as 150,000 pounds in load. But the airplane engine of today may be entirely outmoded in a few years, thanks to the development of the jet-propulsion engine. (Propulsion comes from the verb propel, meaning to push ahead. A jet is a sudden rush of a liquid or a gas.)

The principle of the jet engine is remarkably simple. Air is drawn into the engine as the plane flies through the atmosphere. It is then compressed by rotating compressors and is forced into a combustion chamber where burning fuel heats it quickly. The heated air expands and builds up tremendous pressure, and is released in jets or spurts through a nozzle at the rear of the fuselage.

The jets of warm air leaving the plane at the rear do not push the ship through the air as some people think. Here is what happens. After the air has been compressed and heated, it pushes violently in every

direction, up and down, forward and backward. At the rear the pressure is quickly released as the gas escapes through the open nozzle. But there is heavy pressure toward the front end of the plane. The expanding gas has no way of escape in that direction, and there is no longer any counteracting pressure against the rear of the plane. That is why the plane is "bumped" forward.

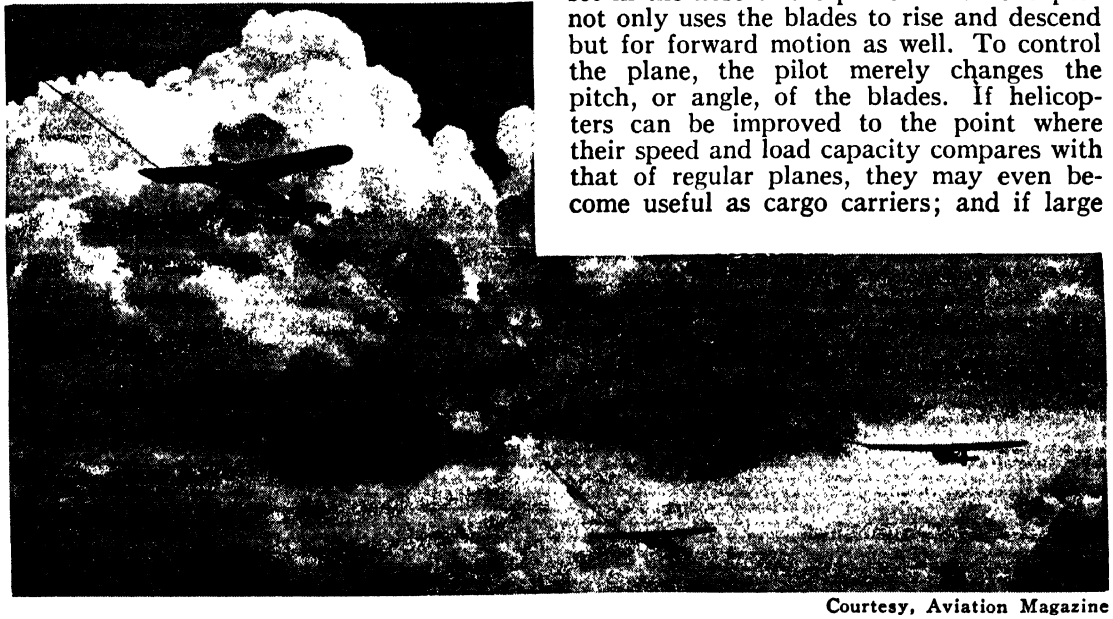
The most widely used jet engine today is the turbojet, which gets its name from the fact that it has a gas turbine to drive its air compressors. There are also two other types, both largely experimental. One is the ramjet, which is efficient at a very high speed. The other is the propjet, and is merely a turbojet engine with a propeller for greater efficiency at low speeds. Jet propulsion is here to stay.

Rocket power, too, has a great future, although its application will probably be limited to military airplanes. The rocket plane is built rather like a fireworks "skyrocket," and is propelled somewhat as the jet plane is propelled. Fuel in the rear of the rocket is ignited and gases escape, and the plane continues to move forward until all of its fuel is burned. Rockets also carry their own supply of oxygen, which will enable rocket ships to fly far above the stratosphere when they are perfected. Both jet- and rocket-powered planes have already been flown faster than the speed of sound. With these new sources of flying power, and with improved standard gasoline engines and, possibly, Diesel engines, planes of the future will assume many forms to suit many conditions.

MODERN AIRPLANES LITTLE RESEMBLE THE FIRST BIRD-LIKE CRAFT OF MAN'S FANCY

For hundreds of years, the airplane designers have been moving further and further away from the bird form in their attempts at human flight. Today the flying machine (ornithopter) of Roger Bacon and Leonardo da Vinci has been all but forgotten. In its stead we find the standard type of plane which is held aloft by the lift of its wing and moved forward by some form of engine. We also have the helicopter, a wingless plane, which rises and moves on the lift and force of two or three long, propeller-like blades whirling above the fuselage or body. The helicopter is one of man's greatest aviation triumphs. This odd-looking machine, which owes much to the great engineer, Igor Sikorsky, will fly forward at speeds exceeding 100 miles an hour; it will stand perfectly still in the air; it can land and take off with ease from an average-sized lawn.

The helicopter should not be confused with the autogiro, which was invented by Juan de Cierva in 1919 and which was first flown successfully in the summer of 1923. The autogiro uses these overhead blades to ascend and descend, but is pulled through the air by a regular engine and propeller set in the nose of the plane. The helicopter not only uses the blades to rise and descend but for forward motion as well. To control the plane, the pilot merely changes the pitch, or angle, of the blades. If helicopters can be improved to the point where their speed and load capacity compares with that of regular planes, they may even become useful as cargo carriers; and if large



Courtesy, Aviation Magazine

Two silent, graceful gliders being towed by a plane. They are useful as troop carriers in wartime.

enough to carry more than a few passengers, they may replace most of the cross-country busses.

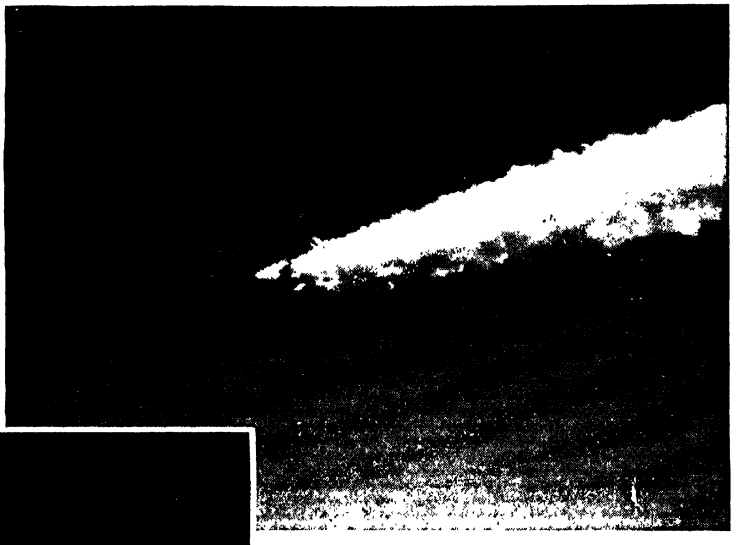
Meanwhile, much experimentation will continue to go into the standard airplanes. In the early days of aviation, every effort was aimed at increases in the lift of airplane wings, wings which were almost as wide as they were long. Nowadays, the airplane designer has so much power available that the wing has become little more than an accessory to lift. Modern engineers are studying ways to reduce drag in the wings.

Because the forces which sustain any airplane in the air are unfamiliar to most of us who live on the ground, it might be well to explain the principles of flight. When any object, whether an airplane or a rubber ball, is sent into the air, the force which we know as gravitation immediately begins to pull that object back to earth. In aviation, gravity contributes to a force known as drag. The larger the airplane, the greater the drag, for gravity has a larger area to pull upon.

When early aeronauts built large wings, they were getting increased lift, but increased drag at the same time. The lift, which opposes gravity, results from the air moving across the airplane wings. Thus, a wing twenty feet long will allow twice as much air to pass over its surface as a wing ten feet long. Part of this lift results from the vacuum, or airless pocket, which forms on top of the wing when the air is struck by the moving wing. The balance of the lift is produced from below the wing.

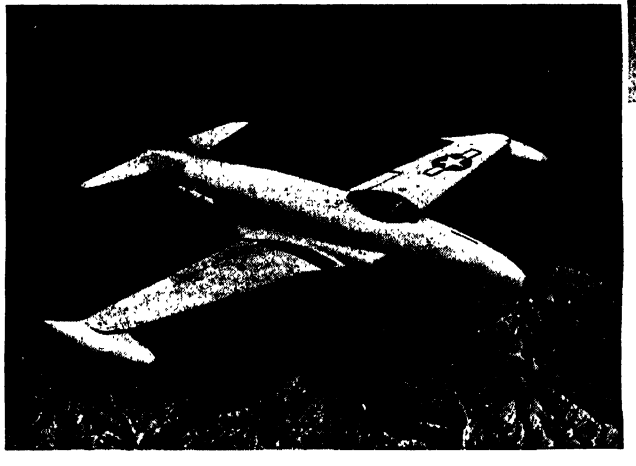
U. S. Navy

A United States Navy plane (a bi-motored Martin Mariner), in a jet-assisted take-off, shoots up from the water like a skyrocket, at a speed otherwise impossible.



Lockheed Aircraft

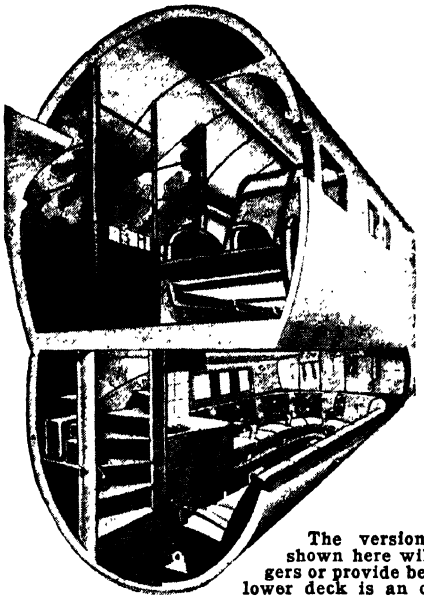
The propellerless Lockheed superfighter, the P-80 Shooting Star, is powered by a jet engine concealed within the fuselage behind the cockpit of the plane. Jet engines make for greater speed and comfort.



As long as airplane engines were not very efficient, this lift could be increased only by enlarging the wing. Now, however, jet propulsion has given us more power than we can use, with speeds of 1,300 miles per hour entirely practical. So our wings can be made smaller without reducing lift, simply because twice as much air will move across the wing when we double the speed. The planes of tomorrow may be almost wingless, with the fuselage, or body, looking much like a bullet which travels through the air with no wings at all.

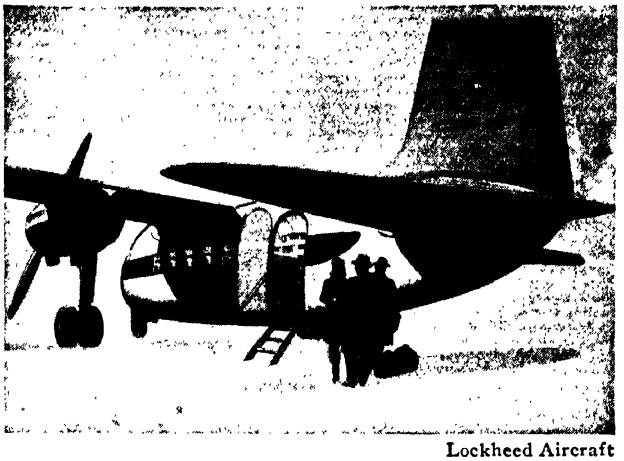
There is one other possibility which may contradict the dream of wingless airplanes. The fuselage, in which passengers or cargo are accommodated, contributes no lift whatsoever. It does, however, contribute a great deal of drag simply because gravity can act upon every inch and every pound of any airplane. With this in mind, Vincent Burnelli and Jack Northrop in the United States have been working for several years upon airplane

PLANES OF THE FUTURE



Boeing Aircraft Company

The version of the Boeing Stratocruiser shown here will seat seventy-two day passengers or provide berths for thirty-six at night. The lower deck is an observation and dining lounge.



Lockheed Aircraft

A Lockheed Saturn 75, designed for short-distance passenger flights. Wings are set high, so they will not obstruct the view from the windows.

Boeing Aircraft Company

Rolling for a strike in a "skyways" bowling alley. This indicates the space available in the Boeing Stratocruiser. The picture was taken on the unfinished deck of a C-97 transport, the Army Air Forces version of the Stratocruiser.

International News Photos

A paratrooper at the moment of leaving his plane. Both sides used paratroop units for invasion in World War II.

designs which carry passengers and cargo inside the wing itself. We usually speak of such airplanes as "flying wings," although a more accurate way to describe them would be "all-wing airplanes."

Such airplanes will undoubtedly be common whenever great load rather than great speed is preferred. Hence, wingless planes powered by jet engines or rockets will probably be most common on long-distance flights across oceans, while all-wing airplanes will carry most of the traffic within a country. Their great capacity will make air-line fares low.

One question is asked again and again in aviation laboratories as well as in school classrooms. Everyone wants to know "how big can an airplane be?" Most engineers will tell you that they do not know. A few years ago, an airplane whose wings measured 100 feet from tip to tip was considered unflyable. Yet in 1947 the United States Navy put into commission the Caroline Mars, an 82½-ton cargo plane with a wingspread of 200 feet, designed to carry 200 people.

Until big airports are built at all of the world's principal cities, flying boats may be more common than equally big land planes; but when that day comes, the land plane will undoubtedly be the favorite vehicle. It seems now that airplanes carrying 200 tons of passengers or freight will be commonplace within a few years.

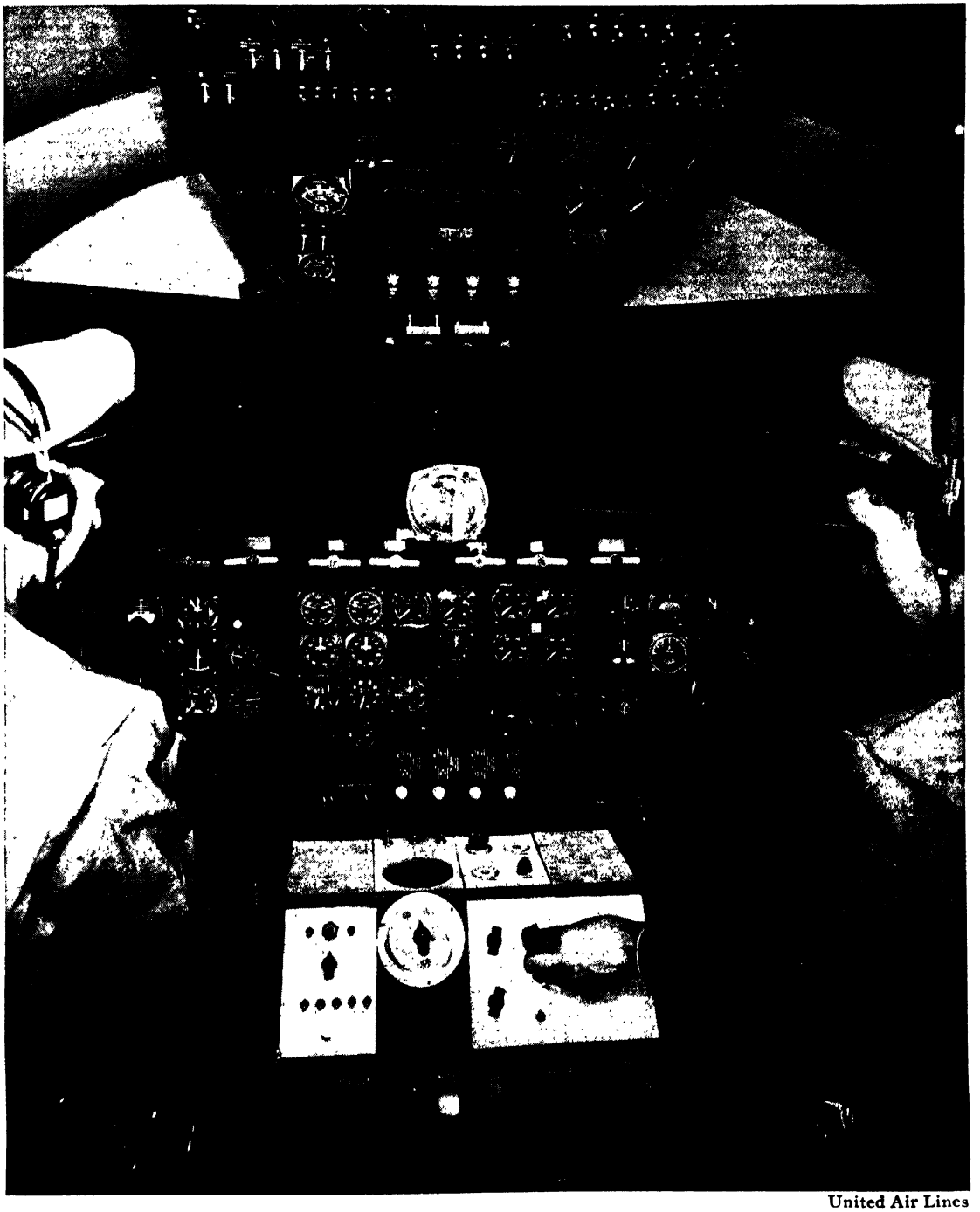
Of course, size alone does not insure success in aviation. On the contrary, the very little airplanes will bring aviation to most of the people in the world. In the days before World War II, such airplanes were known as "private planes." They were owned and flown only by quite wealthy people who enjoyed the sport of flying. Now these airplanes are referred to as "personal planes" because they will be vehicles for personal travel.

They will cost less to operate than a small automobile; and they will make vacation time go four times as far. Salesmen who now travel by automobile will do their long-distance traveling in personal planes. Some of these planes will be so simple to operate that almost anyone will be able to learn to fly. In Ohio, a large number of children aged five to twelve have become accomplished flyers, even though the laws governing aviation will not permit them to fly alone until they are sixteen years old.

No story of aviation or airplanes would be complete without a discussion of the mechanical and electrical devices which have made air travel and air warfare practical. For many years every airplane has carried at least five instruments which pilots refer to as the flight group. Of these the airspeed indicator is the most important. It tells the pilot when his plane is moving fast enough to leave the ground, when it is moving through the air at a speed sufficient to keep it aloft and when it is flying slowly enough to guarantee a safe landing.

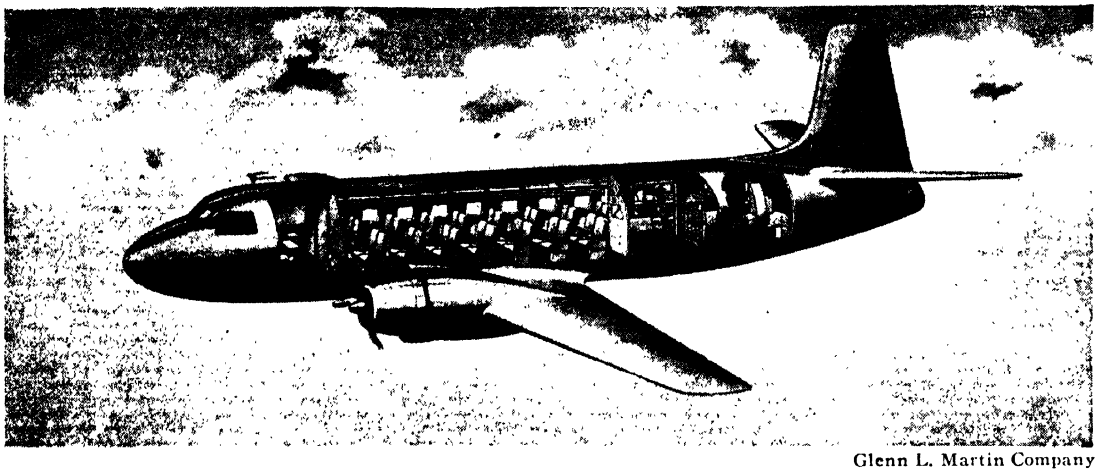
In operation the airspeed indicator is much simpler than the speedometer on an automobile. The pressure of air increases or decreases as the speed of a plane becomes greater or less. In flight, air is admitted to

A WILDERNESS OF INSTRUMENTS



United Air Lines

This photograph shows some of the flight instruments used in the DC-6, the 55-passenger, 300-mile-an-hour, four-engine Mainliner of the United Air Lines. A glance at the two crowded instrument boards reveals the reason for the long and technical training demanded of pilots. Many years of patient research preceded the development and perfection of each of these instruments, and patience and training are necessary for their efficient use. Each of these many dials and levers has a distinct and important function. Instrument failure or incorrect instrument reading can cause disaster. Speed, safety and comfort—all depend upon the brains and skill of the engineers who designed the modern planes and the men who fly them. Some of the instruments shown here make it possible for the pilot to fly through fog and darkness. This plane, like most large four-engine passenger planes, is equipped with double controls so that one pilot can relieve the other without changing places. Most of these developments were not even imagined in the early days of flying, when aviation was still an experiment and a science of flying unknown.



Glenn L. Martin Company

A modern passenger plane. Its design permits ground crews to service many of its parts without entering the cabin.

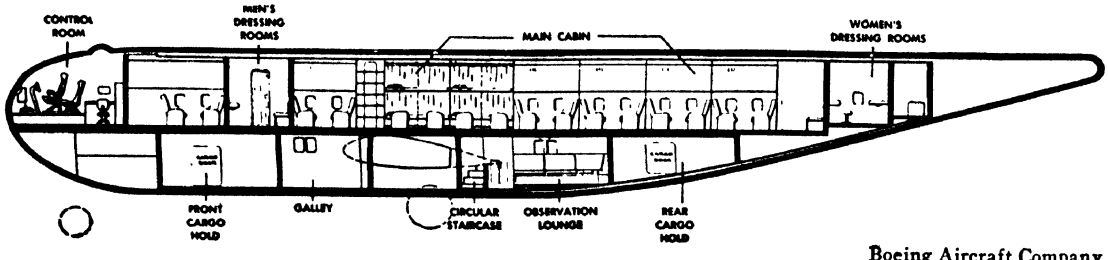
the pitot tube, a small metal spike extending forward from the airplane wing. When the plane moves rapidly, a great deal of air rushes into the pitot tube. When speed is reduced, less air enters the tube. These changes in air pressure cause a metal disc to move up and down in an airtight chamber; the disc movement affects the needle of the airspeed dial on the plane's instrument panel.

The altimeter, which ranks next to the airspeed indicator in importance, records the plane's altitude above sea level. The altimeter, by telling the pilot at what altitude he is flying, helps him to hold his course and to avoid collisions with other planes. He needs the information also if he is to get the maximum speed from his engines. The altimeter is affected by barometric pressure, which changes as altitude increases. Some altimeters register changes in hundreds of feet, while the so-called sensitive altimeters, which are too expensive to be used on most personal planes, record altitudes in units of a foot.

In commercial planes, which carry both the airspeed indicator and the altimeter, a terrain-clearance altimeter is also used. The terrain-clearance device registers the distance from any obstruction on the earth's surface. This instrument, which was the ancestor of modern radar, sends an electric signal toward the ground from one wing tip. When this electric wave strikes a solid surface, it bounces back and is recorded by a receiver in the opposite wing tip. A dial on the instrument panel quickly tells the pilot when he must climb higher to avoid a mountain peak or any other obstacle that might endanger his plane.

The other instruments in the flight group are the rate-of-climb indicator, or variometer, which tells the pilot how fast his plane is climbing; the turn-and-bank indicator, which registers all changes in the plane's angle or direction of flight; and a compass. Actually, most modern planes carry several different compasses to avoid errors which might occur in a single instrument.

One is a simple magnetic compass, similar to the pocket instrument known to most Boy Scouts and Girl Scouts. The second is a radio compass, with a needle that moves in response to radio waves sent out by the radio-range stations which guide all commercial planes. The third, which came into being



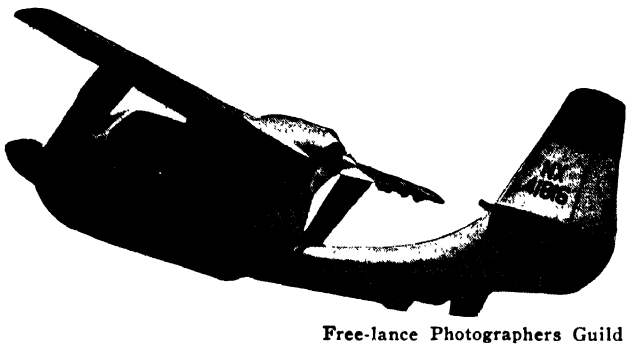
Boeing Aircraft Company

This cut-away drawing shows the cabin arrangement of the seventy-two-passenger Stratocruiser. Sleeping accommodations are available for thirty-six persons. There are likely to be more such luxury liners in the future.

during the war, is the gyro flux-gate compass.

A complicated and expensive device, the flux-gate compass picks up the electric currents which surround the earth, then strengthens these currents with an electrical amplifier to make them strong enough to move a compass needle. Because this is the only compass which retains its accuracy when planes fly close to the North Pole, it will become increasingly important when air lines use the Great Circle routes over the polar regions.

Of all the new inventions available to aviation, few can match the value of radar. With it, a pilot can "see" the ground beneath his plane as a ghostly outline on his receiving screen, through fog, clouds, darkness, rain and snow. With radar, a pilot can be "talked" in for a safe landing by means of an apparatus called the Ground Control Approach unit. The approaching plane is spotted on the ground screen while some distance away from the airport. Operators then talk to the pilot by means of short-wave radio, and, on the screen, follow the course of the plane as it nears the field. They give the pilot exact instructions for a safe landing—telling him when to lower his altitude, when to decrease his speed, and so on—keeping him "on course" for the runway. As yet, only military and naval planes are equipped with radar sets.



Free-lance Photographers Guild

This unusual amphibian (the Republic Seabee) seats four and sells for about $4,000. It is designed to be a family plane.

When this system is fully developed, a scanner in the control tower will register the movements of planes in the air. Special scanners in commercial planes will sweep the sky at all times to prevent collision with other airplanes.

There are other instruments that are important in modern aviation. Although pilots have long known that bad weather never occurs at extremely high altitudes, we have been forced to fly at less than 12,000 feet because no human being can live in the thin air of the stratosphere. During the war the stratosphere was conquered when fighter pilots began to wear oxygen masks which drew life-giving air from small metal flasks in the cockpit.

However, the large commercial air liners that fly at very high "over-the-weather" altitudes—from 15,000 to 20,000 feet and higher—have pressurized cabins. That is to say, the atmosphere in the ship is kept at a suitable pressure for comfortable breathing by the passengers and crew. This is done with a device called a supercharger, which sucks in the thin air from outside the ship and compresses it to the proper density for breathing.

Up to a certain point, the higher you go the colder it is. At 30,000 feet the temperature may be 60° F. below zero, causing moisture in the air to turn to ice. This ice then forms in thick layers on wings, control surfaces and propeller blades. Ice has always been the most dangerous natural hazard known to pilots. Now we have conquered nature's last obstacle to flight. Planes which fly at low levels encounter icing conditions only during the winter months. So de-icers, or rubber blankets, which slip over the leading edge of wing and tail, are mounted on the planes every October and removed again in April. Whenever ice begins to form, the pilot presses a button. Air is blown into these blankets, causing them to expand like a toy balloon. This expansion breaks up the ice, and it falls off the plane.

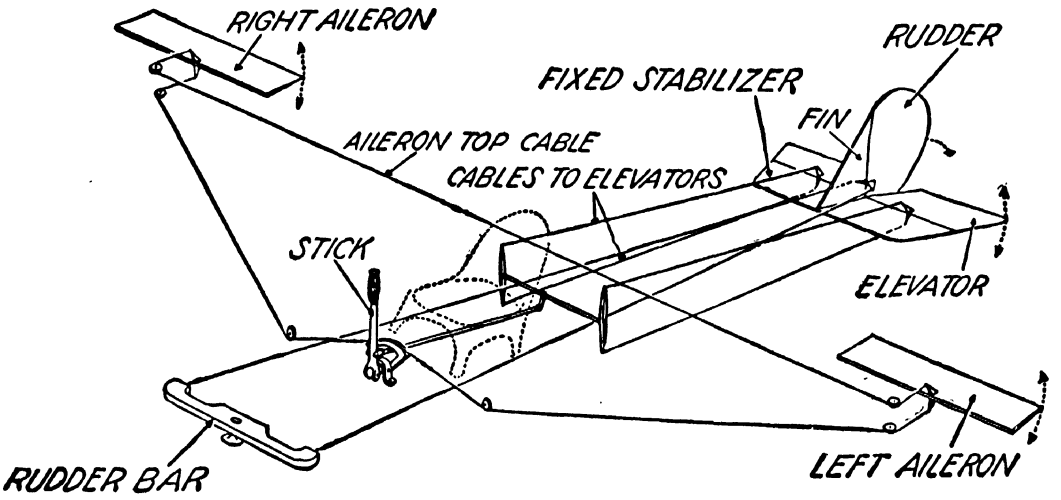
Another kind of anti-icing equipment is used on planes which fly at high altitudes and which, therefore, must guard against ice the year around. Hot exhaust gases from the engines travel through light-weight pipes inside the wing, tail and propeller blades to keep all surfaces so warm that ice can not form.

Such then, are some of the devices that make it almost as safe to fly as to cross a busy city street. Soon big planes and small planes will cause a new world to come into being—a world in which the borders between states and countries will lose much of their significance; a world in which all peoples will be close neighbors.

Read also the articles on Ships That Sail the Sky (Balloons) and Canada's Aviation.

By JOHN PAUL ANDREWS.

HOW AN AIRPLANE IS PILOTED



AN automobile needs to be steered only to left or right; but an airplane must also climb and dive, turn about the axis that runs from nose to tail. All this is done by means of control surfaces. These are (a) the rudder, (b) the elevators and (c) the ailerons. They are so arranged as to deflect the passing air when the plane (or the air) is in motion.

The rudder *steers* the plane—that is, it turns it to right or left. It operates exactly like the rudder on a rowboat. Cables or rods run to the rudder bar in the cockpit or control cabin. This is operated by the pilot's feet. If he presses the right rudder pedal, the rudder turns to that side and so does the ship.

As the name indicates, the elevators (also called the *flippers*) control the climbing and diving of a plane. The control wires from the elevators run to a lever which rises directly in front of the pilot's seat. This lever is called the joystick (originally Joyce stick, after the inventor), or simply the stick. By pulling back the stick, the elevators are raised, which depresses the tail and raises the nose of the plane, and the plane goes into a climbing position. Pushing the stick forward lowers the elevators and the plane's nose, and the plane goes into a dive or glide.

The ailerons are hinged sections of the wing that move up or down, but always in opposite directions. When one aileron is down, the other is always up. The control wires from the ailerons also run to the joystick, but in such a way that only a side-to-side motion of the stick will operate them. Pushing the stick to one side raises the aileron on that side and lowers the one on the other. This changes the lift on each side, and the wing which has less lift (the one on which the aileron is up) will drop, while the other will rise. Such a maneuver is called banking. You have seen, perhaps, the steep banks used on race tracks; they are built up in order to prevent skidding when the curve is taken at high speed. In an airplane, which travels at much greater speed than an automobile, banking is of the greatest importance in order to prevent skidding when the plane is turned. If the stick is pushed too far to one side in banking, the airplane will sideslip, a maneuver used sometimes to decrease altitude. Aileron control is also necessary in order to counteract wind gusts which may suddenly raise or lower one wing.

Ailerons and elevators may thus be controlled in one motion, by moving the stick at the proper angle. In some modern planes the ailerons, instead of being moved by a side to side motion of the stick, are controlled by a steering wheel which is mounted on top of the stick. We show two steering wheels of this sort (intended for the pilot and the co-pilot, who alternate at the controls) in the picture on page 183.

When on the ground, the elevators are often kept up to prevent a sudden gust of wind from raising the tail of the plane. In taxiing, that is, running on the ground, the plane is steered either by the rudder, or by applying one of the separate brakes for each landing wheel. In multimotored planes, the engines may be used for taxiing. A turn either way can be made by speeding up the engines on one side, while slowing down those on the other. In taking off, which is done into the wind, the elevators are lowered until the tail rises off the ground. As the plane gathers speed, the stick is gradually pulled back, lifting the plane off the ground.

When it is about to land, the plane approaches the field in a gentle glide against the wind, with the engine throttled. Just before it strikes the ground the machine is leveled off, that is, the tail is lowered gradually until the landing wheels and the tail skid (or rear wheel) touch the ground at the same time. This is known as a three-point landing.

The above drawing shows the controls of a small plane with a single set of controls. Most large transport planes have two sets of controls, for the pilot and co-pilot.

AVIATION HIGHLIGHTS

About B.C. 230. Archimedes determined the law of flotation, proving that solids may be supported by the buoyancy of liquids and gases.

A.D. 1519. Leonardo da Vinci, Italian artist and mechanical engineer, died, leaving behind him a great many reports and drawings bearing on the problem of human flight.

1670. Francesco de Lana, Italian priest, proposed a vacuum balloon flying machine in a book published at Brescia. The device was to have four copper spheres, quite large but light in weight. From these air would be drawn out to provide a buoyancy sufficient to lift a boat with regular sails suspended beneath the globes.

1766. Henry Cavendish, English chemist, detected the lightness of "inflammable air" (that is, hydrogen). This provided the basis for lighter-than-air research.

1783. Joseph-Michel Montgolfier and Jacques-Etienne Montgolfier, French brothers, conceived the idea of a flight in bags inflated with warm air. On June 5, at their home town of Videlon-les-Annonai, they sent a globe measuring 104 feet in circumference into the air. The balloon remained aloft for ten minutes and traveled more than a mile.

1783. J. A. C. Charles, French physicist, supervised the building of a hydrogen balloon, made of thin varnished silk and measuring thirteen feet in diameter. On August 27, the first hydrogen balloon rose to an altitude of 3,000 feet, remaining in the air over the Champ-de-Mars, in Paris, for forty-five minutes despite a heavy rainstorm.

1783. Jean-François Pilâtre de Rozier and the Marquis d'Arlandes ascended in a Montgolfier-type balloon on November 21. They thus won the honor of being the first men to fly.

1784. Guyton de Morveau, French chemist, built a controllable balloon for military purposes; it flew successfully on April 25, June 14 and September 26.

1784. The Frenchmen Launoy and Bienvenu built a model helicopter for exhibition on April 28 at the Academy of France. With two rotors made from feathers and driven by spring action, the model was the first heavier-than-air device to lift itself into the air.

1784. Jean-Baptiste-Marie Meusnier, French general, developed the elongated balloon. Driven by propellers, this streamlined forerunner of our modern airship had a speed of three miles an hour.

1785. Jean-Pierre Blanchard, French aeronaut, and Dr. J. Jeffries, American physician, crossed the English Channel in a balloon measuring twenty-seven feet in diameter. The flight began at Dover, England, and ended near Calais, France.

1794. Jean-Marie-Joseph Coutelle, French aeronaut, trained men from Napoleon's armies in the military use of balloons. In two flights lasting four hours, the French obtained military information which proved to be valuable.

1796. Sir George Cayley, English inventor, built an improved version of the helicopter following precise scientific formulas. Powered by a bow-and-string arrangement, the rotor could be wound and the "aerial carriage" sent to the ceiling.

1797. André-Jacques Garnerin, French aeronaut, made the first successful parachute descent from a balloon on October 22.

1821. Charles Green, English aeronaut, traveled 500 miles in a balloon of his own construction; it contained 85,000 cubic feet of coal-gas.

1830. Charles Ferson Durant, of New York, became the first American to fly in the United States, traveling from Castle Garden, New York, to South Amboy, New Jersey, in a balloon inflated with 10,000 cubic feet of hydrogen. The historic flight began on September 9 after much advance notice.

1835. Richard Clayton, English watchmaker, traveled by balloon from Cincinnati to Monroe County, Virginia, on April 8. On July 4, he carried America's first "air mail" from Cincinnati, landing at Waverly after a journey of more than 100 miles.

1842. William Henson, English inventor, patented an airplane design based upon principles established by Sir George Cayley. A model was built with one square foot of wing area for every half-pound of weight. An improved version, built by John Stringfellow, was flown in 1848.

1852. Henri Giffard, French engineer, designed and built an engine-powered balloon which flew successfully on September 24. Although hydrogen, used to inflate the bag, is very inflammable, Giffard later used a steam engine to power this dirigible. The balloon measured 144 feet in length and carried 88,300 cubic feet of hydrogen.

1858. Thaddeus Sobieski Coulincourt Lowe, later famous as the chief aeronaut of the Army of the Potomac in the American Civil War, made his first ascension in a military observation balloon.

1860. Samuel Archer King, American aeronaut, made the world's first aerial photographs in the course of a balloon flight over Boston.

1873. Etienne-Jules Marey, French physicist, prepared the first scientific illustrated report on the flight of birds, using photographic records of bird wings in flight to demonstrate ornithopter principles.

1883. John Joseph Montgomery, California educator, made the first successful flight in a glider in the United States. The ship, a biplane, had wings measuring ten feet in length, approximately five feet in width.

1884. Charles Renard and Arthur Krebs built a dirigible powered by an electric motor. Named La France, the airship was 165 feet long, 27 feet in diameter and was inflated with 63,000 cubic feet of hydrogen. It made seven successful flights.

1896. Otto Lilienthal crowned five years of glider research with his 2,000th successful flight.

1897. Count Ferdinand von Zeppelin, German army officer, began construction of his first dirigible. Sixteen gas bags mounted within the aluminum framework each contained 4,000 cubic feet of hydrogen. The balloon eventually flew at a speed of 18 miles per hour and provided the basis for Count Zeppelin's later balloons, which came to be known as Zeppelins.

1903. Wilbur and Orville Wright, Ohio bicycle-makers, became the first men to fly in a mechanically powered vehicle of heavier-than-air construction. Orville flew first on December 17 at Kitty Hawk, North Carolina, remaining aloft for 59 seconds in the course of a flight of 852 feet.

1904. Captain Thomas Scott Baldwin built the first American dirigible, with power provided by a Curtiss air-cooled engine.

1905. Major General Frank P. Lahm became the first American army pilot and won the first Gordon Bennett International Balloon Race to Paris.

1907. Paul Cornu, a French mechanic, became the first man to fly in a helicopter. He reached an altitude of several hundred feet in a short flight over

AVIATION HIGHLIGHTS (continued)

Lisieux, France, on November 13.

1909. Louis Blériot, French aeronaut, made the first successful flight across the English Channel, flying a monoplane of his own invention from Baraques, France, to Dover, England, on July 25. His achievement won an award of $5,000 offered by a London newspaper, THE DAILY MAIL.

1910. Georges Chavez, French pilot, made the first air crossing of the Alps, flying from Brig, Switzerland, and concluding the flight with a forced landing fifty miles from Milan, Italy. If he had reached Milan, Chavez would have won $20,000 in prize money. He was awarded half of that amount in recognition of his almost successful flight. Chavez died in the hospital as a result of injuries suffered in landing.

1911. Earle Ovington, New York flyer, became the first American air-mail pilot, carrying a packet of post cards from Garden City to Jamaica, New York.

1911. Galbraith P. Rodgers made the first transcontinental flight, flying from Sheepshead Bay, New York, to Los Angeles. The flight began on September 17 and ended on November 5.

1918. The first regular air-mail service in the United States was launched, with army pilots carrying mail between Washington and New York, on May 15. Although Lieutenant G. L. Boyle started the first trip, his forced landing gave Lieutenant J. C. Edgerton the honor of carrying the first Washington-New York mail successfully.

1919. Walter Hinton of Ohio made the first seaplane crossing of the Atlantic, piloting the NC-4 on its famous flight, May 16.

1919. Captain John Alcock and Lieutenant Arthur Brown made the first non-stop flight across the Atlantic, flying from Newfoundland to Ireland on June 14 to win a prize of $50,000 offered by the London DAILY MAIL.

1923. John A. Macready of California, accompanied by Oakley Kelly, made the first non-stop flight across the North-American continent on May 2. The flight covered 2,500 miles and lasted 26 hours, 50 minutes.

1923. Juan de la Cierva, Spanish civil engineer, made the first successful autogiro flight on June 9, flying a plane of his own invention. Five years later, the Cierva autogiro flew across the English Channel.

1924. Colonel Lowell H. Smith of California led a group of United States Army round-the-world flyers on a flight which began April 6 and ended September 28. Four planes started the 25,553-mile journey, but only two planes completed the historic flight.

1924. Colonel Russell L. Maughan of Utah made the first dawn-to-dusk flight across the United States. Flying from Mitchel Field, New York, on June 23, he covered a distance of 2,670 miles to land at San Francisco 21 hours, 44 minutes after take-off.

1926. Rear Admiral Richard E. Byrd of Virginia made the first airplane flight over the North Pole when his trimotor monoplane crossed the top of the world on May 9. The same year, Roald Amundsen, Lincoln Ellsworth and Umberto Nobile duplicated the feat with the dirigible Norge.

1927. Charles A. Lindbergh of Michigan flew non-stop across the ocean. The Lindbergh flight ended at Paris on May 21. Charles A. Levine and Clarence D. Chamberlin flew from New York to Germany on June 4. Richard E. Byrd, Bernt Balchen, Bert Acosta and Lieutenant George O. Noville flew from New York to France on June 29. William S. Brock and Edward F. Schlee flew from Newfoundland to England on August 27.

1927. Lieutenant Lester J. Maitland and Lieutenant Albert F. Hegenberger made a non-stop flight across the eastern Pacific Ocean, flying from Oakland, California, to Honolulu on June 28. On August 16, Arthur C. Goebel and Lieutenant W. V. Davis duplicated the feat, flying from San Francisco to Honolulu in slightly over 26 hours to win the $25,000 Dole prize.

1928. Amelia Earhart of Kansas became the first woman to fly across the Atlantic; completing a flight from Newfoundland to Wales on June 21. Her companions on the flight were Wilbur Stutz, pilot, and Louis Gordon, mechanic.

1931. Professor Auguste Piccard, Swiss physicist, made the first balloon flight into the stratosphere in company with Charles Kipfer, rising to an altitude of 52,000 feet on May 27.

1937. Captain Edwin C. Musick commanded the first clipper flight between the United States, Hawaii and New Zealand, establishing the Pan American Clipper routes across the Pacific Ocean.

1938. Howard Hughes of Texas flew around the world in 91 hours, 8 minutes, 10 seconds.

1939. Captain Arthur E. Laporte and Captain Harold E. Gray established transatlantic air-mail service. Laporte opened the southern route on May 20, and Gray the northern route a month later, on June 24.

1944. Howard Hughes and Jack Frye set a transcontinental record of 6 hours, 58 minutes April 17. The flight was made in a Lockheed Constellation, from Burbank, California, to Washington, D. C., at an average speed of 355 miles an hour.

1946. The United States Air Force announced December 10 that the Bell XS-1 experimental rocket plane had been flown 550 miles an hour at Muroc Lake, California.

1947. Marine Major Marion Carl set a world speed record of 650.6 miles an hour in a Douglas D-558 jet-propelled Navy plane at Muroc Lake, California, August 25. Air Force Captain Charles E. Yeager was reported to have flown the Bell XS-1 at supersonic speed in October at Muroc Lake, California. William P. Odom landed in Chicago, Illinois, August 10, completing a record round-the-world solo flight of 19,645 miles in 73 hours, 5 minutes, 11 seconds. The flight was made in a converted A-26, 2-engine attack bomber.

1948. Air Force Major Richard L. Johnson set a world speed record of 670.98 miles an hour in an F-86 jet-propelled plane at Muroc Lake, California, September 15.

1949. William P. Odom set a world record for non-stop distance flying in light planes with a Beechcraft. He flew 5,300 miles from Honolulu, Hawaii, to Teterboro, New Jersey, March 7-8, in 36 hours. Air Force Captain James Gallagher and a crew of 13 landed at Fort Worth, Texas, March 2, in "The Lucky Lady II," a B-50, completing the first round-the-world non-stop flight. They traveled 23,452 miles in 94 hours and 1 minute, refueling in the air from B-29 "tanker" planes four times along their global line of flight.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 197.

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This procession of shaggy horses and a wild cow form part of the magnificent gallery of early cave-man art discovered in a French cavern by five schoolboys. Along the walls are also pictures of stags, lions, birds and men.

THE CAVE-MEN AND THEIR PICTURES

THE story of art begins, like a fairy tale, with the words "long, long ago." We can not at first realize what this long, long ago means. In fact, the very early beginnings of art were buried for ages, and until about almost one hundred years ago nothing was known of these treasures.

Some of these were found quite by accident in the year 1868 by a hunter who fell down through some brushwood into a deep hole that led to a long underground cavern. However, the most ancient of all remains were found as late as the year 1940, near Montignac, in southwestern France, when five schoolboys found the entrance to a cave that had long since been filled in to prevent cattle from falling into it. Once within the cavern, the boys were amazed to find the rocky walls covered with paintings of all sorts of creatures—oxen, bison, stags, lions, woolly rhinoceroses, birds and even men.

Interested by the reports of the boys, the Abbé Henri Breuil, one of France's most prominent authorities on early European man, investigated the place. In one part of the dark underground corridors, the Abbé Breuil counted more than eighty pictures, most of them done on blocks of stone that had tumbled from the vaulted cavern roof.

Other paintings have been found in caves, though none so old as these. Scholars think that the pictures were not made simply to please the eyes of those who dwelt in the caves. Instead they probably served a religious or magical purpose. Most likely they were done to insure a plentiful supply of game, for these long-ago ancestors lived by hunting. A man possibly believed that by painting a picture of the animal he wanted to kill and then hurling spears and arrows at it, he would make stronger the magic that would enable him to slay the beast on the next day's hunting expedition.

The paintings in the caves of Montignac are thought to be as much as 30,000 years old; they are supposed to have been made in what is known as the Aurignacean Period of the Old Stone Age.

Let us see what that expression means. Geologists have divided the history of the earth's development into five great eras, and during the last of these there were times when Europe and North America were held in the grip of an intense arctic cold. Upon the surface of Europe were piled great glaciers, much more like the polar ice-fields than like the glaciers on the Swiss mountains to-day. Then there would be a warmer stage, followed by another glacial period.

Before this bitter cold had seized the world, and in between the various glacial periods, the primitive tribes of Europe

THE AGES OF MAN'S PROGRESS NAMED AFTER HIS TOOLS

Eolithic, or Early Stone Age

Paleolithic, or Old Stone Age
- Older Paleolithic
  - Prechellean
  - Chellean
  - Acheulean
  - Mousterian
- Younger Paleolithic, often called the Reindeer Period
  - Aurignacean
  - Solutrian
  - Magdalenian
  - Azilian

Mesolithic, or Middle Stone Age

Neolithic, or New Stone Age

Copper Age

Bronze Age

Iron Age

basked in a long summer. They lived an indolent, semitropical life, their food chiefly fruits and berries which were easily gathered. The Mediterranean Sea was shallow, with land bridges in places, so that men and animals freely passed across into Europe from Africa and Asia.

When Europe slowly cooled to the temperature of an icehouse, men found life hard. Their fruits and berries disappeared, and they had to find another kind of food or die. They turned for the means of life to the flesh of animals. Hard necessity made them the greatest race of hunters the world has ever known.

At first they had only one kind of weapon, a flint (hard stone that can be chipped) knife, or dart or hammer. Because of the stone weapons of these hunters the age in which they lived is called the Stone Age. At first men simply used stones they found lying around that happened to be of a handy size and shape. This period of years was called the Eolithic, or Early Stone, Age. It gradually merged into the Paleolithic, or Old Stone, Age, when men learned to fashion edges and points on their stone darts by chipping and flaking. The long period of the Paleolithic has been divided by scholars into parts, Older and Younger Paleolithic, and each of them into parts. The Aurignacean is the oldest part of the Younger Paleolithic, and the pictures on page 189 are thought to have been painted in that period.

THE YOUNGER PALEOLITHIC IS OFTEN CALLED THE REINDEER PERIOD

But even before they learned to use paints they had been artists. Let us follow the story. The hunters were driven by the cold, and by the wild beasts, to take shelter in caves, often in rocky holes which had been bears' dens. To keep themselves alive, they dressed in the skins of the beasts they slew. Arctic animals—reindeer, musk sheep and mammoth—roved over the frozen fields where formerly hippopotamuses, lions and elephants, hyenas and tigers had basked in the sun. These were the ancestors of the animals we know by the same names to-day. Because there seem to have been many reindeer, the Younger Paleolithic is often called the Reindeer Period; and the cave-men are called reindeer-hunters. As centuries passed by, the reindeer-hunters advanced in civilization. They developed their knowledge of the use of flint instruments, and had factories for their manufacture. They had cook-houses, and knew something of domestic management in their caves. Their dead were buried with peculiar and mysterious rites.

And there grew up in the minds of this race of hard, cruel hunters a strange love of beauty and decoration. It was as if their souls, struggling for expression, turned to art. We have no knowledge of their speech, they had not developed the first clumsy signs which are the beginnings of an alphabet; they knew nothing of spinning or weaving or making pottery.

THE CAVE-MEN'S LIFE CENTRED AROUND THEIR HUNTING

Of even the simpler kinds of knowledge which underlie our present civilization they were as ignorant as the arctic fox or the prairie buffalo to-day. Their whole scheme of life centred around their hunting—the finding of food and of skins for clothing; and their thoughts were continually on the animal world around them. We may be quite sure that they had firsthand knowledge of nature and its ways in their savage heads; and they drew animals which show us how marvelously accurate were their observations, as the pictures on these pages prove.

The early drawings, it is true, are crude, and in some cases almost impossible to understand. Many can hardly be deciphered,

because they have been lying for thousands of years deep down in the earth. In order to find them archæologists have to dig through layers of the deposits of many ages, and then remove stalactites—which, we know, take an incredibly long time to form—before they can touch the original cave wall or ceiling where the pictures are.

Most of the work of the cave-men was a kind of rude engraving done with the point of their one weapon and tool, the flint knife. Before they reached the stage of making pictures on their walls, they tried their hand on all the small articles of their daily life—bones, tusks, teeth and horns of the animals they slew. They made ornaments of shells,

Picture, American Museum of Natural History, New York

This painting by Charles R. Knight gives a modern artist's idea of how artists worked before history. It is not, however, completely imaginary. We do have some knowledge of what these early men looked like, for skeletons have been found; and some of their art remains. With sharp tools they engraved on the stone walls of their cave homes pictures of animals they knew. The three mammoths here are faithful copies of some cave art.

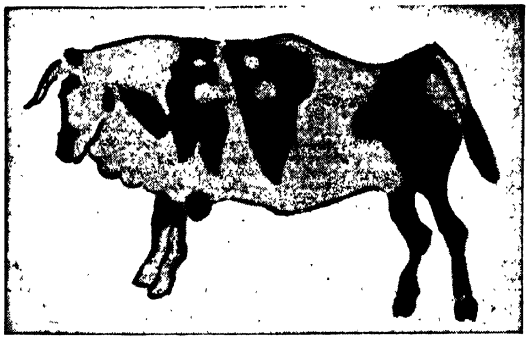
Not all of the hundreds that have been discovered are worthy of mention, but there are among them some astonishingly excellent drawings. And the men who made them were far greater in their day than Raphael in his, because Raphael was the child of a civilization that was already old. His tools and materials were ready to use. Art had established customs and a young artist could find teachers to help him. But the hunters of the Stone Age were the heirs of nothing but life itself and naked instincts.

horn needles, tiny plaques of schist (rock which splits easily), ear pendants of various materials.

As their civilization progressed they learned to make daggers of horn to supplement the stone dart. These were set in bone handles, which the cave-men delighted in decorating. Dagger-handles and some mysterious horn or bone sticks beautifully carved are among the most wonderful of the remains which have been dug up out of the debris of the cave-dwellings. The sticks were cer-

FROM THE FIRST PICTURE GALLERIES

The wild boar.

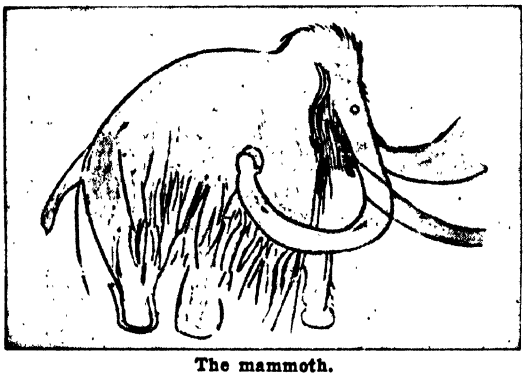


An ox.

An elephant feeding.

Man attacking a stag.

A comical figure.

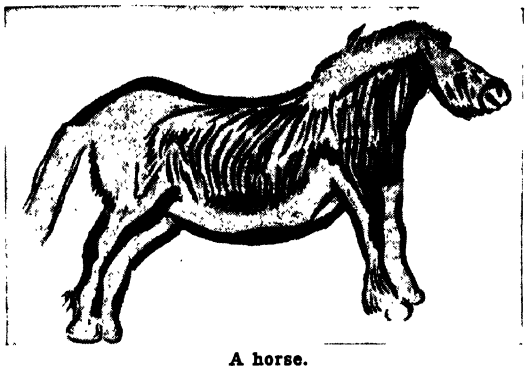


The mammoth.

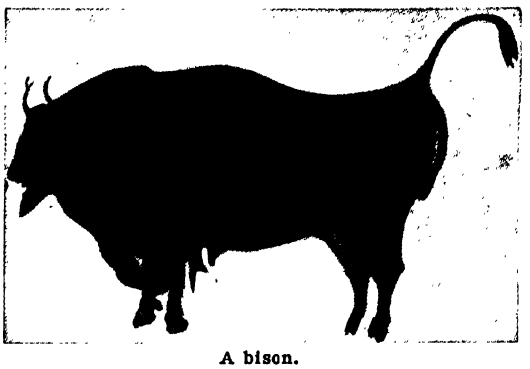
A reindeer running.

Quaint group of figures of the Stone Age.

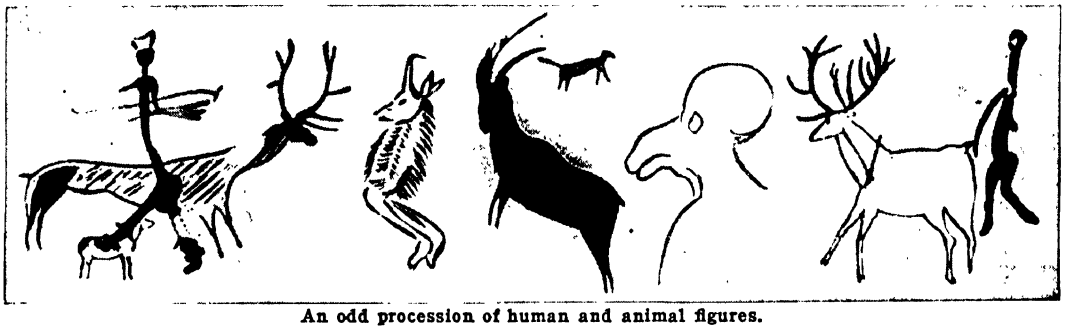
THE JOLLY PICTURES THE CAVE-MEN MADE



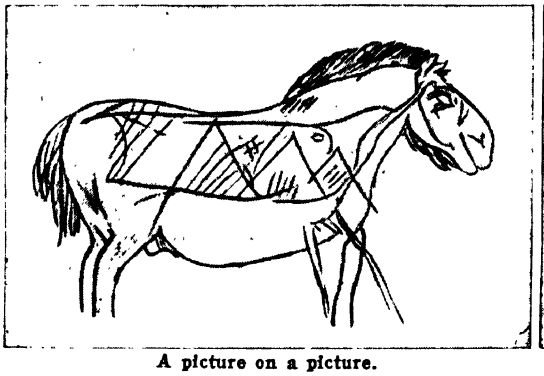
A horse.



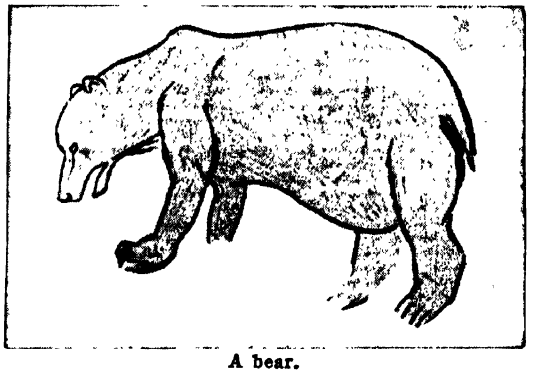
A bison.



An odd procession of human and animal figures.



A picture on a picture.



A bear.

The war men of the Stone Age.

tainly not a means of defense. Possibly they belong to the class of sticks we call sceptres, or staffs of office. They may have marked the headship of a family. They may, on the other hand, have been wizards' wands or, as some think, devices for straightening shafts of darts. Archæologists used to give them the name of *bâtons de commandement.*

THE DAINTY PATTERNS SCRATCHED ON THE BATONS DE COMMANDEMENT

Upon them the primitive men concentrated their daintiest and most imaginative skill. One can see in the mind's eye these dark-skinned, uncouth men squatting at the mouths of their caves, tossing the hair out of their eyes as they scratched away at their dagger-handles or batons. The designs were of various kinds, sometimes repeated strokes, sometimes a leaf pattern, but more generally adaptations of animal life. For the most part, the creatures drawn can be recognized, although their forms were made too long, on account of the shape of the space. The lines are peculiarly free and lifelike.

In addition to these two special pieces of ornament, the cave-men made pictures—probably for the pure pleasure of the work—on objects which do not appear to have had any definite use. Bits of mammoths' tusks and branched reindeer horn were favorite materials, and the height of an artist's ambition seems to have been to draw all over the surface.

Sometimes they made a procession of animals, sometimes a medley of differing forms of life. In the same way, a little child given a piece of paper to draw on will cover every inch, upside down and cornerwise. And again, in this delightful childlike manner, when the artists had used all their available space, they would often begin again on the drawings they had already made. Inside the outline of a reindeer they would draw something else—a fish, or the head of another reindeer, or a horse's head; or they would find room for something that looks like a serpent.

THE WONDERFUL PICTURE GALLERIES IN THE ROCKY CAVES

Interesting as are these smaller objects of the cave-men's art, they give place in importance to the wall, floor and ceiling decorations of their cavern and rock shelters. There the love the artists had for animal shapes and the growing joy in self-expression found an almost endless scope. The galleries of their caves were covered with isolated drawings or long friezes (continuous strips); and sometimes an attempt was made to represent the massing of a herd of the creatures of the wild.

THE ANIMALS MOST OFTEN PICTURED BY THE CAVE-MEN

The animals which were most often portrayed were horse, reindeer, mammoth, bison and goat. Occasionally there is an outline of a kind of ox, or deer. Here and there a man is drawn, but it would seem that the cave-dwellers were not much interested in picturing themselves.

The pictures of the kinds of animals which still exist on the earth to-day we can judge from our own knowledge. From the skeleton of a mammoth found in perfect condition in Siberia we can judge how faithful were the drawings of this huge creature which has died out.

For the most part, these pictures were made on the rock with the point of a flint tool. Sometimes the artists scratched an outline and chiseled the interior rock away to give an illusion of "relief." Their best work was pure engraving of outline.

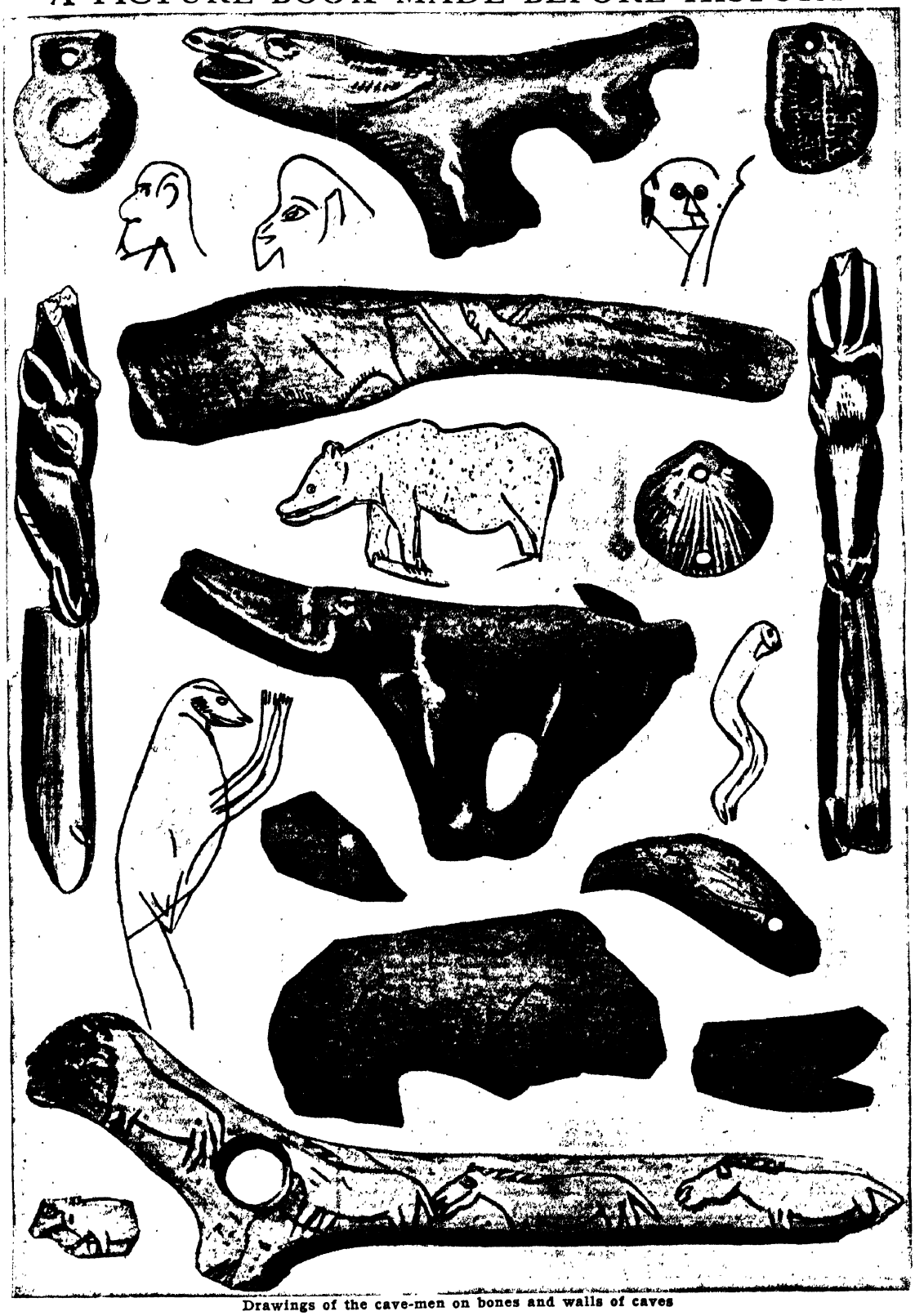
THE FIRST PAINTINGS AND THE FIRST PAINTS

As their sense of art grew they supplemented the engraved line with a brushwork line. Somewhere in those years they learned to paint. The substance they used, the "pigment," was a mixture of charcoal, oxid of manganese and some oily material. Their brushes were fine, and the result is a freedom of line that most artists might envy. It is because the art of the cave-men was in a way so "artless," so free from conscious construction, that it is so great.

We find this simplicity marking the work of famous men all through the ages; for a perfect picture, like a perfect poem, should give the impression of having written or painted itself. If we are conscious that one rhyme is dragged in to match another, one shape to explain another, the poem or picture falls short of greatness. Such a work may be clever, but, generally speaking, cleverness is the enemy of greatness. Or, to put it another way, cleverness steps in where pure inspiration fails.

One kind of cleverness the reindeer men allowed themselves in their work is very interesting to us because it reveals their unconscious feeling for true shape. They took every possible advantage of the uneven surface of their rocky walls. Where a bump came that in any way suggested an animal's head or shoulder, they would avail them-

A PICTURE BOOK MADE BEFORE HISTORY



Drawings of the cave-men on bones and walls of caves

selves of it as if it were natural statuary, and make a line round it. In some cases this blending of relief and contour made a startlingly good, vivid piece of work; in others it would seem that the artists left the engraving unfinished.

In the southwest of France, in the district of the Pyrenees and in northern Spain, about forty of these underground picture galleries have been discovered. The conditions of life in this part of Europe seem to have been the happiest and most productive of art.

HOW THE STRANGE CIVILIZATION OF THE CAVE-MEN CAME TO AN END

In this fascinating branch of archæology it is impossible to say definitely to what district belong the greatest treasures. Scientists are continually exploring; and classifications made to-day may be undone to-morrow. In addition to those in the caves at Montignac, the next finest and most famous wall pictures are at Niaux, near Tarascon, in France, and at Altamira in northern Spain. There are few things more wonderful in the history of art than the horde of animals that chase each other across the rocky ceiling of the Altamira cave. We wonder whether they were done by one man or many, by a family or by a generation, and still more do we wonder what kind of art the cave-men would have worked out if their strange civilization had developed further. All we know is that, about twelve thousand years before Christ was born, there came another of the mysterious slow earth-changes. The ice-fields melted and Europe flowed with rushing rivers and swollen lakes; the face of the Continent was altered. The Mediterranean became the inland sea we know to-day; the English Channel and the North Sea divided Britain from Europe. The mammoth and the reindeer retreated to the Arctic Circle, the former to disappear from the world.

THE BRONZE AGE THAT FOLLOWED, AND THE DAWN OF HISTORY

The cave-men, dying out, gave place to a new type of men, who discovered metals and grain and learned to spin and make pottery. The first layer of earth and debris began to grow over the cave floors. The Bronze Age, another stage of human culture, followed after the Stone Age. The dawn of history, for Europe at any rate, then began.

The Stone Age, of course, was not confined to Europe; it existed in different parts of the world at different times. Among certain semicivilized races the retreating Stone Age is still within hail, so to speak. Even so late as the close of the eighteenth century one third of the habitable globe had not advanced beyond the use of flint tools.

In Egypt and Palestine, and in some regions still inhabited by uncultivated peoples, there are found traces of the Stone Age, its rude, harsh way of living, and its arts. But in many countries the use of flint has been overlapped in time by the use of other tools and the knowledge of other methods and materials. So the cave drawings of Europe stand out as the finest known examples of Stone Age art, untouched by other kinds of development.

THE EARLY ART OF THE AMERICAN INDIANS AND ESKIMOS

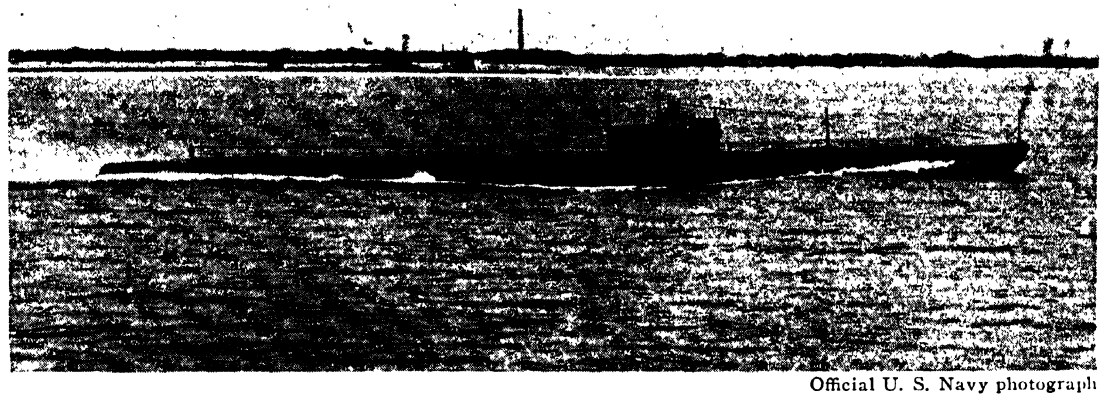
The expression of art among the backward peoples of the earth is, generally speaking, flavored by superstition. Only here and there do we find a faint family likeness to the pure art of prehistoric man in France and Spain. The early American Indians chiseled drawings on the face of the rocks of the Pacific coast. The Eskimos still engrave beautiful and very small designs on walrus tusks and teeth, and so on. But the Indian art evolved into the carving of the mysterious totem poles of the various tribes. Strangely enough, the real primitive art of the Indian is a craft—basketry. The most perfect and delicate basketry in the world—woven from strands of the pith of certain trees—comes from a tribe in California. In Polynesia we find skillful engraving done on turtle shell and clever grotesque carvings in wood. The Maori races in New Zealand have left some amazing engravings on whalebone and wood, and their canoes show to what extent they have developed the art of carving.

WHY THE WORK OF THE REINDEER-HUNTER CAN TRULY BE CALLED ART

But all these peoples lack the simplicity of thought that underlay the work of the reindeer-hunters. They revel in coarse representations of the human body and superstitious idolatry. When we think of their work and then turn back to the art of the European cave-men, we get a sudden sense of purity and vigor, as of a strong, clear wind after a thick atmosphere. The art of the reindeer-hunters is separate and distinct, and can never be forgotten.

Many thousands of years have rolled over the world since those early cave pictures were made. As we think of those artists long ago it is impossible not to be moved by a sense of awe.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 291.



Official U. S. Navy photograph

The U. S. Navy submarine Tarpon. When submarines run on the surface, they are driven by Diesel engines.

THE SHIP BENEATH THE WATERS

IT was in World War I (1914-18) that the submarine first became the terror of the seas. The history of the craft, however, goes back several centuries before that time. In the year 1624, a Dutchman, called Cornelius Drebbel, demonstrated a submarine on the Thames River in England, before James I, the English king.

During the American Revolution, the Turtle, an American submarine designed by David Bushnell, tried to sink an English man-of-war by attaching a gunpowder charge to its hull; the attempt failed. In the first years of the nineteenth century, the American inventor, Robert Fulton, built a submarine for the great Napoleon. Napoleon does not seem to have been impressed by the performance of the craft.

In 1864, during the American Civil War, a Confederate submarine succeeded in setting a torpedo against the hull of the Housatonic, a Union warship that was blockading Charleston Harbor. The Housatonic was blown up. The submarine also sank when water came pouring into it through a hatch that was blown open.

Toward the end of the nineteenth century, John P. Holland, an Irishman living in the United States, launched the Holland 9, a submarine that proved to be remarkably successful. In the years that followed, the submarine was perfected by Simon Lake, an American, and Max Laubeuf, a Frenchman.

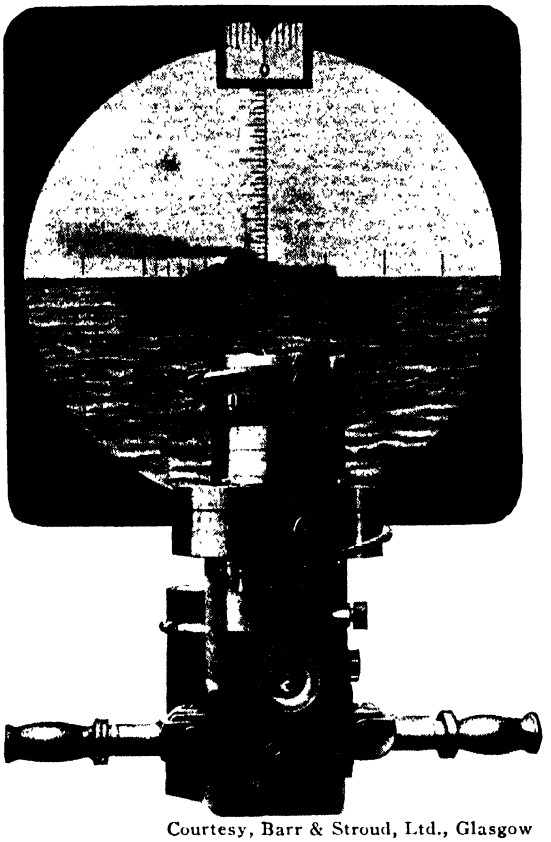
The modern submarine is a narrow vessel, shaped somewhat like a cigar, but flat on top to allow standing room for the officers and men. At the middle of the deck is a raised structure, called the conning tower, which has a bridge on top.

Submarines vary greatly in size. There are tiny submarines not much larger than rowboats, with an operating crew of two men and a range of about a hundred miles or so. At the other extreme, there are seagoing submarines of 4,000 tons with a cruising range of 15,000 miles.

When the submarine runs on the surface, it is much like any other surface craft. It is driven by powerful Diesel engines, using heavy oil as fuel. It shells or fires torpedoes at enemy ships and even attacks coastal points.

The submarine is particularly effective, however, because it can submerge (sink) below the surface of the sea. It can thus escape hostile warships and planes; it can also approach its prey unseen. It submerges by opening valves which are set in special tanks. When enough water has been taken in to make the vessel sink to a certain depth, the valves are closed. When the boat is ready to rise to the surface, compressed air is blown into the tanks to force the water out.

Formerly, no submarine could use its Diesel engines when running under water. The engines would soon use up all the oxygen in the air and leave none for the crew to breathe. Therefore, when it was submerged, the submarine was driven by great storage batteries;



Courtesy, Barr & Stroud, Ltd., Glasgow

This is what the eyepiece of the submarine looks like. The handles turn and control the instrument. Above is the view seen through the eyepiece.

these were charged by the Diesel engines when the boat rose to the surface.

There was plenty of fresh air for submarines when the boat was running on the surface. When it was submerged, the oxygen in the air was gradually used up and was replaced by an emergency supply of oxygen. This also would be exhausted after a time and the air would be filled with poisonous carbon-dioxide gas, breathed out from the lungs. Few submarines could remain submerged safely for more than two days.

Today, an ingenious device, called a Schnorkel, or snorkel, has brought about great changes in running and ventilating submarines. The Schnorkel was developed by the Germans in World War II. It consists of two tubes extending upward from the submarine to the surface. Fresh air is drawn through one tube; the other is for the exhaust. In submarines which have a Schnorkel, Diesel engines are used to drive the craft under water, thus adding a great deal to their speed. Furthermore, it is no longer necessary for the submarine to rise to the surface in order to charge its storage batteries and to provide the crew with air that is fit to breathe. The submarine, therefore, can remain submerged for days or even weeks at a time. Schnorkel-equipped submarines are now replacing the older types.

When the submarine is running on the surface, it is generally steered from the bridge of the conning tower, or from inside the tower if the weather is bad. When the boat is submerged, the steering station is in the control room within the hull. Besides the usual vertical rudders which steer the vessel to the right or left, there are horizontal rudders which are used when the ship is to go up or down. The balance of the ship under water is affected not only by these rudders but also by certain tanks, which are emptied or filled as required.

When the submarine, conning tower and all, is under water, the crew would be unable to see anything upon the surface if it were not for an ingenious device called the periscope. This word comes from the Greek word *periskopein,* meaning to look around.

The submarine periscope consists of a vertical tube, with a mirror at the top end, a mirror and eyepiece at the bottom and several lenses in between. Both mirrors are set at an angle of forty-five degrees. The

Official U. S. Navy photograph

This submarine has just risen to the surface.

image striking the upper mirror is reflected downward to the lower one. Here the image is seen by the observer looking through the eyepiece. The periscope may be turned around so as to cover all points on the horizon.

The eyepiece part of the periscope is located within the hull. The upper mirror part, when it is in use, extends for a considerable distance beyond the conning tower. The upper part of the tube may be drawn back, like the smaller section of a folding telescope, into the conning tower by means of electric or hydraulic power. Most submarines have at least two periscopes.

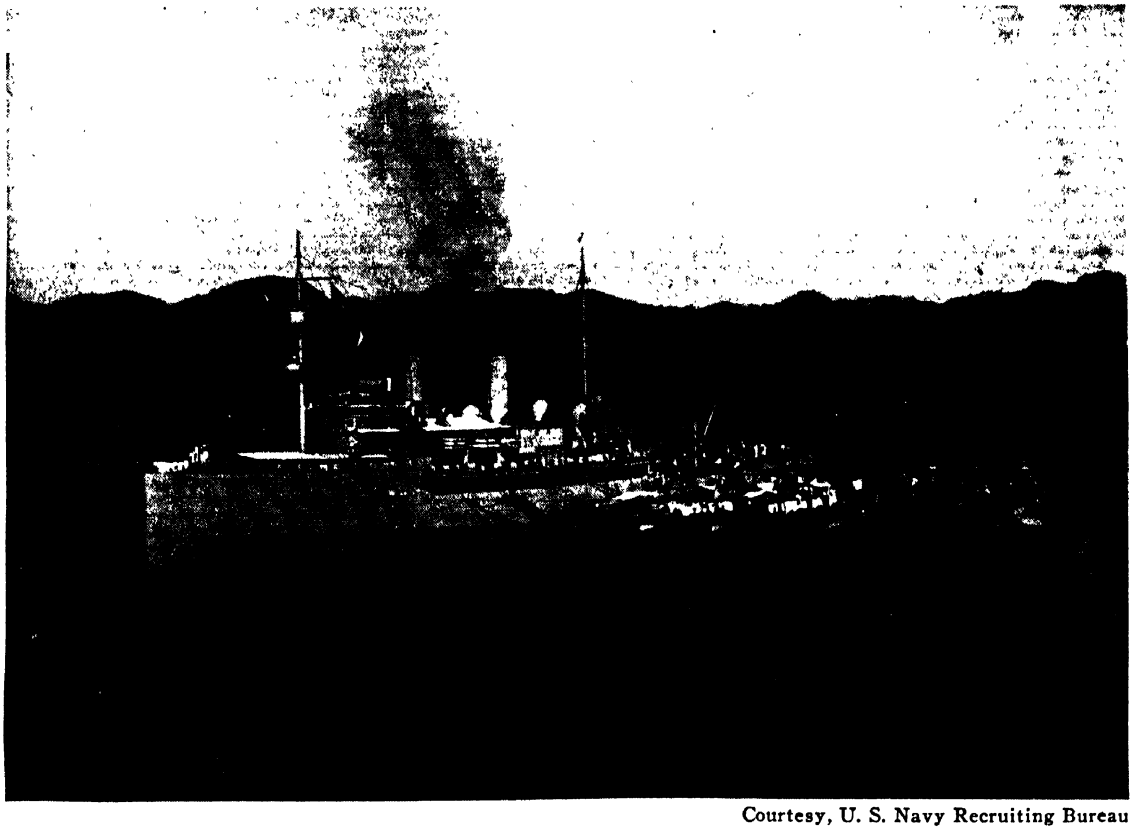
The chief weapon of the submarine is the torpedo. The modern torpedo is like a small submarine. It ranges from 14 inches in diameter and 15 feet in length to 21 inches in diameter and 21 feet in length. It has an engine and propellers to drive it, a steering rudder to keep it on its course and diving rudders to keep it at the right depth. It is driven by compressed air. The front part contains the high-explosive charge, which is set off when the torpedo strikes the target.

The torpedo is kept in a large tube, from which it is fired by means of compressed air. It can travel much faster than the submarine itself (forty miles an hour or so). The depth at which it moves is regulated so that it may hit the vitals of its intended victim; it generally travels about ten feet below the surface. Submarines carry from three to ten tubes; all submarines carry spare torpedoes in addition to those in the tubes.

Most modern submarines carry two or more guns (up to 8 inches in caliber), mounted on the deck. Some submarines carry anti-aircraft guns, to be used against planes. Other submarines have guns with muzzles that can be raised so that they are effective against planes as well as surface craft.

The submarine is used chiefly for attack. It is also employed to lay mines and to land spies and other agents on enemy soil. It has also been used in more peaceful ways. A famous German submarine, the Deutschland, served as a merchant vessel in World War I. Later, the explorer Sir George H. Wilkins used the submarine to explore the icy wastes of the Far North.

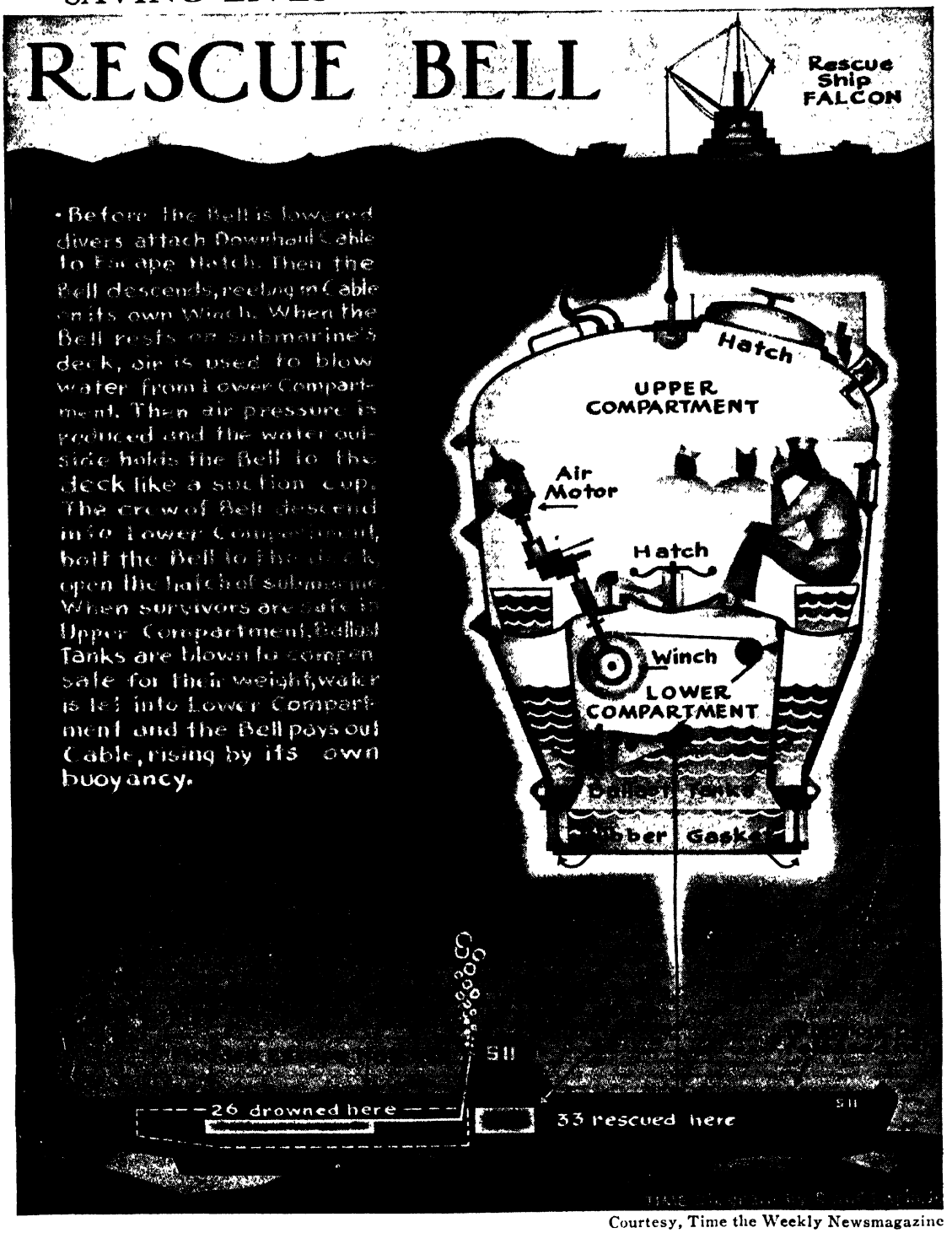
THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 261.



Courtesy, U. S. Navy Recruiting Bureau

The U. S. Navy submarine tender Oglala, with its flotilla of submarines. Often submarines work from a mother ship, which contains supplies of all kinds—spare torpedoes, fuel, food and the like. The larger submarines, with a cruising range up to 15,000 miles, are not dependent on supply ships.

SAVING LIVES IN SUBMARINE DISASTERS



Courtesy, Time the Weekly Newsmagazine

The year 1939 was marked by a number of peacetime submarine disasters. A ray of light was given by the trial of the McCann Rescue Bell, when the U.S.S. Squalus sank, in May. This bell had never been used before in a major accident, but it proved equal to the occasion and rescued thirty-three men from the forward compartments of the submarine. The picture shows how it works.

THE WILD GOAT'S KID

By LIAM O'FLAHERTY

The scene of this story is one of the small, bleak islands off the western coast of Ireland. The author, Liam O'Flaherty, was born nearby, and knew every rock and crag.

THE kid was born in a tiny, green glen under an overhanging ledge of low rock that sheltered it from the wind. It was a male kid, an exquisite thing, tinted delicately with many colors.

The white goat, his mother, bleated over him, with soft eyes and shivering flanks, gloating over the exquisite thing that had been created. And she had this delicate creature all to herself, in the wild solitude of the beautiful little glen, within earshot of the murmuring sea, with the little birds whistling their spring songs around her, and the winds coming with their slow whispers over the tops of the crags.

How she maneuvered to make him stand! She raised him gently with her forehead, uttering strange, soft sounds to encourage him. Then he stood up, trembling, staggering, swaying on his curiously long legs. She became very excited, rushing around him, bleating nervously, afraid that he should fall. He fell. She was in agony. Bitter wails came from her distended jaws and she crunched her teeth. But she renewed her efforts, urging the kid to rise, to rise and live . . . to live, live, live.

He rose again. Now he was steadier. He shook his head. He wagged his long ears as his mother breathed into them. He took a few staggering steps, came to his padded knees, and rose again.

She stayed with him all day in the tiny glen, just nibbling a few mouthfuls of the short grass that grew around. Most of the time she spent exercising her kid. When the sun had set he was able to walk steadily, to take little short runs, to toss his head. They lay all night beneath the shelter of the ledge, with the kid between his mother's legs, against her warm body.

Next morning she hid him securely in a crevice of the neighboring crag, in a small groove between two flags that were covered with a withered growth of wild grass and ferns. The kid crawled instinctively into the warm hole without any resistance to the gentle push of his mother's horns. He lay down with his head toward his doubled hind legs, and closed his eyes. Then the goat scraped the grass and fern-stalks over the entrance hole with her forefeet, and she hurried away to graze, pretending that she was not aware of her kid's nearness. But still, she pricked her little ears at every distant sound.

At noon she took him out and played with him on a grassy knoll and watched him prance

Night passed with a glorious dawn that came over a rippling sea from the east.

about. She taught him how to rear on his hind legs and fight the air with his forehead. Then she put him back into his hiding-place and returned to graze until nightfall.

Just when she was about to fetch him from his hole and take him to the overhanging ledge to rest for the night, a startling sound reached her ears. It came from afar, from the south, from beyond a low fence that ran across the crag on the sky-line. It was indistinct, barely audible, a deep, purring sound. But to the ears of the mother-goat it was loud and ominous as a thunderclap. It was the breathing of a dog sniffing the wind.

She listened stock-still, with her head in the air and her short tail lying stiff along her back, twitching one ear. The sound came again. It was nearer. Then there was a patter of feet. Then a clumsy black figure hurtled over the fence and dropped on the crag, with awkward secrecy. The goat saw a black dog, a large, curly fellow, standing by the fence in the dim twilight, with his forepaw raised and his long red tongue hanging. Then he shut his mouth suddenly, and raising his snout upward sniffed several times, contracting his nostrils as he did so, as if in pain. Then he whined savagely, and trotted toward the goat sideways.

She snorted. It was a sharp, dull thud, like a blow from a rubber sledge. Then she rapped the crag three times with her left forefoot loudly and sharply. The dog stood still and raised his forepaw again. He bent down his head and looked at her with narrowed eyes. Then he licked his breast and began to run swiftly to the left. He was running toward the kid's hiding-place, with his tail stretched out straight and his snout to the wind.

With another fierce snort the goat charged him at full speed, in order to cut him off from his advance on the kid's hiding-place. He stopped immediately when she charged. The goat halted, too, five yards from the hiding-place, between the dog and the kid, facing the dog.

The dog stood still. Then he slowly raised his bloodshot eyes to the goat. He bared his fangs. His mane rose like a fan.

The dog stood still. His eyes wandered around in all directions, with the bashfulness of a sly brute, caught suddenly in an awkward position. Then slowly he raised his bloodshot eyes to the goat. He bared his fangs. His mane rose like a fan. His tail shot out. Picking his steps like a lazy cat, he approached her without a sound.

When he was within six yards of her he uttered a ferocious roar—a deep, rumbling sound in his throat. He raced toward her, and leaped clean into the air, as if she were a fence that he was trying to vault. She parried him subtly with her horns, like a sword-thrust, without moving her forefeet. Her sharp horns just grazed him as he whizzed past her head. But the slight blow deflected his course. Instead of falling on his feet as he had cunningly intended to do, between the goat and the kid, he was thrown. The goat whirled about and charged him.

But he had arisen immediately and jerked himself away, with his haunches low down, making a devilish scraping and yelping and growling noise. He wanted to terrify the kid out of his hiding-place. Then it would be easy

to overpower the goat, hampered by the task of hiding the kid between her legs.

The kid uttered a faint, querulous cry, but the goat immediately replied with a sharp, low cry. The kid mumbled something indistinct, and then remained silent. There was a brushing sound among the ferns that covered him. He was settling himself down farther. The goat trotted rigidly to the opposite side of the hiding-place to face the dog again.

The dog had run away some distance, and lay licking his paws. Now he meant to settle himself down to the prolonged attack. He yawned lazily and made peculiar, mournful noises, thrusting his head into the air and twitching his snout. The goat watched every movement with her ears thrust forward past her horns. Her great, soft eyes were very wild and timorous in spite of the valiant posture of her body, and the terrific force of the blows she delivered occasionally on the hard crag with her little hoofs.

The dog remained lying for half an hour or so, continuing his weird pantomime. The night fell completely. Everything became unreal and ghostly under the light of the distant myriads of stars. An infant moon had arisen. The sharp rushing wind and the thunder of the sea only made the silent loneliness of the night more menacing to the white goat, as she stood bravely on the limestone crag defending her newborn young.

Then the dog attacked again. Rising suddenly, he set off at a long swinging gallop, with his head turned sideways toward the goat, whining as he ran. He ran around the goat in a wide circle, gradually increasing his speed. A white spot on his breast flashed and vanished as he rose and fell in the undulating stretches of his flight. The goat watched him, fiercely rigid from tail to snout.

When he passed his starting-point, he was flying at full speed, a black ball shooting along the gloomy surface of the crag, with a sharp rattle of claws. The rattle of his claws, his whining, and the sharp tapping of the goat's forefeet as she turned about, were the only sounds that rose into the night.

He sped round and round the goat, approaching her imperceptibly each round, until he was so close that she could see his glittering eyes and the white lather of rage on his half-open jaws. She became dizzy and confused, turning about in a confined space. His whining grew louder and more savage. The rattle of his claws was like the clamor of hailstones.

He came in a whirl on her flank. He came with a savage roar that deafened her. She shivered and then stiffened in rigid silence to receive him. The kid uttered a shrill cry. Then the black bulk hurtled through the air, close up, with hot breathing, snarling, with reddened fangs and . . . smash.

He had dived for her left flank. But as he went past her head she turned like lightning and met him again with her horns. This time she grazed his side, to the rear of the shoulder. He yelped and tumbled sideways, rolling over twice. With a savage snort she was upon him. He was on his haunches, rising, when her horns thudded into his head. He went down with another yelp. He rolled over and then suddenly, with amazing speed, swept to his feet, whirled about on swinging tail and dived for her flank once more. The goat uttered a shriek of terror. He had passed her horns. His fangs had embedded themselves in the matted ringlet that trailed along her right flank. The dog's flying weight, swinging on to the ringlet as he fell, brought her down.

But she was ferocious now. As she wriggled to her feet beside the rolling dog that gripped her flank, she wrenched herself around and gored him savagely. He yelped and loosed his hold. She rose on her hind legs in a flash, and with a snort she gored him again. Her sharp, pointed horn penetrated his side between the ribs. He gasped and shook his four feet in the air. Then she pounded on him with her forefeet, beating his prostrate body furiously. Her little hoofs pattered with tremendous speed for almost a minute.

Then she suddenly stopped. She snorted. The dog was still. He was dead. Her terror was passed. She lifted her right forefoot and shook it with a curious movement. Then she uttered a wild, joyous cry and ran toward her kid.

Night passed with a glorious dawn that came over a rippling sea from the east. The white goat and her kid were traveling eastward along the cliff-tops. They had traveled all night, flying from the horrid carcass of the beast that lay stretched on the crag beside the little glen. Now they were far away, on the summit of the giant white Precipice of Cahir. The white goat rested to give suck to her kid, and to look out over the cliff-top at the rising sun.

THE NEXT STORIES ARE ON PAGE 397.

TWO ACROBATS QUENCHING THEIR THIRST

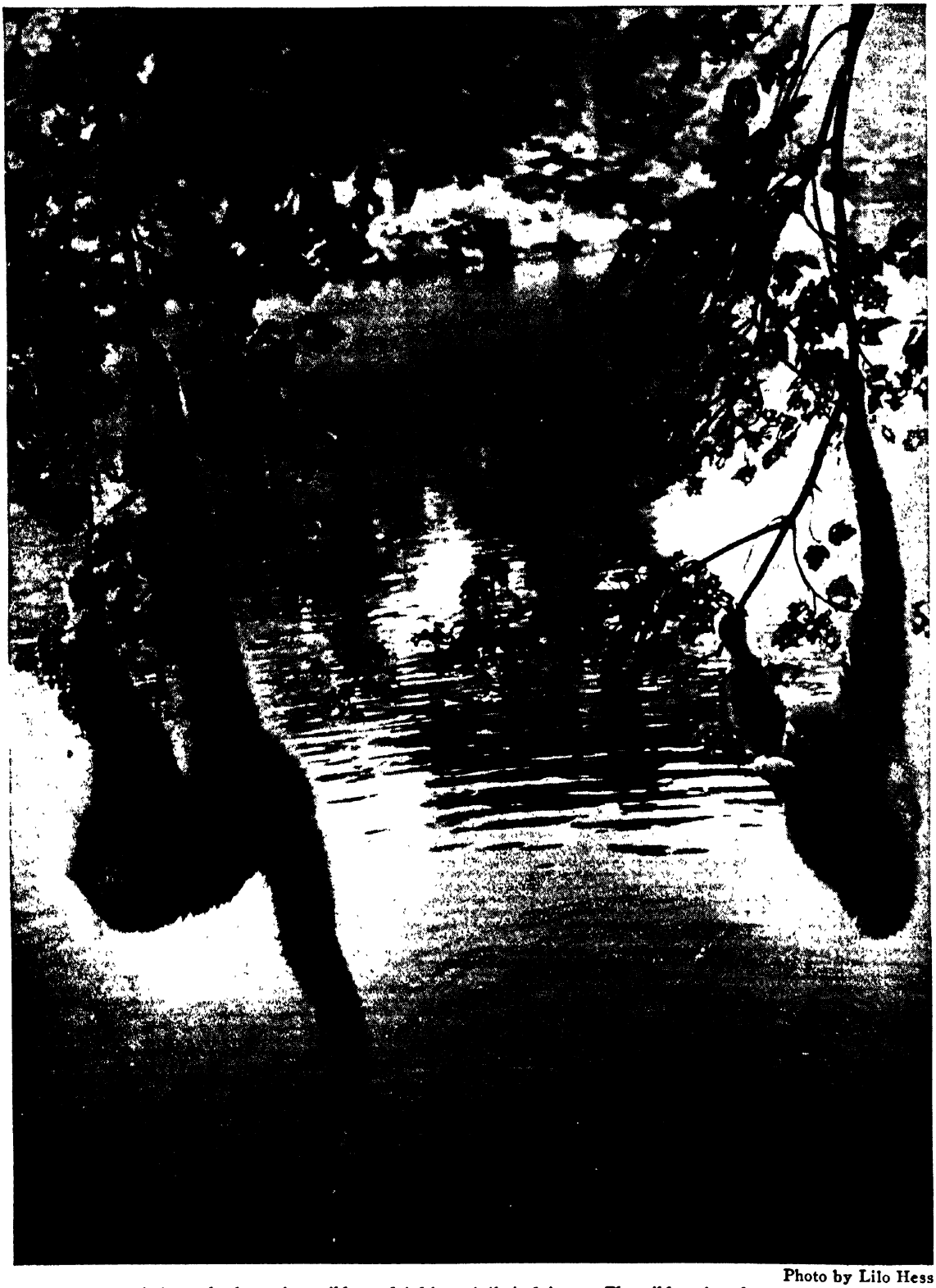


Photo by Lilo Hess

This striking photograph shows two gibbons drinking at their leisure. The gibbon is related to the chimpanzee and the orangutan, but it is smaller and more slender; its arms are longer in proportion to its body. This interesting animal ranks lowest among the anthropoid, or manlike, apes. It lives almost entirely in the trees. A remarkable acrobat, it swings from branch to branch with truly astonishing skill. On the ground, however, it is awkward and can not move with much ease. The gibbon is a gentle creature and makes an affectionate pet.

APES, MONKEYS AND LEMURS AND THEIR KIND

IN our study of animal life, we shall, in general, proceed from the most complicated forms to the most simple. Now the most complicated animals are the mammals, those whose babies are born alive and are fed for a while on their mother's milk. There are a great many mammals—cats and dogs, cows, whales, mice, bats, lions and tigers—in fact, the list of mammals is very long. So we must divide the mammals into groups, or orders, and take up one order at a time.

The most important of all mammals is man. We shall study man in a separate department of our book, called Our Own Life. Man is a member of the order of Primates.

The animals which are ranked below man in the order Primates—the apes, monkeys, baboons, marmosets and lemur-like animals — are extremely varied. Some show remarkable resemblance to us in appearance, others are very different. All are found in, or near, tropical regions, although some live high on the mountains where the climate is far from mild.

Man, with his highly developed brain, his upright posture, his sense of duty and appreciation of beauty, is very different from the lower Primates, but his structure resembles theirs closely. The bones and muscles are almost the same, the teeth show great similarity, and even the brain differs chiefly in its much greater size. All of the sense centers and the areas that govern various movements are alike in man and the great apes, as many experiments have shown.

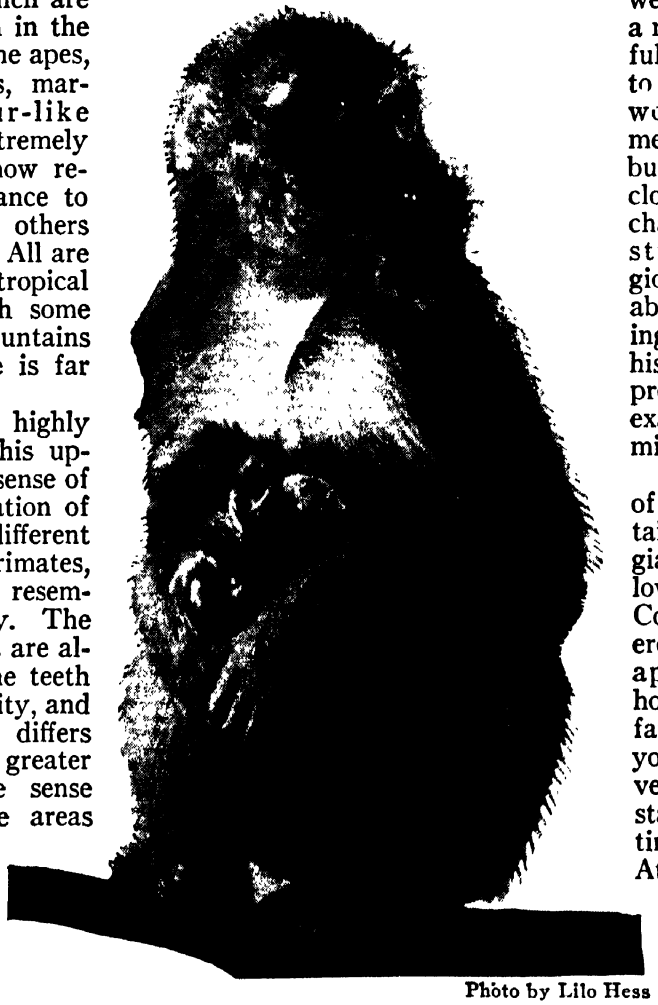


Photo by Lilo Hess

Safe in mother's arms—a female macaque and her baby.

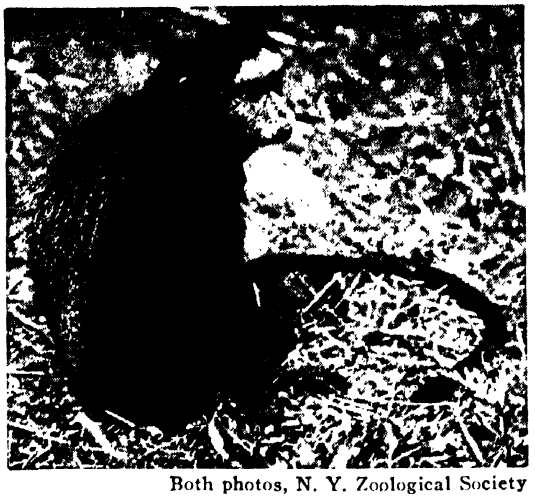
The ape family includes gorillas, chimpanzees, orangutans and gibbons. Perhaps you have seen some of these apes. They have no tail. Their intelligence is almost childlike. They can stand up on their legs, but walking this way is usually done with an effort. Normally they walk on all fours, on the knuckles of their fingers and the flat of their feet. Apes and monkeys are often called four-handed because their feet are much like their hands, the great toe being thumb-like and grasping.

The gorilla is the greatest member of the ape family and the largest living member of the Primates. Old male gorillas may weigh four hundred pounds or more, the females well over half this. As a rule they are peaceful giants, preferring to run through the woods, away from men who hunt them; but if pressed too closely the male will charge fiercely. His strength is prodigious; the old stories about a gorilla bending a gun barrel in his bare hands were probably not so much exaggerated as they might seem to us.

In the dense forests of the Kivu Mountains, in eastern Belgian Congo, and in the lowlands of French Congo and the Cameroons, these great apes make their homes. They live in family groups. The young gorillas climb very well, but old ones stay almost all the time on the ground. At night the gorilla family sleeps on the ground in nests made of branches and leaves. They feed

on fruit, wild celery, buds and shoots of many sorts and often raid the plantations of the African natives. Gorillas are especially fond of plantains and bananas. They destroy much more than they use. The Africans try to kill as many of them as they can.

Meat is extremely scarce in the forests of Africa; and this is still another reason why the natives like to hunt gorillas. The entire village sets out for the hunt with spears, nets and guns. If the hunt succeeds, there is plenty of meat.



Both photos, N. Y. Zoological Society
The black guenon, an inhabitant of Africa.

Most gorillas we see in zoos are caught as babies in such hunts. Their parents and partly grown brothers and sisters are speared or shot, but a baby gorilla makes an attractive pet. The natives often give them affectionate care, and this keeps the helpless little gorillas alive. Then some are sold to zoos and brought to foreign lands.

These great apes are hard to keep in captivity, for they are likely to get human diseases, such as tuberculosis. Some have grown up in zoos, and in most of the big cities today there are one or two either adult or partly grown. They are generally a center of attraction.

Gorillas are usually deliberate in all their actions, not so lively or mischievous as chimpanzees, but they are on the move most of the day. Sometimes one beats on his chest, or pounds the floor to attract attention. They climb about on bars or ladders and turn part-somersaults. Sometimes they throw things or splash water.

The hamadryas baboon.

The chimpanzee is smaller than the gorilla and much more agile and playful. Even old ones never have the great jaws of the other African ape. Chimpanzees live more in the trees, climbing to the roof of the forest and making their overnight nests in the tree tops. They are found in the great forests of Africa from Sierra Leone east to Uganda and south to the mouth of the Congo.

They, too, live in family groups. Fruit and buds are their chief foods, and they keep away from native clearings. Chimpanzees are the most intelligent of the apes. Their curiosity is pronounced and they show powers of observation and imitation that are astonishing. They have a sense of rhythm, shown in a kind of dance. They sometimes beat on the ground or on trees, producing sounds like a drummer.

Most performing chimpanzees are young animals. Older ones are too powerful and too uncertain in temper. The young apes learn to ride bicycles, eat with spoons and ride ponies. They can learn many of the things that a three-year-old child can learn.

Orangutans are larger than chimpanzees but never grow to the size of gorillas. They are reddish brown in color, with long, shaggy hair. Old males have odd skin growths on each cheek, giving them full-moon faces, and heavy folds on their throats. Some have long, shaggy whiskers, like the mustache and beard of an old man. Females and young ones are apt to look appealing and mischievous.

All the orangs there are live in the dense forests of Sumatra and Borneo. They spend almost all their time in the tree tops, even the big males, which may weigh as much as 175 pounds. The long, powerful arms, which reach almost to the ground when the apes stand upright, are used to swing from branch to branch. The legs are short, ending in hand-like feet. Orangs are slow, generally testing each branch before trusting their weight to it. Yet they travel through the trees more rapidly than a man can go on the ground.

These apes feed on fruit, but they also eat buds and shoots. Like the other apes, orangs live in family groups. Old males are often

solitary. All male orangutans have powerful voices, which are a result of the great development of the larynx.

THE GIBBONS ARE MUCH SMALLER AND LIGHTER THAN THE OTHER APES

Gibbons are much smaller and more lightly built than the great apes. Most of them are less than three feet high when standing up. The arms are long, like those of the orangutan, so that they can stand upright and touch the ground with their finger tips. They are the only apes that normally walk upright for any distance. While they usually walk along a branch with their hands held over their heads for balance, they can walk on the ground, too.

Gibbons live almost entirely in the trees. They are the acrobats of the ape world, swinging from branch to branch with speed like that of a bird, and without hesitation. They never miss the next branch, though it be twenty or thirty feet away.

They feed largely on fruits and buds, but birds, eggs, insects and spiders are eaten when opportunity offers. At morning or evening their loud whoops make the forest ring with weird sounds.

There are six or seven species, all found in southern Asia, from China and Burma to the islands of Borneo and Java. Most species are black, with small white markings; some individuals are straw-colored, and one, found on the islands of Borneo and Java, is gray.

The monkeys that live in Africa and Asia are less human-looking than the apes, though they "make faces" because their muscles of expression are well developed, as ours are. Their nostrils are close together. Most species have long tails, although these can not be used to hang from branches like those of some American monkeys. A few macaques have short tails. In several kinds the tail is very much reduced indeed. They have the same thirty-two teeth which man has.

Only one kind of monkey lives wild in Europe, a few tailless Barbary apes, or macaques on the Rock of Gibraltar. They are not apes, though called Barbary apes. This species is found in the African mountains of Algeria and Morocco, and the ones on the Rock may have been brought there long ago. In the days when the British first held Gibraltar, Spanish soldiers almost surprised the garrison, but the monkeys gave the alarm by chattering at the strangers' stealthy approach.

THE RHESUS MONKEY AND OTHER MEMBERS OF THE LARGE MACAQUE FAMILY

Most macaques live in the Orient. The best known is the rhesus monkey of China, India and Burma. It has a rather short tail and rusty hind quarters. The long-tailed crab-eating macaque lives along the rivers and lagoons of the Malay region and islands and in the Philippines. These monkeys swim well. The whole tribe may dive, one after another, into a great river and swim swiftly across when frightened.

The Indian bonnet monkey and the toque monkey of Ceylon are long-tailed, too. They have strange, radiating hair-tufts. The wanderoo, or lion-tailed macaque, also found in

Photo by Lilo Hess

This proboscis monkey, so called because of its amazing nose, lives in Borneo.

India, is one of the most striking of the group. It is black, with a gray beard and ruff, and its tail is tufted.

The pig-tailed macaque is about the size of a dog; its tail is short and thin. This species is found in the Malay region and on Borneo and Sumatra. Natives of Sumatra often tame young animals and teach them to climb trees and throw down fruit and coconuts for their masters. Old males are powerful and treacherous.

Stump-tailed macaques live from Tibet to the Malay Peninsula. Their tails are only an inch or two long. The Moor macaque of Celebes and the Japanese monkey are also short-tailed.

On the island of Celebes, there is, besides the Moor macaque, another monkey of this group, called the black ape. Its tail is hardly visible, its head has a high crest of hairs, and its muzzle is longer than those of the others.

N. Y. Zoological Society

The black-and-white guereza colobus monkey.

A large variety of slenderly built African monkeys, called guenons, are commonly seen in zoos. Their hairs are marked by many rings, giving them a mottled coloration. They are active, mischievous animals. Some are greenish gray, some are brilliantly marked with reddish and white, some have beards, while others have white spots on the nose or a line like a mustache on the upper lip.

Another African group is that of the mangabeys, long-tailed monkeys resembling the macaques but more slender in build. Their upper eyelids are white. Some are sooty gray in color, others black, while the white-collared mangabey has a reddish crown and the white of the collar extends onto the cheeks and chest.

The gelada of Ethiopia might be called the lion baboon, for its mane and tufted tail make one think of a lion. On the breast of the males there is a vividly red crescent of bare skin.

TRUE BABOONS LIVE IN LARGE TROOPS, GENERALLY IN ROCKY PLACES

True baboons are more hideous than other Primates, their long muzzle and great dog-teeth adding to this effect. They live in large troops, spending most of the time on the ground. Rocky places are usually preferred, and baboons are found in dry regions as well as in open forests. They reach a large size, 140 pounds in old males.

The sacred baboon, or hamadryas, was well known to the ancient Egyptians, who revered this animal as representing their god Thoth. Sacred baboons are gray in color. The males have a long mane. Today they are found in southern Arabia and the near-by northeastern corner of Africa. Other baboons are greenish gray, golden, reddish, or almost black. They are found in most of the rough, partly open country south of the Sahara Desert, in places even invading the great forest.

The mandrill and the drill are two short-tailed baboons, with bright-colored faces and swellings between eye and nostril. The drill is less brilliant. Its face is black, but the males have bright scarlet lips. The face of the male mandrill is blue, with purple and scarlet lines. Their buttocks are also scarlet. Females of both these baboons are without the color and are only about half as large as the males.

Another family of Old World monkeys lacks the cheek pouches of the macaques and their relatives. The monkeys of this group have a complex and large stomach, which is very well suited for their diet of leaves.

The langurs, or leaf monkeys, of southern Asia are slender animals with long tails. The Indian sacred monkeys, or hanumans, are white, or whitish, animals with blackish faces and great, projecting eyebrows. Some of these live high on the slopes of the Himalayas, while others live in the peninsula of India and in Ceylon.

There is a wide variety of langurs, black, gray or red in color, with stripes on limbs or on the head. They are found in the Malay region, India, Burma, Indo-China and on the

THE ANIMALS MOST LIKE MAN

ORANG-UTAN

CHACMA BABOON

AN OLD GORILLA

ORANG-UTAN

YOUNG MONKEYS

A BLACK APE

CHIMPANZEE

ANUBIS BABOON

A NISNAS MONKEY

WHITE-TAILED GUEREZA

COLOBUS ANGOLAN MONKEY

WHITE-COLLARED MANGABE

The photographs on these pages are by Messrs. Gambier Bolton, D. Seth-Smith, W. S. Berridge, T. A. Barns, W. P. Dando, C. Reid, and F. S. Bond.

TWO BABY ORANG-UTANS SIT FOR THEIR PHOTOGRAPH

A BARBARY APE AND HER LITTLE ONE

A CAPPED LANGUR WITH HER YOUNG ONE

CHIMPANZEES IN PLAYFUL MOOD

THE PIG-TAILED MONKEY

JOHNNY GORILLA

MANDRILL

MACAQUE MONKEY

WANDEROO MONKEY

GALAGO

YELLOW BABOON

RHESUS MONKEY

A CHIMPANZEE TAKES A WALK

CAPUCHIN MONKEY

SLOW LORIS

A GIBBON

RING-TAILED LEMURS

islands of Sumatra, Java and Borneo. The curious proboscis monkey, with huge, pendulous nose, is found in Borneo. In the mountains of western China and Tibet live the

Both photos, N. Y. Zoological Society
The sapajou monkey lives in the New World.

snub-nosed monkeys; some of them are beautifully marked with gold. These species do not thrive in captivity and are almost never seen in zoos.

The colobus monkeys of Africa are close relatives of the langurs. The handsome black-and-white guereza colobus have been hunted for their fur which is used not only for women's coats, but also for the war dress of East African natives. Other colobus monkeys are red in color, or pure black, or gray. They are all creatures of the high tree tops, feeding on leaves, buds and fruits.

VARIOUS SPECIES OF PRIMATES HAVE THEIR HOME IN THE NEW WORLD

Most of the New World monkeys have prehensile tails (tails that can grasp things). In some species, the tail is an excellent grasping organ, a fifth hand. The nostrils are widely separated in New World monkeys. Best known of these animals are the ring-tailed capuchins, or sapajous. They are extremely intelligent and make good pets. Spider monkeys are the acrobats of the American Primates, rivaling the gibbons in the ease and grace of their leaps through the air. Howlers, black or red in color, are large monkeys; males can roar almost as loudly as the lion.

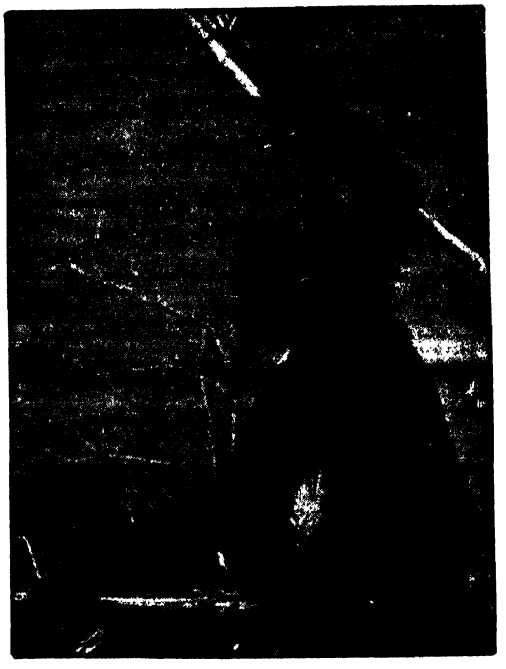
Squirrel monkeys are about the size of squirrels, with a long, slender tail. Their fur is a very delicate, greenish gold, and silky. Sakis are covered with long, shaggy black or grizzled hair, while the woolly monkey has dense, kinky hair, usually dark gray.

Tropical America is also the home of marmosets. They have claws on their fingers and toes, except for the thumbs and great toes, which have nails. The tail is usually ringed with dark-colored bands and it is never prehensile. Often the ears are covered with long tufts of hairs. The smallest species is the pigmy marmoset, about the size of a long-tailed chipmunk. The cries of pigmy marmosets are like the sounds of birds.

One of the strangest of all Primates is the tarsier. Its legs remind you of a frog's legs, and the ends of its fingers and toes have large pads that act as suction discs. Enormous, owl-like eyes, dwarfing the rest of its head, and a long tufted tail add to the odd appearance. Tarsiers are found in the East Indies, in Sumatra, Celebes and the southern Philippine Islands and the regions that lie between.

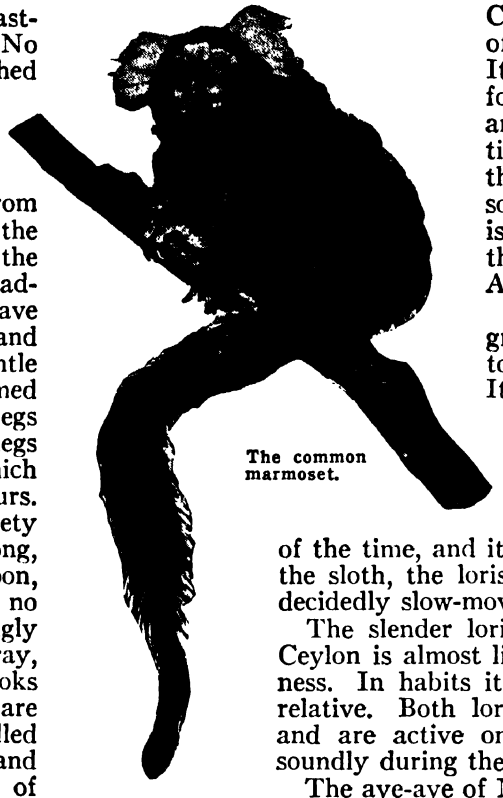
LEMURS ARE FOUND ONLY IN MADAGASCAR, OFF THE EASTERN COAST OF AFRICA

The lemurs are "four-handed," like most Primates, and show many inward resemblances to the monkey group, but at first glance they look more like foxes or mongooses. Their faces are long and pointed. Long ages ago lemurs were found in northern lands, but now they are confined to the island



The black spider monkey is an acrobat.

of Madagascar, off the eastern coast of Africa. No doubt the lemurs reached the island when it was part of southern Africa. Then the land sank, leaving the animals there cut off from those of the rest of the world. Sheltered from the struggle with more advanced mammals, they have been able to persist and flourish. They are gentle creatures and can be tamed quite easily. The hind legs are longer than the forelegs in the true lemurs, which move around on all fours.



The common marmoset.

There is a great variety of lemurs. Some have long, ringed tails, like a raccoon, others have practically no tail. Some are strikingly black and white, some gray, brown or black. One looks weasel-like and there are even mouse lemurs, so called from their small size and mouse-like build. One of these is said to sleep throughout the hot, dry weather, laying up a supply of fat in its tail.

Galagos, or bush babies, are relatives of the lemurs. They are found in Africa. One is about the size of a cat and has a long bushy tail. Another of the galagos is just about the size of a squirrel, but its tail is slender. There is a third, even smaller species; its body is only about five inches long, and its tail seven inches. It dwells in the forests of Guinea and the Congo. Another inhabitant of these regions is the potto. It is like a wee bear, only a foot long; it is four-handed and has big eyes. The awantibo looks a good deal like the potto; it is, however, somewhat more slender. It is found near the mouth of the Niger River, in western Africa.

The Asiatic loris is pale gray, with a stripe on the top of the head and neck. It is like the potto in shape and virtually tailless. The habits of the loris remind us of the sloths; it lives high in the branches of trees part of the time, and it feeds on the buds. Like the sloth, the loris and all its relatives are decidedly slow-moving creatures.

The slender loris of southern India and Ceylon is almost like a skeleton in its thinness. In habits it is much like its stouter relative. Both lorises have enormous eyes and are active only at night; they sleep soundly during the day.

The aye-aye of Madagascar has teeth like a rodent. Indeed, for a long time after its discovery it was supposed to be a strange kind of squirrel. Its feet are lemur-like and so are its internal organs, and all agree now that it is a cousin of the lemurs. In the hand, the fourth finger is very long, and the middle finger is almost as long. This middle finger is so slender it looks as if it had been paralyzed and shrunk. The finger may be used to reach into grub holes and fish out the insect larvae. The aye-aye is about the size of a cat, blackish brown in color, with a bushy tail and large ears.

By JOHN ERIC HILL.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 314.

Both photos, N. Y. Zoological Society

The red howler monkey, a noisy inhabitant of the New World. It lives up to its name, for the male can produce an ear-splitting howl.

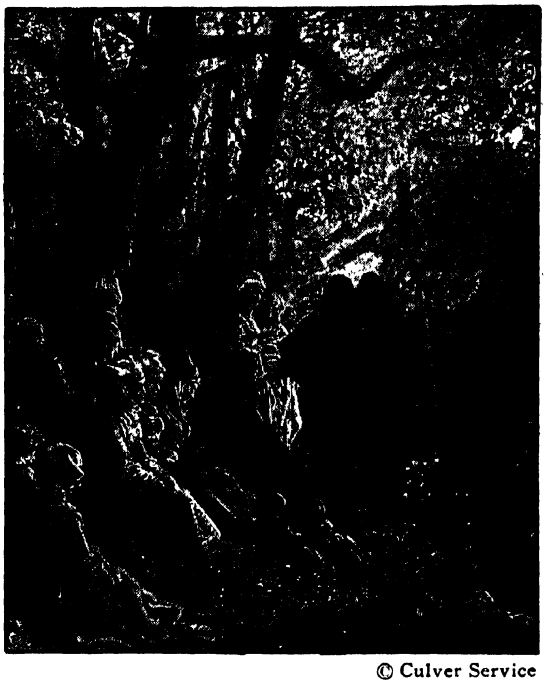
OUR UNWRITTEN LITERATURE

IN the article Digging Up the Past, beginning on page 6763, you may read how history is giving up her secrets long buried deep under the earth. A child's tea set and a doll found in a grave thousands of years old tell us that even so long ago little girls played with toys not so very different from our own. Statues of great antiquity show styles of clothing and of hairdressing. We can, in fact, secure a fair picture of life in early times from the things our far-away ancestors left behind.

They left us also a treasure much more wonderful than objects of gold or marble. Down through the ages there has come to us a marvelous collection of stories and tales about the great people who lived in the springtime of the world. We use the word "collection," because now the stories are collected and written down and translated into many languages.

In the beginning, as you know, there was no reading or writing. Even kings and princes were unable to sign their own names, except by the use of a primitive symbol or a seal. Nevertheless, they loved stories, just as much as we do. They enjoyed their stories not by reading, but by listening.

On page 55, you may read of the adventures of Beowulf, a Danish hero. He lived, perhaps 1500 years ago, at the court of his uncle, the king, where it was the custom to have a story-teller entertain the guests after feasting. This was true in all parts of Europe and also in Asia. Often the story-tellers chanted their tales, to the accompaniment of a simple melody on the harp. An astonishing thing about these men (bards, or minstrels, as they were usually called) was their memories. They could recite for hours at a time without pausing or losing their place in the tale. They loved to tell of kings and heroes, and knew by heart long lists of battles and often carried the origin of a hero back into the mists of time and declared him to be descended from one of the gods.



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A troubadour of old France, singing his story-songs.

It is largely through these old tales that we know something about the religion of the early peoples. The old Greek gods and goddesses have long since passed away. In all the world to-day there is no longer a single person who worships Zeus or Minerva or the fair-haired Apollo. The Norsemen no longer worship Odin or Thor or the other turbulent dwellers of the Northern heaven, Asgard. We know about them because the minstrels of their day wove into their songs legends of the gods they loved. We also know about home life and court life, and something of the laws and taboos of the people whose stories the minstrels told. Their listeners must have loved descriptions; there are word-pictures of boats and banquet halls and of furniture and clothing and scenery. Their interest in the changing aspects of the starry heavens reveals the ideas of astronomy which they held. Unconsciously, therefore, the ancient bards were handing down a historical record of their day.

They were conscious historians, too. Chieftains took bards along with them when they went to war, to amuse the camp when fighting was not going on, and to celebrate the victories by composing songs about them. There was exaggeration in the songs, but we can trust the main outlines of the stories. Archæologists have found that there really

was a walled city of Troy that fell in a great fire, as Homer told. Beowulf actually lived and was a mighty warrior, though of course his victory over a dragon is but a romantic tale. Some of the legends of King Arthur seem to have a foundation in fact. The Teutonic Nibelungenlied is probably a mixture of truth and fiction.

The bards were highly honored and were sure of a welcome in the castle and by the fireside of the humblest peasant. You can imagine why. If you lived in a world where there were no books or magazines or newspapers, no radio or telephone or phonographs and scarcely any travel, you would be delighted if a stranger appeared one day, and offered to pay for his board and lodging by describing the news of the great world, and by telling exciting stories to you, and singing popular songs.

The profession of bard was handed down from father to son through countless generations. A father would teach his son the stories, word for word. The son might, in his turn, make a few additions that proved popular with his audiences, and so, gradually, the stories did grow and vary in detail, but the main outlines were preserved for hundreds of years, until writing came in, and the accounts of the ancient heroes were inscribed in books for all to read. We call them epics, or sagas. The word epic comes from the Greek *epos,* meaning a word, a speech, or a tale. Saga is the Icelandic word for a saying.

THE FINNISH SAGA THAT WAS NOT WRITTEN DOWN UNTIL THE NINETEENTH CENTURY

Let us glance briefly at some of the most important epics or sagas. A very interesting one is the Kalevala, which was handed down by the ancient bards of Finland until minstrelsy died out in the country; from that time it existed only in the memories of the peasants until the nineteenth century, when a few songs were published. Then a Scandinavian scholar, Dr. Elias Lönrot, spent years, wandering from one remote hamlet to another, living with the peasants, taking down bit by bit the fragments of their epic, and putting the pieces together. Later, other scholars took up the task until more than 25,000 lines were collected and arranged. The American poet Longfellow was much impressed by the Kalevala, which was first made known to the world during his lifetime. His Song of Hiawatha was an imitation of it, in theme and metre, just as Virgil's Æneid is an imitation of the true Greek epics of Homer, the Iliad and Odyssey.

The metre of the Kalevala is like this:

Thus the little Hiawatha learned of every
bird its language.

The metre of the epics and of Virgil's imitative one, is reproduced by Longfellow in Evangeline:

This is the forest primeval. The murmuring
pines and the hemlocks.

The Kalevala tells the adventures of three heroes, Wainamoinen, the ancient inventor of the sacred harp, Ilmarinen the cunning smith, and Lemminkainen, the gallant. Most epics are about wars and bloodshed. The Kalevala is gentle and romantic, full of a strange, misty Arctic beauty.

"GRANNY'S TALES" THAT ARE AMONG THE WORLD'S MOST IMPORTANT EPICS

The Iliad and the Odyssey are the most dignified and highly perfected of the world's epics. (See Index for accounts of these.) Possibly the next in importance are the eddas of Iceland. The word edda is thought to be Norse for great-grandmother, and then by a sort of figure of speech to mean a "granny's tale." Iceland, from the ninth century onward, was inhabited by Irish and Norse immigrants of heroic character—Viking stock. The story-tellers (or saga-men) were popular and talented. The sagas were composed according to set rules, and saga-making was a fine art. Only three major themes were permitted: warfare, civil struggle and genealogy (the history of a particular family); but around these central themes were woven romances, humorous episodes and a wealth of detail.

From the twelfth century onward, men who could write collected these Icelandic sagas from the lips of those who remembered them. The scholars wrote on sheets of vellum. We are fortunate in having to-day much of the work of these medieval saga-writers. It gives a fascinating account of a brilliant civilization that blossomed and died in a few hundred years on its tiny island in the North Atlantic. The most important collections of the Icelandic sagas are called eddas. There are two eddas, one in prose, one in verse.

The prose edda was collected and put together by Snorri Sturlason, who lived from 1178 to 1241. This work contains five parts or sagas, one of which gives the best information that exists on the heathen gods of ancient Scandinavia.

The older, poetic edda was written in the tenth and eleventh centuries, but goes back much farther, as do all true epics, to a time when writing was unknown. This collection

of sagas tells of the exploits of gods and heroes, sybils and giants and dwarfs, living in a fabulous world, half heaven and half earth. About twenty of the numerous sagas in the collection relate to the heroic families of the Volsungs and the Nibelungs who were celebrated throughout northern Europe; their fortunes are also traced in the prose edda; they are mentioned in the epic Beowulf and form the basis of the Teutonic epic, the Nibelungenlied (Song of the Nibelungs) which in turn furnishes the theme of Richard Wagner's cycle of operas, the Ring series. Some scholars believe that the Nibelung-sagas had their start in the wars between Franks and Burgundians in the Dark Ages and gradually spread north into what is now Germany and northwest, across Ireland and the northern islands, to Iceland. It is believed that in the beginning the tales were about adventures that really happened. As the years passed, and the songs were retold, they were slowly changed and finally the true facts almost dropped out.

Pagan and Christian elements were woven together in a mythical story. The German version, the saga of the Nibelungs, has had a great influence on Germans through the centuries. Even to-day many Germans consider that the ideal type of young man resembles Siegfried, hero of the Nibelungs. The Nibelungenlied is still the great epic of Germany and continues to exercise a strong influence upon some of her writers and thinkers.

THE LEGEND OF KING ARTHUR AND OTHER SAGAS OF THE BRITISH ISLES

In the British Isles, the principal sagas may be classified as Welsh, Irish and Old English. The King Arthur legends (some of which you may read on pages 6941 to 6953) originated in Wales, and spread to England and Brittany. They appear in the Red Book of Hergest, a Welsh collection, which includes the Mabinogion, one of the world's important epics. The Story of Branwen, in the Mabinogion, is one of the most touching romances in literature. Branwen the Beautiful, sister of the King of Britain, wife of one of the high kings of Ireland, was made the occasion of bloody conflict between the two islands. She is a sort of Celtic Helen, but, unlike Helen of Troy, Branwen was without guilt in causing the war and the desolation. When, in fact, she observed the ruin upon the lands she loved, caused by the war, her heart broke, and she died of grief.

The Irish, or Gaelic, sagas were collected by various scribes. One such collection is called The Book of the Dun Cow, because an ancient saga was said to have been written, as early as the sixth century, on parchment made from the hide of the writer's favorite cow; later the title was applied to the larger collection which now bears the name. There is a large library of Irish epic material. From it we learn that professional story-telling in Ireland was carefully organized. The fili, or poet, of highest rank, knew 350 stories.

ONLY FRAGMENTS REMAIN OF THE EARLIEST ENGLISH LITERATURE

The Druids of Britain, Ireland and northern Gaul were said by Greek and Roman historians to have known many solemn heroic poems, celebrating the deeds of kings and chieftains of an incredibly early time. But the Druids left no written literature, and their epics disappeared with them.

There are fragments of four story-poems in Old English, of which Beowulf is the most complete. As you read the exciting story of Beowulf's adventure with the dragon, remember that the epic was originally chanted in an uneven metre which we find awkward. There was much use of alliteration, which was a favorite device of primitive English verse. The following lines are typical of this kind of repetition:

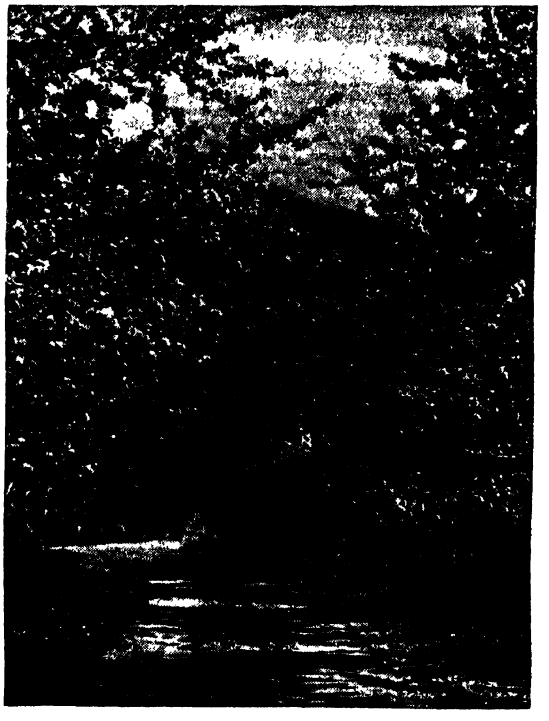
Then after wassail was wail uplifted, loud moan in the morn.

Epic legends flourished in France; they dealt with many themes. Some stories told of the great Emperor Charlemagne, of the members of his family and of his faithful followers. There were stories about the fights of the barons of the South against the Saracens. Other legends dealt with the fights of the feudal lords among themselves. The most famous legend of all told of the Emperor Charlemagne's nephew, Roland, who was slain at Roncevaux, in Spain, by the Saracens. Many of the epic legends blossomed into the written poems called the *chansons de geste* (songs of exploits). We tell you about these interesting epic poems on page 6560.

Other countries, too, have had their unwritten literature and fragments of some still exist. Almost all of them relate the fortunes of national heroes, such as Igor of Russia and Rustum of Persia. Bards and saga-tellers, mothers singing to their babies and old men spinning out their tales of ancient days have transmitted a literature of power and beauty. The wonderful thing about it is that it was made by the people themselves, who kept it alive in their memories and on their lips.

THE NEXT STORY OF LITERATURE IS ON PAGE 299.

THE GREAT GROUPS OF PLANTS



JOHNNY-JUMP-UP, Dutchman's breeches, Indian pipe, creeping Charley—these are very pleasant nicknames of flowers, but they are not the names by which scientists call these flowers. You can identify a sunflower growing in a field, but an expert in flowers can tell you which of the 70 kinds (or species) of sunflowers it is; each has its name. Each of the 135 different goldenrods has a name, and each of the 250 or more species of wild asters.

Some plants (and animals) have no nickname, or common name. Some have many. That tall woolly weed, mullein, is also known as velvet dock, woolens, Aaron's rod, velvet plant and almost forty other names.

A plant may have different names in different countries; our buttercup is called golden button in France. Or the same common name may refer to different plants. Sycamore means a fig tree in Egypt, a maple in Europe and the plane tree or buttonwood in our country.

Clearly, there must be a scientific way of naming living things, with names that are known all over the world. There is such a way. Two hundred years ago a Swedish botanist, Carolus Linnaeus, gave us a system that is easily understood.

Each kind of plant has a Latin name of two words. The first word indicates the genus, the second word the particular species. A genus is a group of species that are closely related. The plural of genus is genera; the plural of species is species. The genus is written with a capital initial, the species, in small letters.

All of the white oaks in the world form the species *Quercus alba*. (*Quercus* means oak and *alba* means white in Latin.) Red oak is *Quercus rubra* (*rubra* means red). By the shape and appearance of the leaves and acorns, we can tell a white oak from the red, or black, or any other species of oak.

A group of similar genera form a family. Oak trees, chestnut trees and beech trees resemble each other in such important ways that they are placed in the beech family, or Fagaceae.

A group of related families make an order, a group of orders make a class, related classes form a phylum (from a Greek word meaning tribe). The beech family and the birch family form the beech order. The beech order the rose order, the buttercup order and a great many others make up the class of angiosperms, or Angiospermae. The angiosperms together with the pine trees and their relatives make up the phylum of seed plants.

We think of living things as belonging to one of the two great divisions, the plant kingdom, or the animal kingdom. The plant kingdom is divided into four sub-kingdoms, or phyla: thallus plants (thallophytes, or Thallophyta); mosses and liverworts (bryophytes, or Bryophyta); ferns and their relatives (pteridophytes, or Pteridophyta); and seed plants (spermatophytes, or Spermatophyta).

THALLOPHYTES have no flowers, no fruits, no seeds, and no leaves, roots or stems corresponding to those of higher plants. Sometimes they are called the "simple plants." There are two great divisions, the Algae and the Fungi.

Algae is the plural of alga and also the Latin name of the group. Algae differ from fungi in that algae have chlorophyl, while fungi do not. Algae range in size from microscopic single cells to giant seaweeds more

than 200 feet long. As algae have chlorophyl, they can carry on photosynthesis, the process by which green plants make their own food. Practically all the food that supports the fishes and other sea animals is manufactured by algae. Some of the classes of Algae are:

Blue-green Algae. Besides chlorophyl these little plants have other coloring matter. Sometimes it is blue-green, but sometimes it is red, yellow or purple. Some blue-green algae thrive in hot springs at temperatures between 150° and 170° F. Some can be frozen in solid ice for months without being injured. Many grow in the soil and some grow inside the roots of other plants. Next to bacteria, the blue-green algae are the most primitive plants.

Green Algae are typically a bright grass-green in color, though some are yellow and some are brown. The single-celled forms occur both in fresh and salt water. The green coating on tree trunks and old fences that looks like fresh green paint after a rain is composed of millions of one-celled green algae. Some green algae form a partnership with corals and certain sea worms and live inside their tissues. Many of the one-celled algae swim actively through the water, whirling living threads around like propellers. Some of the larger types look like bright strands of green silk; one is called sea lettuce from its appearance.

Brown Algae contain chlorophyl and also a brown pigment. Their color ranges from olive green to deep brown. They are most abundant in the cooler waters of the ocean. Some are small, but the brown algae include the largest of all water plants. Some of the great kelps of the Pacific Ocean are around 200 feet in length. The gulf weed, which forms the great mass of floating vegetation known as the Sargasso Sea, is one of the brown algae.

Red Algae, as you would guess from their name, contain a red pigment in addition to the green chlorophyl. Some of them are red in appearance, some purple, some blue. Some red algae grow attached to rocks near shore, but some of them can carry on photosynthesis at greater depths and with dimmer light than any other plants. Some of them thrive in the shadows more than 200 feet below the surface of the ocean. Many are among the most delicate of all plants; but the coralline algae of tropical waters take part in the formation of coral reefs. Like the coral animals, the coralline plants form great masses of limestone rock.

Fungi. Since the fungi lack chlorophyl, they can not carry on photosynthesis. Hence they have to live on food originally made by other plants. The fungi are the great agents of decay. They reduce anything that dies to simple substances that can be used by the green plants. For this reason the fungi are very important. In fact, life could not go on without the fungi of decay. Just as the green plants make it possible for the fungi (and the animals) to live by supplying them with food and oxygen, the fungi of decay are needed to make available to green plants the elements that otherwise would be locked up in dead remains of plant and animal life.

Bacteria. Each bacterium consists of a single cell, much smaller than any other plant or animal. Like the blue-green algae, bacteria have no definite nucleus. Bacteria are found wherever other living things are found. They are of the greatest importance in decaying dead materials, but unfortunately they cause many diseases in man, the lower animals, and plants.

The true Fungi include an enormous variety of forms. Yeast, molds, mildews, and mushrooms are all fungi. Other types are the truffles which grow underground, the puffballs, and the bracket fungi which grow like shelves from the sides of trees. Ringworm and athlete's foot are caused by fungi that grow in human skin. Many fungi cause diseases in plants, among the worst being the rusts and smuts. Other important fungi include the yeasts, the mold that produces penicillin, the other common blue and green molds and the familiar mushrooms and toadstools.

Lichens. A lichen is a partnership. Every lichen consists of two kinds of plant. Each specimen is a fungus with a large number of alga cells growing inside it. The alga cells make food that the fungus also lives on. The fungus absorbs water and mineral matter and apparently gives the alga some protection. Lichens are the toughest of all plants in resisting the elements. They grow in places where nothing else could live, on Antarctic mountains where the temperature rarely climbs above freezing and on desert rocks at temperatures of 175° F. The "reindeer moss" of northern Canada is a lichen.

BRYOPHYTES also have no flowers, fruits or seeds. They have no true roots, but some of them have delicate stems and leaves. A curious development called alternation of generations takes place in these plants. The leafy green moss plants produce eggs, which are then fertilized. The fertilized egg, while still attached to the original moss plant, develops into a stalk with a little capsule looking something like a salt cellar at the tip. This stalk is really a new plant. The capsule at the end of the stalk produces a great many tiny spores. The wind blows these about until they fall to earth. When the spores sprout they develop into new moss plants. There are two classes of bryophytes, the liverworts and the mosses.

Liverworts. If you find bright green slimy little plants so thin that they are almost transparent, they are probably liverworts. Other types are flat, leafless growths, somewhat fleshy but intensely green. They are usually found in damp places.

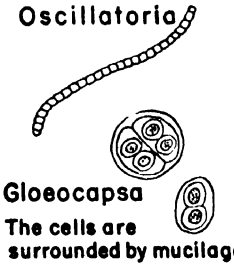
Mosses are to be found in the woods, under plants in meadows, frequently competing with the grass in unsuccessful lawns. They are frequently found in cracks in sidewalks and even growing between the bricks in buildings in cities.

THE GREAT GROUPS OF PLANTS

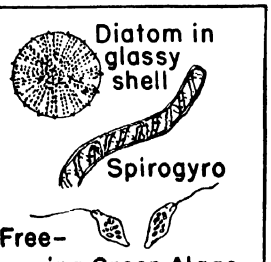
THALLOPHYTES. Simple plants without stems, roots or leaves.

I. ALGAE. *Have chlorophyl; mostly water plants.*

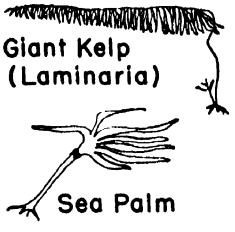
Blue-green Algae. Very small, without a nucleus. Found in hot springs, and other unfavorable surroundings.



Green Algae. Abundant in fresh water and at surface of ocean. Some can swim. Some have glassy shells.



Brown Algae. Include largest seaweeds, up to 200 feet long, also the seaweeds of Sargasso Sea.

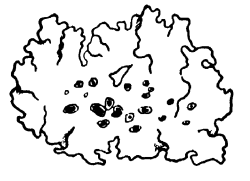


Red Algae. Some red algae thrive in dim light 200 feet below ocean's surface.

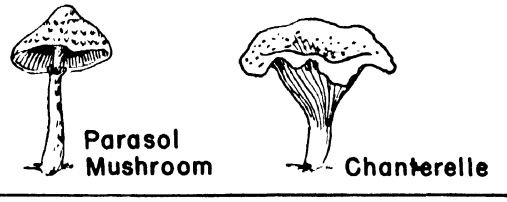
II. FUNGI. *Lack chlorophyl; depend on food made by green plants.*

Bacteria. Extremely small, one-celled. Found almost everywhere where life is possible.

Lichens. Each lichen is a partnership between a fungus and an alga.



True Fungi. Include molds, mildews, mushrooms, etc.



BRYOPHYTES. Small, delicate plants, lacking flowers, seeds and true roots.

Liverworts. Small plants. Cling to ground or plant they grow on.

Mosses. Much more abundant than liverworts. Peat mosses form great bogs.

THE GREAT GROUPS OF PLANTS

PTERIDOPHYTES. Ferns and their relatives. Have well-developed leaves, roots and stems, but no flowers or seeds.

Club mosses. Moss-like in appearance but more highly developed than the true mosses.

Ground Pine

Shining Club Moss

Horsetails. Stiff, leafless plants, often called scouring rushes. All extinct except one genus.

Ferns. By far the most abundant and familiar of the pteridophytes.

SPERMATOPHYTES. The seed plants. The only plants which reproduce by seeds.

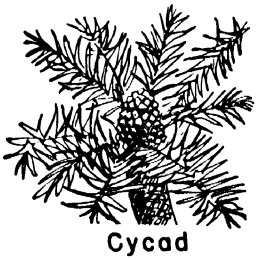
I. GYMNOSPERMS. *Seeds are called naked, because they are not enclosed in a fruit.*

Ginkgo. Once this group was abundant, but only one species is left.

Ginkgo

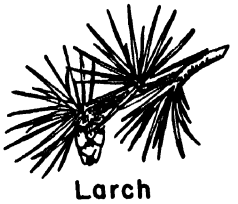
Ginkgoales (Extinct)

Cycads. Stiff, slow-growing plants of warm climates. Look like palms.



Cycad

Conifers. Include most evergreen trees. Some are oldest living things.



Larch

II. ANGIOSPERMS. *Seeds are enclosed in fruit. Most familiar plants are angiosperms.*

Monocots. Seedling has one seed-leaf. Flower parts usually in threes or sixes. Grasses, palms, orchids, lilies, bananas, etc.

Annunciation Lily

Dicots. Seedling with two seed-leaves. Flower parts in fours or fives. Most trees, fruits, weeds and other familiar plants.

Dog Rose

A very special kind of moss is the peat moss that often forms floating masses in lakes. Under favorable conditions the moss accumulates under the surface as it dies, but does not decay. Eventually the undecayed material forms peat.

PTERIDOPHYTES. Coal is composed of the remains of plants that grew millions of years ago. Scientists believe that the vegetation may once have been even more luxuriant than it is in rich tropical forests today. But the plants were different. There were no flowers. Instead of the oaks, the elms and the apple trees we know, the forests were composed of great fern-like trees. Other large trees of those days were closely related to the present horsetails and club mosses. There are three classes in this phylum.

Ferns. There is little danger of mistaking a fern for any other plant. Usually they have large leaves divided into many leaflets. The tip of the young leaf is coiled, and as the leaf grows it uncoils. In most ferns the stem is underground. Most ferns prefer to grow in the shade of forest trees, but there are some that thrive in sunny meadows and some that grow on the trunks or branches of trees.

Like the mosses, the ferns and their relatives have an alternation of generations. The familiar fern plant produces great numbers of spores on the under side of the leaves. If a spore lands in a moist spot it grows into a delicate green structure much like a liverwort. This structure produces the microscopic eggs of the fern, and the egg develops into the large fern plant.

Club mosses. These beautiful plants are called club mosses because they produce their spores in club-like cones and because they somewhat resemble mosses. They frequently cover the ground under pine woods or cedar groves. Some of the most attractive species are called ground pines or ground cedars.

Horsetails. These stiff, thin, leafless plants are most common in wet meadows and woods and in the gravel of railway embankments. Horsetails are sometimes called scouring rushes because their stems are so rough that they can be used for scouring floors.

SPERMATOPHYTES. Most of the common plants with which we are familiar belong to this phylum. They reproduce by means of seeds. None of the plants in the other phyla produce seeds. Just as the algae are the typical plants of the ocean, the seed plants are the typical plants of the land. The seed plants are divided into two great groups.

Gymnosperms, the pine trees and their relatives. They differ from the other seed plants in the way their seeds develop and in the structure of the wood. In the lumber trade they are called soft woods. They are considered to be the most primitive seed plants.

The cycads, are stiff, palm-like trees that grow very slowly. They were abundant in the days of the dinosaurs, but only a few species remain. Most of them grow in the tropics.

The ginkgo (also called maidenhair tree, because its leaves look like the leaflets of the maidenhair fern) has apparently completely died out in the wild state. Fortunately it was preserved in gardens in China and Japan.

The conifers (cone-bearers) are the only gymnosperms that are successful today. The pine, spruce, fir, hemlock, cedar, redwood and California big tree are conifers. Most of them are evergreen, but the bald cypress of the South and the larch lose their leaves in winter. The oldest and the largest living things are conifers.

Angiosperms. These are the most successful land plants. About 129,000 species of angiosperms are known, out of a total of 238,000 species of plants of all kinds from the bacteria up. When angiosperms form wood is has a different structure from that of the gymnosperms; and the seeds of the angiosperms are enclosed in a fruit, though sometimes the fruit is very inconspicuous. As they all have flowers of one kind or another, they are often called the flowering plants.

There are two classes, the dicotyledons (dicots, for short) and the monocotyledons (monocots, for short). They are named for the number of leaves that the baby plant starts out with when it is still in the seed. The dicots have two such seed leaves; the monocots have one seed leaf. Sometimes these seed leaves are large and fleshy, as in nuts, beans and peas. In some plants, such as the lima bean, the seed leaves are raised into the air and turn bright green.

Monocots. The parts of the flower are usually in threes or sixes, and the leaves have parallel veins. Among the monocots are many beautiful flowers such as the lily, the tulip, the iris and the 5,000 species of orchid. Other monocots include the palms, the banana, the grasses, including wheat and the other cereals.

Dicots. The parts of the flower are usually in fours or fives and the leaves are net-veined (with the veins running in different directions and crossing each other.) Many dicots are famous for their beautiful flowers. Among these are the buttercups, anemone, delphinium, hepatica, rose, daisy, and aster. Most important fruits are here, such as blackberries, strawberries, apples, cherries, peaches and oranges. Most trees, except the evergreens, are dicots.

By THOMAS GORDON LAWRENCE.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 329.

LITTLE ONES AND LULLABIES

Illustrated by Harriet Wolpin

Lullaby

From THE PRINCESS

By ALFRED, LORD TENNYSON (1809-1892)

SWEET and low, sweet and low,
Wind of the western sea,
Low, low, breathe and blow,
Wind of the western sea!
Over the rolling waters go,
Come from the dying moon, and blow,
Blow him again to me;
While my little one, while my pretty one,
sleeps.

Sleep and rest, sleep and rest,
Father will come to thee soon;
Rest, rest, on mother's breast,
Father will come to thee soon;
Father will come to his babe in the nest,
Silver sails all out of the west,
Under the silver moon:
Sleep, my little one, sleep, my pretty one,
sleep.

Baby*

By GEORGE MACDONALD
(1824-1905)

WHERE did you come from, baby dear?
Out of the Everywhere into the here.

Where did you get those eyes so blue?
Out of the sky as I came through.

What makes the light in them sparkle and
spin?
Some of the starry twinkles left in.

Where did you find that little tear?
I found it waiting when I got here.

What makes your forehead so smooth and
high?
A soft hand stroked it as I went by.

What makes your cheek like a warm white
rose?
I saw something better than any one knows.

Whence that three-cornered smile of bliss?
Three angels gave me at once a kiss.

Where did you get this pearly ear?
God spoke, and it came out to hear.

Where did you get those arms and hands?
Love made itself into bonds and bands.

Feet, whence did you come, you darling
things?
From the same box as the cherub's wings.

How did they all just come to be you?
God thought about me, and so I grew.

But how did you come to us, you dear?
God thought about you, and so I am here.

The Children's Hour

By HENRY W. LONGFELLOW (1807-1882)

BETWEEN the dark and the daylight,
When the night is beginning to lower,
Comes a pause in the day's occupations,
That is known as the Children's Hour.

I hear in the chamber above me
The patter of little feet,
The sound of a door that is opened,
And voices soft and sweet.

From my study I see in the lamplight,
Descending the broad hall stair,
Grave Alice, and laughing Allegra,
And Edith with golden hair.

A whisper and then a silence:
Yet I know by their merry eyes
They are plotting and planning together
To take me by surprise.

A sudden rush from the stairway,
A sudden raid from the hall!
By three doors left unguarded
They enter my castle wall!

They climb up into my turret
O'er the arms and back of my chair;
If I try to escape, they surround me;
They seem to be everywhere.

*Reprinted by special permission of the publishers, *Messrs. Chatto & Windus, London, England.*

They almost devour me with kisses,
Their arms about me entwine,
Till I think of the Bishop of Bingen,
In his Mouse-tower on the Rhine!

Do you think, O, blue-eyed banditti,
Because you have scaled the wall,
Such an old moustache as I am
Is not a match for you all?

I have you fast in my fortress,
And will not let you depart,
But put you down into the dungeon
In the round-tower of my heart.

And there will I keep you forever,
Yes, forever and a day,
Till the walls shall crumble to ruin,
And moulder in dust away.

Shuffle-Shoon and Amber-Locks*

By EUGENE FIELD (1850-1895)

SHUFFLE-SHOON and Amber-Locks
Sit together, building blocks;
Shuffle-Shoon is old and grey,
Amber-Locks a little child;
But together at their play
Age and youth are reconciled,
And with sympathetic glee
Build their castles fair to see.

"When I grow to be a man,"
So the wee one's prattle ran,
"I shall build a castle so—
With a gateway broad and grand;
Here a pretty vine shall grow,
There a soldier guard shall stand;
And the tower shall be so high,
Folks will wonder, by-and-by!"

Shuffle-Shoon quoth: "Yes, I know;
Thus I builded long ago!
Here a gate, and there a wall,
Here a window, there a door;
Here a steeple wondrous tall
Riseth ever more and more!
But the years have levelled low
What I builded long ago!"

So they gossip at their play,
Heedless of the fleeting day.
One speaks of the Long Ago
Where his dead hopes buried lie;
One with chubby cheeks aglow
Prattleth of the By-and-by;
Side by side they build their blocks—
Shuffle-Shoon and Amber-Locks.

A Gaelic Lullaby

HUSH! the waves are rolling in,
White with foam, white with foam;
Father toils amid the din;
But baby sleeps at home.

Hush! the winds roar hoarse and deep—
On they come, on they come;
Brother seeks the wandering sheep;
But baby sleeps at home.

Hush! the rain sweeps o'er the knowes,
Where they roam, where they roam;
Sister goes to seek the cows;
But baby sleeps at home.

*From Poems of Eugene Field, copyright, 1910, by Julia S. Field: Permission of the publisher, Charles Scribner's Sons.

A Parental Ode to My Son

(AGED THREE YEARS AND FIVE MONTHS)

By THOMAS HOOD (1799-1845)

THOU happy, happy elf!
(But stop,—first let me kiss away that tear!)
Thou tiny image of myself!
(My love, he's poking peas into his ear!)
Thou merry, laughing sprite,
With spirits feather-light,
Untouched by sorrow, and unsoiled by sin,—
(My dear, the child is swallowing a pin!)

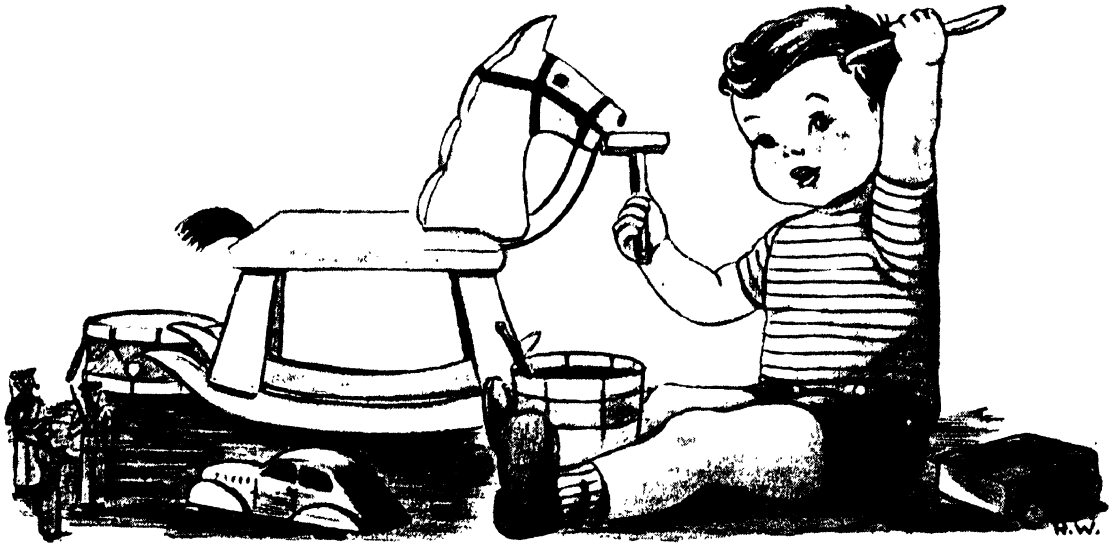
Thou little tricksy Puck!
With antic toys so funnily bestuck,
Light as the singing bird that wings the air,—
(The door! the door! he'll tumble down the stair!)
Thou darling of thy sire!
(Why, Jane, he'll set his pinafore afire!)
Thou imp of mirth and joy!
In Love's dear chain so strong and bright a link,
Thou idol of thy parents,—(Drat the boy!
There goes my ink!)

Thou cherub,—but of earth;
Fit playfellow for Fays, by moonlight pale,
In harmless sport and mirth,
(That dog will bite him, if he pulls its tail!)
Thou human humming-bee, extracting honey
From every blossom in the world that blows,
Singing in youth's Elysium ever sunny.—
(Another tumble! That's his precious nose!)

Thy father's pride and hope!
(He'll break the mirror with that skipping-rope!)
With pure heart newly stamped from nature's mint,
(Where *did* he learn that squint?)
Thou young domestic dove!
(He'll have that jug off with another shove!)
Dear nursling of the hymeneal nest!
(Are these torn clothes his best?)
Little epitome of man!
(He'll climb upon the table, that's his plan!)
Touched with the beauteous tints of dawning life, —
(He's got a knife!)

Thou enviable being!
No storms, no clouds, in thy blue sky foreseeing,
Play on, play on,
My elfin John!
Toss the light ball, bestride the stick,—
(I knew so many cakes would make him sick!)
With fancies, buoyant as the thistle-down,
Prompting the face grotesque, and antic brisk,
With many a lamb-like frisk!
(He's got the scissors, snipping at your gown!)

Thou pretty opening rose!
(Go to your mother, child, and wipe your nose!)
Balmy and breathing music like the South,—
(He really brings my heart into my mouth!)
Fresh as the morn, and brilliant as its star,—
(I wish that window had an iron bar!)
Bold as the hawk, yet gentle as the dove;—
(I'll tell you what, my love,
I cannot write unless he's sent above.)



The Barefoot Boy

By JOHN GREENLEAF WHITTIER
(1807-1892)

BLESSINGS on thee, little man,
Barefoot boy, with cheek of tan!
With thy turned-up pantaloons,
And thy merry whistled tunes;
With thy red lip, redder still
Kissed by strawberries on the hill;
With the sunshine on thy face,
Through thy torn brim's jaunty grace;
From my heart I give thee joy,—
I was once a barefoot boy!
Prince thou art,—the grown-up man
Only is republican.
Let the million-dollared ride!
Barefoot, trudging at his side,
Thou hast more than he can buy
In the reach of ear and eye,—
Outward sunshine, inward joy:
Blessings on thee, barefoot boy!

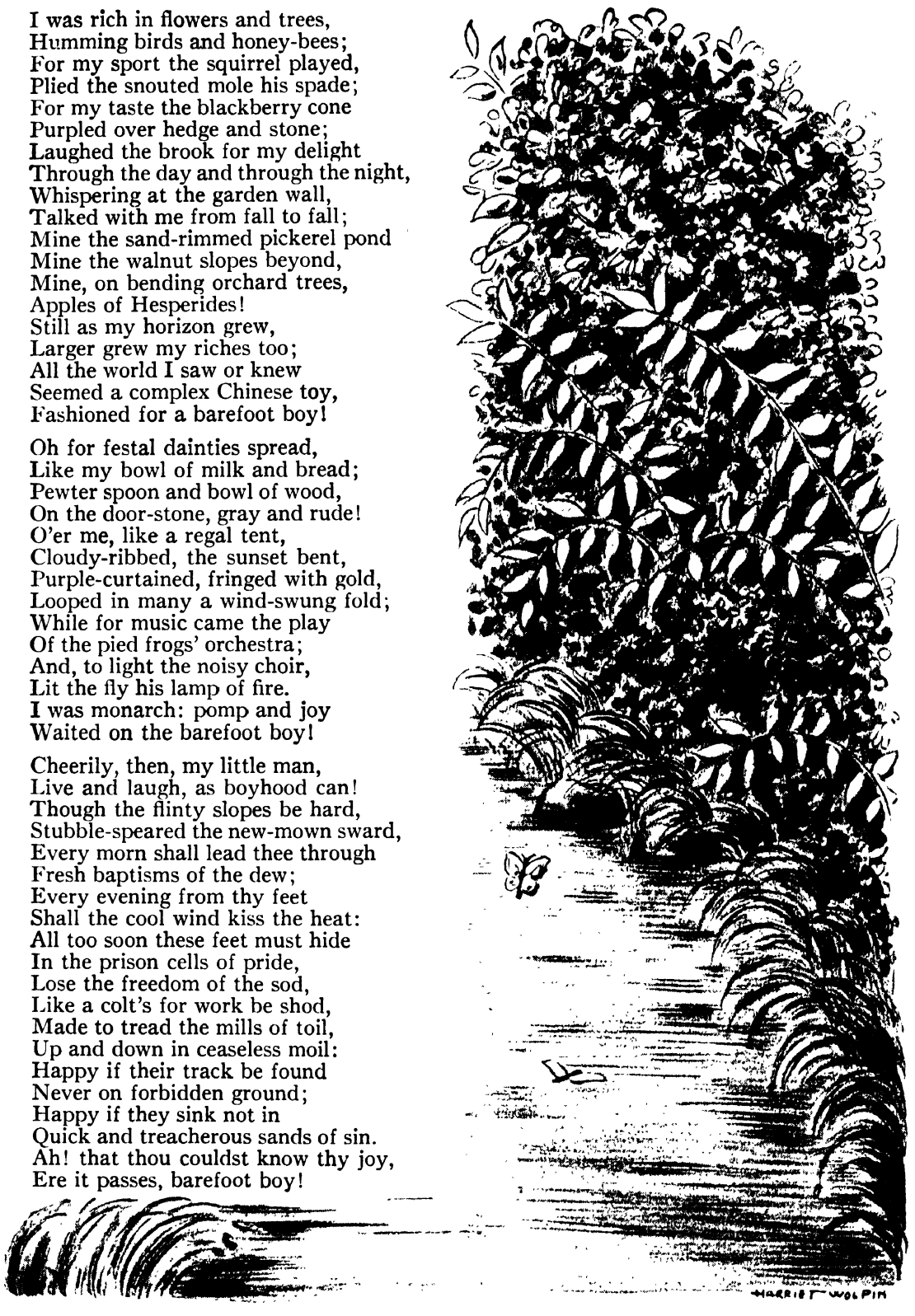
Oh for boyhood's painless play,
Sleep that wakes in laughing day,
Health that mocks the doctor's rules,
Knowledge never learned of schools,
Of the wild bee's morning chase,
Of the wild flower's time and place,
Flight of fowl and habitude
Of the tenants of the wood;
How the tortoise bears his shell,
How the woodchuck digs his cell,
And the ground-mole sinks his well;
How the robin feeds her young,
How the oriole's nest is hung;
Where the whitest lilies blow,
Where the freshest berries grow,
Where the ground-nut trails its vine,
Where the wood-grape's clusters shine;
Of the black wasp's cunning way,
Mason of his walls of clay,
And the architectural plans
Of gray hornet artisans!
For, eschewing books and tasks,
Nature answers all he asks;
Hand in hand with her he walks,
Face to face with her he talks,
Part and parcel of her joy,—
Blessings on the barefoot boy!

Oh for boyhood's time of June,
Crowding years in one brief moon,
When all things I heard or saw,
Me, their master, waited for.

I was rich in flowers and trees,
Humming birds and honey-bees;
For my sport the squirrel played,
Plied the snouted mole his spade;
For my taste the blackberry cone
Purpled over hedge and stone;
Laughed the brook for my delight
Through the day and through the night,
Whispering at the garden wall,
Talked with me from fall to fall;
Mine the sand-rimmed pickerel pond
Mine the walnut slopes beyond,
Mine, on bending orchard trees,
Apples of Hesperides!
Still as my horizon grew,
Larger grew my riches too;
All the world I saw or knew
Seemed a complex Chinese toy,
Fashioned for a barefoot boy!

Oh for festal dainties spread,
Like my bowl of milk and bread;
Pewter spoon and bowl of wood,
On the door-stone, gray and rude!
O'er me, like a regal tent,
Cloudy-ribbed, the sunset bent,
Purple-curtained, fringed with gold,
Looped in many a wind-swung fold;
While for music came the play
Of the pied frogs' orchestra;
And, to light the noisy choir,
Lit the fly his lamp of fire.
I was monarch: pomp and joy
Waited on the barefoot boy!

Cheerily, then, my little man,
Live and laugh, as boyhood can!
Though the flinty slopes be hard,
Stubble-speared the new-mown sward,
Every morn shall lead thee through
Fresh baptisms of the dew;
Every evening from thy feet
Shall the cool wind kiss the heat:
All too soon these feet must hide
In the prison cells of pride,
Lose the freedom of the sod,
Like a colt's for work be shod,
Made to tread the mills of toil,
Up and down in ceaseless moil:
Happy if their track be found
Never on forbidden ground;
Happy if they sink not in
Quick and treacherous sands of sin.
Ah! that thou couldst know thy joy,
Ere it passes, barefoot boy!



Only A Baby Small*

By MATTHIAS BARR

ONLY a baby small,
Dropped from the skies;
Only a laughing face,
Two sunny eyes.

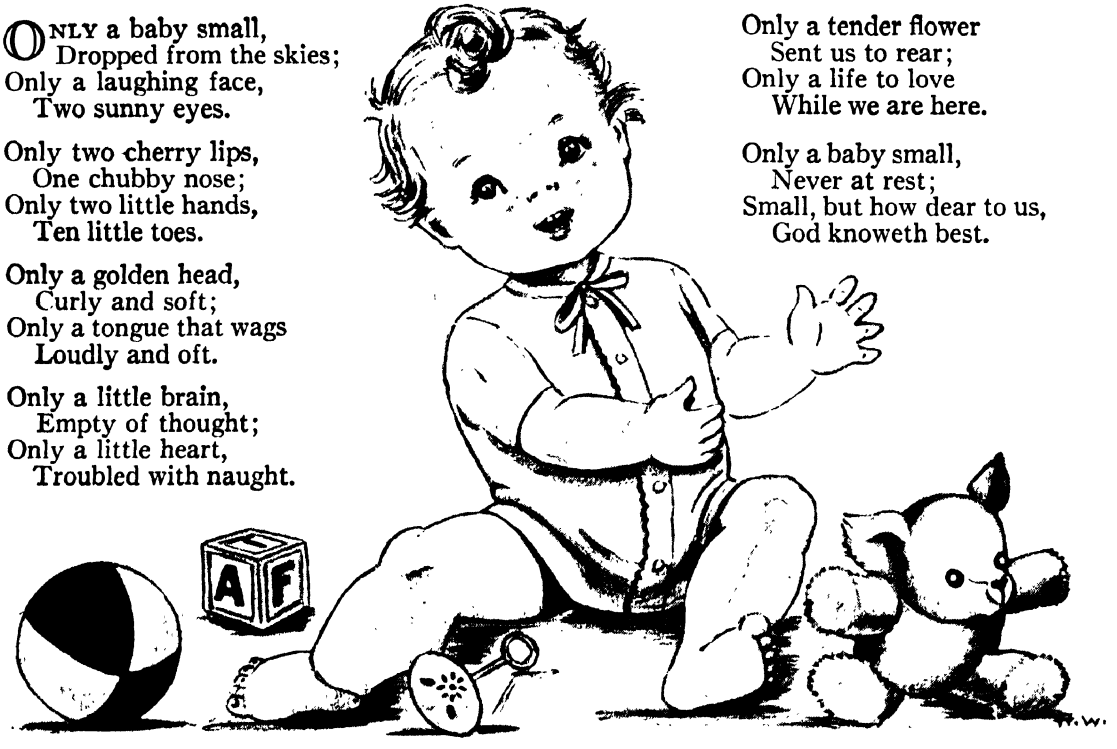
Only two cherry lips,
One chubby nose;
Only two little hands,
Ten little toes.

Only a golden head,
Curly and soft;
Only a tongue that wags
Loudly and oft.

Only a little brain,
Empty of thought;
Only a little heart,
Troubled with naught.

Only a tender flower
Sent us to rear;
Only a life to love
While we are here.

Only a baby small,
Never at rest;
Small, but how dear to us,
God knoweth best.



Lullaby of an Infant Chief

By SIR WALTER SCOTT (1771-1832)

OH, hush thee, my baby! thy sire was a knight,
Thy mother a lady, both lovely and bright;
The woods and the glens, from the towers which we see,
They all are belonging, dear baby, to thee.

Oh, fear not the bugle, though loudly it blows!
It calls but the warders that guard thy repose;
Their bows would be bended, their blades would be red,
Ere the step of a foeman draws near to thy bed.

Oh, hush thee, my baby! the time will soon come
When thy sleep shall be broken by trumpet and drum;
Then hush thee, my darling! take rest while you may,
For strife comes with manhood, and waking with day.

*From Rhymes and Jingles, published by Charles Scribner's Sons.

Norse Lullaby**

By EUGENE FIELD (1850-1895)

THE sky is dark and the hills are white
As the storm-king speeds from the north to-night;
And this is the song the storm-king sings,
As over the world his cloak he flings:
"Sleep, sleep, little one, sleep";
He rustles his wings and gruffly sings:
"Sleep, little one, sleep."

On yonder mountain-side a vine
Clings at the foot of a mother pine;
The tree bends over the trembling thing,
And only the vine can hear her sing:
"Sleep, sleep, little one, sleep—
What shall you fear when I am here?
Sleep, little one, sleep."

The king may sing in his bitter flight,
The tree may croon to the vine to-night,
But the little snowflake at my breast
Liketh the song I sing the best—
Sleep, sleep, little one, sleep;
Weary thou art, a-next my heart,
Sleep, little one, sleep.

**By permission of the publishers, Charles Scribner's Sons.

THE NEXT POEMS ARE ON PAGE 481.

The Trudeau Sanatorium has wide porches looking out upon green lawns.

THE BELOVED PHYSICIAN

IT was cold but very beautiful and quiet in the deep woods that afternoon. The mountains covered with unbroken forest rose steeply from the river, and at their base the valley swept out of sight in gracious waves. A hunter, clad in well-worn corduroys, thick leather boots and a fur cap, had fallen asleep, his gun beside him, as he waited for a fox. As he slept he dreamed. Instead of the fox runway where he stood, he saw the forest melt away and the whole mountainside become covered with curiously built houses. As he gazed intently upon them the man saw that they were built inside out, as if the inhabitants lived on the outside.

To-day, if you stood on the spot where the hunter waited through the cold midwinter afternoon, you would see that his dream has come true. Dotted over the mountain side are many small buildings, all of them with porches bigger than themselves. Sidewalks and roads run from point to point in the little colony. In the summer, instead of tracks of unbroken forest, green lawns and flower-beds meet the eye.

Who is it that in so little time has worked this great transformation? None other than the hunter himself, Dr. Edward Livingstone Trudeau (1848-1915), called "the beloved physician." When he fell asleep with his gun that cold winter day he was not merely a weary sportsman waiting for a wily fox; he was also a very sick man who had come to the Adirondacks merely to spend his last days amid surroundings which he loved. He had nursed a brother who had died from tuberculosis, and because so little was known in those days about the disease Dr. Trudeau had exposed himself to unnecessary risks and so contracted the illness. He was only twenty-five years old, at the beginning of a promising medical career, and happily married, when the blow fell. After some months' stay close to Saranac Lake at the lodge of the famous guide, Paul Smith, Dr. Trudeau gained so much benefit from the beautiful air and restful woods that he returned a second time. This treatment of open air and rest is one that is usually followed now, but in those days it was a new thing. If the patients were ill enough they were kept in bed, and all fresh air was carefully excluded; or if they were well enough to be about, violent exercise, such as horseback riding, was often prescribed. The second summer Dr. Trudeau, against advice, decided to re-

main on through the severe winter, although Paul Smith's was then sixty miles from a doctor or a railroad, and entirely cut off from all connection with the outside world.

The Adirondacks were a real hunter's paradise, and every day the doctor followed his favorite sport, which was quite possible without going far from the house. His wife and two children joined him, and the doctor so improved that he began to practice among the people who lived in the region. After four years he moved to Saranac Lake, then a small lumber centre with only a few houses and a sawmill.

LAND FOR THE SANATORIUM WAS THE GIFT OF THE GUIDES

A few patients placed themselves under his care, and gradually the number increased. The visitors to the lakes were generally wealthy people, but Dr. Trudeau gave the guides and their families free medical attention, and they were all devoted to him. When the doctor made up his mind to build a sanatorium at Saranac Lake for people of moderate means, the guides found out the piece of land he wanted and by subscription raised the money and gave Dr. Trudeau the land. Plans for building were at once considered and the doctor, putting his pride in his pocket, began asking his friends, acquaintances and patients for subscriptions toward the expenses. For thirty years he bravely continued to beg money for others, and on many occasions had great pleasure in the generosity of his friends.

This was not done easily or without setbacks. On the contrary, the thirty years were full of uphill and heroic effort, often in the midst of bad health, difficulties, trials and sorrows. Year by year he faced the problem of paying a debt on his sanatorium, because patients were charged a fee that did not cover expenses. Each and every day was lived among people who were often in the saddest condition. Three of his four children died, but he continued bravely in his work. His house and little laboratory were burned down—all his instruments and precious records lost—but he gradually rebuilt them.

STUDYING THE GERM THAT CAUSES THE DREAD DISEASE

Besides looking after his patients in the sanatorium, and those who came from the country round or journeyed from far to see him—for his fame grew fast—Dr. Trudeau was occupied constantly with experiments that would help in the fight against the disease. It was very hard to get instruments and apparatus even in the cities, in those days, and we can imagine what the difficulties were so far away, in the heart of the woods. His first laboratory was a little room at Saranac Lake, heated by a wood stove (there was no coal). He had a home-made apparatus, heated by a kerosene lamp, and in this he succeeded in growing the tubercle bacillus, which had been discovered by Koch to be the germ that causes the disease.

Dr. Trudeau had many curious experiences among his patients. On one occasion at the end of a long day's work he saw a wretched-looking man waiting outside his office. The doctor was worn out, and it was in no very pleasant tone that he told the patient to enter, yet when he saw how thin and ill the last visitor was, his heart softened. The tramp sat down, put his hands in his pockets and stared at the doctor.

THE MAN FROM THE POORHOUSE WHO MADE HIS WAY TO DOCTOR TRUDEAU

"How did you come here, and what is wrong?" asked the doctor, and his visitor told a frank tale. He had been sent to a large public hospital, and not liking it, determined to get out. In the ward he heard the doctors and patients speak of Saranac Lake and Dr. Trudeau, and made up his mind to strike out for the sanatorium. He was without a cent, but begged enough to get some little way on his journey. Soon, however, he was observed and put in the poorhouse. He told the authorities his story and his aim, and they bought him a ticket to Saranac. "In that way I finally got here. Now what can you do for me, Doctor?" The doctor collected enough money from some of his patients for the tramp to build a little rough board shanty on a vacant lot. There he slept on a straw bed, and the hotel proprietor gave him food so that he lived very contentedly. He stayed for eighteen months and the doctor grew very fond of him.

So the work prospered and spread, and the fame of the delicate doctor grew. Other states, other cities and other individuals followed the plan of Saranac Lake Sanatorium, which was the first of its kind in America to practice the simple principles of fresh air, suitable food and rest. When Dr. Trudeau died, in 1915, he had the satisfaction of knowing that his work marked the raising of the standard in the great fight against the white plague.

THE NEXT STORY OF GOLDEN DEEDS IS ON PAGE 402.

Party table set with gay cover and decorations of paper.

A CIRCUS PARTY

WHAT'S this? Gobo, the clown, performing tricks on a circus table? Yes, here is a circus party table which you can decorate without asking help from Mother. A Christmas party table may be decorated in much the same way, using a white paper "tablecloth," red and green crepe paper for trimming, and Santa Claus figures instead of clowns.

The circus party is a good suggestion for early spring. The clowns are clipped from decorated crepe paper and mounted on cardboard. The base of the centrepiece is only a hat box cover turned upside down, filled with confetti for circus sawdust, and decorated with yellow or green bands and ruffles. Small pieces of wire hold the clowns in position. Each little favor, a nut cup, a candy bag, or popcorn ball, has a clown head and a ruffle of yellow crepe with a name card tied to ribbon to show each guest where to sit. Set the table with a yellow paper table cover, use dishes banded in green, napkins with circus design, and paper forks and spoons, as illustrated, and after the party just toss them away.

Materials for Centrepiece, Favors and Boxes:

1 fold yellow crepe paper
1 fold bright green crepe paper
2 No. 7 wires
1 spool white wire
paste
gummed tape
nut cups, candies and popcorn balls
bright package wrappings
boxes
11 yards of yellow ribbon half an inch wide
top of a hat box

Centrepiece: Gather a strip of green crepe paper four inches wide and long enough to go once and a half the distance around the

box cover. Gather it on the sewing machine or by hand. Flute the edge of the ruffle. This is done by holding the edge between thumb and forefinger of each hand, placing the fingers close together. Bring the right hand toward you and push the left away, making a deep fluting along the edge. Paste the paper to the edge of the box cover. In case a cover is not available, make one of a circle of cardboard and a three-inch band taped to the edge.

Paste a folded band of yellow crepe around the edge of the base with a one-inch strip of green in the center. Stretch the paper as you paste it. Cut clowns from decorated circus crepe; paste them to cardboard backs. Tape a four-inch length of No. 7 wire to the back of each, letting the end extend two inches below the figure. Cover the wire and the back of the figure with a second figure turned wrong side out. Bring wire through the base, bend at right angles, and hold with tape. The little dog stands on a nut cup covered with green crepe.

Favors: Cover nut cups with bands of green crepe. Plain strips are also gathered around the top and bottom of popcorn balls and tied in place with ribbons at base and wire at top. Wrap candies in green crepe paper. Cut, mount and wire clown heads as for centrepiece. Bring a yellow crepe ruffle around the clown's neck, holding it in place with spool wire. Make the ruffle from a strip three inches wide, eight inches long, folded and gathered over a ruler that has been slipped into the fold. Remove the ruler and slip spool wire in the fold. You will need a favor to place at the plate of each guest.

DOLLS OF ALL NATIONS

You Can Make a Collection of Dolls in Costume, From Bright Colored Crepe Paper

THIS is Mimi. Her curls are yellow. Her blouse is pink. Her skirt is blue. When you have made Mimi, you can make all kinds of dolls, Spanish, Mexican, Dutch and many others.

For Mimi, you will need crepe paper in peach, yellow, white, light blue and black; white spool wire; a crepe paper twister; and paste.

To make crepe paper raffia cut the paper across the crinkles in a strip one inch wide. Open up the band and stretch the paper. Twist one end to a point. Thread the twisted end through a hole in the crepe paper twister, and pull the rest of the strip through the hole. When it comes out it will look like raffia. Make one strip of peach, one of white, one of pink, two of blue, and a bit of yellow. The illustration shows how to make Mimi.

To dress Mimi, start with a blouse. Take a piece of cardboard, two inches wide. Wrap pink raffia around it fifty times. Slip a six-inch piece of spool wire under the top loops, as you did in making Mimi, Figure 1. Remove cardboard. Fasten the pink blouse around Mimi's neck.

For the skirt, wrap blue raffia fifty times around a piece of cardboard two and a quarter inches wide. Slip spool wire under the top loops, remove the cardboard, fasten the skirt around Mimi's waist and cut the bottom loops.

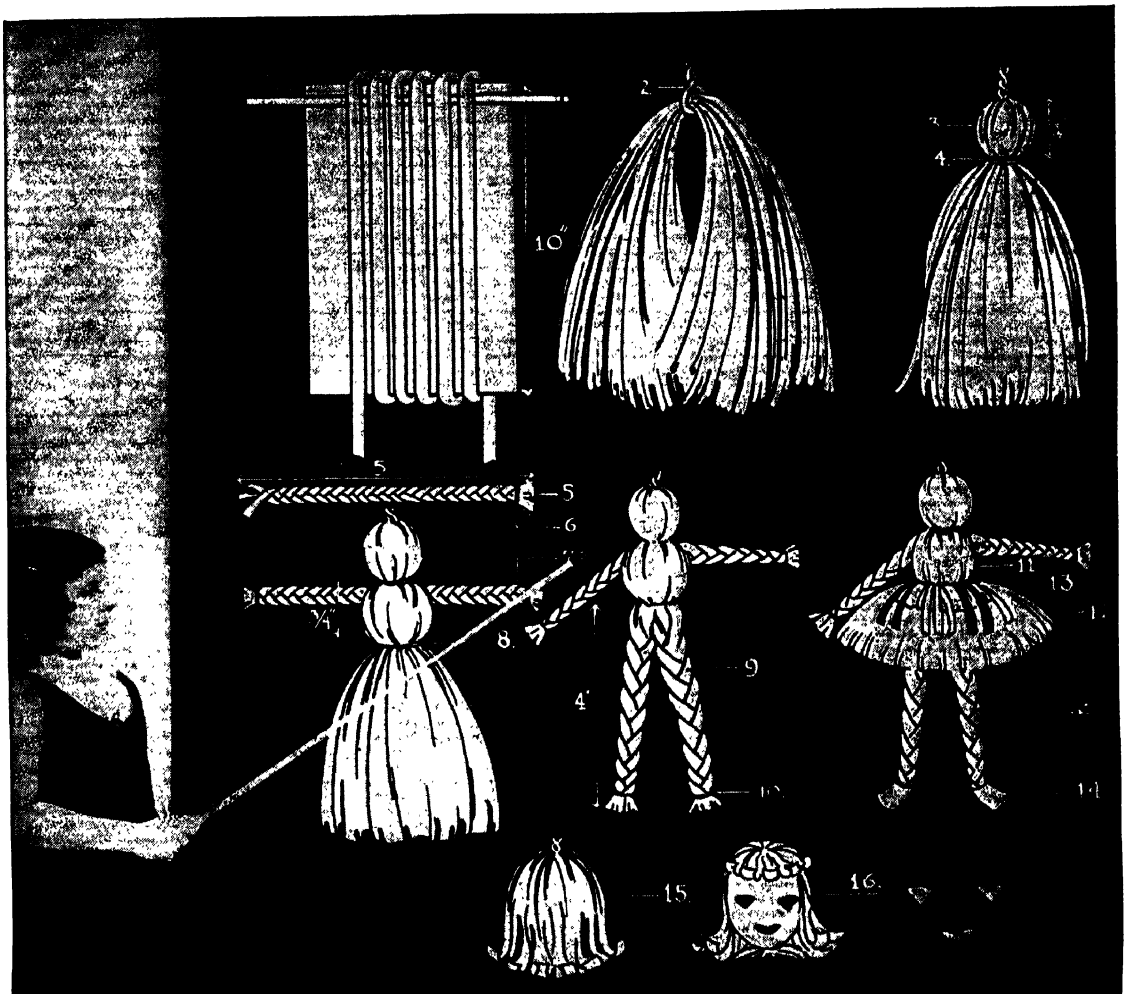
Mimi's apron is made of white raffia, wrapped thirty-six times around a piece of cardboard one and one-half inches wide and made like the skirt. The apron in the illustration is made from dark blue and white, wrapping each color around the cardboard eighteen times. You may do this, too, if you wish.

Her hair is made of yellow raffia and pasted to the top of her head. Follow Figures 2, 15 and 16 in the picture. Cut bangs in front, after the hair has been pasted on the head.

Mimi's socks are of blue raffia wrapped around the ankles and pasted down. Her shoes are of black raffia wrapped around the ends below her ankles, and pasted down. Her eyes are of black paper, pasted on, and her mouth of red paper. Patterns for these are in Figure 16. You can give some of your dolls blue eyes, and some, brown.

The picture of the party table on the preceding page and the picture-directions for making the dolls on the next page, courtesy Dennison Manufacturing Company, Framingham, Mass.

MAKING THE DOLL, STEP BY STEP



THIS IS THE WAY TO MAKE THE DOLL

1. Wrap peach crepe "raffia" around a 10" piece of cardboard 12 times. Slip spool wire 6" long under top loops.
2. Tie wire tightly. Cut bottom loops. Remove cardboard.
3. Slip wad of peach crepe the size of a nut under the wire and top loops.
4. Tie spool wire tightly under the head.
5. Braid the arms with 3 bunches of peach "raffia" each containing 6 pieces of raffia 7" long.
6. Tie wrists with spool wire.
7. Slip arms under head.
8. Tie waist tightly with spool wire.
9. Braid the legs.
10. Tie ankles with spool wire.
11. Tie on blouse.
12. Tie on skirt.
13. Tie on apron.
14. Paste on shoes.
15. Paste on hair.
16. Paste on eyes and mouth cut from black and red paper.

AN ELEPHANT MADE OF BLACK WALNUT SHELLS AND PIPE CLEANERS

THIS little elephant makes a very jaunty appearance when set upon a mantelpiece or a bookcase. His body is made of a black walnut and his head of a smaller one (about half as large). The rest of the elephant is made up of odds and ends. His menacing tusks are simply toothpicks. His neck consists of a little rounded stick. His trunk, ears, legs and tail are to be made of pipe cleaners, which you may buy at any tobacco shop. If father smokes a pipe, he will undoubtedly have a supply of these pipe cleaners on hand.

Figure 1 will show you how the little fellow is to be put together. With a boring tool, such as a gimlet, you make small holes in the large walnut for the four legs and the tail; each hole is to be barely wide enough to permit the wire of the pipe cleaner to pass through it. With a pair of scissors cut five pieces from a pipe cleaner; each piece is to be an inch long. Four of these pieces are for the legs, one for the tail. Glue the ends of all these pieces and insert them in their holes. The toes are to be made by fluffing out the cotton material at the end of each of the legs. The tail should be set at a saucy angle.

You are now to prepare the elephant's head by making a small hole for the trunk and four other holes for the ears (two for each of the ears), at the places indicated in Figure 1. As before, each of these holes is to be wide enough to allow the wire of a pipe cleaner to be inserted. The elephant's trunk will consist of two inches of pipe cleaner; one end of this is to be glued and inserted in its hole. Each ear will consist of an inch of pipe cleaner. Each end is to be glued and then is to be inserted in the hole (see Figures 1 and 2). The tusks consist of

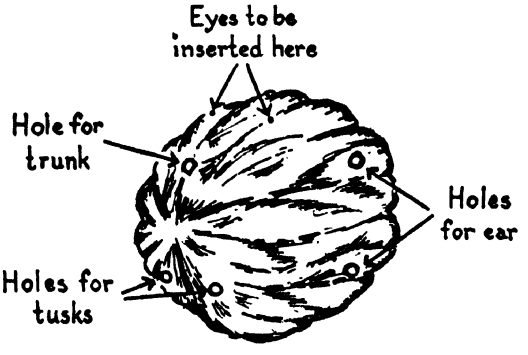


Figure 1

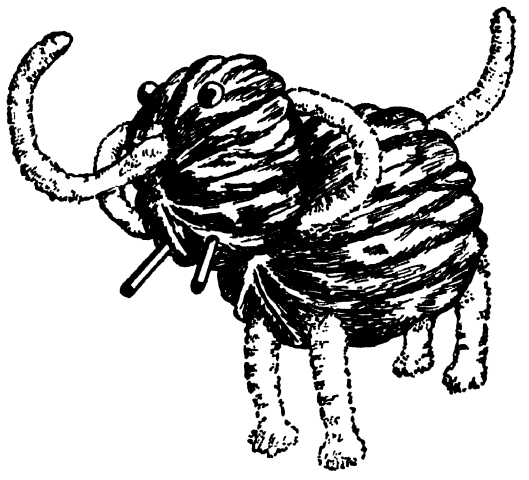


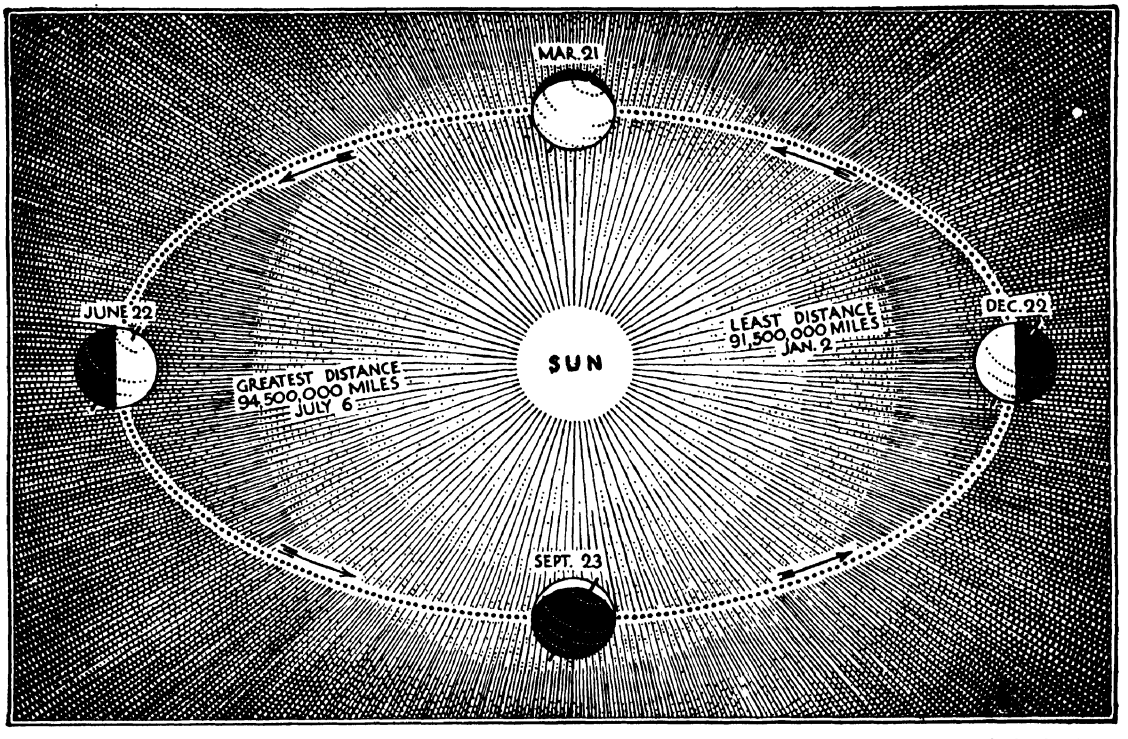
Figure 2

two little pieces of wood, each one-half inch long, cut from two rounded toothpicks. The tusks are to be fitted into two holes cut under the trunk as shown. The end that is inserted must be glued before insertion. The eyes are made of two little glass-headed pins, stuck into the elephant's head at the points indicated. To give a realistic effect, the eyes may be painted white. When the white paint has quite dried a little daub of black paint may be placed in the middle of each eye. This added touch will produce a very droll effect.

The last step is to join the head to the body. The neck will be a little cylindrical piece of wood half an inch long and with a diameter of a quarter of an inch. Holes for the neck are to be made in the body and the head; these holes are to be just wide enough so that the little cylinder of wood may be inserted. Now glue one half of the neck and place this half in the head. When the glue has set, put glue on the other half of the neck, which will be protruding from the head, and place this in the elephant's body. When this too has set, the elephant is complete.

If you wish, you may make a stand for your little elephant by cutting out a block of wood, two inches square and one-eighth of an inch thick (the wood of an old cigar box will do for this purpose). To mount the elephant, glue the ends of the pipe cleaner legs to the stand. Our elephant will now appear to the best possible advantage.

THE NEXT THINGS TO MAKE AND DO ARE ON PAGE 335.



The path traveled by the earth around the sun is not a circle but an ellipse. On July 6 the earth is farthest from the sun; on January 2 it is nearest to the sun. Note that the earth is tilted on its axis.

The EARTH'S YEARLY JOURNEY around the SUN

YOU have learned that the earth is a great ball in the heavens, wheeling around the sun in a yearly path that is almost a circle. You know that it spins about its axis every twenty-four hours. You know that its axis is tilted.

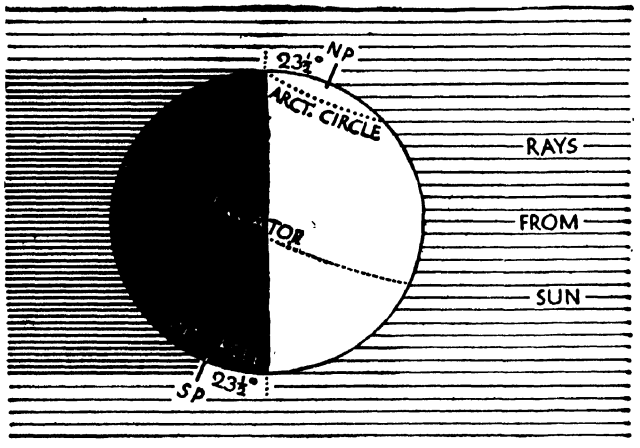
This tilt has some very interesting effects. The picture above shows the path which the earth takes around the sun. The artist has drawn the earth's position on four different days in the year, March 21, June 22, September 23 and December 22.

On March 21 you see both the North Pole and the South Pole lighted by the sun. Everywhere on earth night and day are within a few minutes of the same length, and so we call this March day the spring equinox. The word equinox means equal night. The term vernal or spring equinox is used by astronomers to indicate the point in the sky where the sun may be found on this date.

September 23 is called the autumn equinox, and on this date we find much the same conditions as on March 21. In this picture you are looking at the dark half of the globe, where it is night.

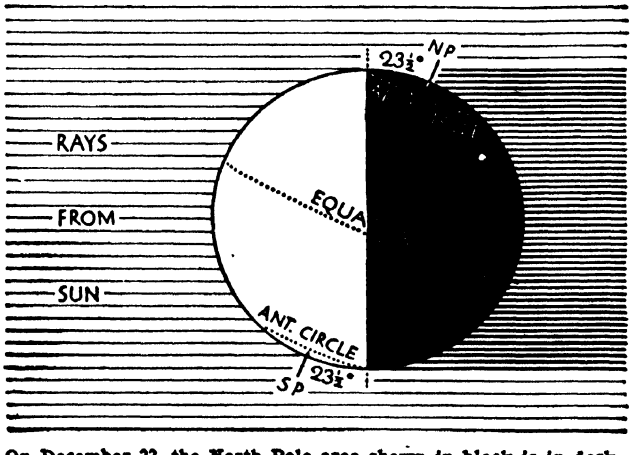
All over the earth sunrise and sunset are just about twelve hours apart on the equinoxes.

Now look at the earth's position on June 22. An area all round the North Pole is in the sunlight, while an equal area around the South Pole is in darkness. On that date the sun never sets in the far north and never rises in the far south. What about the parts of the earth between those two areas of total light and total darkness? North of the Equator you find a very long day and a very short night on June 22. You have noticed this yourself. The sun rises early in the



On June 22 there is sunlight for twenty-four hours in the area shown in white around the North Pole. Around the South Pole there is darkness for twenty-four hours on that day.

morning and goes down late in the evening on June 22. Suppose you could fly northward in a swift airplane, starting out just after sunset. You would soon see the sky ahead growing lighter. If you could fly north fast enough you would see the sun shining brightly in the heavens at midnight, at all places north of the Arctic Circle. This is called the midnight sun. At the North Pole the midnight sun is seen for a period of six months, but at the Arctic Circle for only a few days. June 22 is called the summer solstice because at this time of the year the sun does not seem to change its height at noon for several days. The word solstice comes from two Latin words meaning sun and stand. At the summer solstice (and also at the winter solstice) the sun seems to stand still. Look at the top diagram.



On December 22, the North Pole area shown in black is in darkness for twenty-four hours, and the South Pole area has twenty-four hours of light. See also the drawing on page 235.

South of the Equator, people have a very short day and a very long night on June 22.

On December 22 we see the area around the South Pole lighted. We call this day the winter solstice. This is the shortest day in the year, and the longest night, where most of the readers of this book live. As you go farther north on December 22, the night grows longer and longer until, around the North Pole, there are twenty-four hours of darkness.

In the Southern Hemisphere, just the reverse is true. On December 22, in Little America, there are twenty-four hours of daylight.

How far from the poles do these strange areas extend, where the sun seems to stand still in the heavens twice a year? The areas extend 23½ degrees from the poles, as the diagrams show.

The distance all around any globe, or any circle, is said to be 360 degrees. We write it 360°. That is an easier way of measuring and studying the earth, than if we used miles. The distance between the Equator and the North Pole, or the Equator and the South Pole, is one-fourth of the whole distance around the globe, or 90°.

The earth is so tilted that on the summer solstice every portion of the earth between the North Pole and a line drawn around the earth 23½° south of the North Pole has twenty-four hours of light; and every portion between the South Pole and a line 23½° north of the South Pole has twenty-four hours of darkness. And on the winter solstice, the light and darkness are reversed.

You already know that we draw a line about the middle of our globes and maps of the earth, and call it the Equator. Long ago men drew lines 23½° from the poles. The line near the North Pole they called the Arctic Circle, and the one near the South Pole they called the Antarctic Circle. Arctic comes from the Greek word meaning northern. Antarctic means the opposite of Arctic; therefore it is the Southern Circle.

On the equinoxes, the sun's light and heat strike directly at the Equator and taper off toward the poles.

Between March 21 and September 23, the very top of the globe, the North Pole, has constant sunlight. It has six months of daytime and no night at all. Between September

23 and March 21 the North Pole has six months of darkness. As you travel from the Arctic Circle to the North Pole in summer you find longer and longer days. If you made the journey in winter, you would find longer nights the farther north you went.

Around the South Pole, the story is just the reverse. Days grow longer as you go from the Antarctic Circle to the South Pole, between September 23 and March 21.

On June 22 the earth's position causes it to catch the sun's light and heat most directly at a line 23½° north of the Equator. We draw a line here on our maps and globes and call the line the Tropic of Cancer.

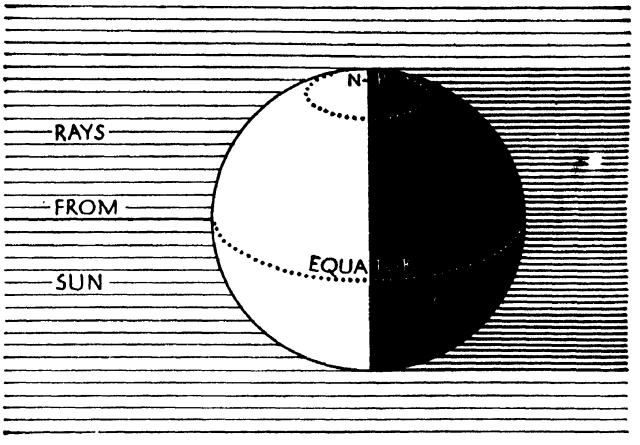
The sun's light and heat fall directly on a line 23½° south of the Equator on the day of the winter solstice, December 22. We call this line the Tropic of Capricorn.

The word tropic comes from a Greek word for turn. The men of old thought the sun moved so that its rays were strongest at a point farther north each day, until they reached the Tropic of Cancer. Then they thought the sun turned, and its rays were strongest at a point farther south each day for six months, until they reached the Tropic of Capricorn, and made to turn north again. All this is true, except that the sun does not move around the earth, as you know. Cancer is the Greek word for crab. The ancients thought a group of stars in the sky looked like a crab; they thought another group, seen in the same part of the sky six months later, looked like a goat (capricorn). They said the sun was in the constellation of Cancer on June 22, and in the constellation of Capricorn on December 22.

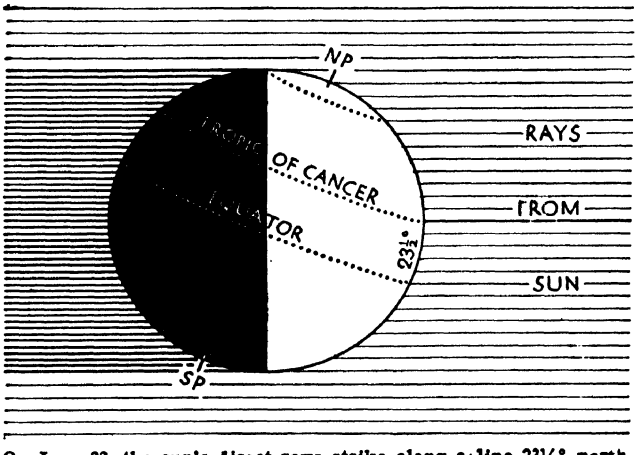
So now we have five lines around the globe, the Arctic Circle, Tropic of Cancer, Equator, Tropic of Capricorn and Antarctic Circle.

The sun's direct rays of light and heat strike the earth in a broad belt between the Tropics of Cancer and Capricorn, 23½° north and 23½° south of the Equator. We call this belt of 47° the Torrid Belt, or Torrid Zone. Here it is summer all the year. Zone is another word for belt. Torrid means hot.

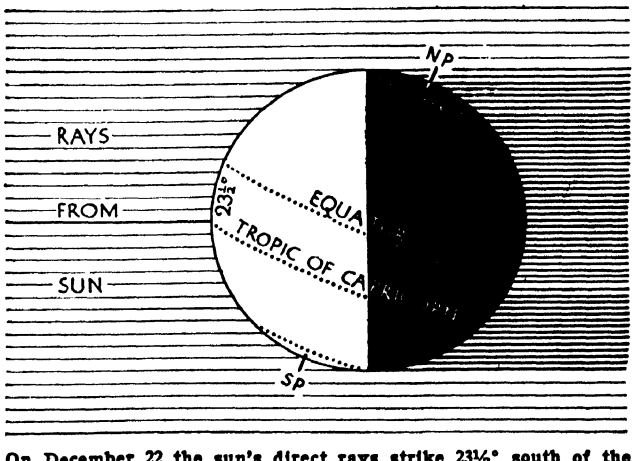
Between the tropics and the circles



On the equinoxes (March 21 and September 23) the sun's rays strike the earth directly at the Equator. North and south of the Equator the rays are increasingly slanted.



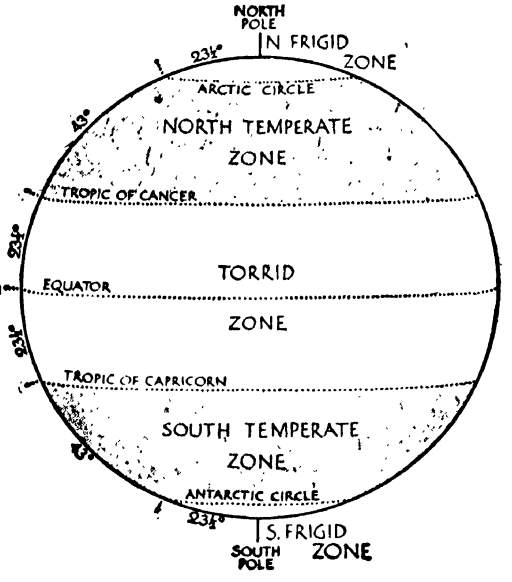
On June 22, the sun's direct rays strike along a line 23½° north of the Equator, at the Tropic of Cancer. Between June 22 and December 22 the direct rays strike a little farther south each day.



On December 22 the sun's direct rays strike 23½° south of the Equator, at the Tropic of Capricorn. Between the tropics is the earth's hot belt, which we call the Torrid Zone.

are two belts of medium light and heat. We call these the Temperate Zones. The North Temperate Zone is the one in the Northern Hemisphere. The South Temperate Zone is in the Southern Hemisphere.

The Temperate Zones are warm near the tropics and cooler the farther from the tropics you go, all year round. These zones never receive the direct rays of the sun; but



This chart shows the North and South Frigid (cold) Zones; the Torrid (hot) Zone; and in between, the North and South Temperate (medium) Zones.

from December 22 to June 22, in the North Temperate Zone, the sun's rays are less and less slanted. Each day we have a few minutes more light in the morning and evening, and our part of the earth grows gradually warmer. We have spring and then summer. From June 22 to December 22 the days grow gradually shorter and cooler. We have autumn and then winter.

In the South Temperate Zone, conditions are reversed. Ir Melbourne, Australia, and in Buenos Aires, Argentina, June is cold and December is warm.

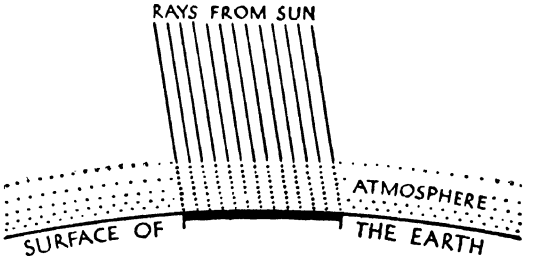
Between the poles and their circles, the rays of the sun, when they strike, are always very much slanted. Fewer sloping rays, and more direct rays, fall upon equal areas, so around the poles the sun's light and heat are feebler. Also, because of their slant, the sloping rays have to pierce through more of the earth's blanket of atmosphere, and they lose heat in that way. So the regions around the poles are cold. The belt around the North Pole we call the North Frigid Zone; the belt around the South Pole we call the South Frigid Zone. Frigid means cold.

The earth is farthest away from the sun in July, when the South Frigid Zone is in darkness, so the winters there are somewhat colder than the winters in the North Frigid Zone. Winter in the Southern Hemisphere also lasts about seven days longer than in the Northern Hemisphere. We are nearest the sun in December. This helps to relieve the cold of the North Frigid Zone somewhat, though the temperature during winter often goes down to more than 50 degrees below zero.

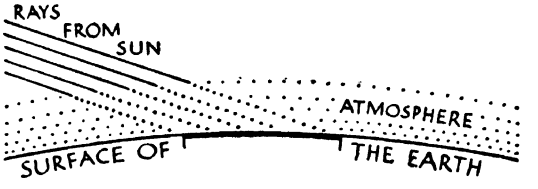
During the summer, some of the land inside the Arctic Circle is warmed enough to allow many plants and flowers to grow, and in places even trees exist. Warm winds blowing from the south and warm ocean currents flowing northward also help to relieve the cold of the Arctic area. The Antarctic region has no such good fortune, so it is an area of intense cold.

There are many things that affect the climate of a region. The temperature is cooler on mountain tops and warmer lower down. Large bodies of water usually retain summer's heat for weeks or months, and give it to the surrounding lands slowly, so that winter is shorter in those lands.

There are warm ocean currents and cold currents. We tell you about these elsewhere

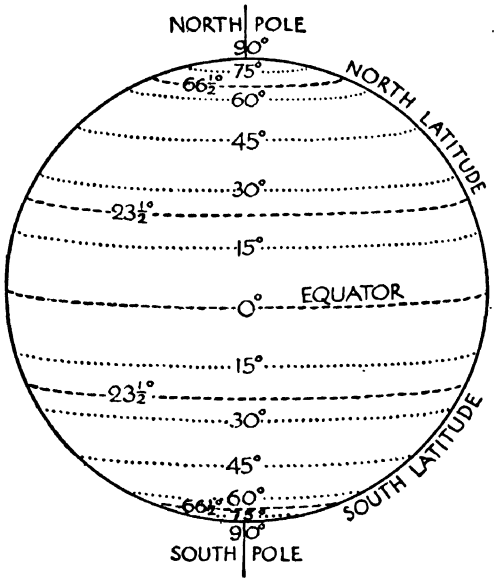


NEAR THE EQUATOR THE STEEP RAYS HAVE A SHORTER DISTANCE TO TRAVEL THROUGH THE ATMOSPHERE, AND MORE RAYS FALL WITHIN A GIVEN AREA



NEAR THE POLES THE SLOPING RAYS HAVE A LONGER DISTANCE TO TRAVEL THROUGH THE ATMOSPHERE, AND FEWER RAYS FALL WITHIN THE SAME AREA

in our book. In the main, however, the earth's climates are made by the way a particular part of the earth tilts toward or away from the sun; the Frigid Zones are cold, the Torrid Zone is hot, the Temperate Zones range from cold to hot, but are generally



Latitude is figured by degrees (of about 69 miles) north and south of the Equator. Only a few of the lines (parallels) of latitude are shown on this chart.

comfortable. It is in the Temperate Zones that most of the world's people live. It is in the Temperate Zones that civilization has gone furthest.

There are very few cities north of the Arctic Circle, and no cities in the South Frigid Zone. Many of the cities in the Torrid Zone are built on mountains or plateaus where the climate is cooler. Mexico City; Caracas, Venezuela; and La Paz, Bolivia, are good examples.

Distance north and south of the Equator is called latitude and is measured in degrees. The Equator is latitude 0°. The North Pole is 90° north latitude. The South Pole is 90° south latitude. The Arctic Circle is 66½° north latitude. The Tropic of Capricorn is 23½° south latitude. Lines around the globe parallel to the Equator marking off these and other distances are called parallels. Of course they are imaginary lines, to help us find our way.

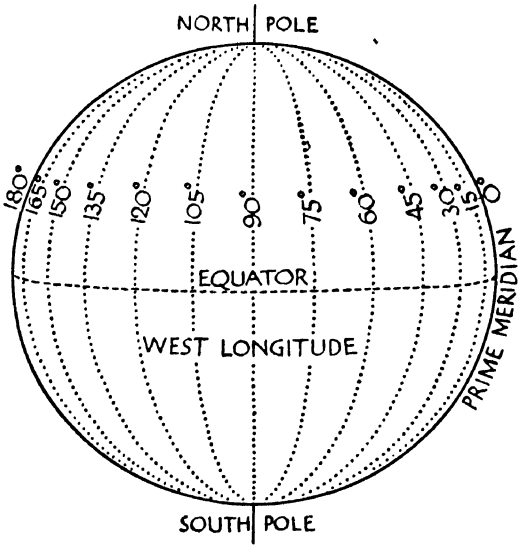
The degrees of latitude are divided into 60 smaller parts called minutes (′), and each minute is divided into 60 seconds (″). A degree of latitude is about 69 miles.

We also measure distance the other way round the earth, by drawing lines on our globe from one pole to another passing through the Equator at points 69 miles apart. Distance measured this way is called longitude. Each of these lines is called a meridian. The meridians meet at the poles. The meridian passing through Greenwich, England, has been chosen as 0°, and distances are measured up to 180° east and west of Greenwich. When we come to 180° east of Greenwich, we start figuring west longitude. The next meridian is 179° west longitude and the number gets smaller as we keep going in the same direction until we reach Greenwich again. A degree of longitude is divided into 60 minutes and a minute into 60 seconds.

If you know the latitude and longitude of any place, you can easily find it on a map. What city is 42° north latitude, 79° west longitude? Yes, Toronto.

Mariners have long used latitude and longitude to find their way across the pathless seas. The position of the sun in the daytime and of the stars by night have helped them to figure their position. Now they have other instruments for figuring, but they still rely on latitude and longitude to tell where they are, and where to set their course. Aviators also must use latitude and longitude, and explorers and mapmakers, and all of us who wish to know about the earth on which we live.

THE NEXT STORY OF THE EARTH IS ON PAGE 279.



Longitude is figured east and west of a line through Greenwich, England. A degree is 69 miles wide at the Equator, narrowing to nothing at the poles.

CHIEF LANGUAGE STOCKS OF NORTH AMERICAN INDIANS

THERE are several ways of studying the American Indians. One is to examine the manner of life as it was lived in various areas. That is the method followed in this article. Another is to group the Indians by the languages they spoke. This is a very complex study, because there were almost 150 main language-families (stocks), each of which had a number of different tongues, or dialects, as spoken by the different tribes. The table below gives some of the chief stocks and tongues, adapted from a classification worked out by J. W. Powell, an authority employed by the United States Government.

Algonkian Stock

BLACKFOOT — Piegan, North Blackfoot, Blood

CHEYENNE—Several tribes

ARAPAHO—Several tribes

EASTERN - CENTRAL DIVISION — Cree, Montagnais, Menomini, Sauk, Fox, Kickapoo, Shawnee, Abnaki, Pennacook, Micmac, Passamaquoddy, Penobscot, Ojibway (Chippewa), Potawatomi, Ottawa, Algonkin, Peoria, Natick, Delaware, Illinois, Miami, Massachuset, Narraganset, Wampanoag, Montauk, Wappinger, Pequot, Powhatan, Chickahominy and others

Iroquoian Stock

WYANDOT (often called Huron)

NEUTRALS

IROQUOIS CONFEDERACY (Five Nations) —Mohawk, Onondaga, Seneca, Oneida and Cayuga. Later the Tuscarora moved from the South to join the confederacy which was thereafter called the Six Nations

CONESTOGA (also called Susquehanna)

ERIE

CHEROKEE—Several tribes

OTHERS

Athapascan Stock

NORTHERN GROUP—Many tribes, including Chipewyan, Dog-rib, Hares, Yellow Knives, Beaver, Kutchin

PACIFIC COAST GROUP—Many tribes, including Hupa

SOUTHERN GROUP — Apache (several tribes), Navajo, Jicarilla, Lipan

Caddoan Stock

Pawnee, Wichita and others

Chinookan Stock

Several tribes

Eskimauan Stock

Many tribes with separate dialects

Kiowan Stock

Klamath Stock

Kutenai (Kootenay) Stock

Muskhogean Stock

Many groups and tribes, including Alibamu, Apalachee, Tuskegee, Choctaw, Chickasaw, Muskogee (or Creek), Seminole, Natchez

Piman Stock

Salishan Stock

Many groups and dialects, including Salish (or Flathead), Tillamook

Shahaptin Stock

Nez Percé, Wallawalla, others

Shastan Stock

Shoshonean Stock

PUEBLO GROUP—Hopi

PLATEAU GROUP--Ute, Paiute (Diggers), Shoshoni, Comanche, Snake, Bannock, others

OTHER GROUPS

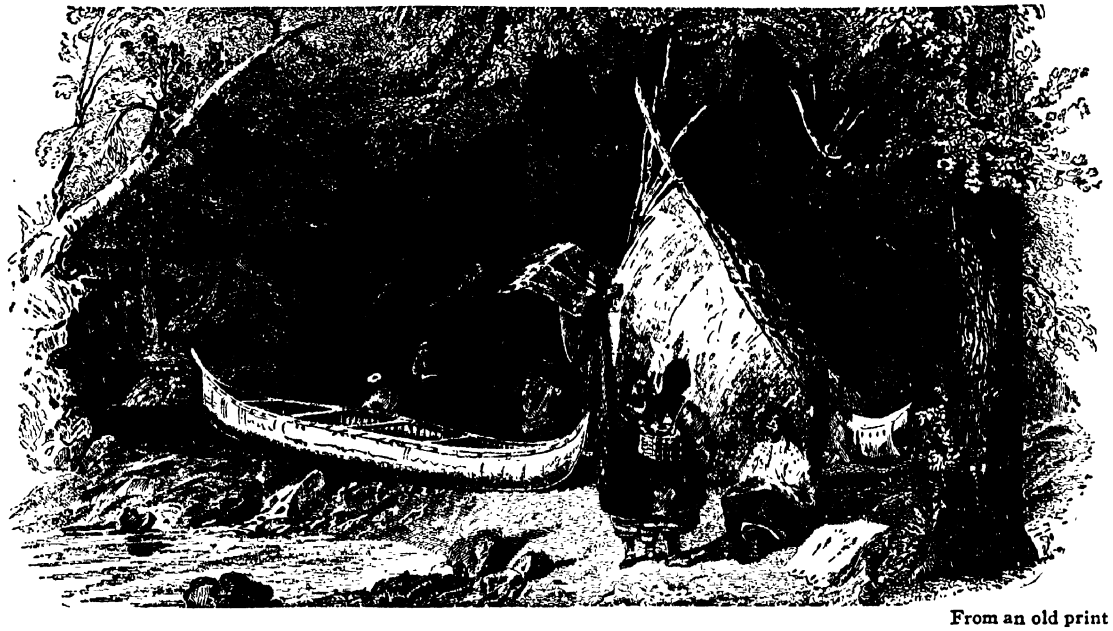
Siouan Stock

Many groups of tribes, including Dakota, Yankton, Teton, Blackfoot, Assiniboin, Sioux, Kansa, Omaha, Osage, Iowa, Missouri, Winnebago, Crow and a great number of others

Tlingit Stock

Uto-Aztecan, a name that has been suggested to include Shoshonean, Piman and Nahuatlan stocks.

Zuñi Stock



From an old print

An Indian camp in the forest, showing tipi (teepees).

NORTH AMERICA BEFORE WHITE MEN

WHAT do we know of the history of the early inhabitants of the New World, those people whom Columbus described as Indians, in the belief that he was near the coast of south Asia? In the first place, let us describe them. Indians are not all alike, but on the whole they have certain characteristics in common. Their hair is straight and black; their eyes are black; cheekbones are prominent; skin color ranges from reddish brown to yellowish brown. You would never mistake an Indian for a Negro from Africa or for a white man, but there are in Asia many individuals of the Mongolian race having the characteristics just mentioned, as well as other likenesses. So we believe that the Indians are distantly related to the Mongol peoples of Asia.

The outer corner of Alaska is only fifty miles from the corner of Siberia; and if the people of eastern Asia and of North and South America are related, this must have been the bridge over which the crossing was made.

Did the Indians come from Asia, or did these Mongols go to Asia from America? In different parts of Asia and of Europe there have been found relics of very early men. No relics of such antiquity have been found in North or South America, and from this fact, as well as from other bits of knowledge, wise men feel justified in saying that the wandering men must have gone from Asia to America.

When did they come? Here we must call in the help of the geologist. He tells us that there were periods when the northern part of the northern hemisphere was entirely covered with ice, which moved southward as glaciers (slow-moving streams of ice) carrying loose boulders along and scouring the solid rock into a thousand hills and rounded tops. Traces of these ice movings are to be found in huge boulders carried away from the Laurentian rocks of Canada and deposited far to the southward in southern Ontario and the eastern United States. Such movings of the ice occurred, not once, but four times.

At the time of the last period of cold, while eastern North America was completely covered with ice, there seems to have been a western strip not covered that extended up into Alaska. It must have been along this western route that the early ancestors of the American Indians wandered, from Asia,

This map of the United States area shows the location of some of the most important Indian tribes before the white settlers began to plant permanent colonies. There were a great many other tribes and subtribes which can not be shown on so small a map. The Iroquois Confederacy in New York State really consisted of five nations, before the first white settlers came; the sixth nation, which later moved north to join the league, was the Tuscarora tribe of North Carolina.

while the ice of the last glacial period still covered eastern North America. It is foolish to try to express this too definitely, however.

We have said that the physical characteristics of the American Indians seem to prove their relationship to the Mongols of Asia. This does not mean, however, that all the Indians are closely related to the present Asiatics. Both Asiatics and the Indians have been changing for thousands of years and it seems likely that the first immigrants to America came before the high development of those traits which we think of as distinctively Asiatic.

Did these Indians live in complete isolation here in America up to the arrival of Columbus? Here again we can not answer exactly, but there is a great deal of evidence to show that America was not entirely cut off from the rest of the world.

TRAVEL WAS EASY FROM THE TIP OF ASIA TO THE TIP OF NORTH AMERICA

As we have said, Bering Strait is only fifty miles wide, and the small Diomede Islands lie in the middle of it. On a clear day one can even see the cliffs of Alaska from the shore of Siberia. The Diomede Islands teem with nesting sea birds, whose eggs are eagerly sought after to-day by the natives both of Alaska and Siberia. In frail skin boats men put out from either shore to collect the nesting birds and their eggs, and frequently pass from continent to continent. Travel from this northwestern tip of America to the northeastern part of Asia has been carried on throughout the last two or three hundred years. Tools and other articles found in ancient sites in Alaska indicate that such travel had gone on for centuries before the coming of the white man. America, it seems, was first populated from this corner of Siberia, and the contact has continued to the present time. But this corner of Siberia was itself completely cut off from the teeming centres of China and India, so that America remained isolated from the civilized world in spite of this actual contact.

The Chinese had vague traditions of lands across the ocean, known as the "Isles of the Blest." It is possible that these vague memories are based on voyages across the Pacific. Furthermore, in the past two hundred years a number of Japanese junks have been washed up as wrecks on the Pacific coast, occasionally with one or two survivors. Probably the same thing has been happening for many centuries. Such castaways, however, could not have been numerous enough to leave any mark on Indian life.

The same thing may be said for the Polynesians of the South Pacific. They were skillful and courageous seafarers, accustomed to travel long distances in their outrigger canoes. In such frail craft they often sailed to find new homes on far-scattered islands, many of them pin-pricks of land in the vast expanse of ocean.

At least one canoe from Polynesia must have reached the New World, because a stone club like many found in New Zealand has been found in South America in a grave dating back before the time of Columbus. However, contacts of that kind must have been too few in numbers to have had any effect upon the physical characteristics of the American natives, or upon their mode of life.

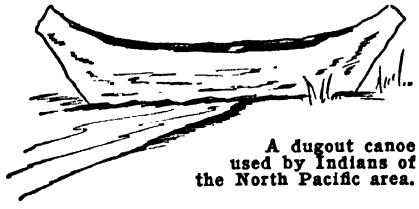
What about contact across the Atlantic Ocean? The Greeks knew of land beyond the Pillars of Hercules, as they called the Straits of Gibraltar. Occasionally vessels had sailed out to the west, through this strait, and had returned with tales of land. Was the land that they visited the Canary Islands, was it that part of Africa which bulges far to the west and south, or did they succeed in reaching the coast of Brazil or of Central America? Probably we shall never know. However, some of the Indians of Central America had traditions of bearded gods who visited their country long ago; some of them thought that the Spaniards were akin to these ancient gods. The American Indian does not have a beard. Who can these bearded, godlike people have been? Surely the most probable explanation is that they were Europeans, perhaps Greeks; but here, too, any contact must have been so slight that no permanent influence was left.

COLUMBUS MAY HAVE HEARD FISHERMEN'S TALES OF A NEW LAND

There are vague traditions of fishermen from Brittany returning to their ports, in the fourteenth century, with extraordinary catches of cod fish. Did they reach the Grand Banks of Newfoundland? If so, they left no clear records. The same is true of Danish discoveries said to have been made in the fifteenth century. Perhaps Columbus had heard some of these stories; they may have influenced him in setting out, but they could not have been much more than half-believed travelers' tales.

One definite contact across the Atlantic, however, was that of the Norsemen. Every-

one knows of the Norse settlements in Iceland, and later in Greenland. In Greenland the Norsemen came in contact with the Eskimos, with whom they hunted and fished. These Greenland Eskimos are closely related to the Eskimos of the northeastern Canadian Arctic, with whom they were in constant contact, so that the Norsemen of Greenland must have learned something about the



A dugout canoe used by Indians of the North Pacific area.

A light birch-bark canoe of Algonkian tribes. It was made over a frame. Both the canoes shown on this page were propelled by paddles.

northeast corner of America and its inhabitants. Furthermore, the Norsemen made trips west and south of Greenland. Vinland (or Wineland) and Markland, places reached by the Greenlanders and described in their sagas, were, without question, on the mainland of America; just where is uncertain. The coast of Labrador was undoubtedly known to them, and probably they landed as far south as New England.

In our own time the discovery near Lake Nipigon, Canada, of a Norse sword, ax and shield-handle showed that Vikings must have been in that area, which can have been reached only from Hudson Bay, and probably the Albany River. Whatever its extent, however, such contact left little or no effect upon the Indians.

When we think of our own neighborhood, we can understand how much the life of a community changes from generation to generation. Automobiles, radios, telephones and airplanes are now a part of everyday life; but they were completely unknown not so long ago. Think of the changes that have taken place in the life of our ancestors back through the days of Queen Elizabeth, to the days of the Crusades, and still further back, to William the Conqueror, and the Saxons whom he conquered. Through these centuries, life has, of course, changed much. The same is true throughout the world. In fact, we may say with certainty that there is no important group of people in the world who live as did their ancestors three hundred, five hundred, or a thousand years ago.

It took thousands of years for the Asiatic Mongols, who became the ancestors of the Indians, to spread into America. Over the centuries each group of immigrants to the New World must have brought different ideals, different knowledge, different customs, the things which we describe as culture. This fact is one of the reasons for the great variety in the life of the American Indians.

Once in America, the spreading of the Mongols was the result of fitful wanderings; people traveled considerable distances, but only with the lapse of many years. Several generations, at least, would have lived and died before a body of people would reach the shores of Bering Strait, cross it, and wander southwards into the heart of North America.

Again let us use our imaginations and think of the effect of this long stay in the Arctic upon the way they lived. If they had been farmers they could not have planted seeds in the Arctic. Even if they had carried seeds with them, these would have perished. So with other elements of culture. Most domestic animals can not live in the Arctic. Knowledge of how to work metal would be lost in the course of wandering where there were no metal mines. Regardless of what knowledge they had when they started out, they could keep only those crafts, or that knowledge, which could survive for a generation or more in the Arctic. As far as we can tell from the investigation of early American settlements, it seems clear that the early Indians everywhere knew how to chip stone implements, and how to smooth and polish them by grinding. They had the dog as a domestic animal. They had some knowledge of boats; they had vivid beliefs in the power of supernatural beings. How many other parts of their life were lost

A dog "travois" of the Plains. Goods were strapped to the poles and the dog dragged the contraption.

in crossing from Asia we shall never know.

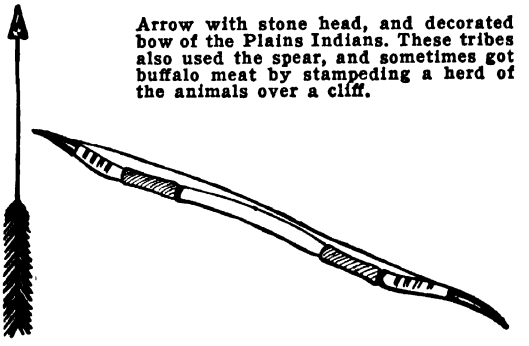
Thus the early American Indians made their way slowly to all parts of North and South America, where in course of time their mode of life developed in very different ways. Some of the facts which caused change we can never know. Often it must have been the inventive genius, or the ideas, of a single man which started a group along a certain path. One fact of tremendous importance, as we shall see, was the varied geographical conditions in which the Indians came to live in the two Americas.

In fact, a good plan for our study of North American Indians is to examine them in their homelands. There were, roughly speaking, ten great areas of North American Indian life, or culture:

1. The Eskimo area — the far northern coastline and the northern islands, and the western half of Alaska.
2. The Mackenzie area—the northwestern part of the continent inside the Eskimo coastline area.
3. The North Pacific coast area—a long, narrow region along the western coast between California and Alaska.
4. The California area—roughly covering the area of the present state.
5. The Plateau area—the smallest of the areas, covering the eastern half of Oregon, Washington and British Columbia, some of Idaho and southwestern Alberta.
6. The Plains—a great inland section roughly between the Rocky Mountains and the Mississippi River, ranging down into Texas, and up into southern Alberta, Saskatchewan and Ontario.
7. The Southwestern area—New Mexico, Arizona and the northern part of Mexico.
8. The Nahua area—the southern part of Mexico and Central America down to about the middle of Honduras.
9. The Southeastern area—the southern section of the United States east of Oklahoma and Texas, and south of Kentucky.
10. The Eastern Woodland area—a huge section stretching from the Atlantic Ocean west to the Plains, north to the Mackenzie and Eskimo areas and south to Kentucky.

All in all, there were hundreds of tribal groups, some living largely by themselves, some joined together in friendship, by kinship, or by a common language, or for warfare against a common enemy. They did not always stay in one place, but often roamed over wide territories. They spoke a large number of languages and dialects, even within the same culture areas.

From Bering Strait to Greenland, across the whole of the broadest part of North America, stretches the Arctic belt, consisting in part of mainland, and in part of numerous islands. The ground here is permanently frozen, and only an inch or two at the top thaws during the short summer. Life would be impossible without the teeming animals of the ocean, seals, whales, fish and a multitude of smaller forms of life; and the natives, for the most part, live near the coasts so as to get food from the sea. Cultivation of the soil is, of course, completely impossible; and the Eskimos who inhabit this area are, even to-day, entirely dependent on fishing and hunting for a livelihood. The important land mammals are the caribou (the American reindeer), polar bear and fox. It is an enormous region; but even now it is incapable of supporting a large population.



Arrow with stone head, and decorated bow of the Plains Indians. These tribes also used the spear, and sometimes got buffalo meat by stampeding a herd of the animals over a cliff.

The Eskimos are Indians. Their forefathers wandered across from Asia like the rest but their mode of life became specialized through long residence in the Arctic. This way of life has probably not changed very much since the days of Columbus and therefore the article on Eskimos of to-day (page 2563) will tell you about this branch of Indians.

The Indians of the Mackenzie area were hunters. Across those great northern plains roamed great numbers of caribou; the tribesmen banded together in the winter for caribou drives, surrounding the animals on the ice, or capturing them by snares. Most of the food was caribou meat, and caribou hides made most of the clothing, and the tent coverings. (Some tribes covered their tents with bark.) From the sinews of the caribou the Indians made snowshoes, snares and nets. They varied their diet with small game (which they took in snares and nets), fish, wild berries and roots. They did not raise crops, or weave (except for rabbit skins) or make pottery. They cooked in wood or bark

vessels. Canoes were of spruce or birch bark. In winter they traveled by dog-sled or snowshoes. They knew how to use copper in a small way, but their stone implements were inferior. Little is known about their family or community life. There seem to have been clans based on relationship to the mother.

THE FISHING INDIANS OF THE NORTH PACIFIC COAST

We come now to an area of snow-capped peaks, forests and rushing streams teeming with fish. It is a section of moisture, of short winters and long summers in which the heat of the sun is lessened by mist and rain. The region was the home of many distinct tribes, each tribe speaking its own language, which might not even be related to the speech of others not far away. Yet these tribes had certain similarities, and their mode of life was very different from that in any other part of North America.

The keynotes of their existence were fish and wood. The tribes were largely dependent upon fish for food. Salmon entered the rivers in millions every year and were taken in traps, nets and by spear. Most of the catch was eaten at once, but large quantities were smoked and stored for winter use. On the Queen Charlotte Islands and Vancouver Island, the catch of halibut, cod and other deep-sea fish was plentiful, and large quantities of shellfish were gathered along the shores. Another important fish was the olachen, a very greasy fish which enters the rivers in April, which was taken by thousands. It was stored in large vats, allowed to rot, and then boiled; the grease that rose to the surface was stored in receptacles and used as seasoning with a great variety of foods. Whaling was carried on to a very limited extent. Deer, mountain goat and beavers were used for food, and great quantities of berries were eaten raw, or smoked or sun-dried for winter use. For the most part, however, the North Pacific Coast people were fish-eaters.

Wood was almost as essential as fish. A new-born infant was sponged with a wad of pounded cedar bark, then laid in a wooden box as a cradle. Houses were huge rectangular affairs made of cedar planks lashed to heavy upright posts, each house containing six, eight or even more families. Wooden boxes served as storage bins. Wooden spoons were commonly used, though bone ones were brought out on ceremonial occasions. Cooking was done in water-tight wooden boxes filled with water into which red-hot stones were dropped to bring the contents to a boil. Toys were generally of wood; even much of the clothing, in the forms of capes and hats, was of pounded cedar bark. Wood was the fuel. Wooden boxes and baskets of roots were used for carrying everything. Huge boxes served as drums for the winter dances; boiled hemlock bark was eaten; canoes were made entirely of wood; and among many tribes a corpse was placed in a wooden coffin. From the cradle to the grave, wood was vital.

A tipi, or conical skin tent, and a crude wigwam.

All this was made possible through the existence of suitable trees. The cedar is even-grained and easily split. With the aid of fire and of wood or stone wedges, huge planks were split from the standing tree, to make the walls and roofs of the houses. These planks were so valuable that if a settlement was moved they were laid on canoes and taken away to be set up in the new location. Some planks were further split into thin sections which were steamed and bent to form boxes. The single joint at one of the corners was sewn or pegged together, and the bottom fastened on in the same way, the seams being waterproofed with soot and spruce gum. Canoes were hollowed out from a single trunk, and widened after they were softened by being filled with water brought to the boiling point with the aid of hot stones.

The villages consisted of a number of large communal houses, spread along the seacoast or on the banks of a river. They were relatively permanent settlements, changing only in case of necessity. Many families dwelt in a single house, separated only by thin partitions. Everyone gossiped, and everyone knew everyone else's business; the force of public opinion was a powerful control on behavior.

Weaving was practiced in certain districts with mountain goat wool, dogs' hair and strips of cedar bark. Copper was pounded out in southern Alaska, more for plaques which served as ceremonial objects and as

currency, than for objects of daily use. Skin was worked very cleverly; on the Queen Charlotte Islands and in the lower Fraser Valley a greenish stone known as nephrite was sawed with sandstone saws and rubbed down for axes, but the chipping of stone was not highly developed. Shells were made into ornaments.

AMONG NORTH PACIFIC COAST TRIBES, DESCENT FOLLOWED THE FEMALE LINE

Unlike any other Indians north of Mexico, the tribes of the North Pacific Coast looked up to rank and wealth. Particularly among the northern tribes, chiefs had tremendous powers which they transmitted to their heirs, their sisters' sons, for descent followed the mother's line instead of the father's as with us. Chiefs were treated with great respect; their word was obeyed instantly, and their influence was felt beyond the limits of their own village.

These Indians kept slaves, usually prisoners taken in war or other strangers obtained through trade. Slaves were usually well treated and valued for their working ability, but they were true slaves, subject to their masters' whims.

THE POTLATCH, WHERE A MAN GAINED HONOR BY GIVING AWAY HIS GOODS

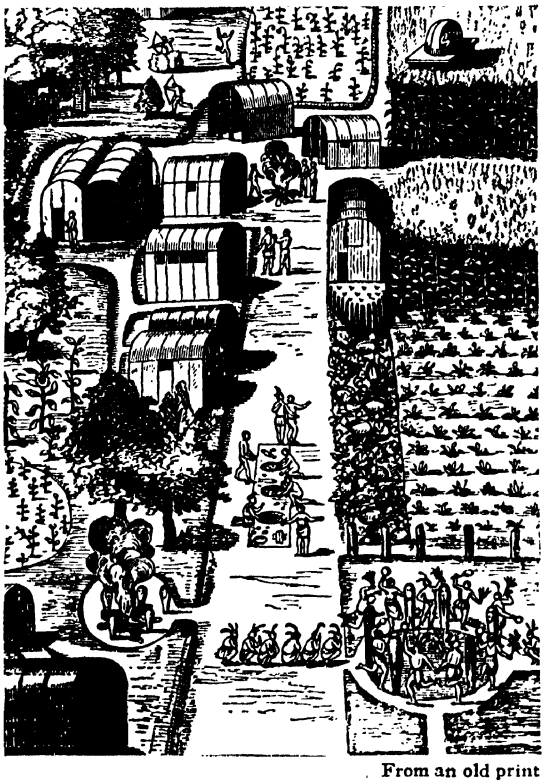
Wealth, too, was a mark of a man's importance; not, however, the wealth that he actually possessed, but the wealth that he had given away, in accordance with what is called the "potlatch" system. This involved the giving away of gifts when a man laid claim to an honor. For instance, suppose a coastal Indian wished to assume a name that had been in his family generations ago. He could not do so until he had called all his neighbors to his house, announced his new name, and related the myth with which the name was associated. Then he had to give presents to all. To a slave the present would be a trifle, to a commoner, a larger amount; a chief received a still greater sum of planks, canoes, dried fish or slaves. The worth of the name was measured by the amount spent in this public announcement of it.

The one who gave gloried in his act; the one who received was shamed by the lavish generosity of his host. An ambitious person carefully remembered how much, and from whom, he had received such gifts, and when he was able to take on a name or to display some other ancestral honor of his own, he would give presents in his turn, taking care to give back larger amounts than he had received. In this way his influence and his honor in the tribe rose considerably.

Another way of showing the experiences of ancestors was by means of paintings upon the front of the houses, or of carvings upon the upright pillars which supported the front corners. Early explorers speak of grotesque carvings of bears, wolves and eagles. After the coming of the white man, wealth increased on the coast as a result of the fur trade, and with this increase in wealth came a desire to give greater honor to the family history. The house post was no longer big enough, and about 1820 someone started the use of posts set apart from the house, the kind that we now speak of as totem poles.

Life was simple and probably easy in the California area. The food was chiefly acorns, varied by wild seeds, fish and small game. Acorns were not eaten raw, but made into bread.

Houses were merely shelters of piled up brushwood or poles or bulrushes. Bulrushes, tied together, made crude rafts on which the Indians ferried themselves across streams. They had no canoes, no pottery, no woven cloth, no picture-writing. Stone implements were very crude. The weapon was the bow. They wore very little clothing. They seem



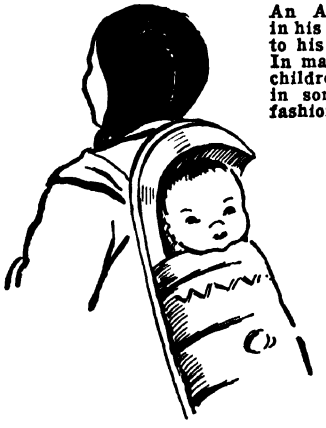
From an old print

An Indian village of the Northeastern Area.

to have had no knowledge of metals. They did fine basket work, however.

Little is known of their family or social life. Religion meant a good deal to them, and they had elaborate ceremonies.

The Indians of the very small Plateau area shared some of the habits of the North Pacific Coast tribes and some of the habits



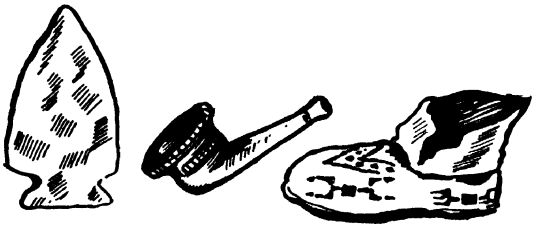
An Algonkian baby in his cradle, strapped to his mother's back. In many other tribes children were carried in somewhat similar fashion.

of the Plains Indians, but they had certain characteristics of their own. They ate chiefly salmon, deer, roots and berries. They cooked their food on hot stones dropped into holes or baskets. They knew how to dry and pulverize the salmon and roots for winter food; and they had strange winter houses, half underground, covered with a conical roof with a hole to let the smoke from the fire escape. Their summer homes were tents or lean-to shelters. They sometimes used dogs as pack animals. Their canoes were crudely made; they had no pottery and their work in stone was very simple. They were, however, good basket-makers and their clothing of deerskin was well made. They had blankets of woven rabbit skin, and the warriors had fine, heavy shirts of leather. Their weapons were bows, clubs, knives and lances. They had only a weak tribal organization; and the wealthy man was the one respected. The potlatch was a custom here, though to a smaller extent than among the tribes to the west.

The Plains Indians were hunters. At the time the white men began settling the continent, the Plains Indians were almost as dependent upon the bison as the Eskimos were upon the seal. Its flesh was their staple food, either fresh, or smoked and pulverized with fat and berries. Bison meat prepared in this last way is called pemmican. It keeps for a long time and is still used by travelers, particularly in the north. The skins of bison cows were used for clothing, those of the full-grown bulls for heavy blankets, and sometimes as coverings for the conical skin tents, *tipi* (teepees). Tufts of bison hair were sewn as ornaments on clothing; bison bones were sometimes made into tool handles; bison sinew was used for lashing; bison skin was used for bags; and even the dried dung served as fuel. Before the coming of the white man the hunting of the bison was, as we know from Indian traditions and other evidence, a laborious task, in which a considerable number of hunters worked together to drive the animals into a stockade or to stampede them into rushing over the edge of a steep cliff. When stalking was employed, the hunter stole up on a herd with bow and spear. Bison hide is thick and tough, and the Indian's stone arrow point was not so very sharp. You can imagine the difficulty and the danger of the hunt.

When the Plains Indian and his family went on a journey, his tent and everything else he owned would be made into a bundle. This was lashed on two or three poles and one end of the poles lashed to a dog's back. The other end dragged on the ground. This was called a *travois*.

Working on the bison skins was one of the tasks of the women, and they were very skillful. Another woman's craft was the elaborate decoration of clothing, blankets,



A stone arrowhead; a pipe of the kind made by Iroquoian tribes; and a beaded moccasin of the Plains.

etc., with sections of porcupine quill dyed in various colors and sewn on as a form of embroidery.

The chief occupation of the men, as we have said, was hunting. In addition, it was their duty to manufacture stone and bone implements. In early times very fine arrow and spear points were made on the Plains, but those in use when the white man came were less skillfully made. In prehistoric times, also, a certain amount of pottery must have been made; but the use of that had disappeared, probably as a result of the in-

creasing use of skin, and all that have been found are broken fragments. Perhaps at the same period a certain amount of corn may have been grown; but that, too, had disappeared from the central Plains, and the only crop cultivated was tobacco, which was used for smoking on ceremonial occasions. The pipes were of stone, the work of the men. The stems were often decorated with tufts of hair; these pipes were known as *calumets*.

To the Plains Indian a man's importance was judged by his prowess in war. Each tribe was distinct; it might be on friendly terms with some of its neighbors, but it was bitterly hostile to others, and warfare was constantly in the minds of everyone. The man respected for his prowess was not the one who had killed the largest number of enemies; in fact, the goal in warfare was not to slaughter the enemy, but to humble or shame them.

THE "MILITARY AWARDS" OF THE PLAINS WARRIORS WERE DYED EAGLE FEATHERS

Prowess was measured by a strict code. Each feat had a recognized value. A man who accomplished one of them was famed for what he had done, and his achievement was shown by a particular type of decoration in the form of a dyed eagle feather worn on his headdress. This was the basis of the feather regalia which caught the imagination of early white travelers, and led to the belief that "the Indians" always wore feathers. Instead, the use of feathers on the Plains was restricted in accordance with military feats.

Although a man could thus distinguish himself, Plains life required co-operation—the individual was dependent upon his fellows. Bison hunting, for instance, needed a large number of individuals and the hunters obeyed a rigid discipline. So, too, with the war party; those who followed a leader obeyed him without question, though a fighter had the right to distinguish himself in hand-to-hand conflict, or as a scout. This same combination of individualism and joint action was seen also in the realm of religion. There were no priests. Each man sought divine favor by prayer and fasting, and by mutilating his body to show the strength of his desire and his bravery; but there were also elaborate ceremonies in which the whole community acted under the leadership of a single man or woman.

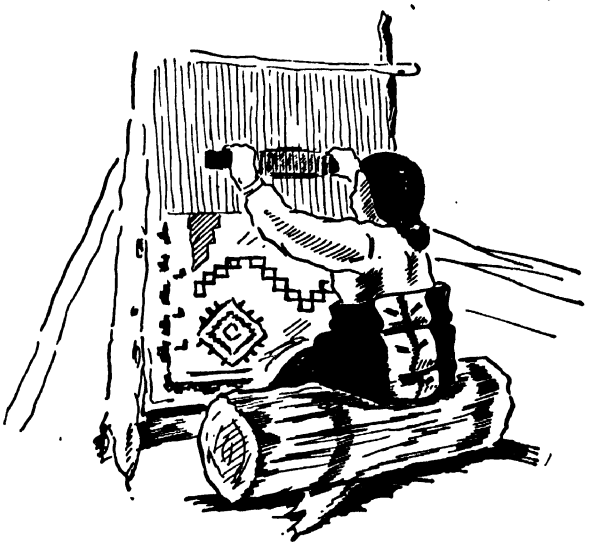
Secret societies flourished in which a group of individuals, usually men, banded together. To these societies were entrusted such duties as police measures while the group was hunting bison, enforcing morals or in other respects regulating the behavior of the tribesmen.

Within the Southwestern area there were two types of culture; some tribes were nomadic (the families roamed about) and others lived in houses made of mud bricks (adobe).

Most of the houses were pueblos—square buildings with several floors and room enough for many families. There is a picture of a pueblo on page 3028, in the chapter, Deserts of Arizona. That chapter, telling about the present-day Indians of the Southwestern area, gives a fair idea of the life there before white men came. Then, as now, there were tribes roaming the plains (the Navajo) and tribes living in pueblos (the Hopi, Zuñi and others). Then, as now, the Pueblo Indians raised maize (what we call corn) and other foods and cotton; they wove cloth on a loom, ground the corn meal between stones, made and decorated pottery. In the old days they raised turkeys, hunted bison and deer, rabbits and antelope.

Their clothes were elaborate. They had garments of cotton material, robes of buffalo skin and deerskin garments and sandals, and robes of woven rabbit skin sometimes trimmed with turkey feathers.

The mother was the head of the family. Each village had its own elected governor and a war chief and priests. Religion was very important and there were many cere-



The crude loom of the Navajo weaver produced beautiful designs. The Navajo were nomadic (wandering) tribes.

monies. Almost everybody knows about the snake dance of the Hopi, and the rain dance of the Zuñi.

Other tribes, the Pima and others, lived in adobe houses of a simpler sort, not apartment houses.

In Mexico a strange civilization had flourished long before the coming of Cortez, the white conqueror. He found the gleaming Aztec city, Tenochtitlan, and he met other tribes with a well-developed culture. Centuries earlier the Maya, in Yucatan, had built a civilization; then, mysteriously, their vitality dwindled, and their culture all but died. To-day archæologists are busy in the jungle uncovering Maya relics, and trying to piece out their story.

Iroquoians built up pottery vessels with "sausages" of clay, then baked the vessels.

The Maya and the Aztec were good farmers. They raised corn, peppers, beans, cacao beans and cotton. They kept bees. They wove cotton cloth incredibly fine and beautiful. We know that they had books but these have been lost to us. They were astronomers, and worked out a calendar. Their ornaments of beaten gold and copper were quite lovely; the Aztec also learned the use of copper tools.

The Aztec were noted also for their fine feather work. Religion was highly organized among the earlier Maya and the later Aztec. The priests were the learned ones, though there were schools for rich boys and girls. Handsome temples and altars were built, and blood sacrifices of animals were performed. Human sacrifices were also offered to the gods.

A few of the Southeastern tribes lived somewhat as the Plains Indians did, hunting buffalo, bear, deer and other game. Some tribes lived chiefly on fish. Some made bread from roots, having learned to do it probably from the Indians of the Caribbean isles. Some actually ate human flesh. However, the tribes typical of the area were farmers, raising corn, pumpkins, melons and tobacco. They raised dogs for food, hunted large and small game and wild turkeys. They fished, sometimes using poison which killed the fish in the water; when the dead fish rose to the top they were easily taken.

They lived in rectangular houses with curving roofs of thatch or bark. The walls were sometimes of mud interwoven with wicker switches. The houses stood together in villages which were surrounded with stout fences, or palisades.

These Indians wore clothes woven of bark fibres, bison skins, deer and rabbit skins and gorgeous cloaks of feathers. They made pottery; also mats and baskets of cane, corn husks and splints. Their weapons included knives and darts of sharpened cane and they used the blowgun, that strange weapon of Asian islanders and of South American jungle Indians.

They were sun worshipers, setting their temples and altars on mounds to catch the first and last rays of the sun god. Their chiefs were thought to be under his special protection.

Many of the tribes were good basket makers. Corn husks, cane splints and other materials were used.

Now we come to the area which the early explorers knew best; and to the natives of that area, the Eastern Woodlands.

There was a northern group of tribes living between lakes Superior and Huron and the Eskimo area. They were dependent for food and clothing upon the caribou; and in many other ways their mode of life resembled that of the Mackenzie area Indians.

South of the Great Lakes and the St. Lawrence were three other groups:

Iroquioan-speaking tribes — including the Huron or Wyandot, Cherokee, Erie, Susquehanna and the Five Nations. The Five Nations were the Mohawk, Onondaga, Oneida, Cayuga and Seneca who, about 1570, formed

a league. In 1722 the Tuscarora, from North Carolina, joined them, and then they were called the Six Nations. The Six Nations together made up the Iroquois. The Huron, Cherokee and others were distantly related to the Iroquois and spoke dialects of the same language.

Algonkian-speaking tribes, two large groups living east and west of the Iroquoians, who thus occupied a sort of island in the vast Algonkian territory.

The Algonkian Indians taught the early settlers how to use the canoe and the toboggan and how to make maple sugar and maple syrup. Pocahontas and her father, Powhatan, belonged to the Powhatan tribe of the Algonkian stock. The Delaware was another Eastern Algonkian tribe.

The keynote of existence in the Eastern Woodlands was corn. Fields were cleared in the forests, and between the stumps hills of corn were planted, often with squashes, pumpkins and beans planted in the same hill. The corn was carefully tended and when the ears were ripe they were eaten fresh; they were dried and pulverized for storage through the winter; the meal was cooked in various ways, with fat, berries and meat. Deer were hunted. So were wild turkeys and fish. Wild rice was gathered, and occasionally planted; and we have already mentioned maple sugar and syrup.

Families banded together and lived in villages usually on high land not far from a stream, the fields spreading in all directions from the village. The summer house of the Algonkians was dome-shaped, covered with bark or mats. It was called a *wigwam*. The winter house was a rectangular affair, with walls of bark stretched over saplings.

The clothing was of woven bark fibre, rabbit skins, deerskin and (among the Eastern Algonkians) feather robes. They were fair tailors; the women's usual costume was a two-piece dress. Moccasins provided foot gear; sometimes leggings were added.

Planting Indian corn in the Southwestern Area.

Weapons were the bow and arrows, clubs and, later, tomahawks. Birch bark was made into various utensils; mats were woven of reed and bark. The canoes were of birch bark.

There were no social classes and little attention was paid to ownership of property within the tribe. Religion was important, and there were dances and ceremonies for many occasions, especially centring around warfare. The Algonkian had many stories about their gods and their forefathers; some of these stories have come down to us.

Grinding corn on a flat stone. Another stone was pressed over the kernels with a circular motion.

The Eastern Algonkian tribes made better pottery; they were also better farmers than the branch that lived west of the Iroquois.

The Iroquoian tribes lived in "long houses" covered with bark. Several families lived in a house, each family having a fire in the central passage. In these houses life was very public. The children played to and fro around the fires; everyone could see what everyone else was doing; privacy was unknown, as the early French explorers noted sadly.

A village consisted of ten or twenty houses of this kind, often surrounded by a stockade. The villages were moved from time to time, perhaps after seven or eight years, as the fields around them became exhausted, and firewood became more and more difficult to obtain.

Like the Algonkians, the Iroquoians used wood extensively. Instead of bark for canoes, however, they hollowed their craft from solid tree trunks, using fire to char the wood, and then chiseling it out with stone adzes. They made baskets of spruce roots and sometimes of birch bark, although sections of split ash

wood were more frequently used. Their stone work lacked the skill of the Algonkians; spear and arrow heads were uneven and coarse, but the heavy axes and adzes were beautifully made. Indians have been called lazy. But we forget the labor involved in clearing the forests with stone tools and in hewing out canoes from solid tree trunks.

The Iroquoians used shell extensively for ornament, obtaining large shells, from what is now the southern United States, in trade and cutting them into ornamental pieces which were used as pendants. Clam shells were cut into circular discs which were strung as beads, or sewn in patterns of different colored shell. This type of worked shell became known as *wampum* and was often used as money. It was not true money but it was valued for its beauty, as well as for the labor involved in its production. To bind treaties between different tribes it was customary to exchange belts of valuable wampum, sometimes with the beads arranged in symbolic designs.

Another industry of the Iroquoians was pottery. Judged by our standards the work was crude, but it provided receptacles in which corn could be stored, and food could be boiled. It was made by the women who rolled out "sausages" of clay and built up by hand vessels which were baked in open hearths. Clay pipes were also made, as well as some of stone. Clothing was of skins, generally similar to the dress of the Algonkians. Two or three feathers were worn in the hair for ornament.

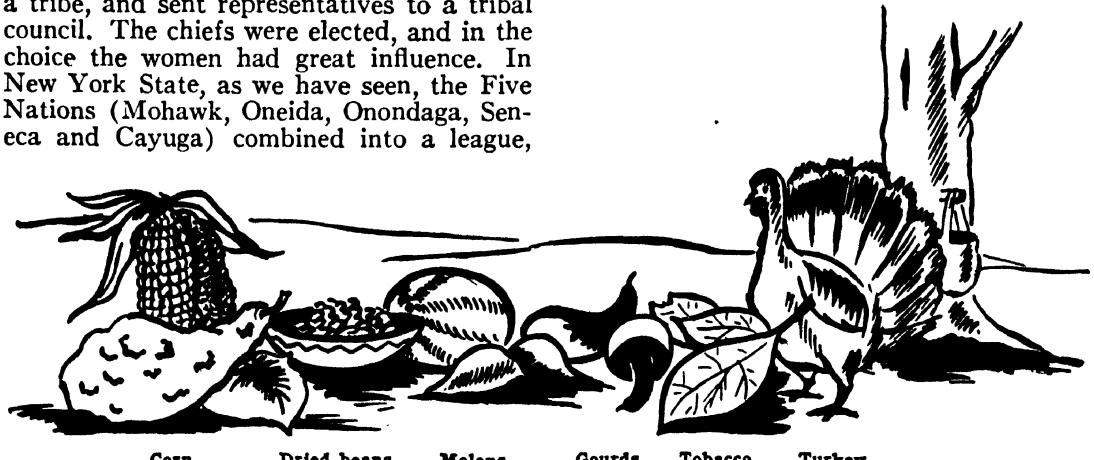
The Iroquoians are best known for their political structure, which was more complicated than that of other tribes of the United States or Canada. Each village was part of a tribe, and sent representatives to a tribal council. The chiefs were elected, and in the choice the women had great influence. In New York State, as we have seen, the Five Nations (Mohawk, Oneida, Onondaga, Seneca and Cayuga) combined into a league, each sending representatives to the league council. The strength of the league may be judged by the fact that it lived on after the coming of the whites, and indeed held the balance of power between French and English for some two hundred years.

The Five Nations became famous as warriors, spreading fear far and wide among other Indians and white settlers alike, even among the more peace-loving Iroquoians, the Huron. They adopted captives to replace their braves who fell in battle and thus maintained the traditions of their people. Few people have played as large a part in history with as small numbers; and even to-day the surviving Iroquoians maintain a shadow of their national life.

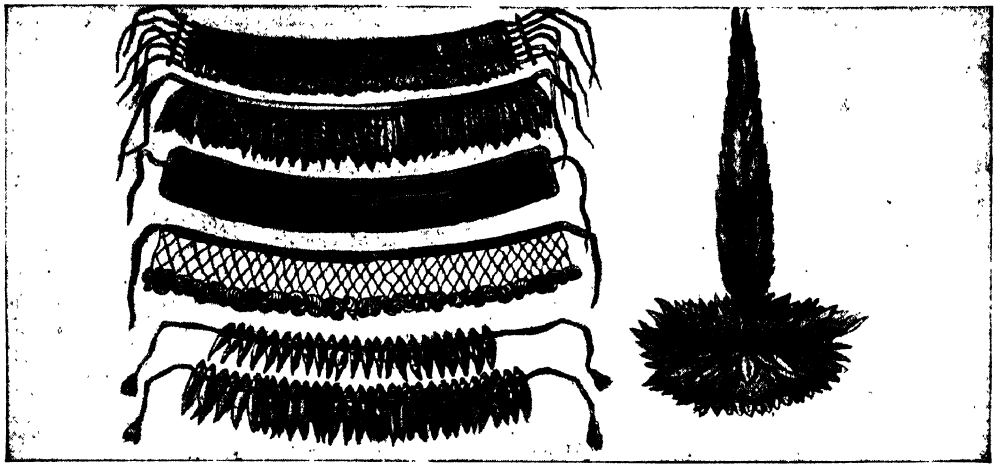
Iroquoian religion centred around three sisters, Corn, Squash and Tobacco, supernatural beings who were responsible for these basic crops. People worshiped in groups, or congregations. Ceremonies included crop festivals associated with the changing seasons. Priests were those who had had particular experiences or who had special knowledge. In the council of the league, moreover, the priests had particular duties to perform; in fact, the league of the Iroquois was partly a religious institution.

When Columbus discovered America, there were perhaps a million Red Men north of Mexico. There are about half that number now, though not all are of pure Indian stock. Some Indians have intermarried with whites and their descendants are counted as Indians in the censuses. The article beginning on page 7235 will tell you about the Indians of to-day in our country.

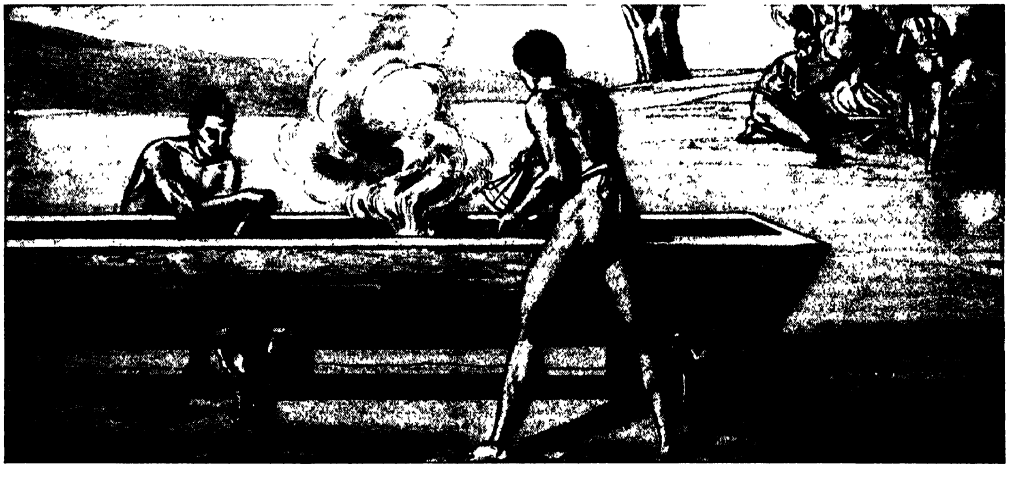
THE NEXT BOOK OF UNITED STATES IS ON PAGE 361.



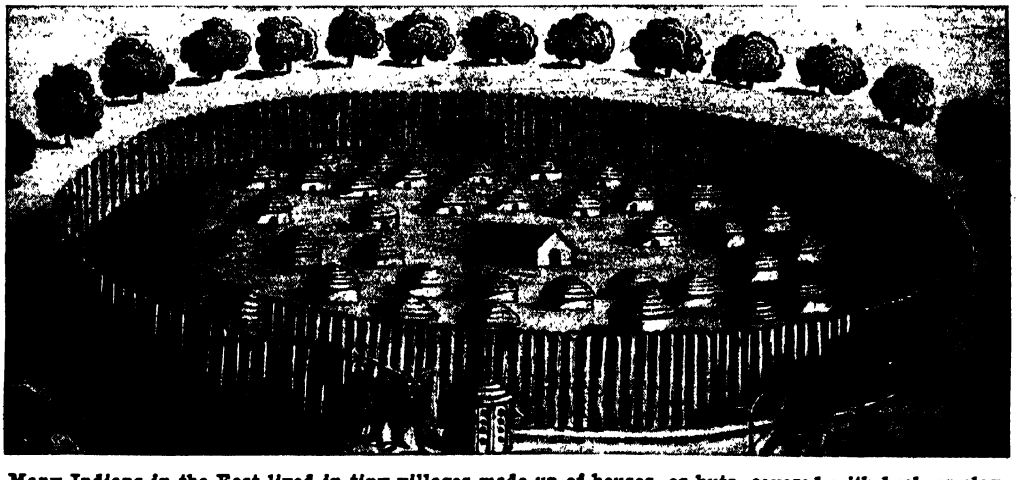
INDIAN PICTURES THREE CENTURIES OLD



Shells strung together, used for money (wampum) and ornament. Indian feather head-dress.



Here we see Indians burning and scraping out the centre of a log in order to make a rude canoe.



Many Indians in the East lived in tiny villages made up of houses, or huts, covered with bark or clay. A stockade, or high fence made of poles, surrounded such villages and offered protection against sudden attacks by enemies.

INDIAN WARRIORS AT WORK AND AT PLAY

From an old print

Here we see Indians on horseback hunting buffalo. There were no horses in America before the Spanish came, and the Indians sometimes would corner a few buffalo by building grass fires around them, then run in and kill them.

From an old print

The Indians had many games, and some of them, like lacrosse, were adopted by the white men. These are Dakota Indians playing a game of ball on the ice. The game is a little like our modern ice hockey.

Both pictures, American Museum of Natural History

The diplodocus, a huge dinosaur, a serpent-like animal which dwelt in the western part of North America.

ANIMALS WITH BACKBONES

IN the first article of the Department of Our Own Life we learned what life is; we saw that plants and birds and cats and dogs and boys and girls all have life upon the earth, while such things as stones and bricks and dishes do not have life.

All living things may be divided into two great groups—animals and plants. Each of these groups is further divided into smaller groups, and in The Book of Knowledge we show you the smaller groups, one after another, in the Departments of Plant Life, Animal Life and Our Own Life.

Human beings belong to the great group of animals; but we are so complex and do so many wonderful things that we must be specially studied. There are many ways in which we are like the animals, and we need to know something about the whole animal kingdom in order to understand ourselves.

If we were to look over all the animals on earth we should find that some of them, including human beings, have a backbone. We call these vertebrates (backboned animals). Animals that have no backbones at all we call invertebrates (not-backboned animals). In the Department of Animal Life, the vertebrates are studied first.

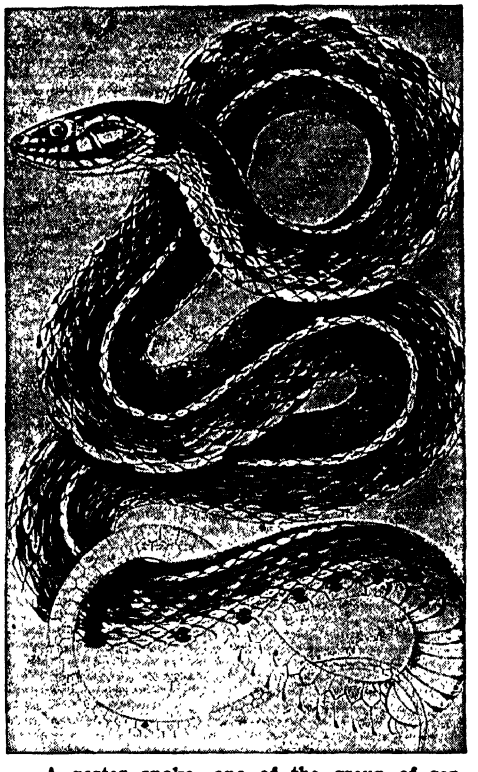
There are some animals, such as the lancet or amphioxus, and the tunicates, that stand between these two great groups. These are called the lower chordates and have only a gristle-like rod instead of a backbone. Other animals, like the lampreys, look like eels but have only this gristle-rod and poorly developed vertebræ.

There are five major classes of animals that have backbones. We would need only a very small menagerie to show us one animal of each of these five kinds. So let us pretend we have five animals right here where we can see them. One is a goldfish swimming about

Skeleton of the allosaurus. This animal was a flesh-eating dinosaur.

EXAMPLES OF BACKBONED ANIMALS

On these two pages are examples of our five groups of backboned animals—birds, reptiles, amphibia, mammals and fishes.



A garter snake, one of the group of reptiles. Most snakes have no limbs. Some reptiles have only two limbs, others have four.

Frogs and toads. These animals, and the salamanders and newts, are amphibians, that is, they live part of their life on land and part in the water.

A setter, one of the hunting dogs, a member of the great group of mammals.

American Museum of Natural History

This picture shows some of the fish that lived in the Devonian Age. The fossil remains of these fish were found in a layer of sandstone rock in Scotland. There were more than a hundred species of fish in this period.

in a bowl of water. Next to it is the common spotted frog. Then, in a box, is a garter snake (but you may have a turtle in your box if you would rather). Fourth, a canary is singing in a cage, and fifth is your own dog or cat.

It may seem that these five animals do not have very much in common. The goldfish can not even breathe the way the others do, and the only one that can fly is the canary.

However, all five of these animals have backbones and so they belong to the great group of animals known as the backboned animals or vertebrates. There are very great differences among them, of course. The fish gets its life-giving oxygen from the water by means of its gills but the others breathe the air. The fish, the frog, the turtle and the snake are all cold-blooded. The canary and the dog and cat are warm-blooded. But the possession of a backbone makes all animals that have them very different from all animals that do not.

The names of the five classes of animals with backbones are the Fish, the Amphibia, the Reptiles, the Birds and the Mammals. The great class of fish is represented by the goldfish in the bowl. The amphibia are represented by the spotted frog. The snake (or turtle) is a reptile. The canary represents the birds; and the dog and cat are mammals.

Animals that do not have backbones (the invertebrates) are not at all like these. They may be quite soft and slimy, like an earthworm or a garden slug. Others have impressive suits of armor, like the lobster and the insects. Snails, oysters, scallops and clams are backboneless animals that live in shells.

Many of these invertebrates are very important indeed. Lobsters and crabs are important as food. A bee is most important for the honey it gathers. Mosquitoes, unfortunately, are important too, because they not only bother us but some carry dreaded disease.

Bees, wasps and ants live in cities, have a successful sort of government and share the work and the food. A few kinds of ants even have armies and seem to fight according to plan.

The lowest form of vertebrate animal is the fish. Fish did not always have the fine, strong bones that most of them have to-day. The first backbones were not much more than a very tough string of gristle; and a few fish, such as the sharks and rays, still have cartilage or gristle in place of a good spine made of bone. In most fish, however, bones have replaced the piece of gristle; and, little by little, the framework of bones has been formed that we call a skeleton.

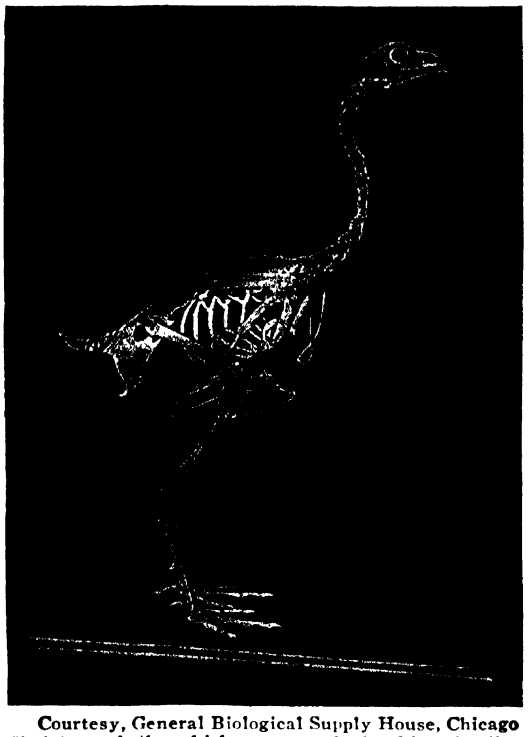
If you like to eat fish, you have probably seen that fish have very good backbones, with many little bones attached to them. The backbone of a fish is excellently suited to a life of swimming in the water by movements of the tail and body.

While you are reading about fish, it would be a good thing to remember that not every animal living in the sea is a fish. Starfish and barnacles, for example, are not fish, nor are the jellyfish that float in the ocean like saucers turned upside down. Such sea creatures have no backbones and are classed with

the invertebrates; but a fish is one of the vertebrates. The mighty whale is not a fish even though it is a vertebrate and lives in the sea; it looks like a fish but breathes air and is a true mammal. We will tell you about the mammals later.

Now it is time to think about your spotted frog. The frog began its life in the water as a tadpole and grew up to be a frog living on land, and so it is a member of the class of animals called Amphibia. Other amphibians are toads and salamanders.

The word amphibia is a familiar word to most of us nowadays because we have heard so much about the famous amphibian planes that can land on the water as well as on the land. The amphibious truck called a "duck" can run in water and surf as well as on the beach. Amphibia is a Greek word meaning "double life," and a double life is just what amphibian animals have—one part of it is spent in the water and the other part of it is spent on land.



Courtesy, General Biological Supply House, Chicago
Skeleton of the chicken, one of the bird family.

In order to live on land an animal must be able to breathe the air, and in order to breathe air it is necessary to have lungs. Fish do not have lungs; they have gills with which they are able to use the air that is in the water.

Amphibia (frogs, toads and salamanders) are hatched from eggs in the water. They come out of the shell as tadpoles, or polliwogs. They can soon swim, and they soon grow gills for their life in the water. When some time has passed, the fish-like polliwog begins to change in a wonderful way. Its lungs grow bigger, its gills smaller, it grows two pairs of legs, its tail slowly disappears —it has become a land animal, walking (or at least jumping) and breathing air. But most Amphibia continue to live near the water; and most of them are good divers and swimmers.

All but a few backboned animals higher than the fish have limbs of one sort or another. These limbs come in pairs. They may be forelegs and hind legs, or wings and legs or arms and legs. Vertebrates like your dog or cat have two pairs of limbs all their lives. Snakes are limbless; but most other reptiles have well-developed limbs. Birds have legs and wings, which are a kind of limb. No backboned animal (except a freak) ever has more than just two pairs.

A frog has hands on its forelegs, as we have, but each hand has only four fingers. On its hind legs it has feet, each with five toes.

The class of animals called reptiles includes the garter snake that we have in our zoo, as well as all other snakes and lizards. It includes the turtle, and all kinds of tortoises, too. Crocodiles and alligators are other well-known reptiles living to-day.

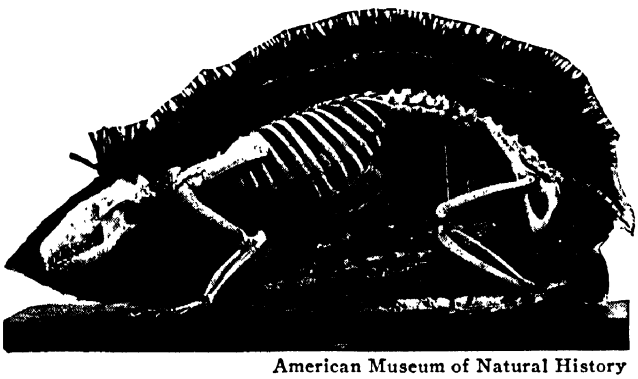
Reptiles were the first animals with backbones that spent all of their lives on land. The very first reptile we know much about is called Seymouria, because its remains were found near the town of Seymour in the state of Texas. This reptile was a little over a foot long, with a short, stubby tail and stubby legs that sprawled out sideways from its body.

In ages past, many reptiles grew to enormous size, until they walked like giants on the earth. Some of these huge creatures were five times as large as any elephant we know today.

Nowadays, reptiles are nothing like so large. We do not know the reason, but we know that those mighty monsters died off. Some of the reptiles grew long and slender and finally they took the shape of snakes. Their limbs were useless and dwindled away. Snakes that live nowadays glide gracefully without them. Except for the fact that snakes have no legs, they are not very different from lizards.

Not all of the reptiles that lived in ancient ages were enormous. Some of them

were smaller, and some of the smaller reptiles were able to fly. Flying reptiles are called pterodactyls. Their forelegs were covered with a leathery membrane which made wings they could use, but they had no feathers. They glided rather than flew like birds. They had sharp, curved teeth and must have been very ugly. None of these strange creatures are alive today. The pterodactyls became extinct long ago.



American Museum of Natural History

Skeleton of the European hedgehog, one of the mammals.

The canary that we have in our menagerie represents the fourth class of vertebrates, the birds. This pretty little bird does not look very much like the first bird that scientists tell us about. This first bird, called an archæopteryx, was not so large as a crow and it had sharp teeth. Its tail was long, like a reptile's tail, but it had feathers, which reptiles do not have. You would never suppose that robins and wrens and bobolinks had much in common with this first homely bird; but scientists believe that this first bird gave rise to all the kinds of birds we have to-day.

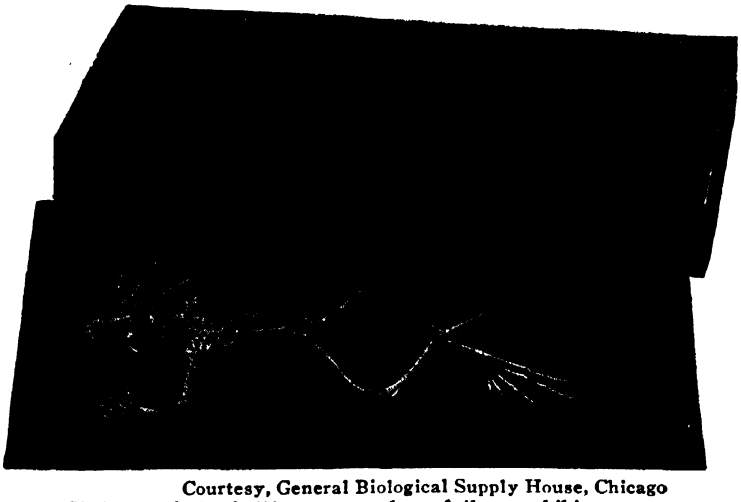
The dog and cat of our menagerie stand for the fifth and last class of vertebrate animals, the mammals. Mammals are animals with hair or fur and they feed their young by means of milk, as, for instance, a cow feeds her calf. A human mother feeds her baby by the same means.

In our study of animal life, we shall take up the mammals first. You have already read about the monkeys and apes and their cousins. They belong to what is called the order, or family, of Primates, the first (highest) of the mammals, to which order man also belongs.

There are several other orders of mammals—the bats, whose hands are wings; the flesh-eaters; the insect-eaters; the gnawers and burrowers, or rodents; the marsupials, animals that are carried in their mother's pouch when young; and others—all of them described in The Book of Knowledge. Some even lay eggs, like birds. Some fly, such as the bats. Some live in the water, the whales, for instance. Some live in trees and others in nests under the ground. The class of mammals, the highest group of vertebrates, is varied and wonderful.

Although man is in all physical respects an animal, a vertebrate, a mammal and one of the Primates, he stands apart from all other animals in many ways—to say nothing of his soul. He walks erect. He has hands that are skillful and a brain that can reason and remember and learn and create. He has developed the use of tools, invented machines and makes use of other animals.

In the Department of Our Own Life we shall learn about man, how he is made of bone and blood and flesh and sinew; his senses, his brain, the many wonderful parts of his body. We shall learn, too, something of men's devices for living peaceably together on this earth—what law is, why we use money and how trade helps nations.



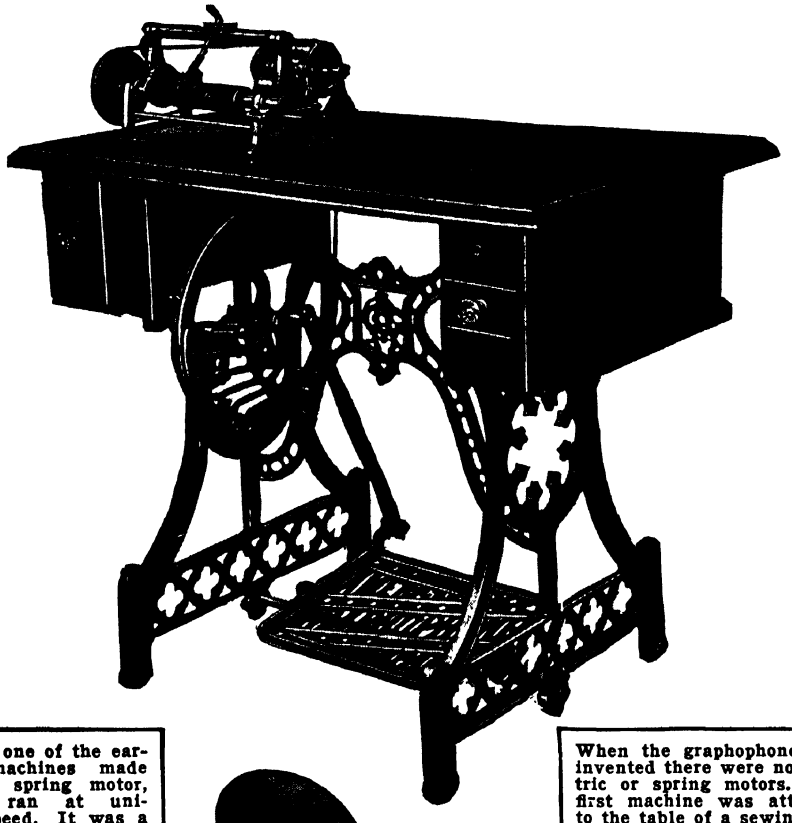
Courtesy, General Biological Supply House, Chicago

Skeleton of the bullfrog, a member of the amphibian group.

Article prepared with the assistance of Dr. John Eric Hill, Assistant Curator of Recent Mammals, American Museum of Natural History.

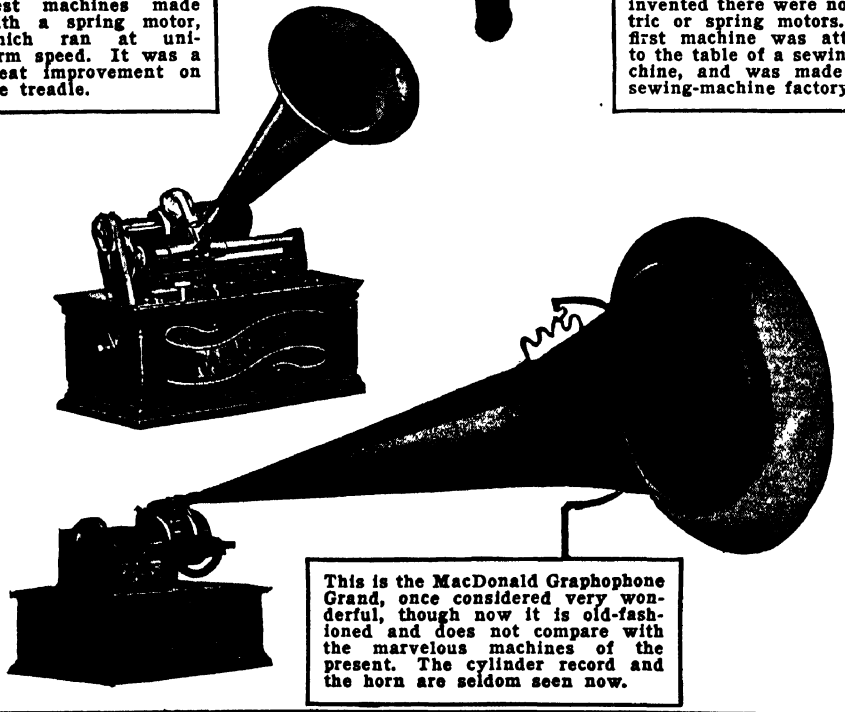
THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 557.

SOME EARLY TYPES OF TALKING MACHINES



This is one of the earliest machines made with a spring motor, which ran at uniform speed. It was a great improvement on the treadle.

When the graphophone was invented there were no electric or spring motors. The first machine was attached to the table of a sewing machine, and was made in a sewing-machine factory.



This is the MacDonald Graphophone Grand, once considered very wonderful, though now it is old-fashioned and does not compare with the marvelous machines of the present. The cylinder record and the horn are seldom seen now.

Here are some early talking machines. The great difficulty at first was motive power, and not until the spring motor, the speed of which could be controlled and kept uniform, was developed, was progress possible.

THE TALKING MACHINE AND ITS RECORDS

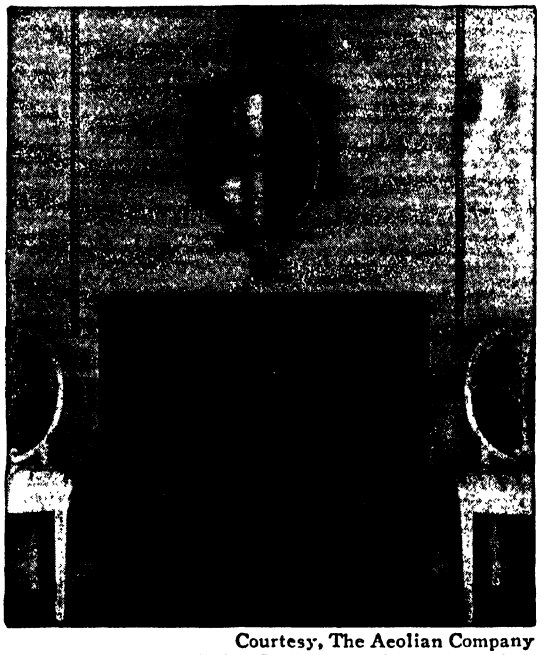
SOUNDS are vibrations, or waves, in the air. They can be sudden, sharp, ugly noises, as when a plate that you are drying drops to the floor with a bang or breaks, and then there are several smaller bangs as the smaller pieces hit the floor and break. Sounds can follow a lovely pattern, as when you read a nursery rime or sing a song to your little brother.

The vibrations, or waves, in the air strike your ears and are carried to the hearing centres of your brain, and so you "hear" the noise of the plate hitting the floor or the sound of your own voice making the air tremble.

A talking machine does the same thing as the plate or your voice. It makes waves in the air that strike your ears and travel to your brain and you hear music, or speech, or laughter, or birds singing, or whatever the talking machine is giving out to you.

Think of it in this way—sounds can be written, and then, instead of reading them, we hear them by means of the talking machine. How did men go about writing sound-waves? At first the inventors used a disc (they called it a diaphragm) which trembled when sound vibrations struck it. A little needle, called a recording stylus, was attached to the diaphragm, and as the diaphragm trembled the needle moved also. As it moved, the needle point traced lines upon a record; in this way the pattern of the air vibrations was written on the record. This old method is called acoustical recording, from the word meaning to hear.

In modern recording the sound-waves enter a radio microphone and are changed to impulses of electricity, which represent these same sound-waves. The impulses are amplified (made stronger). The current, still carrying the sound-pattern, passes through coils which affect an electromagnet. The electromagnet controls a stylus and the stylus writes the sound-pattern on the record. This is called electrical recording, and it produces far clearer, truer records of sound-patterns than the older and simpler acoustical recording.



Courtesy, The Aeolian Company
A recent model of the Capehart radio-phonograph.

A soft wax-like disc is usually rotated (turned) on the recording machine in contact with the recording needle, the stylus. As the stylus is moved by the electromagnet's attraction, it cuts into the soft material of the disc and traces on the surface a spiral line called the tone groove. A magnifying glass shows that this spiral line has indentations (hills and valleys). These hills and valleys in the tone groove form the sound-pattern. In one type of record the indentations are on the sides of the tone groove. In the other type they are on the bottom. That is, in one type the recording stylus moves from side to side; in the other it moves up and down.

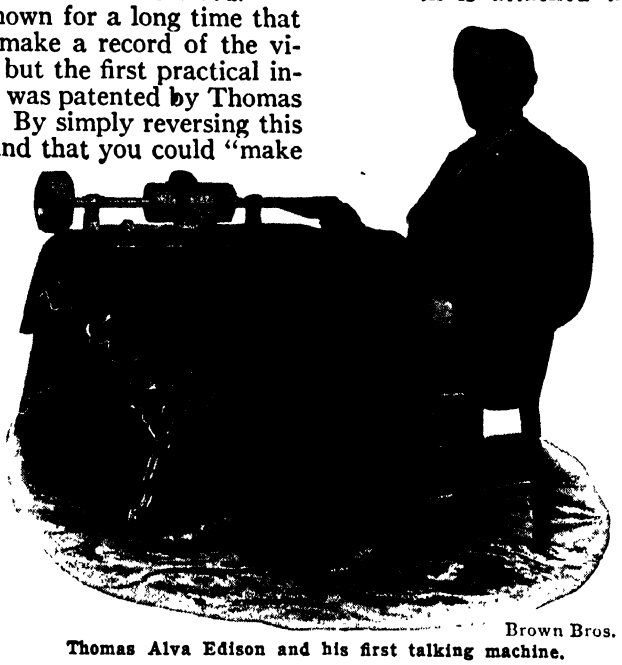
The wax-like disc on which the tone groove is traced is called the master record. When it has been made, it is put through an electroplating process and then we have a mold that is known as a matrix. The matrix is used to make another disc called the original. From the original, other molds are taken, called dies, or stamps; and from these, talking machine records are stamped or pressed. Many duplicates can be made from one stamp, and that is why records are comparatively cheap. In another process a layer of gold is deposited electrically on the master.

Now place a record on your talking machine. Start the machine. You know very

well that you must have a needle moving in the groove on the moving record. In a machine that you wind by hand the motion of the needle sets a diaphragm trembling (vibrating) against the atmosphere, according to the sound-pattern. The vibrations are sent out through a horn, and we "hear" the writing on the record.

In one type of electrical phonograph the needle, moving along the hills and valleys of the tone groove, gives rise to tiny electric currents which are amplified like radio waves and then sent to a loudspeaker. The phonograph gives back what it has received.

Scientists had known for a long time that it was possible to make a record of the vibrations of sound; but the first practical instrument to do this was patented by Thomas A. Edison in 1877. By simply reversing this machine it was found that you could "make it talk." For a long time the new talking machine was looked upon as little more than an interesting toy. Early records for it were not satisfactory. They were shaped like cylinders and covered with tin foil, the best thing inventors could find; but this substance soon wore out. For a time wax was used, and Alexander Graham Bell and others developed and patented a wax cylinder record.



Brown Bros.

Thomas Alva Edison and his first talking machine.

Meanwhile, a good motor had to be developed to make the talking machine operate. Originally, electric motors operated by storage batteries were used, but they were inconvenient and cost too much money. The spring motor, or clockwork motor, then came into use, and it became possible to make a good machine at a low price.

It was discovered not long after the invention of the talking machine that to get the best results in recording music a certain speed should be used, neither too fast nor too slow. Thomas Hood MacDonald, who perfected the first clockwork-motor models, took out patents covering speed.

The next development was the flat disc, the kind of talking machine record most of us know to-day. The experiments of Emile Berliner, a German living in the United States, and the patent issued to J. W. Jones, advanced the art of making the disc record. At first only one side of this was used, but to-day both sides generally have recordings, thus giving twice as much music on a single record.

Many inventors have worked to improve the talking machine, and every separate item of its construction has been re-designed thousands of times. For instance, there are many forms of motors. In the sound box, to which is attached the needle or stylus, almost every possible material has been used for its diaphragm—paper, parchment, metal, paraffined cork, mica and so on. (Mica is now the favorite material.) The early talking machines had a large horn, somewhat like a megaphone. Later the horn was built into the body of the machine cabinet, and it was greatly perfected.

Some inventors worked on "governors" to make the records turn at an even rate of speed; others, on automatic brakes that would make the motor stop when a record had reached its end. Electrically driven motors, operated by house current, were perfected. The steel needle was improved so as to give longer wear; substitutes for steel were developed. The longest-wearing needle at the present time is the diamond stylus. Other needles are made with sapphire tips. Less expensive ones are made of special alloys, chromium, plated steel or special steel.

There have been great improvements in disc-recording materials, disc-driving mechanisms, microphones, amplifiers and methods of recording in recent years. As a result, recording systems are now so sensitive that even the overtones of music are frequently captured, although they can not be heard. Reproduced sounds have become so realistic

that it is practically impossible to tell them from the original.

The early machines had a harsh metallic sound, and sometimes unusual noises would be heard in the recordings. It was discovered that a disagreeable scraping sound was caused by a tiny blower used to blow away the shavings or curls of wax made when the recording needle moved over the face of the recording disc. All such unwelcome sounds have been done away with, and the tone of the instrument has been greatly improved.

This picture shows the record "dough," from which wax phonograph records are made.

A record "biscuit" is made of the dough. It is rolled into a ball and placed on the record press.

The talking machine is used to record music, poetry, stories, and also important speeches and happenings. In the vaults of the Paris Grand Opera House and elsewhere have been placed collections of records made by great musicians. They can be taken out fifty or a hundred years from now and listeners of that far day will be able to hear music of the past. Distinguished men and women of various countries have spoken for the talking machine, and their voices have been preserved for future generations. The voices of birds and animals have been recorded. So have the sounds of battle.

Large sums of money have been paid to artists for their talking machine recordings. Caruso's royalties (commissions on the sales of his records) were the first to reach very large sums. Nowadays it is not at all uncommon for a successful artist to receive as much as $100,000 a year in earnings from records. Some of the larger manufacturing companies maintain their own bands and orchestras, made up of musicians

All pictures, courtesy RCA Victor

The record press is now closed. The "biscuit" in the press is flattened out as pressure is applied to it. At the end of this process we have a disc reproducing all the "hills" and "valleys" of the master record.

of high skill. For a while radio lessened the sale of talking machines, but then a wonderful thing happened. Radio increased the world's interest in music, and the demand for more music in the home. Radio engineers also, as we have told you above, improved the phonographs and the records. Therefore more people than ever before now own phonographs, and they purchase great numbers of records. Combinations of radio, television and talking machine have a large sale.

Making a record is both interesting and difficult. Suppose a record is to be made of a song with orchestral accompaniment. In the recording auditorium the singer first rehearses the song with the orchestra, perhaps several times, so that singer and players perform well together. Perhaps some of the instruments, or groups of instruments, in the orchestra need to be placed nearer the microphone or farther away to obtain the proper balance. Then a section of the song, with orchestral accompaniment, is given a first trial and registered, to see if all is going well.

As one speaks into the tube of a dictating machine, the words are recorded on a revolving wax cylinder.

If all goes well, the recording mechanism is made ready, the signal is given and the conductor brings down his baton. The singer and the orchestra do their best, for what they are producing will be permanent. Even the slightest fault will be apparent in the record.

Many singers find recording much more exhausting than singing before audiences. Scenery, lights, color, the sympathy of the hearers are all lacking in the bare room where the singer faces only a microphone. All communications between singer, conductor and orchestra must be by signs.

Until 1948, the ordinary record revolved on the turntable of your talking machine about 78 times a minute; and each side of the record played for about a minute and a half. For some years radio stations had used larger discs that turn only 33⅓ times a minute and play for several minutes. These longer playing discs, or platters, save storage space. In 1948 and 1949 two new types of records for the home were offered. One of these revolves 33⅓ times a minute and each side plays for twenty minutes. The grooves on this long-playing record are narrower and more tightly packed together than those on the "78" record. It requires a turntable with a special motor.

Both pictures, Dictaphone Corp.

The typist writes what she hears through the tubes in her ears. There are controls at her feet.

The second new type revolves 45 times a minute. It is a much smaller record than the "78," yet plays for as long a time. The "45" requires its own turntable, which has a quick-changing device that shortens the pause between records. Both models save space.

All of the new records, including many of the "78" records too, are made of vinylite, a light, unbreakable plastic material.

Few inventions have given so much pleasure to so many people. In homes and in schools music for entertainment and instruction can be played again and again. In factories and offices men and women at work can hear recorded music, which provides relaxation and relieves fatigue. This music comes to them through plant broadcasting systems developed on electronic principles from the talking machine. More than 10,000 plants have installed systems of this sort.

The talking machine is useful in the busi-

ness office as well. The dictating machine saves much valuable time. A wax cylinder is put on and the machine is started. The man who is dictating a letter talks into the tube, as you see in the picture. As he talks, everything he says is cut in a tiny line on the wax surface. The cylinder will hold perhaps a dozen letters before it is full. When the man has finished, he stops the machine.

When the typist is ready to write the letters, she may use the same machine. She pushes a little lever, puts two tiny tubes in her ears, and the machine gives back to her exactly what has been said. As she types the letter she can make the machine go as fast or as slowly as she wishes, and can make it repeat any part as often as necessary. In large offices different machines are used for dictation and for reproducing.

You can see the many advantages of this machine. The stenographer may be busy or out at lunch when the employer wishes to dictate, or the employer may think of a letter he wishes to write after everyone else has gone home. He dictates into a dictating machine, giving full directions and even spelling unusual words, and the typist can write at her convenience.

When a cylinder has been filled and the letters it has recorded have all been written, a thin film is shaved off the surface and it is ready for use again. A cylinder can be shaved a hundred times or so.

Another wonderful invention called the magnetic recorder makes it possible for you to make records on fine wire or on tape. Here you do not trace grooves with a stylus (needle) on a surface. You re-arrange the molecules of the wire or tape. Sound vibrations are changed into electric impulses, much as they are in radio. These impulses are then registered as a magnetic pattern on the wire or tape as it passes by an electromagnet. In other words, the molecules of the wire or tape become tiny magnets of varying strengths so as to carry the p ttern of the electric impulses.

When you wish to play back the recording, you move the wire or tape (which is now a continuous string of very small bar magnets) past a coil of many turns of fine wire. As the magnets pass the coil, a small electric current is formed. This current flows out to a loudspeaker where you hear it as sound.

The volume of the sound you hear depends upon the strength of the magnet passing by the coil. A strong magnet will produce a loud sound, a weak magnet will produce a soft one. The pitch of the sound depends upon how quickly the poles of the magnets pass by the coil. If the magnets are short and the poles change rapidly from north to south, the sound will be high in pitch. If the poles change slowly, the sound will be low.

Your record, wound on a spool, is easily stored away. It never wears out; and the sound-pattern will remain fresh and clear, unless you wish to erase it. Thi- you can do by a device that scrambles the molecules, that is, unmagnetizes them. Then you can make another recording on the wire or tape, and this recording and erasing can go on indefinitely without injuring the wire or tape.

Magnetic recording is used in making transcriptions of radio programs, public speeches, interviews and other sounds. It has many advantages over disc records, and over the cylinder records for business dictation machines.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 345.

Recording for an electrical transcription. It will be played in a central studio and sent out by wire.

Both pictures, Muzak Corp.

The turntable on which the transcription is played. It reproduces sound-patterns almost perfectly.

THE LAST SCENE OF A TRAGEDY

© Reinthal & Newman, New York.

THE END OF THE TRAIL, BY JAMES EARLE FRASER

A STORY OF THE REDSKINS

THERE is no more picturesque figure in modern romance than the American Indian. Fenimore Cooper, whose life-story is told in this work, became famous for his stories of adventure among the Redskins. This is one of his best-known tales, told over again as a short story. Cooper wrote this romance of the American wilderness in 1826, at a time when the Indians were still fairly numerous and often took to the warpath against the white settlers. They had their encampments even in the Great North Woods of New York. Now the race is greatly reduced, and the "noble red man," as described in romance, no longer rides the Western Plains as of yore.

THE LAST OF THE MOHICANS

IT was summer-time in the year 1757, when the British colonists in America were carrying on a war with the French, then masters of Canada. Always subject to attack by the different tribes of Indians, who were still numerous and formidable, the colonies were at this time more disturbed than ever. War between the French and the British also involved outbreaks with the Indians. Some of the Canadian tribes, taking to the warpath, came down into the British colonies. Danger lurked everywhere; even the townships were not secure from attack.

But one day, in the still beauty of July, three strange and picturesque figures made part of a striking scene in the American wilderness. The scene was so peaceful to look upon that one might never have guessed how near to the most exciting adventures all three were. On the high bank of a swift and swollen river the men were grouped in attitudes of ease. The dull thunder of a waterfall told that the river had come down from the higher land at no great distance away, with a tremendous fall that now sent its water boiling and churning between the steep banks.

Of the three, there were two whose dark, ruddy skins and paint-bedaubed features and bodies, with their picturesque costumes of skins and feathers, betokened them natives of the wild lands of the West. One was older than the other, for, indeed, they were father and son. The old Indian was Chingachgook, known as the "Great Serpent." He was the sagamore, or tribal chief, of the Mohicans, the remnant of a tribe of the Delaware Indians. He had all the dignity and alert bearing of an Indian chief, though his body had no longer the supple beauty and suggestion of boundless energy of his son Uncas, known as the "Bounding Elk."

The third person of this little group wore a green hunting-shirt and Indian moccasins. And there lay across his knees a rifle of unusual length, the trigger of which he fingered from time to time. Almost as dark of complexion as his companions, by long exposure to the sun, it would have been difficult to tell him for a white man. But such he was, and his name was Nathaniel Bumppo. To the Indians, however, he was always known as "Hawkeye." His fame as a fearless scout and hunter was known to the French enemies, by whom he was usually spoken of as "Long Rifle."

The three men were talking quietly, and though they showed no uneasiness, they were evidently on the alert. They knew that General Montcalm, the French leader, was even then making his way through the far-spreading forests, over which their position gave them a splendid view. Montcalm was marching to attack the British in Fort William Henry, on Lake George, which was only a few leagues away from the scene. Suddenly the old Indian, putting his ear to the ground and listening intently, exclaimed: "The horses of

white men are coming!" Quickly taking cover, they had not long to wait before the cavalcade came into view. At its head was a British officer, who wore the uniform of a major in the colonial service. Beside him rode two beautiful young women, Cora and Alice, one fair-haired and blue-eyed, and the other bewitchingly dark. They were accompanied by an Indian guide and a strange, gaunt creature of unkempt appearance. Hawkeye's voice rang out in challenge as he presented himself to the little group, and the officer answered him.

"I am Major Duncan Heyward. These ladies are the daughters of Colonel Munro, who is in command at Fort William Henry, whither we are bound. Unfortunately, our Indian guide has lost his way. We should be glad if you could help us to regain it."

This was enough to make clear to the hunter that the Indian had betrayed the party. "An Indian lose his way!" he said scornfully. He made a sign to his own companions, who immediately slipped into the bushes to cut off the false guide. But with a wild shriek the guide bounded away and succeeded in eluding them.

It was clear that the travelers had been betrayed. No time was to be lost if they were to escape falling into the hands of cruel Indians, for the guide was known as a chief of the Hurons, enemies of the English. Dusk was gathering, and there was no hope of reaching the fort that night. Hawkeye led the four strangers down to the river's edge, giving the horses over to his Indian companions. From a place of concealment he drew forth a frail birch-bark canoe, in which the travelers took their seats with some difficulty, as five persons made too heavy a load. Only the marvelous skill of Hawkeye and his calm steering through the surging water against the current saved them all from drowning. But it was their only hope of escape. The four persons sat in the canoe scarcely daring to breathe, while Hawkeye coolly impelled it forward with dexterous and powerful strokes of the paddle. Meanwhile the two Mohicans led the horses into the water and took them upstream a considerable way to a little cove, where they would not be readily discovered. For, by walking the animals through flowing water, they avoided making a trail for the Iroquois to follow.

It was black night when Hawkeye at last brought the canoe into a little space of quiet water that washed a rocky island, over which the great waterfall descended like a mighty screen. Even when they had stepped on to the island, the travelers were afraid to move, through terror of the darkness and the deafening thunder of waters. There they stood, while the hunter shot away rapidly in his canoe to bring back the two Indians and a store of venison from their cache, or hiding-place. He seemed to have been gone only a little while when he appeared with his companions, and contrived to make the travelers comfortable for the night.

Hawkeye scarcely hoped that their hiding-place beneath the waterfall would escape discovery. He had chosen it only the better to withstand an attack from the Redskins, which, sure enough, was made soon after dawn next day.

But the favorable position of the island on which Hawkeye had placed his party, together with his great skill in marksmanship, kept the savage Redskins at bay until another night had come.

CAPTURED BY THE HURONS, BUT RESCUED BY HAWKEYE AND THE MOHICANS

The situation was now desperate. Their powder was gone, and the next morning would see them all shot or captured. A little council of war was held. It was decided that the scout and the two Mohicans should slip into the water and make their way to the fort in the darkness, returning at once with a rescue party. All agreed that the Redskins would make captives of the others in the morning, and it was necessary that the rescue party should be strong.

Next morning the Hurons returned to the attack. Meeting with no opposition, they made their way to the hiding-place. There they found Major Heyward and the two girls with a fourth member of the party. This was David Gamut, a singing-master attached to a Connecticut regiment, and he was really not quite sane. Instead of scalping his victims, Magua—for such was the name of the false guide—decided to take them captives. David Gamut insisted on singing a funeral psalm when he was captured, so the Indians left him practically at liberty. They believed, like many savage people, that persons of disordered minds are under a special pro-

tection. The real reason of Magua's betrayal was his desire to be revenged on Colonel Munro, at whose orders he had once been flogged.

Happily, Hawkeye and his companions, replenishing their powder from a secret store, had boldly started back on the trail without going to the fort. In the nick of time they overtook the Iroquois on the march with their prisoners, putting Magua and his braves to flight and releasing the captives.

Fall of the Fort and Recapture of the Colonel's Daughters

The little party then pushed on toward Fort William Henry. When they drew near, they found that Montcalm's troops had begun the investment of the place. By good fortune, one of the mists that rise suddenly from the lake came on. Hawkeye, knowing the land so well, was able to lead the party through the French lines unseen, to the great joy of old Colonel Munro, who had made every preparation to defend the fort against the enemy.

Bravely the old Scottish warrior and his small garrison, chiefly composed of the "Royal Americans," the regiment in which Heyward was major, defended Fort William Henry against the overwhelming forces of Montcalm. The end of it all was that Munro and his garrison had at last to surrender. But they were granted the privilege of marching out with the honors of war and a safe conduct to Fort Edward. This proved a hollow promise. They were attacked on their march through the forest by some two thousand Indians, who were attached to Montcalm's army, and a general massacre took place. Magua had also seized the occasion to reappear with a small band of Hurons. In the confusion that followed he succeeded in carrying off the sisters and the half-witted singing-master.

Colonel Munro and Major Heyward, as well as Hawkeye and the two Mohicans, managed to escape from the fray. Uncas was certain that Cora and Alice had been taken captive by the Hurons. So it was decided to make for the Great North Woods, in the hope of rescuing the girls, as in that district the Hurons had an encampment. The Delaware Indians were also encamped there, and the Mohicans were of the same race. Day after day the little party of five followed the trail into the depths of the wilderness until they felt they were nearing the Indian camp.

Emerging cautiously from the wood through which the trail had led, they saw below them a colony of beavers at work in a stream. A strange figure stood there watching the busy little animals. This was none other than Gamut, the singing-master, whose attention the party cautiously attracted. They learned from him that Alice was a prisoner among the Hurons, whose camp was some two miles off. Cora had been placed in the keeping of the Delawares ten miles away. So far the captives had suffered no harm, but what fate was in store for them who could guess? Gamut, not so mad as he seemed, had been allowed the fullest liberty by the Indians, and his help proved of great value to the rescuers.

Uncas, the Young Mohican, Falls into the Hands of the Hurons

Speedily their plans were agreed upon. Heyward was to disguise himself as one of Montcalm's scouts, and boldly visit the Huron camp in the hope of rescuing Alice. Uncas and Hawkeye were to make for the camp of the Delawares and rescue Cora. The old colonel, under the guidance of Chingachgook, was to go to a place of safety along the stream.

The singing-master took Heyward, disguised as one of Montcalm's scouts, to the Huron camp. He was received by a council of the Indians, and was parleying with them when Uncas was brought in as a prisoner. Magua, arriving with his party of braves, was overjoyed to find his enemy at his mercy. While some of the Hurons would have killed the young Mohican chief at once, Magua preferred keeping him alive to torture him later.

In the commotion which the capture of Uncas had caused, Heyward and his supposed mission from Montcalm were for the time being forgotten. The stranger in the camp was not recalled to mind until an aged chief came forward to ask whether the white brother had skill in magic. To this the major, with a little hesitation, not knowing whither he might be led by his reply, answered that he had.

Saying that an evil spirit had entered into the wife of one of his young men, the Indian then led the way to a cave in the mountainside, some little distance from the camp. There a young woman lay, evidently very ill.

"Now let the white brother show his

power," said the old Indian to the major. "I go. Brother, the woman is the wife of one of my bravest young men; deal justly by her. Peace," he added, beckoning to quite a large tame bear that had followed them into the cave, rolling and grunting. "I go."

The old Indian then left the supposed worker of magic in the cave. He had no sooner gone than the animal, which Heyward took to be one of the tame bears sometimes kept in Indian villages, rose on its hind legs. The great ungainly head was lifted up to disclose the bronzed face of Hawkeye the scout!

THE SCOUT AND THE MAJOR OUTWIT THE INDIANS AND RESCUE ALICE

After his first moment of surprise Heyward said to the scout: "Tell me the meaning of this masquerade. Why have you attempted so desperate an adventure?"

"The capture of Uncas is my reason for being here, and his own hot blood was the reason of his falling into the hands of the Hurons. By a stroke of luck I discovered an Indian conjurer, the owner of this bearskin, who was preparing for the entertainment of the village. Speedily securing him, I made free with his finery, and am here to play his part, though not quite as he had intended. But let us hasten, for Alice is most likely hidden somewhere here," said Hawkeye.

In an inner cave they were happy to discover the fair object of their search. Just at that moment Magua appeared at another entrance, only to be instantly disabled by the two white men, and bound and gagged. Quickly wrapping the girl in a blanket, Heyward took her in his arms. Followed by the scout, who again imitated the walking of the bear, they appeared at the entrance of the outer cave, where were some of the relatives of the sick woman.

"Has my brother driven away the evil spirit?" demanded the old Indian. "What has he in his arms?"

"Thy child is better," returned Heyward gravely. "The disease has gone out of her; it is shut up in the rocks. I take the woman to a distance where I will strengthen her against any further attack. She shall be in the wigwam of her husband when the sun comes again."

This speech satisfied the people. So, followed by the bear, Heyward, carrying Alice, passed boldly through the crowd and into the woods. When they had gone some distance, the scout urged Heyward to make with all haste for the camp of the Delawares and demand protection, as they were friendly Indians. Hawkeye would return to try to save young Uncas.

THE HURONS DEMAND THE RETURN OF PRISONERS FROM THE DELAWARES

When the scout had reached the outskirts of the encampment again, he encountered Gamut and disclosed his plans to him. Singing his loudest, Gamut led the way to the wigwam where Uncas was imprisoned. The mad singer told those who watched that he and the bear-conjurer were going to work a spell upon the captive. Believing that within the skin of the bear was the form of their own favorite magician, and that Gamut himself had supernatural power, the Indians made way for the two to enter. No time was lost now in making Uncas exchange places with Hawkeye. The scout changed his own clothes for those of the singing-master, whom they were to leave behind, knowing that the Indians would do him no harm. The ruse was successful. Hawkeye and Uncas escaped into the forest, eluding the pursuit which the Hurons soon began when they discovered the deception that had been practiced.

Major Heyward in the meanwhile had made such good haste that he arrived safely with Alice in the camp of the Delawares, and was granted protection. When Hawkeye and Uncas came later and asked for hospitality, they were placed under guard, though not unkindly treated.

Next morning Magua and a band of his followers appeared in the Delaware camp, dressed and painted as if for peace, to claim the return of their prisoners. A great council of the Indians was called, over which the oldest chief, named Tamenund, presided.

"Justice is the law of the great Manitou," said the venerable chief Tamenund, then over a hundred years old, in delivering judgment. "My children, give the strangers food. Then, Huron, take thy prisoner and depart."

Before the prisoners are given up to Magua, Cora appeals to the old chief. At her request Tamenund orders Uncas to be brought before the council.

In Fenimore Cooper's own words the story is now carried on:

. . . . . .

UNCAS REVEALS HIMSELF TO HIS PEOPLE

THE silence continued unbroken by human sounds for many anxious minutes. Then the waving multitude opened and shut again, and Uncas stood in the living circle. He cast a deliberate and observing look on every side of him, meeting the settled expression of hostility that lowered in the visages of the chiefs, with the same calmness as the curious gaze of the attentive children. But when, last in his haughty scrutiny, the person of Tamenund came under his glance, his eye became fixed, as though all other objects were already forgotten. Then advancing with a slow and noiseless step up the area, he placed himself immediately before the footstool of the sage. Here he stood unnoted, though keenly observant himself, until one of the chiefs appraised the latter of his presence.

"With what tongue does the prisoner speak to the Manitou?" demanded the patriarch, without unclosing his eyes.

"Like his fathers," Uncas replied; "with the tongue of a Delaware."

"A Delaware! I have lived to see the tribes of the Lenape driven from their council fires and scattered, like broken herds of deer, among the hills of the Iroquois! I have seen the hatchets of a strange people sweep floods from the valleys, that the winds of heaven have spared! The beasts that run on the mountains and the birds that fly above the trees, have I seen living in the wigwams of men; but never before have I found a Delaware so base as to creep, like a poisonous serpent, into the camps of his nation."

"The singing birds have opened their bills," returned Uncas, in the softest notes of his own musical voice; "and Tamenund has heard their song."

The sage started and bent his head aside, as if to catch the fleeting sounds of some passing melody.

"Does Tamenund dream!" he exclaimed. "What voice is at his ear? Have the winters gone backward? Will summer come again to the children of the Lenape?"

A solemn and respectful silence succeeded this incoherent burst from the lips of the Delaware prophet. After a patient pause, however, one of the aged men, perceiving that the sage had lost the recollection of the subject before them, ventured to remind him again of the presence of the prisoner.

"The false Delaware trembles lest he should hear the words of Tamenund," he said. " 'Tis a hound that howls, when the Yengeese shows him a trail."

"And ye," returned Uncas, looking sternly around him, "are dogs that whine, when the Frenchman casts ye the offals of his deer!"

Twenty knives gleamed in the air and as many warriors sprang to their feet, at this biting, and perhaps merited retort; but a motion from one of the chiefs suppressed the outbreaking of their tempers, and restored the appearance of quiet.

"Delaware!" resumed the sage, "little art thou worthy of thy name. My people have not seen a bright sun in many winters; and the warrior who deserts his tribe when hid in clouds is doubly a traitor. The law of the Manitou is just. It is so; while the rivers run and the mountains stand, while the blossoms come and go on the trees, it must be so. He is thine, my children; deal justly by him."

Not a limb was moved, nor was a breath drawn louder and longer than common, until the closing syllable of this final decree had passed the lips of Tamenund. Then a cry of vengeance burst at once, as it might be, from the united lips of the nation; a frightful augury of their ruthless intentions. In the midst of these prolonged and savage yells, a chief proclaimed, in a high voice, that the captive was condemned to endure the dreadful trial of torture by fire. The circle broke its order and screams of delight mingled with the bustle and tumult of preparation. Heyward struggled madly with his captors; the anxious eyes of Hawkeye began to look around him, with an expression of peculiar earnestness; and Cora again threw herself at the feet of the patriarch, once more a suppliant for mercy.

Throughout the whole of these trying moments, Uncas had alone preserved his serenity. He looked on the preparations with a steady eye and when the tormentors came to seize him, he met them with a firm and upright attitude. One among them, if possible, more fierce and savage than his fellows, seized the hunting shirt of the young warrior and, at a

single effort, tore it from his body. Then, with a yell of frantic pleasure, he leaped toward his unresisting victim and prepared to lead him to the stake. But at that moment, when he appeared most a stranger to the feelings of humanity, the purpose of the savage was arrested as suddenly as if a supernatural agency had interposed in the behalf of Uncas. The eyeballs of the Delaware seemed to start from their sockets; his mouth opened and his whole form became frozen in an attitude of amazement. Raising his hand with a slow and regulated motion, he pointed with a finger to the bosom of the captive. His companions crowded about him in wonder and every eye was, like his own, fastened intently on the figure of a small tortoise, beautifully tattooed on the breast of the prisoner, in a bright blue tint.

For a single instant Uncas enjoyed his triumph, smiling calmly on the scene. Then motioning the crowd away with a high and haughty sweep of his arm, he advanced in front of the nation with the air of a king, and spoke in a voice louder than the murmur of admiration that ran through the multitude.

"Men of the Lenni Lenape!" he said, "my race upholds the earth! Your feeble tribe stands on my shell! What fire that a Delaware can light would burn the child of my fathers," he added, pointing proudly to the simple blazonry on his skin; "the blood that came from such a stock would smother your flames! My race is the grandfather of nations!"

"Who art thou?" demanded Tamenund, rising at the startling tones he heard, more than at any meaning conveyed by the language of the prisoner.

"Uncas, the son of Chingachgook," answered the captive modestly, turning from the nation, and bending his head in reverence to the other's character and years; "a son of the great Unamis."

"The hour of Tamenund is nigh!" exclaimed the sage; "the day is come, at last, to the night! I thank the Manitou, that one is here to fill my place at the council fire. Uncas, the child of Uncas, is found! Let the eyes of a dying eagle gaze on the rising sun."

The youth stepped lightly, but proudly, on the platform, where he became visible to the whole agitated and wondering multitude. Tamenund held him long at the length of his arm and read every turn in the fine lineaments of his countenance, with the untiring gaze of one who recalled days of happiness.

"Is Tamenund a boy?" at length the bewildered prophet exclaimed. "Have I dreamed of so many snows—that my people were scattered like floating sands —of Yengeese, more plenty than the leaves on the trees? The arrow of Tamenund would not frighten the fawn; his arm is withered like the branch of a dead oak; the snail would be swifter in the race; yet is Uncas before him as they went to battle against the pale faces! Uncas, the panther of his tribe, the eldest son of the Lenape, the wisest Sagamore of the Mohicans! Tell me, ye Delawares, has Tamenund been a sleeper for a hundred winters?"

The calm and deep silence which succeeded these words sufficiently announced the awful reverence with which his people received the communication of the patriarch. None dared to answer, though all listened in breathless expectation of what might follow. Uncas, however, looking in his face with the fondness and veneration of a favored child, presumed on his own high and acknowledged rank, to reply.

"Four warriors of his race have lived and died," he said, "since the friend of Tamenund led his people in battle. The blood of the turtle has been in many chiefs, but all have gone back into the earth from whence they came, except Chingachgook and his son."

"It is true—it is true," returned the sage; a flash of recollection destroying all his pleasing fancies and restoring him at once to a consciousness of the true history of his nation. "Our wise men have often said that two warriors of the unchanged race were in the hills of the Yengeese; why have their seats at the council fires of the Delawares been so long empty?"

At these words the young man raised his head, which he had still kept bowed a little in reverence; and lifting his voice so as to be heard by the multitude, as if to explain at once and forever the policy of his family, he said aloud:

"Once we slept where we could hear the salt lake speak in its anger. Then we were rulers and Sagamores over the land. But when a pale face was seen on every brook, we followed the deer back to the river of our nation. The Delawares were

gone. Few warriors of them all stayed to drink of the stream they loved. Then said my fathers, 'Here will we hunt. The waters of the river go into the salt lake. If we go toward the setting sun, we shall find streams that run into the great lakes of sweet water; there would a Mohican die, like fishes of the sea, in the clear springs. When the Manitou is ready and shall say "Come," we will follow the river to the sea and take our own again.' Such, Delawares, is the chief of the children of the Turtle. Our eyes are on the rising, and not toward the setting, sun. We know whence he comes, but we know not whither he goes. It is enough."

The men of the Lenape listened to his words with all the respect that superstition could lend, finding a secret charm even in the figurative language with which the young Sagamore imparted his ideas. Uncas himself watched the effect of his brief explanation with intelligent eyes and gradually dropped the air of authority he had assumed, as he perceived that his auditors were content. Then permitting his looks to wander over the silent throng that crowded around the elevated seat of Tamenund, he first perceived Hawkeye in his bonds. Stepping eagerly from his stand, he made way for himself to the side of his friend; and cutting his thongs with a quick and angry stroke of his own knife, he motioned to the crowd to divide. The Indians silently obeyed, and once more they stood ranged in their circle, as before his appearance among them. Uncas took the scout by the hand and led him to the feet of the patriarch.

"Father," he said, "look at this pale face; a just man, and the friend of the Delawares."

"Is he a son of Minquon?"

"Not so; a warrior known to the Yengeese, and feared by the Maquas."

"What name has he gained by his deeds?"

"We call him Hawkeye," Uncas replied, using the Delaware phrase; "for his sight never fails. The Mingoes know him better by the death he gives their warriors; with them he is 'The Long Rifle.'"

"La Longue Carabine!" exclaimed Tamenund, opening his eyes and regarding the scout sternly. "My son has not done well to call him friend."

"I call him so who proves himself such," returned the young chief, with great calmness, but with a steady mien. "If Uncas is welcome among the Delawares, then is Hawkeye with his friends."

"The pale face has slain my young men; his name is great for the blows he has struck the Lenape."

"If a Mingo has whispered that much in the ear of the Delaware, he has only shown that he is a singing bird," said the scout, who now believed that it was time to vindicate himself from such offensive charges and spoke as did the man he addressed, modifying his Indian figures, however, with his own peculiar notions. "That I have slain the Maquas I am not the man to deny, even at their own council fires; but that, knowingly, my hand has ever harmed a Delaware, is opposed to the reason of my gifts, which is friendly to them, and all that belongs to their nation."

A low exclamation of applause passed among the warriors, who exchanged looks with each other like men that first began to perceive their error.

"Where is the Huron?" demanded Tamenund. "Has he stopped my ears?"

Magua, whose feelings during that scene in which Uncas had triumphed may be much better imagined than described, answered to the call by stepping boldly in front of the patriarch.

"The just Tamenund," he said, "will not keep what a Huron has lent."

"Tell me, son of my brother," returned the sage, avoiding the dark countenance of Magua, and turning gladly to the more ingenuous features of Uncas, "has the stranger a conqueror's right over you?"

"He has none. The panther may get into snares set by the women; but he is strong, and knows how to leap through them."

"La Longue Carabine?"

"Laughs at the Mingoes. Go, Huron, ask your squaws the color of a bear."

"The stranger and the white maiden that came into my camp together?"

"Should journey on an open path."

"And the woman that Huron left with my warriors?"

Uncas made no reply.

"And the woman that the Mingo has brought into my camp?" repeated Tamenund, gravely.

"She is mine," cried Magua, shaking his hand in triumph at Uncas. "Mohican, you know that she is mine."

"My son is silent," said Tamenund,

endeavoring to read the expression of the face that the youth turned from him in sorrow.

"It is so," was the low answer.

A short and impressive pause succeeded, during which it was very apparent with what reluctance the multitude admitted the justice of the Mingo's claim. At length the sage, on whom alone the decision depended, said, in a firm voice·

"Huron, depart."

"As he came, just Tamenund," demanded the wily Magua; "or with hands filled with the faith of the Delawares? The wigwam of Le Renard Subtil is empty. Make him strong with his own."

The aged man mused with himself for a time; and then bending his head toward one of his venerable companions, he asked:

"Are my ears open?"

"It is true."

"Is this Mingo a chief?"

"The first in his nation."

"Girl, what wouldst thou? A great warrior takes thee to wife. Go! Thy race will not end."

"Better, a thousand times, it should," exclaimed the horror-struck Cora, "than meet with such a degradation!"

"Huron, her mind is in the tents of her fathers. An unwilling maiden makes an unhappy wigwam."

"She speaks with the tongue of her people," returned Magua, regarding his victim with a look of bitter irony. "She is of a race of traders and will bargain for a bright look. Let Tamenund speak the words."

"Take you the wampum, and our love."

"Nothing hence but what Magua brought hither."

"Then depart with thine own. The Great Manitou forbids that a Delaware should be unjust."

Magua advanced and seized his captive strongly by the arm; the Delawares fell back in silence; and Cora, as if conscious that remonstrance would be useless, prepared to submit to her fate without resistance.

"Hold, hold!" cried Duncan, springing forward; "Huron, have mercy! Her ransom shall make thee richer than any of thy people were ever yet known to be."

"Magua is a red skin; he wants not the beads of the pale faces."

"Gold, silver, powder, lead—all that a warrior needs shall be in thy wigwam; all that becomes the greatest chief."

"Le Subtil is very strong," cried Magua, violently shaking the hand which grasped the unresisting arm of Cora; "he has his revenge!"

"Mighty ruler of Providence!" exclaimed Heyward, clasping his hands together in agony, "can this be suffered? To you, just Tamenund, I appeal for mercy."

"The words of the Delaware are said," returned the sage, closing his eyes and dropping back into his seat, alike wearied with his mental and his bodily exertion. "Men speak not twice."

"That a chief should not misspend his time in unsaying what has once been spoken is wise and reasonable," said Hawkeye, motioning to Duncan to be silent; "but it is also prudent in every warrior to consider well before he strikes his tomahawk into the head of his prisoner. Huron, I love you not; nor can I say that any Mingo has ever received much favor at my hands. It is fair to conclude that, if this war does not soon end, many more of your warriors will meet me in the woods. Put it to your judgment, then, whether you would prefer taking such a prisoner as that into your encampment, or one like myself, who am a man that it would greatly rejoice your nation to see with naked hands."

"Will 'The Long Rifle' give his life for the woman?" demanded Magua, hesitatingly; for he had already made a motion toward quitting the place with his victim.

"No, no; I have not said so much as that," returned Hawkeye, drawing back with suitable discretion, when he noted the eagerness with which Magua listened to his proposal. "It would be an unequal exchange, to give a warrior, in the prime of his age and usefulness, for the best woman on the frontiers. I might consent to go into winter quarters now—at least six weeks afore the leaves will turn—on condition you will release the maiden."

Magua shook his head and made an impatient sign for the crowd to open.

"Well, then," added the scout, with the musing air of a man who had not half made up his mind: "I will throw 'Killdeer' into the bargain. Take the word of an experienced hunter, the piece has not its equal atween the provinces."

Magua still disdained to reply, continuing his efforts to disperse the crowd.

"Perhaps," added the scout, losing his dissembled coolness exactly in proportion as the other manifested an indifference to the exchange, "if I should condition to teach your young men the real virtue of the we'pon, it would smooth the little differences in our judgments."

Le Renard fiercely ordered the Delawares, who still lingered in an impenetrable belt around him, in hopes he would listen to the amicable proposal, to open his path, threatening, by the glance of his eye, another appeal to the infallible justice of their "prophet."

"What is ordered must sooner or later arrive," continued Hawkeye, turning with a sad and humbled look to Uncas. "The varlet knows his advantage and will keep it! God bless you, boy; you have found friends among your natural kin and I hope they will prove as true as some you have met who had no Indian cross. As for me, sooner or later, I must die; it is therefore fortunate there are but few to make my death howl. After all, it is likely the imps would have managed to master my scalp, so a day or two will make no great difference in the everlasting reckoning of time. God bless you," added the rugged woodsman, bending his head aside, and then instantly changing its direction again, with a wistful look toward the youth; "I loved both you and your father, Uncas, though our skins are not altogether of a color, and our gifts are somewhat different. Tell the Sagamore I never lost sight of him in my greatest trouble; and, as for you, think of me sometimes when on a lucky trail; and depend on it, boy, whether there be one heaven or two, there is a path in the other world by which honest men may come together again. You'll find the rifle in the place we hid it; take it, and keep it for my sake; and harkee, lad, as your natural gifts don't deny you the use of vengeance, use it a little freely on the Mingoes; it may unburden grief at my loss and ease your mind. Huron, I accept your offer; release the woman. I am your prisoner!"

A suppressed, but still distinct murmur of approbation ran through the crowd at this generous proposition; even the fiercest among the Delaware warriors manifesting pleasure at the manliness of the intended sacrifice. Magua doubted; then casting his eyes on Cora, with an expression in which ferocity and admiration were strangely mingled, his purpose became fixed forever.

He intimated his contempt of the offer with a backward motion of his head and said, in a steady and settled voice:

"Le Renard Subtil is a great chief; he has but one mind. Come," he added, laying his hand too familiarly on the shoulder of his captive to urge her onward; "A Huron is no tattler; we will go."

. . . . . .

"Ay, go," cried Duncan; "go, Magua, go. These Delawares have their laws, which forbid them to detain you; but I—I have no such obligation. Go, malignant monster—why do you delay?"

It would be difficult to describe the expression with which Magua listened to this threat to follow. There was at first a fierce and manifest display of joy, and then it was instantly subdued in a look of cunning coldness.

"The woods are open," he was content with answering, "'The Open Hand' can come."

"Hold," cried Hawkeye, seizing Duncan by the arm, and detaining him by violence; "you know not the craft of the imp. He would lead you to an ambushment and your death—"

"Huron," interrupted Uncas, who, submissive to the stern customs of his people, had been an attentive and grave listener to all that passed; "Huron, the justice of the Delawares comes from the Manitou. Look at the sun. He is now in the upper branches of the hemlock. Your path is short and open. When he is seen above the trees, there will be men on your trail."

"I hear a crow!" exclaimed Magua, with a taunting laugh. "Go!" he added, shaking his hand at the crowd, which had slowly opened to admit his passage. Where are the petticoats of the Delawares! Let them send their arrows and their guns to the Wyandots; they shall have venison to eat and corn to hoe. Dogs, rabbits, thieves—I spit on you!"

His parting gibes were listened to in a dead, boding silence, and with these biting words in his mouth, the triumphant Magua passed unmolested into the forest, followed by his passive captive, and protected by the inviolable laws of Indian hospitality.

. . . . . .

So long as their enemy and his victim

continued in sight, the multitude remained motionless as beings charmed to the place by some power that was friendly to the Huron, but the instant he disappeared, it became tossed and agitated by fierce and powerful passion. Uncas maintained his elevated stand, keeping his eyes on the form of Cora, until the colors of her dress were blended with the foliage of the forest; when he descended, and moving silently through the throng, he disappeared in that lodge from which he had so recently issued. A few of the graver and more attentive warriors, who caught the gleams of anger that shot from the eyes of the young chief in passing, followed him to the place he had selected for his meditations. After which, Tamenund and Alice were removed and the women and children were ordered to disperse. During the momentous hour that succeeded, the encampment resembled a hive of troubled bees, who only awaited the appearance and example of their leader to take some distant and momentous flight.

The calm but still impatient Uncas now collected his chiefs, and divided his power. He presented Hawkeye as a warrior, often tried, and always found deserving of confidence. When he found his friend met with a favorable reception, he bestowed on him the command of twenty men, like himself active, skillful and resolute. He gave the Delawares to understand the rank of Heyward among the troops of the Yengeese and then tendered to him a trust of equal authority. But Duncan declined the charge, professing his readiness to serve as a volunteer by the side of the scout. After this disposition, the young Mohican appointed various native chiefs to fill the different situations of responsibility, and the time pressing, he gave forth the word to march. He was cheerfully, but silently, obeyed by more than two hundred men.

Their entrance into the forest was perfectly unmolested; nor did they encounter any living objects, that could either give the alarm, or furnish the intelligence they needed, until they came upon the lairs of their own scouts. Here a halt was ordered, and the chiefs were assembled to hold a whispering council.

At this meeting divers plans of operation were suggested, though none of a character to meet the wishes of their ardent leader. Had Uncas followed the promptings of his own inclinations, he would have led his followers to the charge without a moment's delay, and put the conflict to the hazard of an instant issue; but such a course would have been in opposition to all the received practices and opinions of his countrymen. He was, therefore, fain to adopt a caution that in the present temper of his mind he execrated, and to listen to advice at which his fiery spirit chafed, under the vivid recollection of Cora's danger and Magua's insolence.

After an unsatisfactory conference of many minutes, a solitary individual was seen advancing from the side of the enemy, with such apparent haste, as to induce the belief he might be a messenger charged with pacific overtures. When within a hundred yards, however, of the cover behind which the Delaware council had assembled, the stranger hesitated, appeared uncertain what course to take and finally halted. All eyes were turned now on Uncas, as if seeking directions how to proceed.

"Hawkeye," said the young chief, in a low voice, "he must never speak to the Hurons again."

"His time has come," said the laconic scout, thrusting the long barrel of his rifle through the leaves and taking his deliberate and fatal aim. But instead of pulling the trigger he lowered the muzzle again and indulged himself in a fit of his peculiar mirth. "I took the imp for a Mingo, as I'm a miserable sinner!" he said; "but when my eye ranged along his ribs for a place to get the bullet in—would you think it, Uncas—I saw the musicianer's blower; and so, after all, it is the man they call Gamut, whose death can profit no one, and whose life, if his tongue can do anything but sing, may be made serviceable to our own ends. If sounds have not lost their virtue, I'll soon have a discourse with the honest fellow and that in a voice he'll find more agreeable than the speech of 'Killdeer.'"

So saying, Hawkeye laid aside his rifle; and crawling through the bushes until within hearing of David, he attempted to repeat the musical effort, which had conducted himself, with so much safety and éclat, through the Huron encampment. The exquisite organs of Gamut could not readily be deceived (and to say the truth, it would have been difficult for any other man than Hawkeye to produce a similar

noise), and consequently, having once before heard the sounds, he now knew whence they proceeded. The poor fellow appeared relieved from a state of great embarrassment; for pursuing the direction of the voice—a task that to him was not much less arduous than it would have been to have gone up in the face of a battery—he soon discovered the hidden songster.

"I wonder what the Hurons will think of that!" said the scout, laughing, as he took his companion by the arm, and urged him toward the rear. "If the knaves lie within ear-shot, they will say there are two non-composers instead of one! But here we are safe," he added, pointing to Uncas and his associates. "Now give us the history of the Mingo inventions in natural English and without any ups and downs of voice."

David gazed about him at the fierce and wild-looking chiefs in mute wonder; but assured by the presence of faces that he knew, he soon rallied his faculties so far as to make an intelligent reply.

"The heathens are abroad in goodly numbers," said David; "and, I fear, with evil intent. There has been much howling and ungodly revelry, together with such sounds as it is profanity to utter, in their habitations within the past hour; so much so, in truth, that I have fled to the Delawares in search of peace."

"Your ears might not have profited much by the exchange had you been quicker of foot," returned the scout, a little dryly. "But let that be as it may; where are the Hurons?"

"They lie hid in the forest, between this spot and their village, in such force, that prudence would teach you instantly to return."

Uncas cast a glance along the range of trees which concealed his own band and mentioned the name of:

"Magua?"

"Is among them. He brought in the maiden that has sojourned with the Delawares, and leaving her in the cave, has put himself, like a raging wolf, at the head of his savages. I know not what has troubled his spirit so greatly!"

"He has left her, you say, in the cave!" interrupted Heyward; "'tis well that we know its situation! May not something be done for her instant relief?"

Uncas looked earnestly at the scout, before he asked:

"What says Hawkeye?"

"Give me my twenty rifles, and I will turn to the right, along the stream; and passing by the huts of the beaver, will join the Sagamore and the colonel. You shall then hear the whoop from that quarter; with this wind one may easily send it a mile. Then, Uncas, do you drive in their front; when they come within range of our pieces, we will give them a blow that, I pledge the good name of an old frontiersman, shall make their line bend like an ashen bow. After which we will carry their village and take the woman from the cave; when the affair may be finished with the tribe, according to a white man's battle, by a blow and a victory; or, in the Indian fashion, with dodge and cover. There may be no great learning, major, in this plan, but with courage and patience it can all be done."

"I like it much," cried Duncan, who saw that the release of Cora was the primary object in the mind of the scout; "I like it much. Let it be instantly attempted."

After a short conference, the plan was matured and rendered more intelligible to the several parties; the different signals were appointed and the chiefs separated, each to his allotted station.

During the time Uncas was making this disposition of his forces, the woods were as still, and with the exception of those who had met in council, apparently as much untenanted, as when they came fresh from the hands of their Almighty Creator. But Hawkeye, whose duty led him foremost in the adventure, knew the character of those with whom he was about to contend too well to trust the treacherous quiet.

When he saw his little band collected, the scout threw "Killdeer" into the hollow of his arm and making a silent signal that he would be followed, he led them many rods toward the rear, into the bed of a little brook which they had crossed in advancing. Here he halted and after waiting for the whole of his grave and attentive warriors to close about him, he spoke in Delaware, demanding:

"Do any of my young men know whither this run will lead us?"

A Delaware stretched forth a hand, with the two fingers separated, and indicating the manner in which they were joined at the root, he answered:

"Before the sun could go his own

length, the little water will be in the big." Then he added, pointing in the direction of the place he mentioned, "the two make enough for the beavers."

"I thought as much," returned the scout, glancing his eye upward at the opening in the tree-tops, "from the course it takes, and the bearings of the mountains. Men, we will keep within the covers of its banks till we scent the Hurons."

His companions gave the usual brief exclamation of assent, but perceiving that their leader was about to lead the way in person, one or two made signs that all was not as it should be. Hawkeye, who comprehended their meaning glances, turned and perceived that his party had been followed thus far by the singing master.

"Do you know, friend," asked the scout, gravely, and perhaps with a little of the pride of conscious deserving in his manner, "that this is a band of rangers chosen for the most desperate service, and put under the command of one who, though another might say it with a better face, will not be apt to leave them idle. It may not be five, it cannot be thirty minutes before we tread on the body of a Huron, living or dead."

"Though not admonished of your intentions in words," returned David, whose face was a little flushed and whose ordinarily quiet and unmeaning eyes glimmered with an expression of unusual fire, "your men have reminded me of the children of Jacob going out to battle against the Shechemites, for wickedly aspiring to wedlock with a woman of a race that was favored of the Lord. Now, I have journeyed far, and sojourned much in good and evil with the maiden ye seek; and though not a man of war, with my loins girded and my sword sharpened, yet would I gladly strike a blow in her behalf."

The scout hesitated, as if weighing the chances of such a strange enlistment in his mind before he answered:

"You know not the use of any we'pon. You carry no rifle; and believe me, what the Mingoes take, they will freely give again."

"Though not a vaunting and bloodily disposed Goliath," returned David, drawing a sling from beneath his parti-colored and uncouth attire, "I have not forgotten the example of the Jewish boy. With this ancient instrument of war have I practiced much in my youth, and peradventure the skill has not entirely departed from me."

. . . . . .

THE UNHAPPY FATE OF CORA, AND THE END OF A BRAVE YOUNG CHIEF

We have given a long extract from the book. Now we shall continue with our summary of the story.

Desperate fighting took place at the Huron camp. Magua and his braves, who still held out, were forced to find refuge in the rocky heights that overhung their camping-place. There they were pursued by the Delawares, and no mercy was shown. Uncas had marked down Magua for his own vengeance. But the crafty Huron had carried Cora with him, and Uncas could reach his enemy only by jumping from one perilous ledge of rock to another.

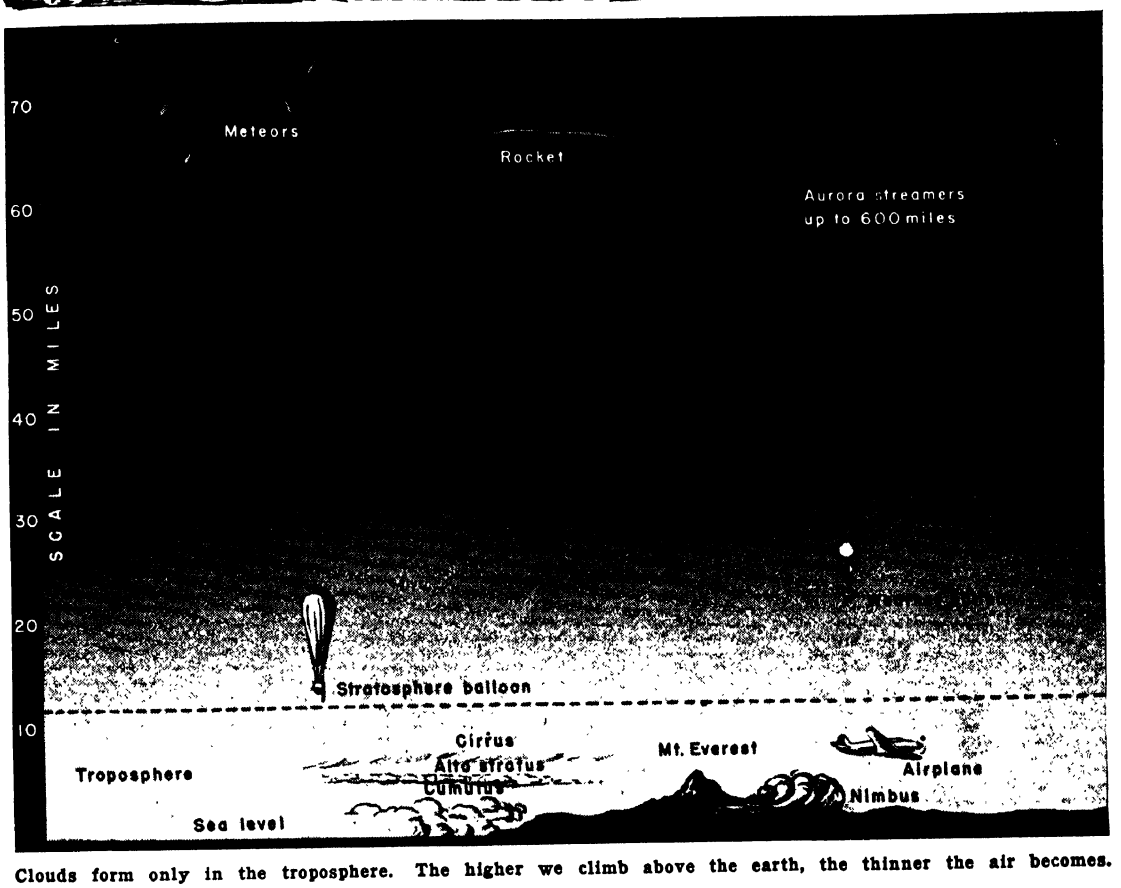
Because Cora refused to advance farther, one of Magua's followers plunged his knife into her breast. Uncas, leaping from the cliff, stumbled and fell at the feet of Magua, who buried his tomahawk in the back of the brave young chief. With a shout of exultation the Huron now sought to escape by leaping across a chasm. He all but succeeded, grasping the roots and grasses on the farther edge, and with his giant strength pulling himself up until it seemed as if he had won. But at that moment the rifle of the scout rang out, and the body of Magua fell whirling into the depths.

Uncas and Cora were laid to rest with all the wild ritual of the tribe. The old colonel, bowed with grief at the tragic fate of his daughter, was guided back to civilization by the scout, accompanied by Heyward and Alice.

Hawkeye, white man though he was, had lived too long in the wilderness to care for the ways of townsfolk, so he returned to be with Chingachgook and the Delawares.

The joy of the old chief Tamenund had been short-lived. His last words were: "My children, the pale-faces are masters of the earth, and the time of the red men has not yet come again. My day has been too long. In the morning I saw the sons of Unamis happy and strong; and yet, before the night has come, have I lived to see the last warrior of the wise race of the Mohicans."

THE NEXT STORY OF FAMOUS BOOKS IS ON PAGE 665.



Clouds form only in the troposphere. The higher we climb above the earth, the thinner the air becomes.

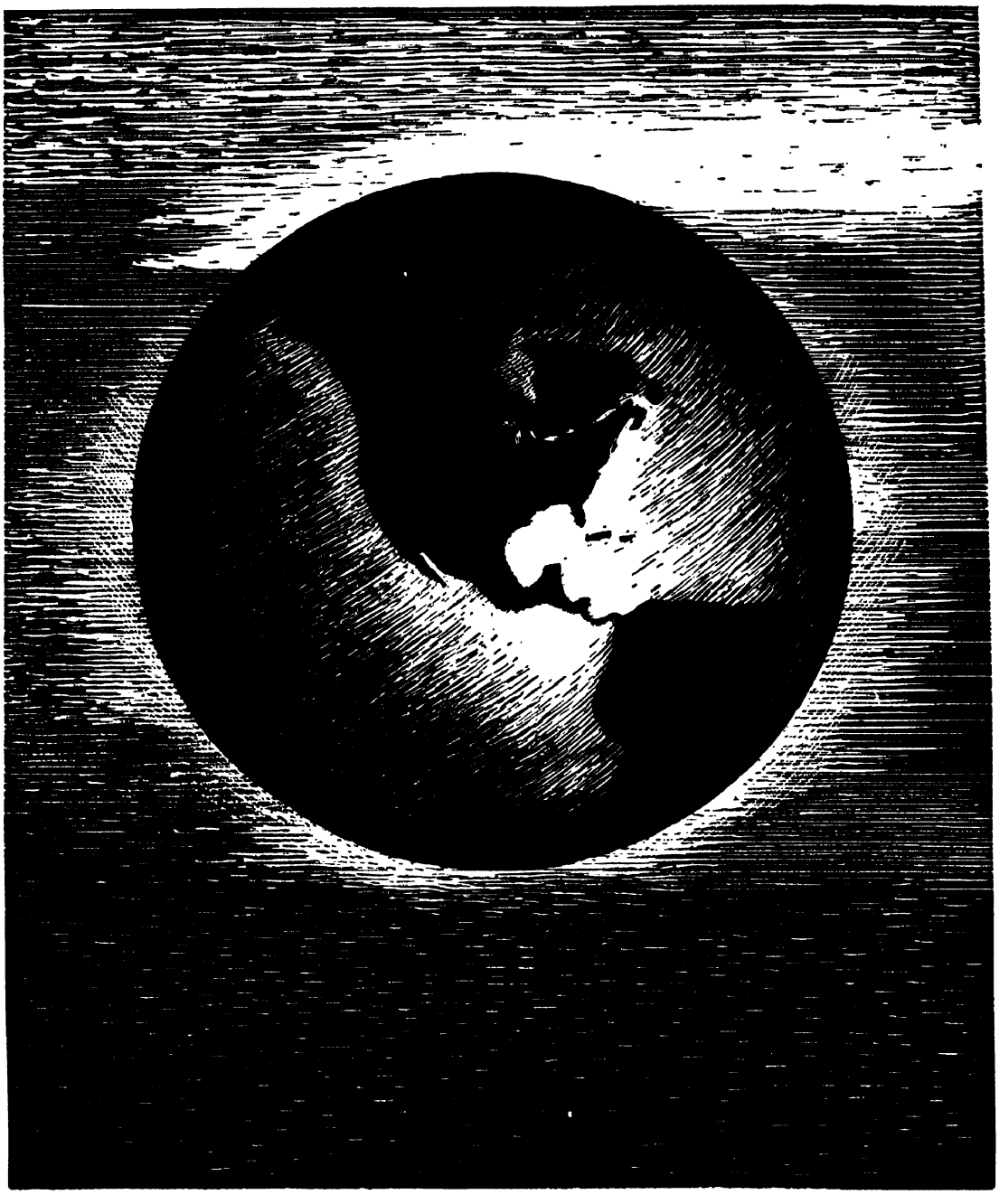
THE STUFF OF THE EARTH

FROM THE BLANKET OF AIR THAT SURROUNDS OUR GLOBE TO THE DENSE CORE INSIDE IT

IN earlier chapters you have read that the earth is a ball of colossal size, 25,000 miles around and about 8,000 miles through. You learned how it was formed; and you know that it is only one of several such balls, which are called planets, moving around a bright star, our sun. There are many other bright stars in the universe—how many we do not know. Perhaps some of them are suns, with planets of their own, and perhaps some of the planets may have life on them.

We can not tell much about the other planets of our solar system; but we do know a good deal about our own earth. Even here we have little first-hand information about the inside of the earth, or the upper atmosphere. Man has actually gone fourteen miles up in the air, two miles down in the earth—that is all. The rest he knows only from observations and instruments. Human beings can not go very high above the earth's crust, because the atmosphere soon becomes too thin—there is not enough oxygen for us to breathe. Nor can we go very deep in the sea or in the rocks, for pressures of water and rock become too great for our bodies to support.

Nevertheless, by experiment, by instruments, by calculations and by inference, we have gained a good idea of the nature of the earth's surface and its interior. We divide the ball now into several parts, or layers. The uppermost layer is a blanket of gas, completely surrounding the solid earth and held there by gravity. This blanket we call the atmosphere, or air sphere. Its composition



The atmosphere is a blanket around the earth. The hydrosphere, a thin layer of water, covers the globe to an average depth of 2½ miles, except where the inner rock sphere, or lithosphere, sticks up above it.

varies; near the ground, where we live and breathe, the air contains about four parts of nitrogen to one of oxygen, plus one per cent of argon, and a little carbon dioxide and other gases. The blanket of air grows thinner as it extends upward; and the lighter gases are more abundant in the higher zones. Finally, the gases grow lighter and thinner until, miles above the ground, there is no atmosphere at all, or so we believe.

Covering three-quarters of the surface of the earth, to an average depth of two and a half miles, we find a thin layer of water. This is called the hydrosphere (water sphere).

If the surface of the earth were perfectly even, without a wrinkle or a bulge on it, seas would completely cover all the earth, and we would have no land. However, since the rocky skeleton of the earth is irregular, and has high places and low places, the water has accumulated in the basins and left large land areas rising above its surface. These form the continents. Small areas of land that rise above the water are called islands.

THE GREATEST KNOWN OCEAN DEEP IS SEVEN MILES

Viewed in proportion, the irregularities of the sea floor are not great. The deepest place known is only about seven miles below sea level; but the deep places are enough to leave us the land on which we live. There is some water on the land, too, in lakes and rivers and in the tiny holes in the rocks. This water has been brought as rain or snow, and most of it is always gradually working its way to the seas; the sun draws it up again, and again it falls as rain or snow.

The solid portion of the earth we call the lithosphere (rock sphere). It is divided into zones, and while we can not see and touch any but the outermost rocks, we can draw certain conclusions about the deeper ones that are far beneath the surface. Let us stop for a moment to notice that as we proceed toward the center of the ball, we find heavier and still heavier stuff. Below the thin upper atmosphere is heavier atmosphere; below that, the water, which is heavier than air; and below the water layer is rock, heavier than water. Now we find that the rock is in layers, or zones, also. There are light-weight rocks near the surface and heavier rocks farther down.

HOW THE EARTH'S CRUST BEGAN TO FORM

No one knows what the earth was like while it was forming and immediately afterward, but according to most theories, it is thought to have been a glowing mass of gases, that slowly cooled to liquids and then to solids. The various gases and liquids did not cool at the same rate of speed; so there was probably a time when the earth was a bubbling, boiling ball, with oxygen, water vapor, carbon dioxide and other gases making their way out from the molten rock in which they were dissolved. While the gases were bubbling up, the heavy metals were probably settling toward the center of the ball; and the lighter materials were ranging themselves in zones according to weight.

Eventually, most of the gas escaped, the turbulence subsided and, as a result of further cooling, a crust began to form. This was undoubtedly broken and engulfed again and again; but gradually it became more and more stable and grew thicker and thicker, sealing some of the gases in and forming a slaggy crust over a still liquid interior. This slag cooled down and formed rocks. The atmosphere also cooled; and the water vapor condensed and fell as rain upon the cooling rocks. Eventually the water collected in the low places of the rocky slag and formed the oceans. When this was finished, the earth looked very much as it does now, except that its surface was made of bare rocks, rough and jagged, or smooth and rounded lava flows rising above the irregular floor of the sea. Great volcanoes probably spouted forth, the seas were hot, and no life existed anywhere on earth.

HOW THE ELEMENTS SORTED THEMSELVES AS THE EARTH COOLED

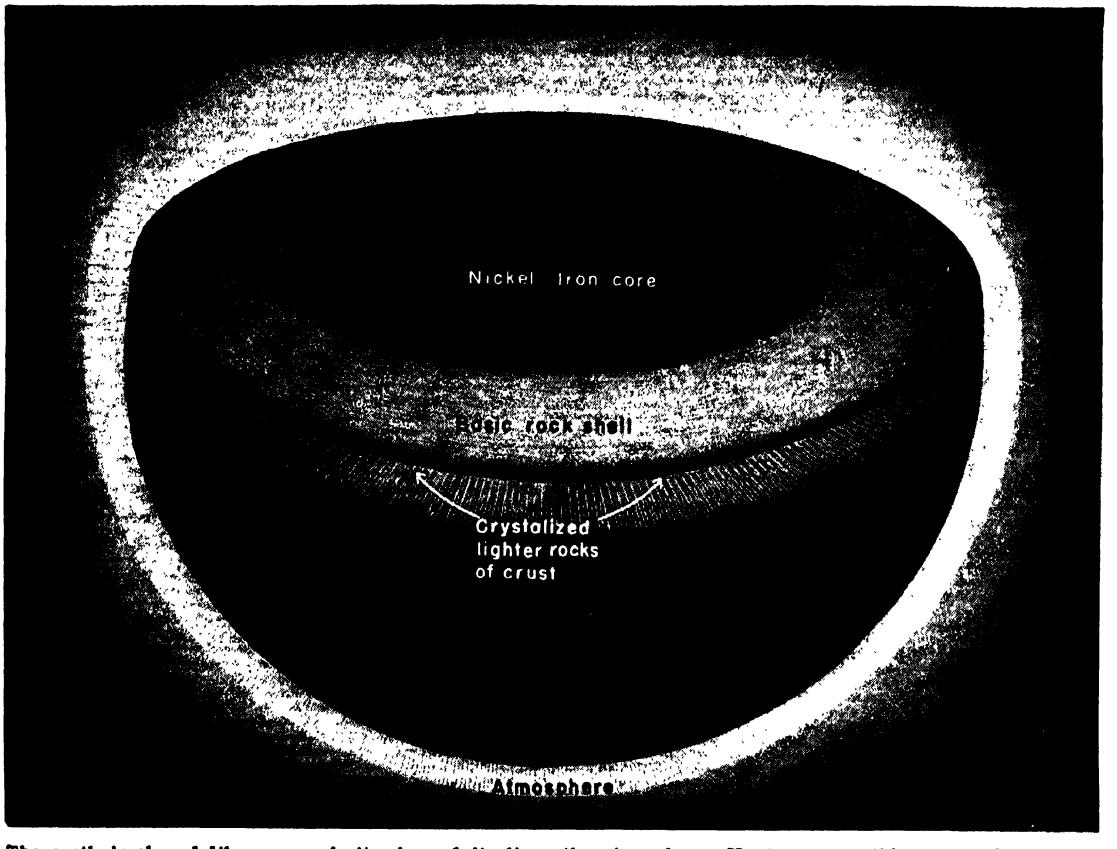
As the earth cooled and as the materials went on sorting themselves, the lighter-weight elements and their compounds became separated from the heavier materials. Hence, the rocks which formed at the surface were of a different composition from the rocks which formed lower down. For instance, rocks rich in silicon were light in weight, since silicon is one of the lighter elements. Where silicon was less abundant and the rock compounds contained more magnesium and iron, the rocks were heavier. This gave the lithosphere an irregular composition of lighter-weight and heavier-weight rocks. Probably the greatest variation in composition occurred near the surface in what it usually called the earth's crust.

The crust grew thicker as it continued to cool. The crust now is considered to be about forty miles thick. No one knows what the lithosphere is like below that depth. According to one theory, the inner part of the lithosphere may be basaltic rock that is so hot it can not be solid and at the same time so compressed that it can not be liquid. On this inner shell the crust is supposed to almost float, the light-weight rocks riding high and the heavy rocks, low.

THE EARTH'S INNER SHELL IS STILL HOT

How is it that the inner shell is still hot, though the crust has cooled? The chief reason is that the crust, as it hardened, sealed up the still hot interior, keeping most of the heat inside, just as you keep most of the heat inside a kettle of hot soup by putting a lid

on. A little heat, to be sure, did leak up through the crust, but that was mostly made up by new heat created in the interior. Some heat was created by radioactivity within the atoms of certain substances. The heavier materials kept pressing or falling downward. As they went they rubbed against other rocks and the rubbing (friction) caused heat. The pressure also caused a certain amount of heat.



The earth is shaped like a grapefruit. Around it clings the atmosphere. Next comes a thin watery layer, and then a crust (the grapefruit skin) which sticks up through the water in places. Inside the crust is a rocky shell, in layers that are heavier toward the inner part. At the center is a dense core of nickel and iron.

THE INNER SHELL IS PROBABLY SHRINKING ALL THE TIME

We believe the inner shell of the lithosphere is still pressing closer toward the center and, therefore, continually shrinking. Some places on the crust are stronger than others and hold firmly as rigid and unbroken arcs when the inner shell shrinks. Other places on the crust, being weaker, wrinkle downward or upward, just like the skin on a withering apple.

This warping and buckling brings about great changes on our earth. Sometimes a region is steadily buckled and down-warped over a period of many years, and layer after layer of ground-up rock is deposited in the wrinkles. Eventually, the crust may break in places, or the pressure may relax in one region and become stronger in another. So a new section begins to buckle and an area, or lens, of light-weight rock, formerly sunken, may start to rise in the air. It may rise slowly far above the average land level. Thus many of our mountain ranges were formed from what was once a sea bed. The Appalachians and the Rockies were formed in this way, rising from ancient sea floors. The Baltic and the Mediterranean seas may, one day, rise up and form new mountain ranges.

THE MANY FORCES THAT HELPED TO MAKE OUR MOUNTAINS

Such large mountain ranges are never simple in their origin, however. Usually molten rock was to be found somewhere in all of the deeply buried sedimentary material (the ground-up rock that was deposited in the wrinkles). The molten rock cooled and be-

came solid and added its bulk to the thickening light-rock mass. When such a range has been uplifted, the earth forces about which you will read later—the processes of erosion—eventually wear away the light rock and may expose some of the underlying solidified molten rock.

Not all mountains are so formed, however. Some are actually built up on top of the old crustal rocks; and this type may grow much more rapidly than the others we have mentioned. These are volcanic ranges and single peaks built up by volcanic action. We shall explain about volcanoes later. Here we wish only to speak of the principal layers of the earth, so that you may understand the origin and nature of the surface on which we are living.

Beneath the layers of lighter rock is heavy rock and we believe that beneath the heavy rock there is rock containing metal, as you go toward the center. Iron and nickel are probably the chief metals. We can not see into the interior, but we do have some means of knowing something about it. One way is by observing the effect of the earth's gravity upon the other planets, and then calculating what it must weigh. When that is done we find that the earth is far heavier than the surface rock would indicate. Therefore the earth must have a very heavy central core. This iron-nickel central core is called the centrosphere. It is thought to be about 4,400 miles in diameter, occupying the center inside all the miles of light-to-heavy rock layers. We assume iron and nickel to be the principal matter of the interior, because we have observed that many of the meteorites which fall upon the surface of the earth are made chiefly of iron and nickel; and we believe that meteorites are stray fragments of planet-material. We believe that all planets contain the same materials in about the same proportions. Since we know that our lithosphere does not contain the high proportion of iron and nickel which meteorites have, we assume that these materials must be packed closely in the earth's inner core.

SOME WORDS WE USE IN SPEAKING OF THE STUFF OF THE EARTH

Atmosphere, or air—a mixture of gases surrounding the earth.
Hydrosphere—the layer of water that forms the oceans.
Lithosphere—the stony part of the earth to about a depth of 2,000 miles.
Crust—the topmost part of the lithosphere, about 40 miles thick.
Centrosphere—the very heavy center of the earth, probably iron and nickel, about 4,400 miles in diameter.
Core—another name for the centrosphere.
Molten rock—hot, melted rock.
Basaltic rock—a type of heavy rock.
Meteorites—pieces of solid material that fall from the sky to the earth.
Warping and buckling—wrinkling of the earth's crust due to uneven cooling and shrinking.
Sedimentary material—ground-up transported pieces of rock.
Erosion—the wearing away of rocks, due to water, wind, glaciers, etc.

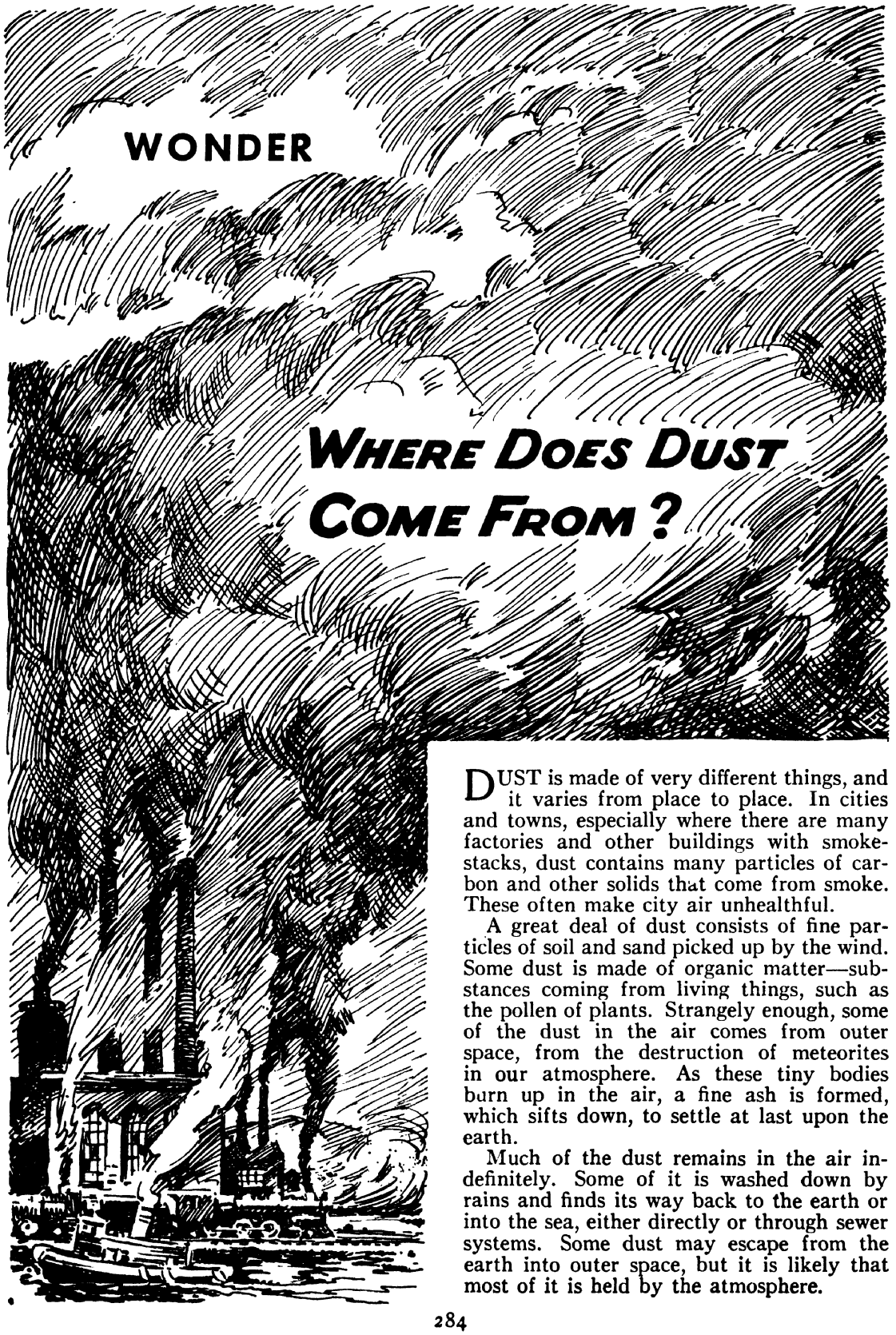
EARTHQUAKES TELL US ABOUT THE EARTH'S CORE

Lastly, we know that the earth must have a dense, heavy centrosphere, because of the manner in which earthquake waves pass through it. Earthquakes are caused by sudden sharp breaks and movements in the crust; and vibrations (called waves) from the place of the break radiate in all directions through the earth. A quake on the opposite side of the world will send out waves which reach us after passing through the center; and we can learn much about the layers through which it passes by studying the type of wave that reaches us and the rate at which it travels. All forms of evidence lead to the same conclusion, that the center of the earth is occupied by a heavy metal core.

A quick summary shows us, then, that the earth is composed of a series of layers of progressively heavier material: 1) the atmosphere, or air sphere; 2) the hydrosphere, or water sphere, a broken layer, pierced by elevations of the underlying lithosphere; 3) the lithosphere, or rock sphere, layers of rock or glass, each layer heavier than the one above; and 4) at the center of it all, a heavy metal core, the centrosphere. The little "dictionary" on this page explains important words in the chapter. By FREDERICK POUGH.

Illustrated by Thomas W. Voter.

THE NEXT STORY OF THE EARTH IS ON PAGE 385.



WHERE DOES DUST COME FROM?

DUST is made of very different things, and it varies from place to place. In cities and towns, especially where there are many factories and other buildings with smokestacks, dust contains many particles of carbon and other solids that come from smoke. These often make city air unhealthful.

A great deal of dust consists of fine particles of soil and sand picked up by the wind. Some dust is made of organic matter—substances coming from living things, such as the pollen of plants. Strangely enough, some of the dust in the air comes from outer space, from the destruction of meteorites in our atmosphere. As these tiny bodies burn up in the air, a fine ash is formed, which sifts down, to settle at last upon the earth.

Much of the dust remains in the air indefinitely. Some of it is washed down by rains and finds its way back to the earth or into the sea, either directly or through sewer systems. Some dust may escape from the earth into outer space, but it is likely that most of it is held by the atmosphere.

WHAT IS THE SUBSTANCE KNOWN AS OZONE?

Ozone is a gas which is really a special form of oxygen, as diamond is a special form of carbon. The molecule of ordinary oxygen is made up of two oxygen atoms; the ozone molecule has three oxygen atoms. Chemists represent it by the symbol O_3.

Ozone is a slightly bluish gas. It has a smell something like chlorine, and when heated it soon breaks up into ordinary oxygen. On a bright, clear, bracing day there is often a considerable amount of ozone present in the air, perhaps carried to the surface of the earth from higher layers of the atmosphere. Ozone can now be produced in various ways, one of which is by the discharge of electricity or by electric sparks.

Twenty to thirty miles above the earth is a layer of atmosphere containing considerable ozone. This is sometimes called the Ozone Layer.

Ozone is produced in large quantities by chemists, and is used for the bleaching of oils, waxes, flour and ivory, and for purifying air. It must, however, be handled with extreme care, since it very easily explodes.

WHY DO WE SOMETIMES GET A HEADACHE IN A CROWDED ROOM?

We get a headache in a crowded room if it is badly ventilated; one cause of the headache is the accumulation of carbon dioxide from many lungs. And there is another reason; we get a headache in a crowded room for much the same reason that we get a headache in thundery weather—simply because the air is at once still, warm and moist.

In a crowded room we have many people whose bodies are giving off heat continually, and the result is that, unless the room is well ventilated, the air becomes very warm and wet. In such a warm, wet atmosphere neither heat nor moisture can readily escape from the body, and this leads to discomfort, and also to reduced activity of the lungs and the heart. The skin is not acting as it should, the lungs and heart are not acting well; the body becomes feverish and naturally a headache follows. Not all headaches come from these causes, however.

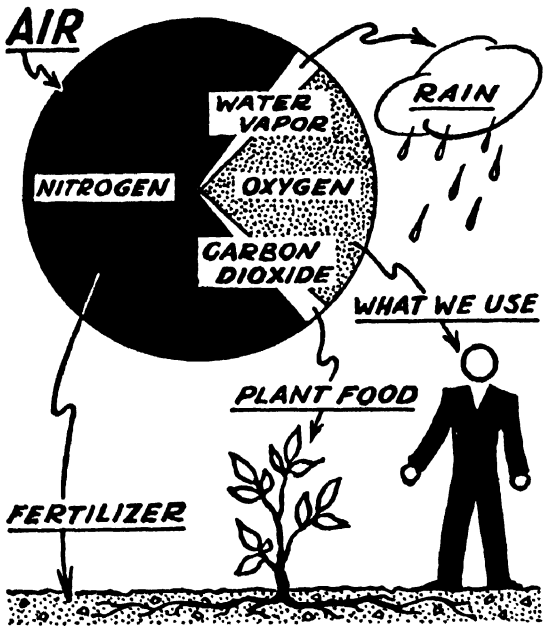
WHERE DOES ALL THE BAD AIR IN THE WORLD GO?

By bad air we usually mean carbon dioxide which has come from our lungs or from a fire, or from the breathing of animals.

We may rightly call such air bad in a sense, because too much of it is bad for us. But as this carbon dioxide is moved about, and gets distributed through the air, it becomes of the utmost importance for our lives. Green plants use it in manufacturing foodstuffs in their leaves. Without these foodstuffs the plants would die; then all the animals that live on plants would die; then all the animals that eat plant-eating animals would die; and human beings, too, would die.

WHAT IS THE AIR MADE OF?

The air is a mixture of several gases, and these are all colorless and transparent. Almost four-fifths of the air is made up of a gas called nitrogen, which is very valuable to plants and therefore to us; about one-fifth is made up of oxygen, which we must have in order to breathe. There are also small amounts of other gases. Among these is carbon dioxide, which we give off when we breathe and



which plants use in manufacturing food in their leaves. Air contains varying amounts of water in the form of a vapor or gas. We also find in air small amounts of the so-called inert gases (see Index, under Inert gases)—argon, neon, helium, krypton and xenon.

DOES THE AIR EVER GET USED UP?

We may say that, in a sense, a great deal of the air has already been used up. We know that by far the greater part of all the surface of the earth, including all the water of the seas, has already combined with oxygen, and so has used up a great deal of the oxygen of the air. That happened a long time ago, however, before there were any living creatures on the earth.

The air is constantly being used now. The oxygen of it is being used in the breathing of all living creatures. The nitrogen is being used by certain microbes which take the nitrogen from the air and change it into free nitrogen in the soil. This free nitrogen is then used by plants, which need it in order to grow. Nitrogen is now also widely used in fertilizers, for men have found ways to extract it from the air. Thirdly, green plants use the carbon dioxide of the air, upon which they feed.

Yet the air does not get used up as far as any of these gases are concerned. There must be compensation of some kind going on. There is compensation in regard to the oxygen because green plants everywhere in the sunlight are giving off to the air a great deal of oxygen—perhaps enough to make up for what they take in by breathing, and possibly also enough to make up for what animals and men take in by breathing.

As for the nitrogen that is used, we can easily show that that is compensated for; for when animals and plants die, their bodies decompose, and most of the nitrogen they contain, which they originally got from the air, is given back to the air. Lastly, the carbon dioxide taken from the air by plants is compensated for by the carbon dioxide which all living creatures give out to the air when they breathe.

But if we were to wait until this impure air had cooled, we should find it heavier than the ordinary air. The most important gas in impure air is carbon dioxide, and this is heavier than ordinary air of the same temperature. Thus, in caves where carbon dioxide is formed, it always tends to lie as low as possible. If we carry a lighted candle into such a cave, it will go out after we have gone down a certain distance. This happens because we have reached a level where there is a good deal of carbon dioxide and not enough oxygen to keep the candle burning.

IS IMPURE AIR LIGHTER THAN PURE AIR?

We are likely to be misled on this point, for other things affect the weight of air besides the kind of matter that is in it. One of the most important of these things is its temperature. When their temperatures are equal, impure air is heavier than pure air. But the impure air that comes from human beings or animals, or from fires or gas burners, is hotter than the pure air that surrounds it. The reason is that the impure air results from the process of burning, and that process produces heat. Now the hotter the air is, the lighter it is. The impure air that has just been burned is lighter than the pure air, and so it rises. But it falls as soon as it is cooled to the temperature of the pure air.

WHY DOES SILVER TARNISH IN THE AIR WHILE GOLD DOES NOT?

There is often sulfur in the air in one form or another. If, for instance, we burn gas, it adds a certain amount of sulfur to the air. No sulfur compound has any action on gold; but several sulfur compounds act on silver, covering the surface of it with a film of what is called sulfide of silver, which is black. We commonly say the silver has tarnished. When we brighten silver we rub this sulfide away. This means that we are slowly losing the silver itself, and in course of time we shall notice the loss. This is particularly noticeable in silverplated ware. After a time, the silver layer may rub off and the baser metal beneath show through. Often people wear silver bracelets next to the skin, and if it happens that such a person is taking sulfur as a medicine the bracelet may turn black. This is because some of the sulfur leaves the body through the skin, and so tarnishes the bracelet by forming a film of sulfide of silver on it. This, in turn, discolors the skin.

Candlesticks, knives, spoons and forks made from silver have such a lovely gleam that they remain popular even though they must be cleaned frequently. However, they may be wrapped in a kind of paper that keeps them free of tarnish.

IS NIGHT AIR BAD FOR US?

There is an old idea that night air is dangerous for us to breathe; but this is nonsense. Night air is purer than day air. Fewer fires and furnaces are burning at night, and so there are not so many harmful gases in the air. Also, as there is less traffic, there is less dust in the air at night.

Long ago it was noticed in certain parts of the world that people who exposed themselves to the night air were very apt to get a serious disease. It was supposed that the disease was caused by the quality of the air. This disease was called malaria, which simply means bad air, and the disease is known by that name to this day. Actually malaria is due to the bite of a certain kind of mosquito which carries the microbes of the disease. This mosquito bites only at night. By destroying it malaria can be prevented.

WHY DOES THE AIR NOT STOP THE LIGHT OF THE SUN?

The air *does* stop a great deal of the light of the sun. The sun and the moon and the stars appear far brighter when we go up in an airplane, or if we look at them through a telescope on a mountain, where their light has to pass through less air to reach our eyes. The air is a blanket which prevents the passage of light to a great extent. If there were no air, the light of the sun striking the earth would be vastly greater than it is. Around the moon there is no air. If there were, even on cloudless nights the moon would not be nearly so brilliant as it is, for a great deal of the sun's light now reflected by the moon would be absorbed by the moon's air.

WHY DO THE HILLS LOOK BLUE AT A DISTANCE?

The blueness of the sky is due to the breaking-up of sunlight by tiny bits of dust in the air and by the molecules of air themselves. Sunlight, as you know, is composed of light of various colors and wave-lengths. When the light from the sun strikes the dust and molecules of air, the blue light, because of its particular wave-length, is scattered more than light of any other color. This is what gives us our blue sky. At sunrise and sunset, the sunlight passes through greater layers of atmosphere, and then the red, orange and yellow light is scattered more than the blue.

Now, if we look through a layer of anything colored to something beyond it, the layer will contribute its own color to the object we see. The blueness of the air, however, is a very faint blue, and we do not usually notice the blueness it contributes to anything near. But when we look at distant hills, we are looking through such a thick layer of air that it gives them a blue tinge. The actual color which we see depends upon many other things, as, for instance, the color of the hills themselves, and the time of day—which decides the angle at which the sunlight falls upon the hills. Sometimes mountains even take on a purple tinge when seen from some point many miles distant.

WHAT DO WE MEAN BY HUMIDITY?

"The temperature is 80 degrees, the humidity 75." Perhaps you have been puzzled by a statement of this sort in the newspaper. What is meant by humidity?

First of all, we must remember that the air is not composed of a simple uniform substance; it is made up of a number of different gases. Nitrogen is one, oxygen is another, carbon dioxide is a third. One of the most important of all is water vapor, or evaporated water.

There is always a certain amount of this vapor in the air. The amount that the air can hold at any one time is determined by the temperature; the higher the temperature, the more water vapor the air can contain. When it can take up no more, we say that it has reached the saturation point. If any more vapor is added, precipitation takes place: that is, the vapor falls in the form of dew, mist, rain, hail or snow.

Now by humidity we simply mean the amount of water vapor in the air. Absolute humidity is the weight of the water vapor per cubic foot of air. Generally, however, when we refer to humidity, we mean relative humidity. This is the percentage of water vapor in the air with respect to the total amount of vapor that the air can hold at any one time. When we say, therefore, that the temperature is 80 degrees and that the humidity is 75, we mean that the air has 75 per cent or three-quarters of the water vapor that it can contain at a temperature of 80 degrees.

When the temperature is high (that is, when the air can hold a good deal of water vapor) and the humidity is also high, we find ourselves exceedingly uncomfortable.

On the other hand, our bodies need some water vapor; and in parts of the earth where the air is hot and very dry, human beings can not maintain health for long. We are most comfortable when the humidity is neither too high nor too low. We can do nothing about it outdoors, but it can be regulated by air conditioning in offices and homes.

THE NEXT WONDER QUESTIONS ARE ON PAGE 455.

AN EGYPTIAN GODDESS IN STONE, AT KARNAK

Metropolitan Museum of Art

Lioness-headed Sekhet, crowned with the sacred asp and the disc of the sun, represented its destructive heat.

A rare study of geese, an Egyptian design.

THE ARTISTS OF THE OLD EMPIRES

EGYPT, BABYLONIA AND ASSYRIA

WE have seen, on page 189, that the uncivilized cave-men, long before history, had an art of their own. What happened to it? That is one of the mysteries of the world. When the Stone Age came to an end, there was no more art for a long time. The impulse that forced men to make those beautiful and simple pictures went out suddenly, like a candle flame.

The Stone Age, as we have seen, was a period of rough, rude existence, when wild animals supplied man's every need. The Bronze Age which followed lasted many thousands of years, and it would appear, looking at this stage of human development, that life was almost as simple as in the Stone Age.

But in glancing back over the bounds and fields of time as over a landscape, we see the Bronze Age in its true perspective. This slow-seeming period was really a time of revolution, for, early during its span, men discovered how to use and to grow corn, barley, millet and flax; and they learned to tame animals. The world has rolled on over a hundred centuries since then, but until the dawn of steam power there was no development so vital to human life as these apparently simple discoveries. It was also in the Bronze Age that men discovered metal—first gold, then copper. Some happy accident led to the mixing of copper and tin, and so the name of the mixture—bronze—was given to the period. A little later the art of making pottery was discovered.

Many relics of daily life in Europe at this time have come to light. They show a certain skill in decoration, but nothing that can be called art. Yet the workmen of those days knew a good deal of the technique of engraving on metal, and we can judge their skill by the decorated swords, bracelets, daggers, plaques and so on, which have been found. The potters also made rough patterns on their bowls and dishes. And the interesting thought that arises about these is that, crude though they may be, they mark the beginning of what we might call household decoration. Many of our cups and saucers and jugs and basins today bear some design. Now, you can see, this habit of making useful things attractive is about ten thousand years old.

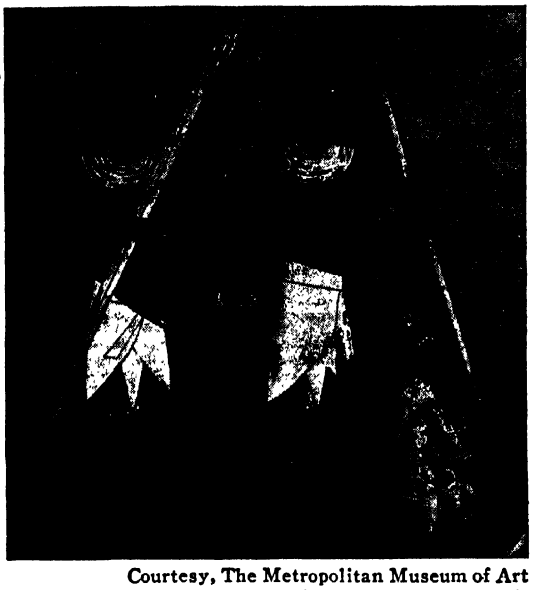
In addition to these small objects the men of the Bronze Age left mysterious and huge decorated granite blocks, which they set up generally in avenues of approach to their dolmens, or stone-built tombs.

The most famous of these are on the island of Gavr'inis, off the coast of Brittany. Other examples have been found in various other parts of France, in Denmark, Sweden, Spain and Portugal. There is one fine specimen near Dublin in Ireland. All bear the peculiar stamp of the Bronze Age ideal of decoration; patterns made of repeated triangles, circles and crosses, and—in the dolmens—minute lines that follow one another much like those on sea charts of a coastline. We have been unable to find out why no living thing is represented among these patterns of geometric lines. Except for one or two clumsy attempts at engraved figures there is no representation of human or animal life. It may be that superstition laid a ban on the representation of living beings.

THE WONDERFUL ART OF EGYPT IN THE LATE BRONZE AGE

But for more advanced art in that distant period we must turn to Egypt. While the men of the late Bronze Age on the continent of Europe were making their small, skillful patterns, a great national art was rising in the country of the Nile.

Egyptian art differs very greatly in quality from the art of any other early nation, because it was inspired by a definite system of religious thought. It is the first such art in the history of the world. It is the next big thing, in time, to the art of the reindeer-hunters, which, as we remember, was warm and natural and beautiful, and was the work of men who had thought very little. Egyptian art, however, was more cold and less natural—the work of men who had thought a very great deal.



Courtesy, The Metropolitan Museum of Art

Chief steward and overseer of cattle. From a wall-painting in a tomb at Thebes, Eighteenth Dynasty.

The Egyptians had worked out for themselves a curious religion, a system embracing over two thousand gods and goddesses divided into certain families, or groups. If it had not been for their animal worship—there were many animal deities, and numerous birds, reptiles and insects were sacred—the religion of the Egyptians would have been lofty and rather wonderful. Some of the chief gods have interesting titles. There was Osiris, the man-god who rose from the dead, and became a god and king of the other world and judge of the dead. There was Set, the principle of evil, the enemy of Osiris. There was Nu, the god of the watery mass whereof the world was made.

There were the goddesses of wisdom, of literature, of earth, sky, rain; almost every physical and mental force had its divinity in the religion of the ancient Egyptians. Portraits of these gods are shown in the sacred books and paintings. Generally speaking, from the shoulders down they are very much alike, but are distinguished one from another by the most wonderful head-decorations.

These divinities imposed upon their subjects a certain way of thinking and behaving which had for a foundation two strong beliefs—that this world is of little account, save for the passing happiness it may afford, and that the wicked are punished and the good rewarded in the world to come. It was on this idea of the future life that the Egyptians based most of their literature and art; and we can not appreciate their paintings, their sculpture or their architecture without first understanding this fact.

A Greek historian once said that the Egyptians looked on their houses as mere places of passage, and on their tombs as their permanent dwellings. They made tombs fit to outlast time itself, and in them buried their dead, wonderfully embalmed so that the bodies would be preserved for thousands of years; and they placed in these houses of long silence very beautiful things. They furnished the house of the dead with as much tender care as if the dearly beloved person had been alive. Tables, chairs, stools, beautifully decorated bowls for oils and spices, painted and inlaid boxes containing mirrors, hairpins and scents, were among the furniture of the tomb. In a child's tomb they placed his toys, in that of a warrior his spears, in that of a hunter his bows and arrows, in that of a state dignitary his staff of office.

In all tombs of any importance they put a remarkable set of writings called the BOOK OF THE DEAD, which was supposed to have been written in the first case by Thoth, the scribe of the gods. It contained religious teaching, stories of the life of the gods and so on. Each copy was separately written and painted by scribes and artists in bright colors and hieroglyphics—picture-words. And these men put into a work which would be seen by the spiritual eye of the dead all the skill generally put into pictures meant to win world-wide fame.

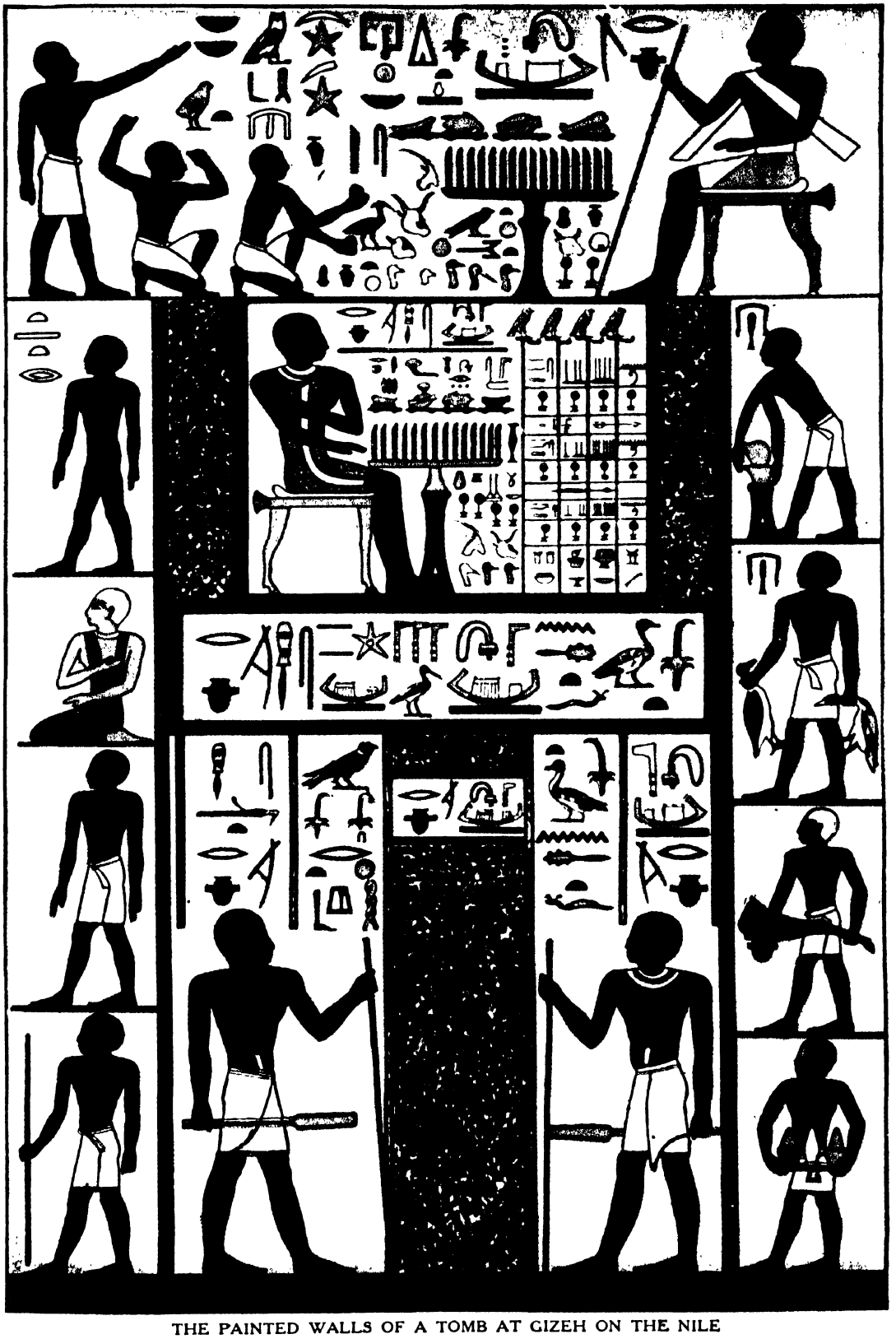
The tombs on which so much time and art were spent are of various kinds: the mastabas of the earlier dynasties—heavy, rec-

THE COLOR OF THE ANCIENT EMPIRES

A PORTRAIT FROM ONE OF THE OLDEST PICTURE GALLERIES IN THE WORLD: KING SIPHTAH OF EGYPT, FROM THE MILES OF PAINTED WALLS AND CEILINGS LEADING TO THE TOMBS IN THE VALLEY OF THE KINGS

This fine piece of Egyptian color was rescued in the excavations carried on at Biban-el-Muluk by the generosity of Mr. Theodore Davis.

PAGE FROM THE BOOK OF THE DEAD, LEFT IN THE TOMBS OF EGYPT FOR THE DEAD TO READ



THE PAINTED WALLS OF A TOMB AT GIZEH ON THE NILE

A KING'S PALACE IN ASSYRIA IN THE DAYS WHEN NINEVAH WAS A GLORIOUS AND ACTIVE CITY

tangular constructions—the pyramids of the later centuries; and the rock-hewn tombs of the mountainous parts of the country. Of these last the most famous are the tombs of the kings at Biban-el-Muluk, near Luxor, on the banks of the Nile. The splendors within them make us feel that death had left royalty thrice royal.

Each tomb contains several chambers and passages, and, in some kinds, a shaft leads to a remote chamber where the sealed sarcophagus was laid. There was generally placed in or near the tomb a statue of the dead, to which offerings were made. These tombs were built and endowed by the wealthy "forever." In some there was a chamber where "the sad and solemn priests" made daily offerings for the dead. A temple built near the later tombs took the place of this room. The walls of the chambers, and in some cases the ceilings, were covered with interesting decorations showing men and animals, gods and goddesses. Figures were often outlined or engraved, sculptured in a slightly raised relief, or sunken.

The Oriental Institute, Chicago
Statue from a doorway to the temple of Nabu at Khorsabad, Iraq.

Usually the decoration was painted in brilliant coloring, and the colors have lasted so well that they are charming today. Often, above and below the rows or groups of figures, are beautiful borders of conventional design, using the lotus, the papyrus and other motives. Inscriptions in hieroglyphics add further to the richness of the pattern, as well as to the meaning of the whole.

The Egyptian artist had to follow strict rules which were prescribed by religious authority. Everything is painted flat. No modeling is attempted; no light and shade shown; the backgrounds hold no suggestion of the laws of perspective. The figures are always intentionally out of drawing, with faces, legs and feet in profile, and shoulders and bodies turned full-front. This distortion is all the more marked because the eye shown in the profile is always the eye as it would appear in a full view of the face. The feet were always shown flat to the ground. Any attempt at a light poise, a resting on the toes, or one foot flying, would have seemed to them a contradiction of their standards of art. The pictures on pages 294 and 295 are faithful to the rules.

The idea that life would go on forever crept into the work even when the artist had no thought of portraying anything of a religious kind. The keynote of their art, so to speak, is a quietness, a waiting. In portraits and statues their kings and queens are often shown seated, knees together, feet together, no twist in neck or shoulders, eyes looking calmly out, the face in complete repose. If the figure is standing, it is pulled out to an abnormal length, and has the same motionlessness of spirit. Egyptian art, alone in the world, is intensely still.

Wandering about the Egyptian rooms of the Metropolitan Museum in busy, modern New York, you can more than glimpse the life and art of ancient Egypt. You can stand within a tomb chamber, with rows upon rows of painted scenes around you, and feel yourself in the presence of Egyptian men and women who came to lay gifts upon the offering-table before those painted false doors, from which the spirit of the departed might come forth at will. You can even see how the artist worked; for on the walls there are unfinished bits, showing where figures had been simply outlined in paint, but not yet cut in relief or colored as they were finally to appear. These wall-paintings, the designs on mummy-cases, furniture and chests, and the exquisite jewelry of kings and queens will be proof enough of the Egyptians' love of color and their artists' skill in using it. And, as for their knowledge of nature, their unsurpassed drawings of birds and their expressive studies of animals can not fail to make us feel how true and sympathetic their vision must have been.

THE BRIGHT DECORATIONS ON THE WALLS OF ASSYRIAN PALACES

Color was used for wall-decoration in Babylonia and Assyria as well as in Egypt. In the palaces of Assyria, which was a hill country with a supply of stone, the brick walls of the buildings were often faced with

slabs of limestone or alabaster, carved in relief (the designs stand out from the background). Sometimes, however, the bricks were simply coated with plaster and this was covered with paintings. In Babylonia, a land of level plains, where stone was scarce, the usual finish for decorated walls was that of glazed tiles, some of which had the design raised like a relief, while some were flat, depending upon color alone to show the pattern. In both countries the colors used were brilliant and gay but were not intended to give the effect of nature. Blue, yellow and white were the most common colors. Of these, blue was generally employed for the background, although green sometimes took its place.

Lions frequently appear on the decorative friezes, almost always nobly and vigorously pictured. Two fine examples illustrate very well the color schemes of the old artists in enamel work. First, a lion from a palace at Khorsabad in Assyria is bright yellow against a ground of intense blue, with the mane and some of the muscles brought out in the same strong blue.

Another lion, belonging to old Babylon, is white with a yellow mane, and stands out against a background of blue. In each case there is a charming border of white rosettes with yellow centers. The Babylonian lion is one of an interesting procession of the kingly beasts forming a frieze on each side of a magnificent festival road built by Nebuchadnezzar from the temple of Marduk, past his own palace, and so on to the river Euphrates. Along this road the god Marduk was carried, once a year, to visit the god Nebo on the other side of the river. This lion frieze is probably the highest accomplishment in the art of brick-enameling. Enamel was used in Assyria, too, but was not of as fine a quality as that which has been found in Babylon.

Other creatures besides the lion—bulls, dragons, birds and mythical monsters—decorated the gateways and side walls in both countries. The palaces were adorned with spirited scenes of warfare and triumph, or of huntsmen on horseback or in chariots pursuing lions and wild boars—a record of the glories of the kings, their victories and their prowess. For, as the underlying feeling of Egyptian art is that of *duration,* so the idea most often and most clearly expressed by the Assyrian is *strength*—strength in action, brute force in full play. Scenes are a wild tumult of movement.

For borders there was a variety of designs. One favorite showed a spiral twist; others were conventionalized flower patterns. All these occur on colored pottery, much of it black, with the lines of the design cut into the surface when it was soft. Then these cut-in lines were filled with a white paste before the clay was baked. The decorations might be in the shapes of fish, boats, waterfowl or geometrical figures. In other cases, stripes of various colors were painted on the bowl or jar by way of ornament.

The art of the Persians closely followed the same lines as that of the Assyrians and Babylonians, with added richness of form and jewel-like radiance of color for their own contribution, and a certain delicacy which indicates Greek influence.

THE NEXT STORY OF FINE ARTS IS ON PAGE 447.

Courtesy, The Metropolitan Museum of Art

A lifelike lion, from a frieze in the stately palace of Darius the Persian, at Susa. The lion, symbol of strength, was a favorite subject for sculpture and enamel work among Assyrians, Babylonians and Persians.

The Canterbury pilgrims leaving the Tabard Inn. This picture was engraved from a painting by William Blake.

MEN WHO FIRST WROTE ENGLISH

IN the article beginning on page 215, we spoke about the unwritten literature of many countries—the early songs and stories that were remembered for ages, just because they were sung and told over and over. The story of Beowulf was such a tale. Eventually this story and others were written as each country began to have a literature of its own.

We who live in Canada and the United States must go back to England to study the beginnings of literature in our language; and we must go back many centuries, to a time when only a few people could read and write.

The story of Beowulf is the first English poem that we have. It was sung in the banquet halls of the Saxons. It was finally written down by a scholar, perhaps of the time of King Alfred, and a copy still exists; but you would not be able to read it, for it was written in Old English, or Anglo-Saxon, a language quite different from the English we use today.

In the eighth century a saintly monk, Bede (673?-735), translated the GOSPEL OF ST. JOHN into English (Old English, of course). Bede also wrote a charming history of the English nation, to his own time, about two hundred years before King Alfred lived. The history was written in Latin. Alfred translated it into his dialect of Old English.

Alfred (840-899) was not only a great king, but a good writer, too, and an educator. He spent much time writing and translating books. He gave instructions for a record to be made by the monks in the monasteries. This is called the ANGLO-SAXON CHRONICLE. Records were made in it for almost 200 years; and though the entries are short, it has helped us to learn the history of the time.

After Alfred's day, there was a blank in English literature. For a century and a half there was constant fighting with the Danish invaders, and in 1066 William, Duke of Normandy, invaded England and made himself king. The Conqueror and all the friends he brought with him spoke French, so French became the language of the court and of all who wished to be considered

Both pictures from The T. F. Healy Collection

A detail from the picture above. The lady with the pointed headdress is the prioress, and next to her is the nun.

Culver Service

King Alfred's mother teaching him to read Old English.

educated, or fashionable. The Anglo-Saxon speech was despised.

But we are mistaken if we think that *no* literature was produced in English during those fierce and turbulent times. In the monasteries patient monks, proud of their skill as penmen and painters, were busy with the chronicles of their day. Tale-tellers or harpers wandered about the country from hall to hall, from fair to fair, and from inn to inn, singing or reciting ballads, new and old, for the amusement of their hosts or companions. Plays, clumsily made from Scriptural incidents or romantic adventures, were acted by the peasantry or by guilds of workmen in the towns. Thus old-time legends were preserved and developed, together with the doings of kings, religious instruction and songs. In this way, though no great writer lived in these centuries, simple forms of literature were circulated.

The popular tales of the times passed from country to country, and were recast, added to and ornamented as they traveled. English and Welsh stories were written down in France and then brought back into England, or were turned into Latin by monks. Four or five sets of these stories can be distinguished—the Greek accounts of the siege of Troy, the adventures of Alexander the Great, the heroic deeds of King Arthur, the history of Charlemagne and, later, the greenwood adventures of Robin Hood.

France was the great workshop for tale-making, and French the language of romance. French was the language of the palace, the castle and the law court. French, not English, was taught in the monasteries, which were the schools of the times. Gradually the native language suffered change. Grammatical forms were altered. French words crept in, and the English of the fourteenth century had become so different from the old Saxon English that King Alfred could not have read it.

But all the while, English remained the speech of the bulk of the people. The descendants of the Norman barons, who now prided themselves on being English, began to look upon the English language as their own.

Slowly one of the dialects of English—the East Midland, which was spoken in London—began to be regarded as standard English. This was a step forward in the making of the nation. The English kings ceased to feel like Frenchmen. English was spoken more

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The Venerable Bede wrote a history of England.

and more by all classes. It was again made the language of the courts of law. Poets began to write in it. The time had come for someone to establish the language forever, by using it in books that all men would read. The man who did this work was Geoffrey Chaucer.

CHAUCER'S LIFE WAS AN INTERESTING AND HAPPY ONE

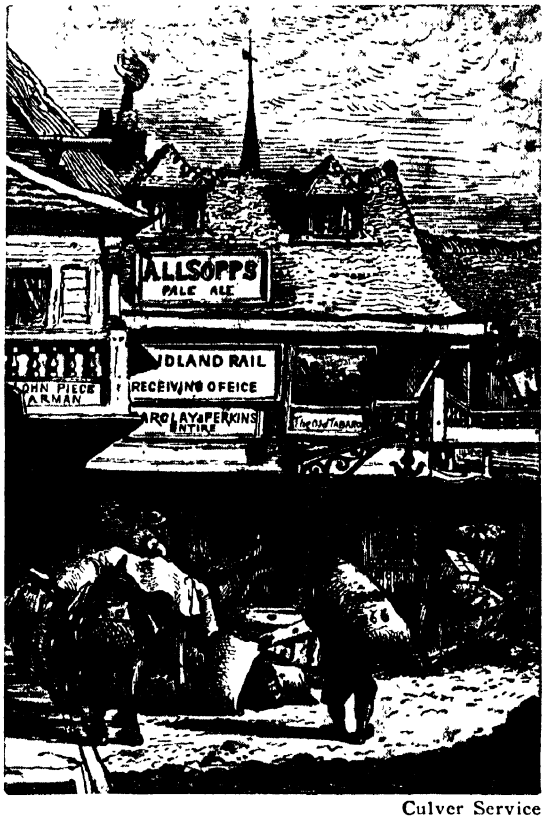
Chaucer was born in London, in 1340 or thereabouts. His father, a wine merchant, was connected by business with the king's court. The boy was given a good education and was made a page to the wife of Prince Lionel, son of Edward III. There is a record that his mistress spent about $25 of our money to buy her page a suit of clothes, including a pair of red-and-black breeches.

When he was about twenty, Chaucer went to France with the army of Edward III, and was taken prisoner, but ransomed. The King himself paid a part of the cost (about $2,400).

In 1367, Chaucer was one of the valets of the king's chamber, with the rank of yeoman. Later he became squire. In the years that followed, he held a number of positions, granted to him, with goodly salaries, by Edward III and the following king, Richard II. Seven times he was sent on royal missions to Italy, France and the Low Countries, and once he remained in Italy for nearly a year. He was, at one time, justice of the peace, and he was for a single term member of parliament. Other difficult posts were given to him, so that we wonder how he had time to devote to scholarship and especially to writing poems. The truth seems that he was a man of learning who could change even everyday business experience into literary gold, as the alchemists of his day hoped to change lead, tin, mercury and silver into gold. His writings show the influence of his travels. At first he translated and imitated the French poets. Then he was captivated by Dante, the greatest poet of the Middle Ages, and by Petrarch, whom he probably met in Italy. But though his later poems often borrowed both form and subject from Italian works, they became increasingly English in thought and original in treatment.

HIS GREATEST WORK WAS THE CANTERBURY TALES

Chaucer's works fill seven hundred pages of close print, but the poems that picture him for us at his best are a collection called THE CANTERBURY TALES, which he had not finished when he died.



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The old Tabard Inn at Southwark. Here Chaucer's pilgrims met to begin their journey to Canterbury.

The plan of these tales gave the poet freedom to choose characters from the rich, the middle classes and the poor, and bring them together under circumstances that made them friendly, yet left them natural and independent.

A company of about thirty men and women, the poet imagines, have met on an April day at the Tabard Inn, in Southwark, over the Thames from London, to start on a pilgrimage to the tomb of Thomas à Becket at Canterbury. They make a merry group, bent on enjoyment as well as religious duty; and the landlord of the inn, a jovial, managing fellow, volunteers to act as their guide. To pass the time pleasantly as they travel on horseback at a walking pace, he proposes that each pilgrim shall tell two stories on the way to Canterbury, and two on the return journey. Whoever tells the best story, the landlord being the judge, is to be entertained at supper by the rest of the company when they return to the Tabard. The poet describes each of the pilgrims, and writes the stories they tell, but only twenty-four. Before they reached Canterbury the tales

broke off, owing to the poet's death, and we do not know which story Chaucer intended should win the prize.

In these tales, supposed to be told by all kinds of people, the manner in which people lived in the Middle Ages is unrolled before our eyes. We see it just as it was, sometimes gentle and romantic, sometimes brutal, cunning and vulgar, with good and evil so mixed we do not know whether to laugh most or lament most at the sight. You can feel that Chaucer greatly enjoyed telling these stories, for all the while he was full of fun and high spirits. He could not help making fun of himself. When he was called forward to tell the other pilgrims his own story, he started a long, romantic rime of love, SIR THOPAS, such as he had in his youth translated from the French, and the landlord stopped him abruptly by exclaiming, "No more of this!"

A picture from THE CANTERBURY TALES printed by Caxton in 1484.

What a mixed company it is that gathers under the guidance of the jolly innkeeper! There is the knight, who has ridden through many lands to fight for love and chivalry and honor, freedom and courtesy, and who yet, in his bearing, is "as meek as is a maid." With him is his son, a curly-headed lad of twenty, his dress as gay as a flower garden, his mind full of love and romance:

> Singing he was and fluting all the day,
> He was as fresh as is the month of May.

As a squire the young man has "borne him well" in France and the Low Countries, and, like the knight, is a gentleman in heart and bearing.

> Courteous he was, lowly and serviceable,
> And carved before his father at the table.

The knight and the squire are attended by an honest yeoman, bow in hand. The Church contributes a group of characters, the chief among them being a prioress, who is a model of the best manners of the day, eating with cleanness and delicacy, and wiping her lips carefully "when she drunken hath her draught." Besides, there is a worldly minded, sport-loving monk; a wandering friar, the best beggar in the whole countryside; a red-faced tax-collector; a pardoner; and a devoted parish priest, who, staff in hand, walks in all weathers from end to end of his parish, visiting great and small in their sickness, teaching Christ's Gospel, "but first he followed it himself." Though poor as any of his flock, this parson is "rich in holy thought and work."

> Benign he was and wonder diligent,
> And in adversity full patient
> To drawen souls to heaven by fairness,
> By good example was his busyness.

The professions provide a doctor, with more than a suspicion of quackery in his talk; a lawyer, who is not so busy as he tries to appear; and a pale, threadbare student from Oxford, who would rather have books than gay clothes. His mind is bent wholly on study, and he speaks with well-formed sentences.

> Sounding in moral virtue was his speech,
> And gladly would he learn and gladly teach.

The landed classes sent to the pilgrim group a farmer; commerce sent a merchant; and among the rest were a miller, a plowman, a sailor, a carpenter, a weaver, a dyer, and a wife of Bath who had been married five times. The whole range of manners of the times, of good taste and of bad taste, is covered by these living figures.

Most of the tales were borrowed from Italian writers, but in turning them into English Chaucer gave them freshness and

even new meanings. Good nature and a quiet humor played over all his writing, but he taught serious natural duties like contentment.

Look up on high and thank thy God for all.

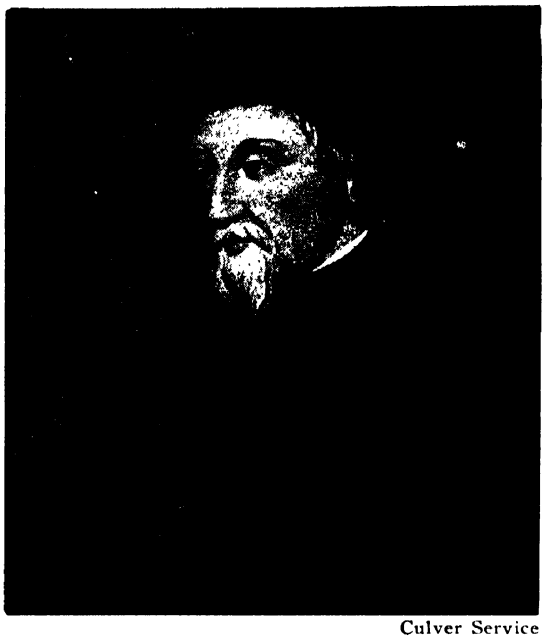
Caxton, who printed books in the English tongue seventy-seven years after Chaucer's death, printed some of the poet's works, and introduced them by saying: "We ought to give singular laud (praise) unto that noble and great philosopher who may well have the name of laureate-poet." With that judgment all later users of the English language agree; for Geoffrey Chaucer not only wrote pleasant poems, but pictured the people of his own day and helped to fix our tongue, which had been changing constantly.

Some of his words have passed out of use, or have changed their meaning. Many words were spelled out more fully than now, and had an extra syllable—as *newë* for new, *bookës* for books, and *gamë* for game. Then words borrowed from the French kept the emphasis on the last syllable, as rea*son* for reason, and vir*tue* for virtue. Also *tion* endings are not pronounced as *shon,* but in the French way, as if they had two syllables and were spoken *ce-on.* But if you go slowly, and take a little trouble, you can still read and understand Chaucer, as in this description of his evening study, after his day's work is done.

But of thy verray neyghebores,
That dwellen almost at thy dores,
Thou herest neither that ne this;
For whan thy labour doon al is,
And hast y-maad thy rekeninges,
In stede of reste and newe thinges,
Thou gost hoom to thy hous anoon;
And, also domb as any stoon,
Thou sittest at another boke,
Til fully daswed is thy loke,
And livest thus as an hermyte,
Although thyn abstinence is lyte.

But of thy very neighbors,
That dwell almost at thy doors,
Thou hearest neither that one nor this;
For when thy labor done all is,
And hast made thy reckonings,
Instead of rest and new things,
Thou goest home to thy house anon;
And, as dumb as any stone,
Thou sittest at another book,
Till fully dazed is thy look,
And livest thus as a hermit,
Though thine abstinence is light.

If we fill in from other personal jottings the picture of himself Chaucer has outlined in his writings, we see him stout in body, pleasantly roguish in face, quiet and retiring, though a man of the world with bright eyes that miss nothing.



Culver Service
Chaucer, who has been called "the poet of the dawn."

Though a student deeply in love with books, he is no hermit, but takes cheerfully whatever life comes to him among his fellowmen, and thanks God for it. He can not resist the chance of poking quiet fun even at men whom he admires. His best mood comes in response to the call of spring.

At the time of Chaucer's death, in 1400, he had been living in a house on the grounds of Westminster Abbey. He was buried in the Abbey for that reason. Gradually, through the centuries, many other poets as they died were buried near him, and that small section of the Abbey is now called The Poets' Corner.

While Chaucer was writing poems for fashionable people to read in books expensively copied by hand, the common folk were telling each other tales in ballads—simple rimes, often stumbling along. They still move our hearts with strong, clear picture-words, or haunt us with recurring phrases or refrains. When printing was invented, these ballads were among the first poetry circulated everywhere. One set, that told the story of the bold outlaw, Robin Hood, and his merry men, was so well known that a poet, Michael Drayton, writing a century later, said of Robin:

In this our spacious isle, I think there is not one
But he hath heard some talk of him and Little John.

We can read, as an example, the ballad recording the tradition that Robin Hood was bled to death, when ill, by a treacherous kinswoman, the prioress of Kirklees, or Kirkley, nunnery. It shows how limping the metre often was, and yet how sad, how vivid, and how powerful the simple verses became when feeling was strong in them.

A WONDERFUL BOOK OF TRAVEL IN FAR COUNTRIES

There were other writers of English about Chaucer's time of whom we shall speak, but first we must go back to a very famous book, THE VOIAGE AND TRAVAILE OF SIR JOHN MANDEVILLE. This was written (not in English, but in French) about the time Chaucer was a page. No one knows exactly who the author was. He may have been a physician of Liège, named Jehan de Bourgoyne, nicknamed Jehan à la Barbe. Some people think he was an Englishman, living as an exile in France for a political offense. Whoever he was, he wrote sometime near the year 1355. He used the pen-name John Maundeville, knyght; and it is as Sir John Mandeville that the world speaks of him. It used to be thought that the author himself translated his book of curious adventures into English. Now it seems clear that someone else translated it, during the author's lifetime. The book is a marvelous account of travels in Egypt and Asia, and describes some things that the writer saw, some he could only have heard or read, and many things that he believed or imagined, but which never existed. It is thought that he died only a few years before the death of Chaucer.

T. F. Healy Collection
Sir John Mandeville.

John Gower (about 1330-1408) was one of Chaucer's friends. He was not a genius like Chaucer, but his poems have considerable merit. He was one of the little group of fourteenth-century writers who helped to settle the form of the English language. (The work started, of course, before his time and was not finished until about Shakespeare's day; and, in fact, it has never been finished, for slight changes in our language are still going on.) In his youth, John Gower wrote in Latin and French, those languages being then considered more elegant for literary purposes. But in his later years he wrote in the quaint English dialect of his time.

It is more than possible that Chaucer knew John Wyclif (1320-1384), a noted religious reformer of the fourteenth century. Wyclif was a Yorkshire man. He went to Oxford University, where he studied at the famous Balliol College, and became a priest and, for his time, a very learned man. He may be said to have begun the movement known as the Reformation of the Church. He wrote sermons and tracts on the state of the Church, and his writing is of interest chiefly to students of history and English literature. He was another of the writers who in the fourteenth century helped to accustom people to read in their native tongue, and so helped to create a demand for books in English. Wyclif probably directed the first full translation of the Bible into English, and it is probable that he translated some of it himself. No fewer than 170 hand-written manuscripts of his version are still in existence.

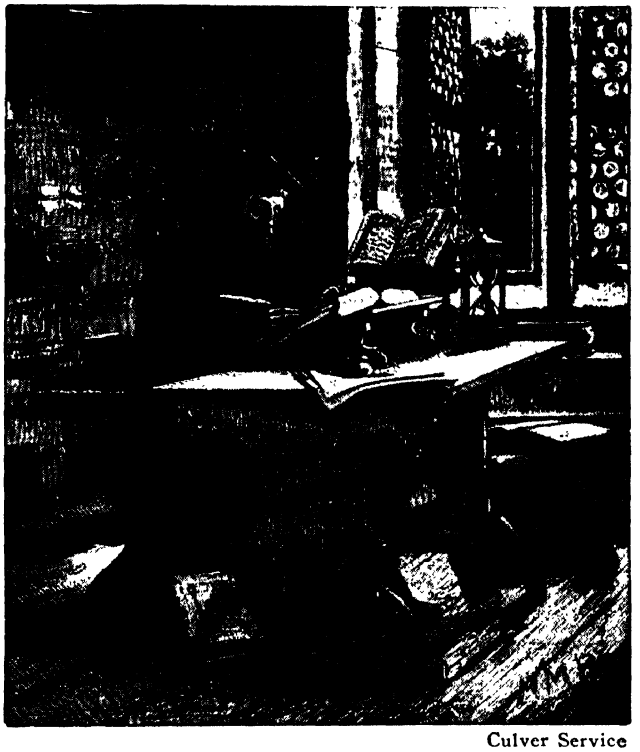
A famous poem has come down to us from Chaucer's time. This is the VISION OF PIERS PLOWMAN, from which we have learned much of what we know about the sadness and misery of the lives of the poor people of that early day. It is written in the form of a vision, or dream, and deals severely with the sins and evils of the time. Although it was written about the time that Chaucer was writing his poems, a large number of the words used are strange to our ears, and it is much more difficult to read than Chaucer's works.

We know nothing, except what the poem tells us, about the author and his life, and indeed it may have been written by more than one person. It is generally believed, however, that at least the most important part was written by a man named William Langland, or Langley, who was born before Chaucer and died in 1400, the year of Chaucer's death. It is thought that he lived at some time of his life in London, but he also knew the country well, else he could not have written as he did of country life.

It is interesting to remember that although books on religion, history, science and law were written in prose, nearly every story that has come down to us from the time of which we have been reading was written in verse.

Perhaps men had not yet gained enough skill in the use of their language to write stories in prose and make them interesting. Perhaps they were still so near the time when stories were always sung by minstrels to the music of their harps, that it did not occur to them to write stories in prose.

Chaucer himself wrote some prose. Two of the CANTERBURY TALES are in prose. He translated a little book called THE CONSOLATIONS, by Boethius, a Roman philosopher; and he wrote a scientific treatise for his son, whom he lovingly called "Litel Lowis, my sone." He commended the boy for his ability to learn the science of numbers and proportions, and for his love of knowledge. The poet shows himself to us here as a loving father, proud of his little son; but he has not left us a model for prose writing. Latin was then the language universally used by scholars. They corresponded in it and wrote learned books in it, because it was understood by every man who went to college, or to the monastery schools.



Culver Service

John Wyclif was a priest and a very learned man. He was one of the first scholars to translate the Bible into English.

When Chaucer died, in the year 1400, English poetry had attained a charm unknown in prose. Two centuries later English prose had acquired a grace, sweetness and strength that it has scarcely surpassed since, while in poetry a stately edifice had been built on the plain foundations that Geoffrey Chaucer laid.

The chief form of the drama in the Middle Ages was religious in character. Some of the plays, called mysteries, dealt with stories from the Bible; others, known as miracle plays, told about the lives of the saints or about the miracles they wrought. The mysteries and miracles had their beginnings under the auspices of the Church.

Before the Norman conquest, some of the church services—which were, of course, in Latin—made use of song and very simple action in order to make the meaning clear. The oldest example which we know was composed around the year 900. This was performed during service at Eastertide. Part of the song was sung by three friars dressed as women, seeking the tomb of Christ, while another part was sung by a friar dressed as an angel guarding the tomb.

After the Norman conquest, plays based on the lives of the saints became increasingly popular in the monastery schools, where the younger pupils honored St. Nicholas, and the older ones, St. Catharine of Alexandria. From these simple beginnings rose the mystery and miracle plays which, in the latter part of the eleventh century, during all of the twelfth and the greater part of the thirteenth, were so closely bound to the Church.

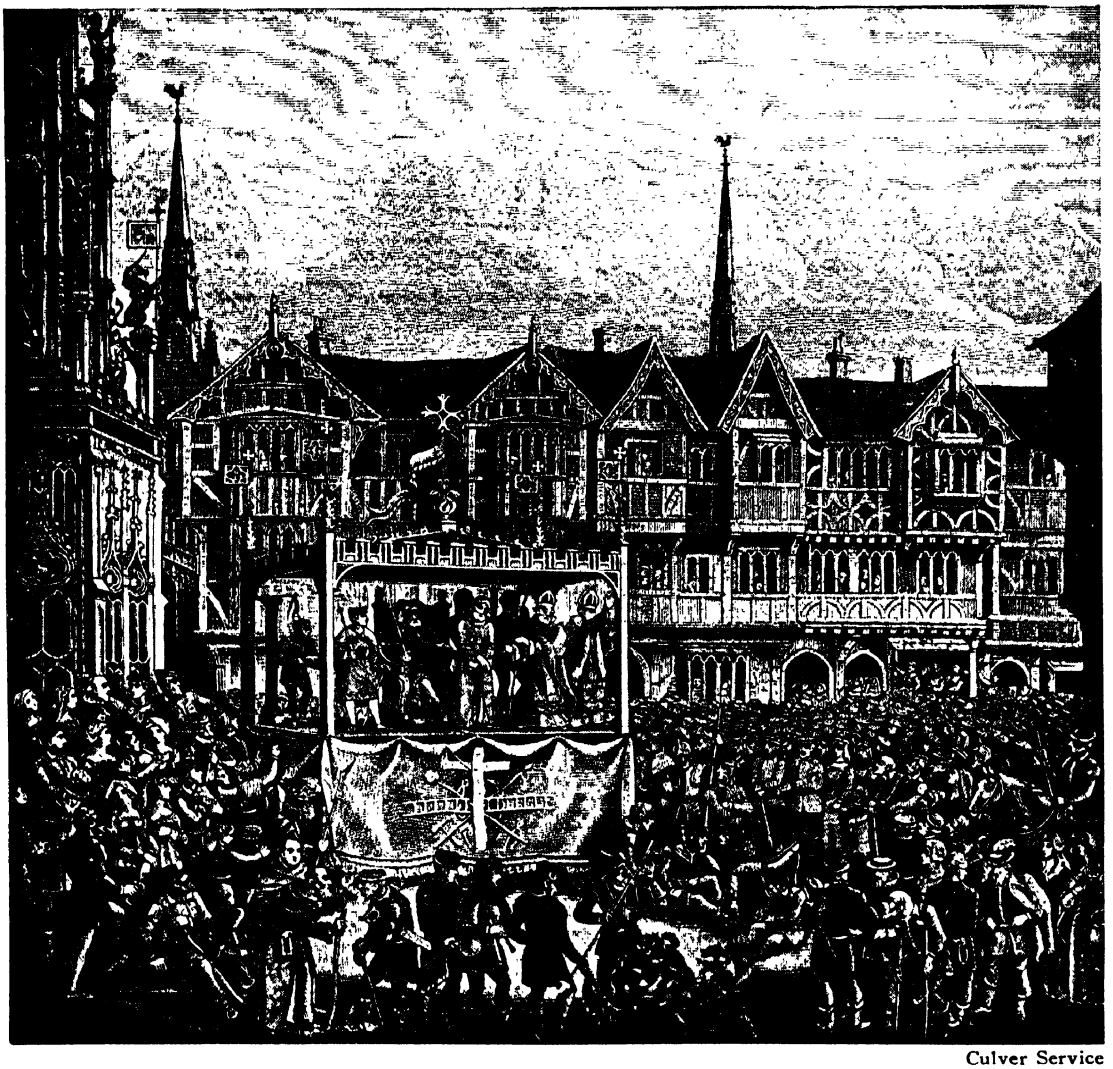
Although religious plays were at first given within the church walls, they began at a very early date to be given outside the building itself, usually on scaffolds set up nearby. They became completely independent of the service and grew more and more popular. The good people of England flocked to see them, weeping at their pathos or shouting with laughter at their comedy which, losing its earlier, gentler humor, in the course of time became boisterous and worldly. One of the favorite comic characters was Noah's wife, who made all sorts of difficulties about entering the ark. Chaucer, referring to her with a smile, calls her "The sorwe (sorrow) of Noe."

Some of the religious plays were performed at the time of the great church festivals, especially the feast of Corpus Christi.

which was first held in 1264. A magnificent procession celebrated Corpus Christi, with the different guilds of craftsmen vying with each other to make the finest showing. Soon stages set up on wheels—we would call them floats today—were introduced in the procession, and each float represented a scene from the story of the Bible. Presently, at different points along the path of the procession, it became the custom for each float to stop. Each group would act out the scene it represented, then move along to the next stopping point, and act it out all over again before a new audience. On the first float might be a little play telling the story of creation. On the second, the subject of the play might be Adam and Eve. In this way, a whole series or cycle of plays grew up. Often four days or more were needed to give the entire performance.

By the fourteenth century, this processional drama had become fully developed in England, but the early manuscripts have been lost. By the fifteenth century, the number of religious plays that had been written was fairly large. The earliest purely English play known to us is probably one dating from the fifteenth century, telling the story of Jacob and Esau. The four great cycles of plays that have survived from the fifteenth and sixteenth centuries are the Coventry plays, the Chester plays, and the York and Towneley mysteries.

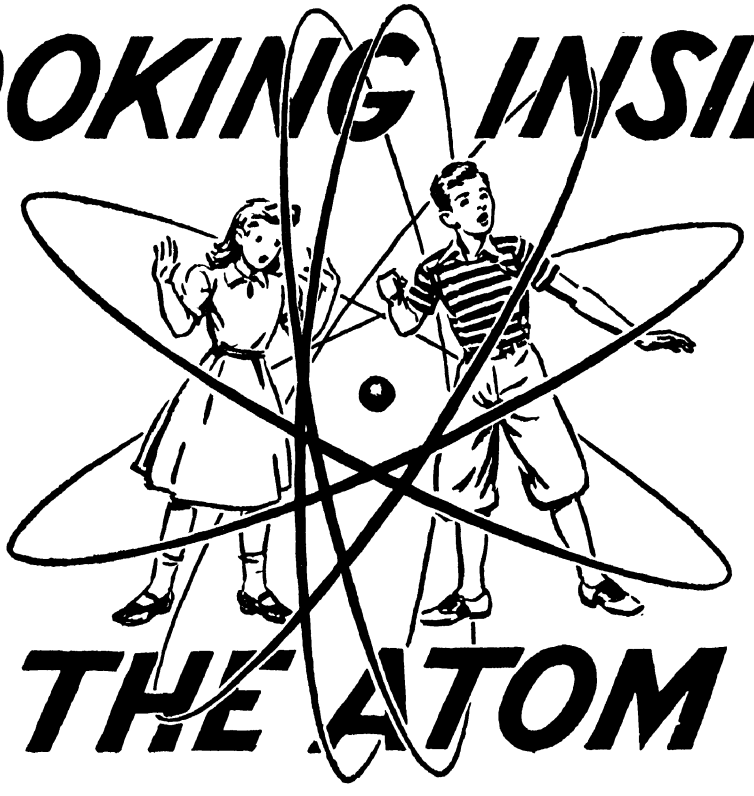
THE NEXT STORY OF LITERATURE IS ON PAGE 475.



Culver Service

A mystery play being acted in front of Coventry Cathedral. Mysteries were plays based on stories in the Bible.

LOOKING INSIDE THE ATOM



YOU have heard people say that we are living at the beginning of the Atomic Age. These people mean that we are just beginning to learn how to make the inner core of atoms work for us. No one has ever seen an atom, but after years of patient study and experiment scientists have worked out an answer to the question: "What is it like inside an atom?" There is much still to be learned; and our knowledge is being added to year by year. Everyone living in this Atomic Age should have some understanding of the atom. In this chapter we shall take an imaginary look at some different atoms, and "see" what goes on inside them.

The word atom means uncuttable. Some scientists of olden days thought an atom could not be cut. They thought it was a tiny, tiny, tiny bit of matter, and that the bits were all alike in any one substance. But they were wrong.

Now we know that an atom, as small as it is, really is made up of still smaller particles of matter, and there are several different kinds of particles. They are not thrown together helter-skelter, but arranged in a beautiful pattern. Inside the atom there is constant change and motion.

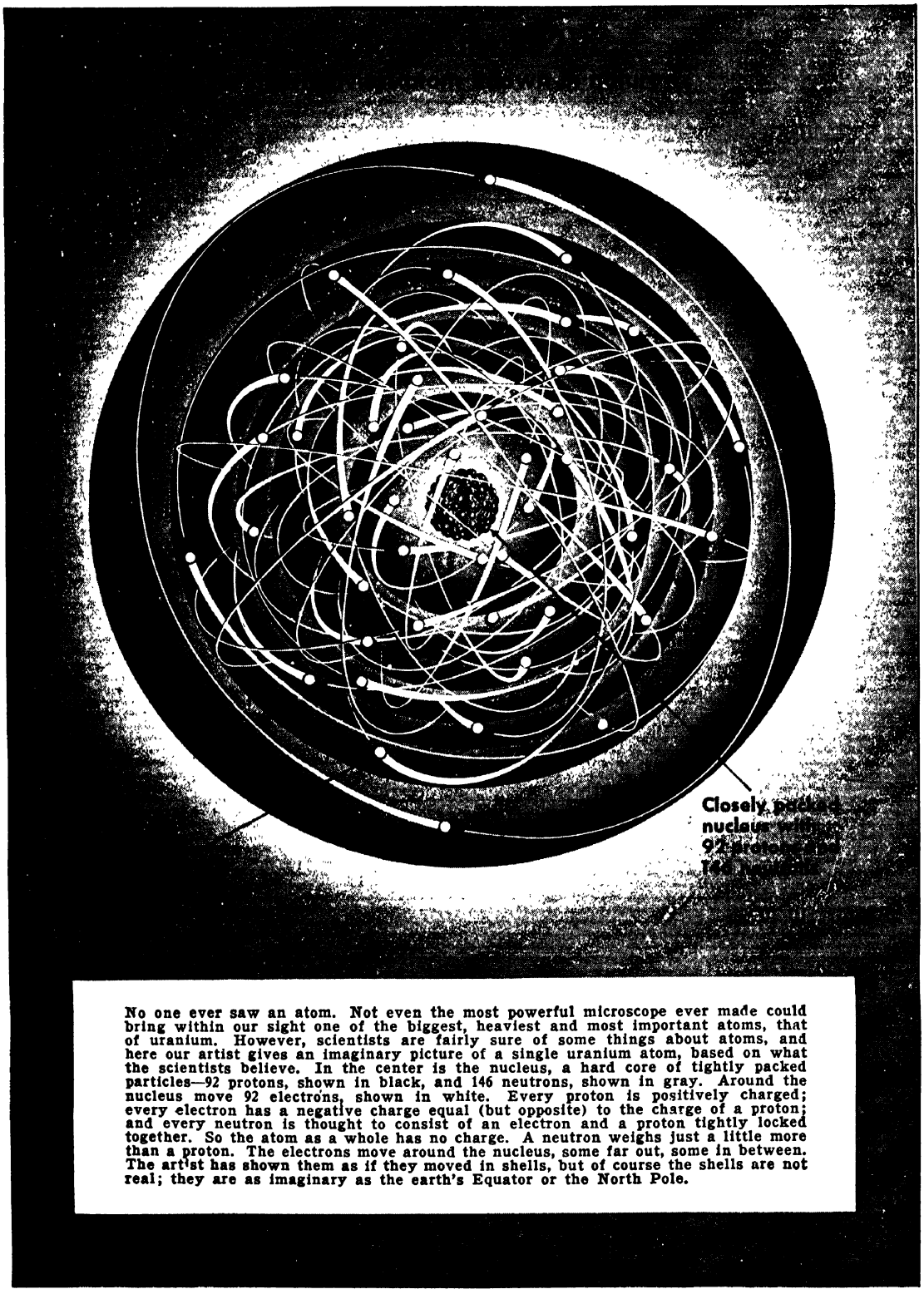
So now let us look into an atom of hydrogen. It is the lightest element, and a single hydrogen atom is the simplest kind of atom. In the center is a mass of substance called a nucleus. Near it, but not always in the same position, is a much smaller bit of matter called an electron. The mass that makes the hydrogen atom's nucleus is called a proton.

You know that there are two kinds of electricity, which have the names positive and negative. Now the proton of the hydrogen atom carries (or is charged with) positive electricity. The electron carries negative electricity. The proton is 1,850 times as heavy as the electron, but their electric charges are equal and opposite. It is easy to see then that the biggest part of the atom's weight is concentrated in the nucleus, where the proton is located.

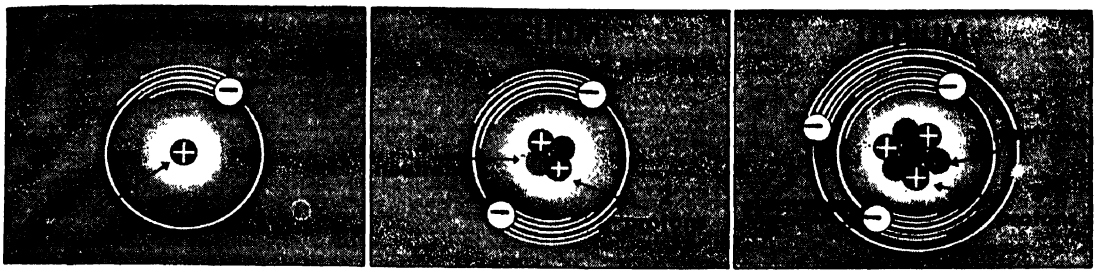
Since the electric charges are equal and opposite, the atom as a whole has no electric charge $-1 + 1 = 0$. This is true of every atom—its electrons are balanced in positive and negative electric charge.

Now let us look into an atom of the next element, helium, with atomic number 2. We see a nucleus and 2 electrons. In the nucleus

ONE OF THE KEYS TO ATOMIC POWER



No one ever saw an atom. Not even the most powerful microscope ever made could bring within our sight one of the biggest, heaviest and most important atoms, that of uranium. However, scientists are fairly sure of some things about atoms, and here our artist gives an imaginary picture of a single uranium atom, based on what the scientists believe. In the center is the nucleus, a hard core of tightly packed particles—92 protons, shown in black, and 146 neutrons, shown in gray. Around the nucleus move 92 electrons, shown in white. Every proton is positively charged; every electron has a negative charge equal (but opposite) to the charge of a proton; and every neutron is thought to consist of an electron and a proton tightly locked together. So the atom as a whole has no charge. A neutron weighs just a little more than a proton. The electrons move around the nucleus, some far out, some in between. The artist has shown them as if they moved in shells, but of course the shells are not real; they are as imaginary as the earth's Equator or the North Pole.

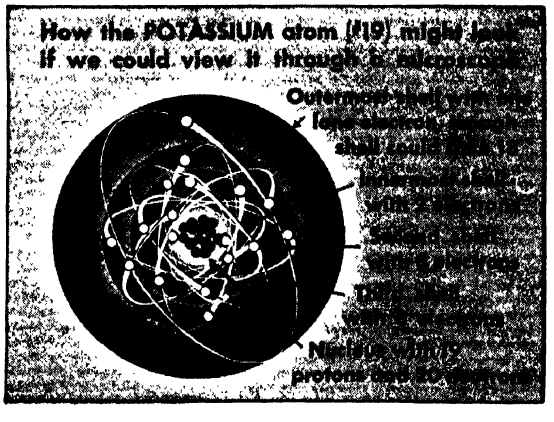


are 2 protons, which balance the electrons; and the nucleus also has 2 other particles of about the mass of protons, yet without any electric charge. They are neutrons. The mass of the electrons is so small as to be insignificant. It is the nucleus by which we tell an atom's weight. We see by the table on page 286 that helium weighs four times as much as hydrogen—now we know why. Hydrogen has 1 proton; helium has 2 protons and 2 neutrons.

How about lithium, the third element? A lithium atom has 3 electrons round about the nucleus. In the nucleus are 3 protons, to balance the 3 electrons in electric charge, and 4 neutrons. The lithium atom must be, therefore, seven times as heavy as the hydrogen atom, and when we look at our table of elements we see this is correct. The atomic weight is 7. Look at the table once more. Column 3 gives the "atomic number." The atomic number is really the number of electrons the atom has. Neon has 10 electrons, and therefore 10 protons. Its atomic weight is 20, so it must have 10 neutrons; and that is correct.

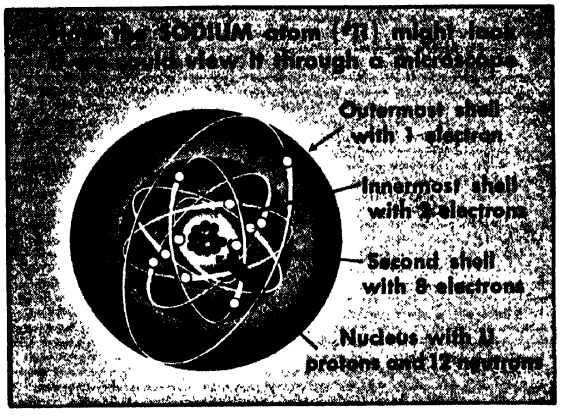
Further down on the list, uranium, one of the heaviest atoms, has 92 electrons, and so it must have 92 protons. Its weight is 238, therefore you can figure for yourself the number of neutrons—146.

The heavy atoms each have a swarm of electrons near the nucleus. Lead, for example, has 82. Bismuth has 83; radium, 88. As a result, the nucleus is very well protected from any outside interference. If you were living in a house surrounded with 82 traffic lanes, and your friends had to dodge cars on all those lanes every time they came to see you, you would probably not have many visitors. Fortunately, the situation is not really so complicated, because the electrons near a nucleus obey very rigid traffic rules. They stay in shells we say when we use the proper technical term. But you can think of them as circling in traffic lanes.



In an atom the first lane, nearest the nucleus, has room for only 2 electrons at any time. The lane next farthest out has room for 8; the one after that, 8; the next one 18; and so on until all the electrons are accounted for. For example, potassium, with 19 electrons, has them circling 2 in the first lane, 8 in the second, 8 in the third, and only 1 in the fourth, although there is room there for 17 more.

These traffic lanes, or electron shells, are not all equally spaced around the nucleus in the way that rings on a shooting target often are. The actual distances do not matter very much to us, but it is important to know that the shell nearest to the nucleus is very close to it, and that the outermost shell, which has only one electron in the case of potassium, is very much farther out than any of the other shells. Yet in spite of all this complex structure, the diameter of the potassium atom, which means the diameter of the outermost electron shell, is only about one hundred-millionth of an inch. It is not possible, but let us imagine that we have a special microscope with which we are able to take a quick look at a potassium atom. The first thing we shall see, naturally, is the most prominent part of the atom, the comparatively large outside shell. It is here that the lone outermost electron is revolving. We would probably notice, too, some sort of tiny structures at the center of the atom, but would not



pay much attention to the details. Actually it would contain the nucleus and the inner shells of electrons.

If we took a quick glance at a sodium atom, we would notice one electron moving in the outermost shell, and, far inside, the nucleus and two other tiny shells. The potassium and sodium atoms both have one very large shell for the single outermost electron, and a central nucleus with other small shells of electrons round it. *The chemical nature of an atom is entirely governed by the outermost shell of electrons.* For sodium and potassium these shells are identical. It is small wonder, then, that sodium and potassium are similar chemical elements and are therefore put in the same column of the periodic table, that column where all the elements have a valence of 1. See the picture above.

The same sort of explanation can be given for atoms in other columns of the periodic table. The noble gases, in column 0, are a rather special case. In all these atoms—helium, neon, argon, etc.—the outermost traffic lane, or electron shell, is full. There is no room for any more electrons. And when the shell is full, it is just as though the atom built up a wall round itself and would have nothing to do with its neighbors. That is why the noble gases stand aloof and do not enter into chemical combination with any other atoms.

Let us take a look at magnesium. The table of atoms tells that it is the twelfth lightest atom, and therefore has 12 electrons circling round its nucleus. These are arranged in two full shells containing 2 and 8 electrons respectively, with the remaining 2 electrons in a very wide shell. The nucleus must have a positive charge of 12 and therefore contains 12 protons. The atomic weight is 24, so there should also be 12 neutrons in the nucleus.

It has been found, however, that the mass of the nucleus is not nearly so important as its charge. The nucleus of magnesium *must* have a charge of 12, but it need not have a mass of 24. Suppose another neutron, or even 2, were added to the nucleus. The charge of the nucleus would still be right for magnesium, and the outside electrons could be arranged just as before. Actually, some magnesium atoms have nuclei constructed in this way, giving them masses of 25 and 26, but keeping the positive charge at 12. Such alternative atoms are called isotopes.

A piece of ordinary magnesium metal always has about 78 per cent of atoms with mass 24, 11 per cent with mass 25 and the other 11 per cent with mass 26. We do not know exactly what determines these percentages. These isotopes are perfectly good magnesium atoms. Chemical tests can not tell them apart; an instrument called a mass spectrograph is needed.

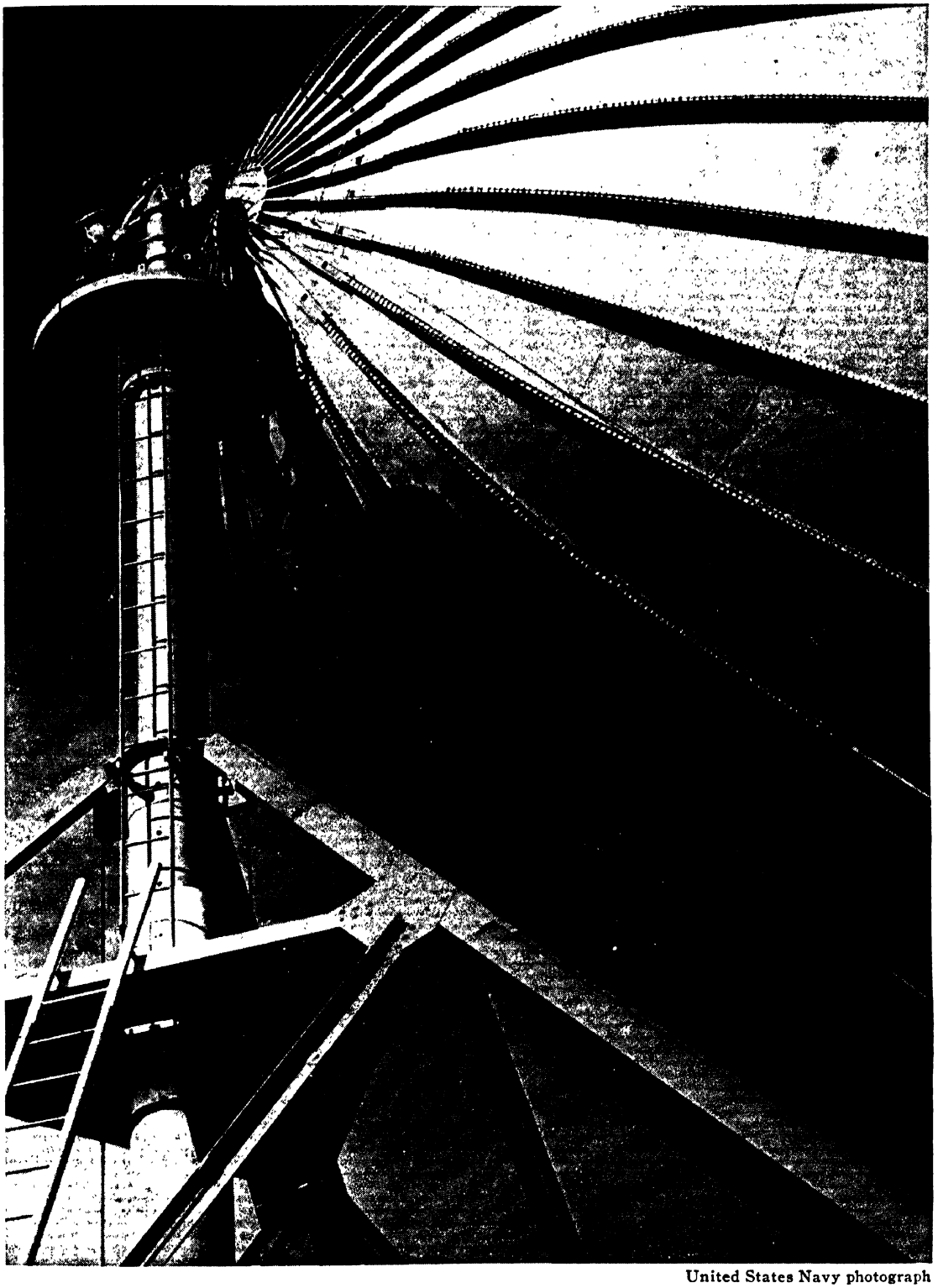
You might think that a great number of other isotopes of magnesium might exist. But they do not. There is actually one other, of mass 27 (12 protons, 15 neutrons), but no sooner do physicists put it together than it falls apart again. It is unstable, or radioactive. Why so few stable isotopes exist, we really do not know. When we have found out more about protons and neutrons we may be able to answer the question.

Most elements consist of several isotopes. There is even a kind of hydrogen atom, with mass 2, called heavy hydrogen, but it is very rare. Tin has as many isotopes as any element. It has 10, all, of course, of atomic number 50, and ranging in atomic weight from 112 to 124.

We now have a picture of a typical atom—a nucleus surrounded by shells of electrons, with the electrons circling continuously. All but the outermost shell have their full share

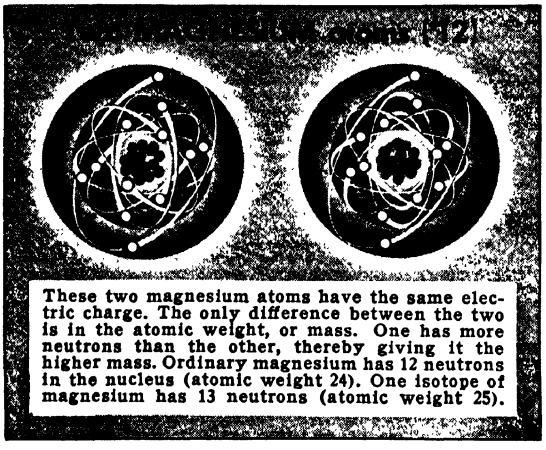
Argon is an inert gas; it will not unite chemically with any other element. This is true because the outer shell of electrons is full.

AN AIRSHIP IS FILLED WITH HELIUM



United States Navy photograph

Helium is the lightest gas known, outside of hydrogen. Because of this, and because of the fact that it is non-inflammable (non-burnable), it is very well suited for use in balloons. Here a United States Navy blimp is filled.



These two magnesium atoms have the same electric charge. The only difference between the two is in the atomic weight, or mass. One has more neutrons than the other, thereby giving it the higher mass. Ordinary magnesium has 12 neutrons in the nucleus (atomic weight 24). One isotope of magnesium has 13 neutrons (atomic weight 25).

of electrons. However, once in a while, this beautiful regular arrangement is disturbed. If some outside influence, such as a free roving electron, comes along, it may knock one of the outermost electrons of the atom slightly out of its regular orbit or traffic lane. The free roving electron will get quickly out of the way, like a hit-and-run automobile driver. The atom will be left a little different from normal. However, very soon the electron which has been slightly displaced will jump back to its former place.

When this happens, the atom gives out light. The light from one atom would be far too faint for our eyes to see, but when millions of atoms behave in the same way, at the same time, the light can be very bright. This is exactly what happens in a neon sign. Roving electrons sent by electricity scurry through the neon gas in the tube and disturb numbers of atoms. When these atoms return to normal, which they do in a small fraction of a second, the familiar red light is given out. Because all the atoms are of the same kind, and behaving in about the same way, the neon light is red. Every kind of atom gives out its own special kinds of light, forming what is known as its spectrum. In this way, atoms can be identified by their light.

In the above paragraph we have learned how an atom gives out light while returning to its normal condition after one of its outermost electrons has been slightly disarranged by some gentle disturbance. However, an atom may be disturbed verv violently, for example, by electrons moving at extremely high speeds. Such high-speed electrons occur naturally as a consequence of the cosmic rays which beat upon the earth from outer space. They can also be produced artificially. An X-ray tube sends a stream of electrons moving at speeds between 50,000 and 180,000 miles per second. When one of these electrons strikes an atom (for example in the metal target in the X-ray tube) it is likely to dislodge an electron from the atom, and will most likely dislodge it, not from the outer shell, but from one of the innermost shells.

WHEN AN ELECTRON JUMPS FROM ONE INNER SHELL TO ANOTHER, X RAYS ARE PRODUCED

Now these shells are known by special names. The one nearest the nucleus is called the K shell; the next one, the L shell, the next, the M. Suppose one electron has been knocked out of the K shell. The disturbance has been so violent that the electron is likely to be removed entirely from the neighborhood of the atom. What is left is, of course, an ordinary atom with one electron missing from the K shell.

This absence of one electron gives the atom, considered as a whole, a positive charge of electricity. The atom can not remain long in this incomplete condition, any more than a good householder will allow a broken window to go unrepaired for a long time, so the atom proceeds to readjust its supply of electrons. Usually an electron from the L shell jumps into the K shell to plug the vacancy, and then, in turn, one from the M shell goes over to fill the space in the L shell.

When these electron jumps occur, the atom gives out X rays, which are really a kind of light, only with a very much shorter wavelength than ordinary light. Thus we see that the formation of that kind of light which we call X rays is not very much different from the production of visible light as we described it in the case of the neon sign. X rays occur when an electron makes a jump from one to another of the *inner* shells of electrons; visible light is given out when an electron makes a very small jump in the *outermost* shells.

AN INCOMPLETE ATOM IS ALWAYS ABLE TO PICK UP A FREE ELECTRON

But we have left the atom, after rearranging its electrons, in an incomplete state, with one electron missing from its outermost shell. How does it acquire an electron to complete its structure again? At all times there are always *free* electrons drifting around in a metal, and even a few in the air. The atom simply picks up one of these free electrons and thereafter continues a perfectly normal existence.

By THOMAS H. OSGOOD.

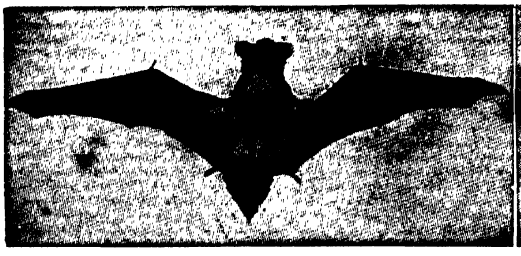
THE NEXT STORY OF SCIENCE IS ON PAGE 524.

TABLE I. THE ELEMENTS

Column 1. Name of element
Column 2. Chemical symbol or abbreviation
Column 3. Atomic number
Column 4. Approximate atomic weight
Column 5. Form when pure: G, gas; M, metal; L, liquid; N, non-metal; V, various.

Hydrogen	H	1	1	G	Indium	In	49	115	M
Helium	He	2	4	G	Tin	Sn	50	119	M
Lithium	Li	3	7	M	Antimony	Sb	51	122	V
Beryllium	Be	4	9	M	Tellurium	Te	52	128	V
Boron	B	5	11	N	Iodine	I	53	127	N
Carbon	C	6	12	V	Xenon	Xe	54	131	G
Nitrogen	N	7	14	G	Cesium	Cs	55	133	M
Oxygen	O	8	16	G	Barium	Ba	56	137	M
Fluorine	F	9	19	G	Lanthanum	La	57	139	M
Neon	Ne	10	20	G	Cerium	Ce	58	140	M
Sodium	Na	11	23	M	Praseodymium	Pr	59	141	M
Magnesium	Mg	12	24	M	Neodymium	Nd	60	144	M
Aluminum	Al	13	27	M	Promethium	Pm	61	147	M
Silicon	Si	14	28	V	Samarium	Sm	62	150	M
Phosphorus	P	15	31	N	Europium	Eu	63	152	M
Sulfur	S	16	32	N	Gadolinium	Gd	64	157	M
Chlorine	Cl	17	35	G	Terbium	Tb	65	159	M
Argon	A	18	40	G	Dysprosium	Dy	66	162	M
Potassium	K	19	39	M	Holmium	Ho	67	165	M
Calcium	Ca	20	40	M	Erbium	Er	68	167	M
Scandium	Sc	21	45	M	Thulium	Tm	69	169	M
Titanium	Ti	22	48	M	Ytterbium	Yb	70	173	M
Vanadium	V	23	51	M	Lutecium	Lu	71	175	M
Chromium	Cr	24	52	M	Hafnium	Hf	72	179	M
Manganese	Mn	25	55	M	Tantalum	Ta	73	181	M
Iron	Fe	26	56	M	Tungsten	W	74	184	M
Cobalt	Co	27	59	M	Rhenium	Re	75	186	M
Nickel	Ni	28	59	M	Osmium	Os	76	190	M
Copper	Cu	29	64	M	Iridium	Ir	77	193	M
Zinc	Zn	30	65	M	Platinum	Pt	78	195	M
Gallium	Ga	31	70	M	Gold	Au	79	197	M
Germanium	Ge	32	73	M	Mercury	Hg	80	201	ML
Arsenic	As	33	75	V	Thallium	Tl	81	204	M
Selenium	Se	34	79	V	Lead	Pb	82	207	M
Bromine	Br	35	80	NL	Bismuth	Bi	83	209	M
Krypton	Kr	36	84	G	Polonium	Po	84	210	M
Rubidium	Rb	37	85	M	Astatine	At	85	211	M
Strontium	Sr	38	88	M	Radon	Rn	86	222	G
Yttrium	Y	39	89	M	Francium	Fa	87	223	M
Zirconium	Zr	40	91	M	Radium	Ra	88	226	M
Columbium	Cb	41	93	M	Actinium	Ac	89	227	M
Molybdenum	Mo	42	96	M	Thorium	Th	90	232	M
Technetium	Tc	43	99	M	Protoactinium	Pa	91	231	M
Ruthenium	Ru	44	102	M	Uranium	U	92	238	M
Rhodium	Rh	45	103	M	Neptunium	Np	93	237	M
Palladium	Pd	46	107	M	Plutonium	Pu	94	239	M
Silver	Ag	47	108	M	Americium	Am	95	241	M
Cadmium	Cd	48	112	M	Curium	Cm	96	242	M

MEMBERS OF THE GREAT BAT FAMILY



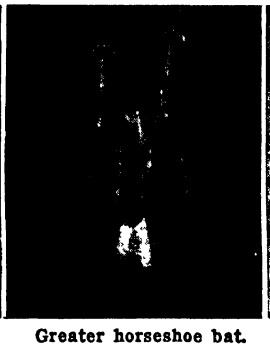
The great bat—or noctule bat.

The African false vampire.

Noctule bats as they sleep.

Long-eared bat.

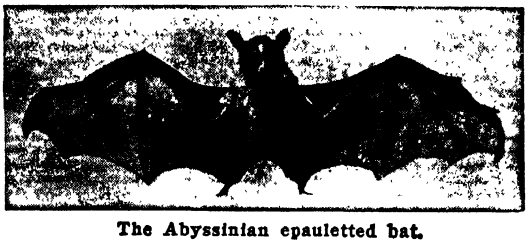
Natterer's bat.



Greater horseshoe bat.

Malay fox bat.

The hairy-armed bat.



The Abyssinian epauletted bat.

American Museum of Natural History

Philippine fruit bats swarming around the branch of a tree.

BATS, FURRY ANIMALS THAT FLY, AND THE INSECT-EATERS

ALTHOUGH bats have wings and fly, they are not birds, but mammals—furry animals. The wings are not like those of birds, but are covered with elastic skin that looks like crepe when it is not stretched out. No other mammal can really fly, although there are several, like the flying squirrel, that glide through the air by means of skin stretched between the front and hind limbs. Bats beat the air with their long pointed wings, which are usually large for the size of the body. The largest bat in the United States is only about six inches long, yet its wings when spread measure sixteen inches from tip to tip.

If the skin were stripped off, you would see a little animal with arms and hands, legs and feet. The hands have five fingers, like ours, but the thumb is short, ending in a hook-like claw, by which the bat can hang itself up to rest. The fingers are extraordinarily long, reminding us of the ribs of an umbrella. The arms are also long, especially the forearm, between the elbow and the wrist.

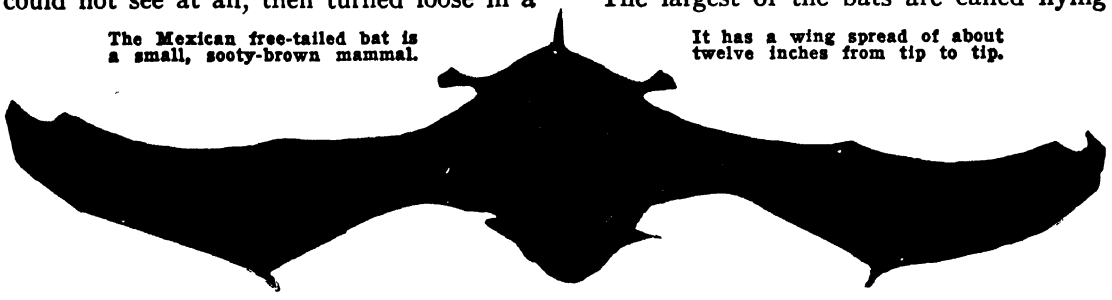
The skin of the wings extends between the fingers, between the wrist and the shoulder, from the hand to the ankle and between the legs and the tail. The thighs project at right angles to the body. The knees face outward and bend backward instead of forward as in most mammals. The foot has a short sole, and the five toes are all about the same length. This is exactly what a bat needs to hang onto rocks and trees, for bats hang upside down to sleep.

All bats sleep by day and come out to hunt for food at night. Some kinds are such sleepyheads that they stay out only a few hours, while others do not return home until nearly sun-up. One often hears the expression, "blind as a bat," but, in fact, bats have sharp, bright eyes and some other wonderfully keen senses.

It is interesting to sit outside a cave, in the dusk of early evening, and watch the bats come out, flying swiftly and silently, like moving shadows. They have a marvelous way of missing obstacles. They never collide with each other unless frightened badly. As they fly they make a series of sharp squeaks, so high-pitched that they can not be heard by the human ear. Delicate machines have recorded the squeaks for us, however. The high-pitched sounds are reflected back as echoes from anything solid

with which the bat might possibly collide.

Bats have been masked so that they could not see at all, then turned loose in a room where piano wires were strung a foot apart. They flew without any difficulty. But when their ears were plugged, or their mouths were gagged, they could be made to fly only if they were thrown into the air; and then they collided with the wires and even with the walls of the room. People thought for a long time that bats were guided by special senses in their wings, but when the wings were covered with nail polish the bats flew as well as usual. Thus their system for avoiding bumping into things is much like the supersonics devices developed in the past few years. Both use echoes, or sound reflections.



The Mexican free-tailed bat is a small, sooty-brown mammal. It has a wing spread of about twelve inches from tip to tip.

U. S. Department of the Interior

Bats are hot-blooded, like birds and like other mammals. In northern climates, however, many bats go to sleep in the winter, and then they become quite cold and motionless. Such bats go deep in caves, where the temperature never gets below freezing. In this way they are like the woodchuck and ground squirrels and very different from any bird.

Bat babies are usually born in the late spring. The mother bat carries her young, usually one or two, with her. The little ones hang on, clinging by their claws and teeth, until they are almost as big as the mother. Then they are left in the nest while the mother hunts food. How the babies hang on while the mother zigzags through the trees is a marvel. One large bat found in the East Indies is almost naked; but, as if to make up for the lack of fur to hang to, there is a pocket under each wing in which the young are thought to be carried.

The largest of the bats are called flying foxes, their sharp foxy faces giving them this name. They, with many smaller kinds, live on fruit. Fruit bats of the Old World tropics have a claw on the index finger, as a rule, and the tail is short or can not be found. Some of the strange members of the fruit-bat family are the African hammerhead bats, the males of which have a huge muzzle, flattened at the end. The tube-nosed bats have the nostrils drawn out into two tubes which stick out oddly from their rounded heads. The long-tongued bats of this family feed on the nectar and pollen of flowers, and have long, narrow tongues that push deep into the flower cup. In the islands of the South Pacific, one of these flower bats has a long tail and its wings are attached down the middle of the back.

N. Y. Zoological Society

Flying foxes are really bats.

The bats that eat insects are smaller, as a rule; their teeth are sharp, able to crush the hard bodies of insects, and their ears do not form a ring at the base. There is generally a spear-shaped growth inside the ear, known as the tragus, suggesting the Jack-in-the-pulpit flower.

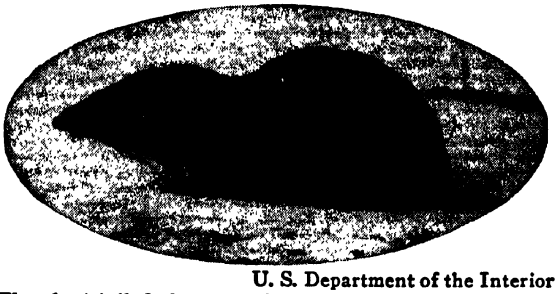
Mouse-tailed bats, found from Egypt to Burma and Sumatra, have long, slender tails, but the tail-membrane is short. The broad muzzle has a short nose-leaf at its end.

The sheath-tailed bats get their name from the way the tail is contained in a sheath, or covering, of skin. When the tail-membrane is spread, only the tip of the tail shows, but it may be rolled up to show most of the tail. These bats have

sharp, pointed noses that project in front of the mouth. The ears and wings are sharp-pointed, too.

In tropical America are found the hare-lipped bats, a family marked by a cleft upper lip. The head is somewhat like that of a mastiff dog. The feet and claws are large. These bats live on fish for the most part.

The false vampires have huge ears, each with a large divided tragus. On the muzzle is a tall leaf-like growth. These bats feed on other bats, mice, frogs, small birds and insects. Some species are pale greenish gray, others, almost white.



U. S. Department of the Interior
The short-tailed shrew repels foes by an unpleasant odor.

In the warmer parts of the Old World are found the horseshoe bats and their relatives, the leaf-nosed bats. The nose-leaf of the horseshoe bats is broad and rounded at the base and tapers up to a point. The ears are large, but have no tragus. The leaf-nosed bats have squarish or rounded growths on the muzzle. Several varieties are bright rust-color.

Most of the bats of tropical America have spear-shaped nose-leaves. Some of the larger species feed on small mammals, birds and insects, but others live on fruit and have simple teeth like those of the flying foxes suitable for crushing fruit.

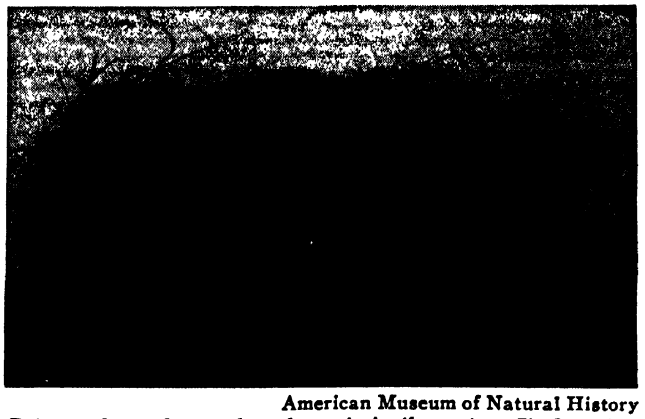
The true vampires are relatives of these American fruit bats, but their teeth are sharp and razor-like. So sharp are they that when a vampire bat alights on a sleeping animal it can cut through the skin without awaking the victim. As the blood flows from the bite the vampire laps it up, as a cat laps milk. Small animals and poultry are often killed by these bats. The danger is not in the amount of blood the vampire laps up, but its cut is so sharp that blood flows for a long time. Tropical diseases are often carried by the vampire, and domestic animals are often infected. In tropical parts of America swarms of these bats live in caves and large hollow trees.

The long-legged bats of the American tropics are delicately built, like large moths. Their ears are funnel-shaped, while their long, broad faces lack any ornaments.

Typical bats are found over most of the world. Most common bats of Europe and North America belong to this family. They live on insects, destroying many moths and beetles, most of which injure our crops. American bats are brown, reddish or grayish in color. Most of them are small; some have great ears, in others the ears are not large.

The tails of the typical bats extend to the end of the wide tail-membrane, and a gap separates the front teeth of the upper jaw. They have no nose-leaves, as a rule. The best known are the mouse-eared bats and the little pipistrelles, found in almost every country. The children of African natives hunt under the thatch of their huts for these little fellows, which they roast and eat as tidbits.

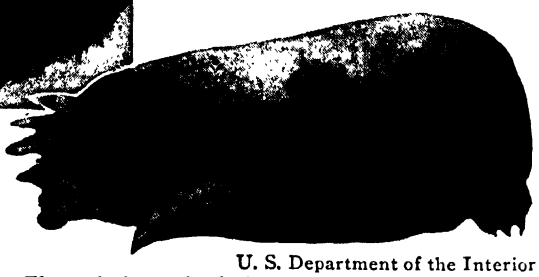
Many hundred different kinds of these bats are known. Some typical bats have funnel-shaped ears, shaped like calla lilies. Other rare kinds found in the Malay region have tube-like nostrils, like the tube-nosed fruit bats; while in Europe, Asia and Africa, bats are found which have high, dome-like heads and oddly proportioned fingers.



American Museum of Natural History
Potamogale, a shrew whose home is in the water. Its long tail serves as a rudder in swimming.

In New Zealand the only native furry animals are two bats, one of a type not known elsewhere. This New Zealand bat's tail projects through the top of the tail-membrane. It has short, heavy legs and the claws of

A mole's nest with three babies.



U. S. Department of the Interior
The mole has a fat body, with thick, velvety hair.

the toes each have a little claw at the base.

Free-tail or mastiff bats (named because their wrinkled face looks like that of a mastiff) have long pointed wings to give them great speed in flying. They fly like swallows. Their fur is very fine and oily. Free-tail bats often live in great numbers in caves, coming out at dusk in such thick crowds that they look from a distance like smoke from a chimney.

Many animals eat insects, but the members of one order of mammals so generally feed on them that they are called Insectivora or insect-eaters. The best-known and most widely distributed of these are the moles and shrews.

THE FIERCE LITTLE SHREWS OR SHREW MICE

Shrews, or shrew mice, are small mammals, often as small as mice or smaller, while the largest members of this family are the size of small rats. Many different kinds are known, but all have long, pointed snouts, small eyes, long whiskers and short legs. Their teeth are sharp and suited to chopping up insects. For all its small size, a shrew has an enormous appetite and it must eat as much as, or more than, it weighs every day to keep up its supply of energy.

Shrews are among the most active of all the mammals, and they are constantly scampering about through the leaves and undergrowth searching for food both by day and by night. They burrow in moss or leaf-mold and through grass roots, although they frequently run about above ground, too. A shrew's eyesight is very poor, and it depends more on its senses of smell and touch. Shrews usually make an underground nest where the young are kept.

Common shrews with long tails are found all over the Northern Hemisphere, from the Arctic to Florida and the Himalayas. Their teeth are tipped with brownish red. The North American water shrew is closely related, but larger, with white fur on the underside of its body. Its feet are fringed with long hairs which help it to swim, for it lives in or near streams and marshes. The European water shrew has fewer teeth than the American one has, but its habits

U. S. Department of the Interior
The "trade-mark" of a mole—the surface ridge pushed up by his underground burrowing, a torment to gardeners.

are similar, and it, too, has fringed toes and tail.

The short-tailed blarina looks like a mole with its gray fur and stout body, and it burrows underground more than most shrews. It is a ferocious little animal and does not hesitate to attack and kill mice much larger than itself. In fact, although it eats insects, snails and even some plant food, its favorite meal is a fat mouse. Other shrews much like the blarina are found from Connecticut to South America.

Although most shrews live in moist woods or swamps, the gray shrew of the southwestern United States and Mexico is often found in desert places.

Many shrews found in the Old World, especially those of the tropics and warm lands, have pure white teeth. All shrews have an unpleasant odor, but these musk shrews are particularly bad-smelling. The largest of these, about ten inches long and dirty gray-brown in color, lives in houses, where it feeds on cockroaches and also gets into flour and other foods intended for people. It chatters and squeaks as it runs along the walls, making a noise like the jingle of coins. From this it is sometimes called the money-mouse. Few animals will eat musk shrews.

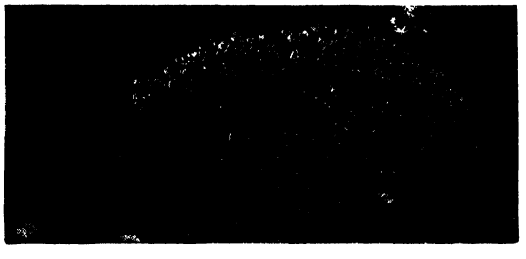
The Asiatic water shrews are related to these, but are handsome—black above and white below, with otter-like fur. Their feet are large, with fringed toes. They live in swift-flowing streams, feeding on water insects and small fishes.

Another white-toothed shrew is the large hero shrew, found in the Congo, Africa. It has an extraordinary backbone, so braced and strong that a man can stand on the shrew without crushing it.

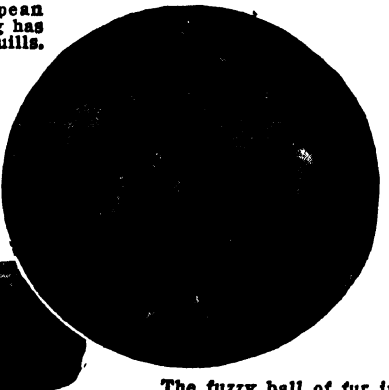
THE UNDERGROUND LIFE OF THE MOLES

The mole family is almost as widespread as the shrews, but no true moles are found in Africa or South America. Moles live their lives underground, forever digging tunnels or pushing their way through the earth in their search for worms and grubs. These "runs," or underground galleries which make ridges on the surface of the ground, and the rounded mole hills of earth they push up cause gardeners to detest them. Moles sometimes eat bulbs, and mice, which make use of their tunnels, do still more damage; so the mole is certainly not a welcome guest in the garden. Away from gardens and lawns, however, moles do much good by eating insects.

The fur of a mole is short and velvety. The body is muscular and streamlined. The snout is wedge-like and covered with a tough skin. The front feet are broad, rounded and shovel-like. Moles vary from about five to ten inches long, measuring from snout to the end of the short tail. They are very active mammals and, like the shrews, need to eat quantities of food. After



A European hedgehog has spiny quills.



All pictures New York Zoological Society

The fuzzy ball of fur in the man's hand is a hedgehog.

The solenodon lives in Cuba; it looks much like a rat.

a rain, when the earth is soft, they make long runs, sometimes as much as a hundred yards in a single night.

One of our strangest animals is the star-nosed mole. It gets its name from a curious rosette on the end of its nose which may be an especially sensitive organ of touch, to help guide the mole in the darkness of its underground life. The star-nosed mole comes up to the surface of the ground more often than most moles.

Another strange mole is the desman of southeastern Russia which lives in streams and lakes, swimming like a muskrat. Another water mole lives in the Alps and the Pyrenees. A number of small shrew moles are found in Asia. One is at home on the west coast of North America. The shrew moles have the habits and looks of shrews; but they are really moles.

American Museum of Natural History

The African jumping shrew is often called the elephant shrew because of its extremely long snout. It jumps like a miniature kangaroo.

THE SPINY HEDGEHOGS AND THEIR COUSINS

The hedgehog family is not found in the New World, but it is widespread in Europe, Asia and Africa. The common hedgehog is a stout-bodied creature about nine inches long, with a short tail and long, pointed snout. Its back and sides are covered with sharp quills. When an enemy frightens it the hedgehog rolls up into a tight ball, all of its quills erected in defense. Hedgehogs feed on insects, lizards, snakes and mice. The name hedgehog is sometimes given to our North American porcupine; but this is a very different animal.

In the Malay region the moon-rats, or gymnures, are found. They are rat-like relatives of the hedgehog, with long, coarse hair instead of spines.

We come now to a number of strange insectivores, not all of whom are insect-eaters today. The otter shrew, found in the rivers of western Africa, belongs to a very different family from those we have read of thus far. It is distinguished by an ancient tooth-pattern. It is about a foot long; the tail, flattened from side to side, is about another foot. The otter shrew feeds on fish.

In Madagascar a number of old-fashioned insectivores live. Some, like the tenrec, are like hedgehogs. Others burrow in the soil like moles, or look like shrews; while two kinds live in the water.

The golden moles, found in South and Central Africa, belong in this group. They have greenish or bronze reflections in the hair and resemble true moles in habits.

The solenodons that live in Cuba and Haiti are large, rat-like insectivores, with long naked tails and long snouts.

The African jumping shrews, or elephant shrews, belong to a very different family. They jump like small kangaroos and have large feet and muscular legs. Their eyes are better developed than those of most other insectivores.

THE ORIENTAL TREE SHREWS

The tree shrews are mostly confined to India, South China and the Malay region, though there is one species on Mindanao, in the Philippines. They are very much like squirrels in size, habits and appearance, except for their long, pointed snouts.

The pen-tailed tree shrew is named for its long tail, the tip of which has a feather-like fringe on top and bottom. It is a handsome animal, brownish in color with white underside and a black mask. Other tree shrews are olive or chestnut, while some have a black stripe down the back.

Tree shrews are active during the day. Their eyes are large and bright and their brains are highly developed. In many ways they connect the lower primates, like lemurs, with the insectivores.

By JOHN ERIC HILL and HILDRED HILL.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 352.

THE THREE LITTLE PIGS

ONCE upon a time there were three little pigs. Each one decided to build himself a house. The first little pig met a man who was carrying a bundle of straw.

"If you please," said the little pig, "will you give me some of that straw to make me a house?"

"With pleasure," replied the man, and away went the little pig with the straw and built his house.

Now, an artful old wolf who lived near by determined to have the little pig for supper. So when it grew dark he went up to the little straw house and called out: "Little pig, little pig, may I come in?"

But the little pig knew his voice and said: "No, no; by the hair on my chinny, chin, chin!"

"Ho, ho!" cried the wolf. "Then I'll huff and I'll puff till I blow your house in."

So he huffed and he puffed, and he huffed and he puffed till the house fell down. Then he sprang inside, pounced on the little pig and gobbled him up.

The second little pig met a man carrying some sticks.

"If you please," said the little pig, "will you give me some of those sticks to make me a house?"

"With pleasure," replied the man.

Away went the little pig with the sticks and built himself a cozy house. That night the wolf came to the door.

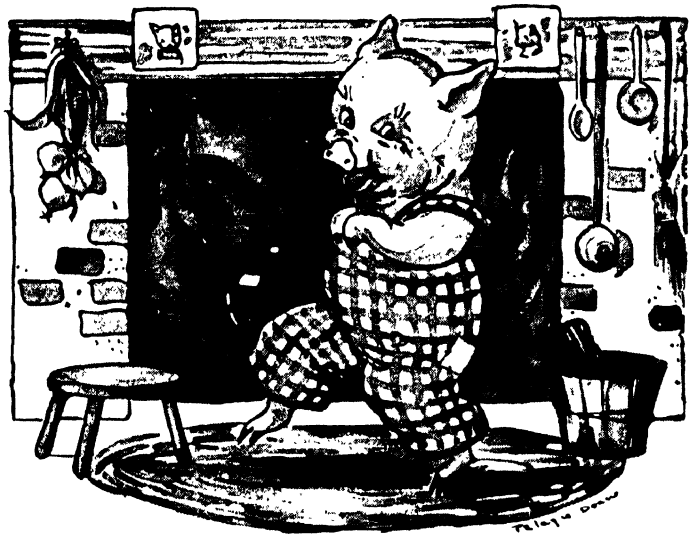
"Little pig, little pig," cried the wolf, "may I come in?"

"No, no," replied this little pig, as the other one had done; "no, no; by the hair on my chinny, chin, chin!"

"Ho, ho!" cried the wolf in a rage. "Then I'll huff and I'll

puff till I blow your house in."

So he huffed and he puffed, and he huffed and he puffed till the house fell down. Then he sprang inside, pounced on the poor little pig and gobbled him up.



But the third little pig was exceedingly wide awake. This little pig went along the road till he saw a man carrying a hod of bricks on his shoulder.

"If you please," said the little pig, "will you give me some of those bricks to make me a house?"

"With pleasure," replied the man, and away went the little pig with the bricks and built his house.

Soon the old wolf came along, and knocked at the door.

"Little pig, little pig, may I come in?" he cried.

"No, no," cried the little pig; "no, no; by the hair on my chinny, chin, chin!"

"Then I'll huff and I'll puff till I blow your house in!"

But the house was made of bricks, and the old wolf huffed and he puffed, and he huffed and he puffed, and still the house stood firm. At last he went away in a rage; but presently he came back again.

"Little pig, little pig, I know a field just down the lane where there are such fine turnips. I'll call for you in the morning and show you the way."

The next morning when the wolf called out: "Are you ready, little pig?" the little pig replied: "Dear me, how late you are! I've been back an hour or more. I'm sure I'm much obliged to you; they are fine turnips!"

The wolf was furious; but, pretending he did not mind, he said, quite pleasantly: "Do you like apples? I know an orchard down the lane where the trees are covered with fruit. I'll call for you in the morning and show you the way."

The next morning the wolf got up very early and walked round to the little pig's house. But the little pig must have got up earlier still, for he was not at home.

The wolf hurried off to the orchard; but the little pig saw him coming and climbed up into a tree.

"These are indeed fine apples," he called out, as the wolf came up to it. "Just try this one." And he threw the apple as far away as he could into some long grass. Then, while the wolf was hunting for it, the little pig scrambled down the tree and ran home.

The wolf did not like being beaten, so the next morning he went again to the little pig's house and said: "Little pig, little pig, there's going to be a fair in the village this afternoon. You come along with me, and we'll both have a fine time. I'll call for you at exactly three o'clock."

The little pig said nothing, but at half-past two he started off for the fair. He bought a churn, and was rolling it home when he saw the wolf in the distance. Quick as lightning the little pig jumped into the churn to hide, and set it rolling down the hill. The hill was steep, and the churn came flying along at such a speed that the wolf became frightened, so he turned back and ran home as fast as he could.

Some hours later, when he felt braver, he went to the little pig's house.

"I was just on my way to call for you this afternoon," he shouted out, "when I met the most awful thing rolling down the hill all by itself. It gave me a horrible fright, I assure you. There must have been a witch inside."

The little pig burst out laughing, and he laughed so loud and he laughed so long that the old wolf was annoyed.

"I was the old witch," said the little pig, as soon as he could speak. "I spied you a long way off, and I jumped inside to save my skin."

This so enraged the wolf that he jumped up

onto the roof and began sliding down the chimney. But it was baking day, and the little pig had made a huge fire. Down, down, down slid the wolf; there was nothing to save him. He fell right down into the fire and was burned to cinders. And that was the end of the wolf.

THE LAMBIKIN

This popular and merry little folk tale had its source in India. The version we give you is from Flora Annie Steel's collection, TALES FROM THE PUNJAB.

ONCE upon a time there was a wee wee Lambikin, who frolicked about on his little tottery legs, and enjoyed himself amazingly. Now one day he set off to visit his Granny, and was jumping with joy to think of all the good things he should get from her, when whom should he meet but a Jackal, who looked at the tender morsel and said: "Lambikin! Lambikin! I'll EAT YOU!"

But Lambikin only gave a little frisk and said:

"To Granny's house I go,
Where I shall fatter grow,
Then you can eat me so."

The Jackal thought this reasonable, and let Lambikin pass.

By and by he met a Vulture, and the Vulture, looking hungrily at the tender morsel before him said: "Lambikin! Lambikin! I'll EAT YOU!"

But Lambikin only gave a little frisk:

"To Granny's house I go,
Where I shall fatter grow,
Then you can eat me so."

The Vulture thought this reasonable, and let Lambikin pass.

And by and by he met a Tiger, and then a Wolf, and a Dog, and an Eagle, and all these, when they saw the tender little morsel, said: "Lambikin! Lambikin! I'll EAT YOU!"

But to all of them Lambikin replied:

"To Granny's house I go,
Where I shall fatter grow,
Then you can eat me so."

At last he reached his Granny's house, and said, all in a great hurry, "Granny, dear, I've promised to get very fat; so, as people ought to keep their promises, please put me into the corn-bin *at once*."

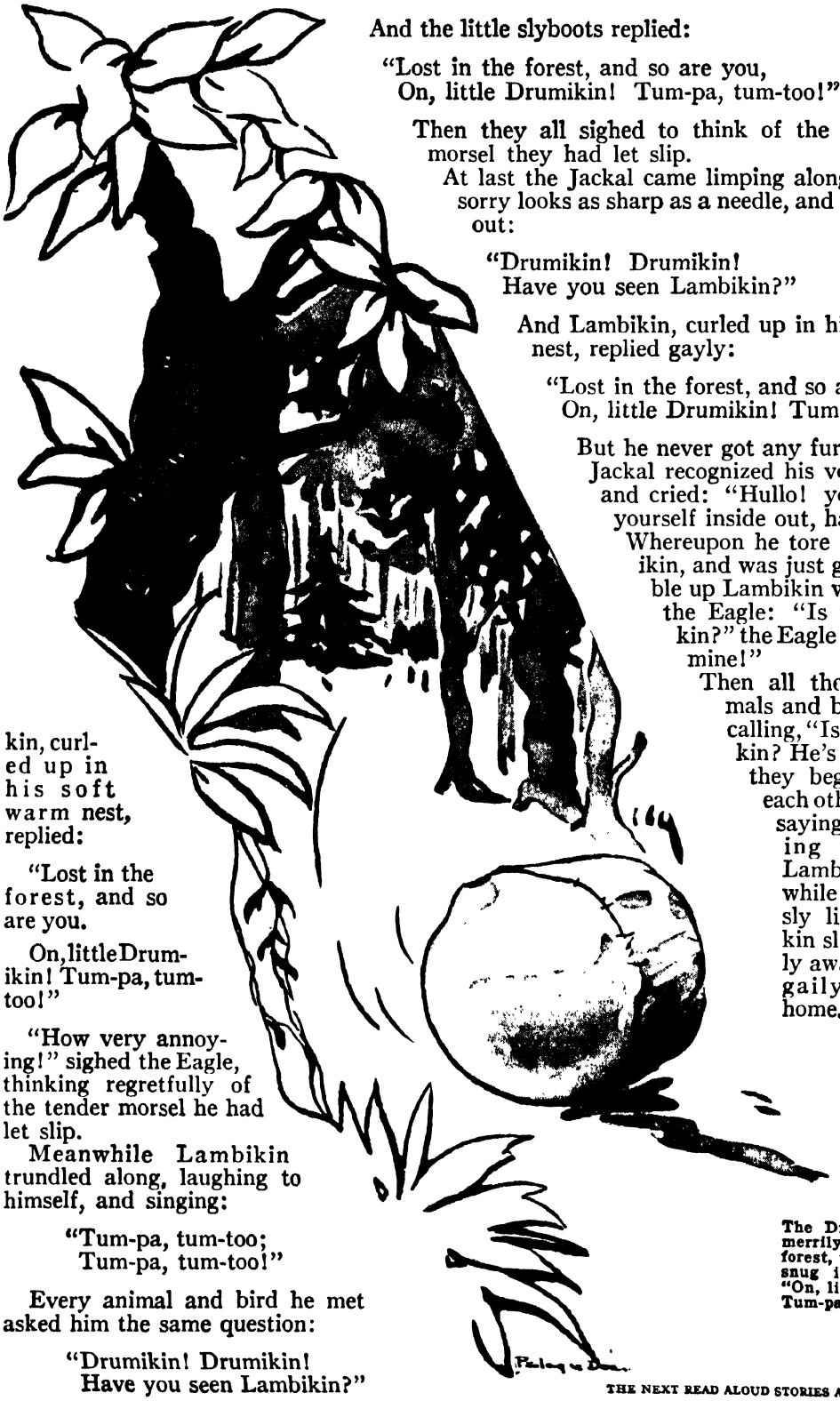
So his Granny said he was a good boy, and put him into the corn-bin, and there the greedy little Lambikin stayed for seven days, and ate and ate and ate, until he could scarcely waddle, and his Granny said he was fat enough for anything, and must go home. But cunning Lambikin said that would never do, for some animal would be sure to eat him on the way back, he was so plump and tender.

"I'll tell you what you must do," said Master Lambikin, "you must make a little drumikin out of a skin and then I can sit inside and trundle along nicely, for I'm as tight as a drum myself."

So his Granny made a nice little drumikin out of a skin, with the wool inside, and Lambikin curled himself up snug and warm in the middle, and trundled away gayly. Soon he met with the Eagle, who called out:

"Drumikin! Drumikin!
Have you seen Lambikin?"

And Master Lambi-



kin, curled up in his soft warm nest, replied:

"Lost in the forest, and so are you.
On, little Drumikin! Tum-pa, tum-too!"

"How very annoying!" sighed the Eagle, thinking regretfully of the tender morsel he had let slip.

Meanwhile Lambikin trundled along, laughing to himself, and singing:

"Tum-pa, tum-too;
Tum-pa, tum-too!"

Every animal and bird he met asked him the same question:

"Drumikin! Drumikin!
Have you seen Lambikin?"

And the little slyboots replied:

"Lost in the forest, and so are you,
On, little Drumikin! Tum-pa, tum-too!"

Then they all sighed to think of the tender little morsel they had let slip.

At last the Jackal came limping along, for all his sorry looks as sharp as a needle, and he too called out:

"Drumikin! Drumikin!
Have you seen Lambikin?"

And Lambikin, curled up in his snug little nest, replied gayly:

"Lost in the forest, and so are you,
On, little Drumikin! Tum-pa——"

But he never got any further, for the Jackal recognized his voice at once, and cried: "Hullo! you've turned yourself inside out, have you?"

Whereupon he tore open Drumikin, and was just going to gobble up Lambikin when up flew the Eagle: "Is that Lambikin?" the Eagle called: "he's mine!"

Then all the other animals and birds ran up, calling, "Is that Lambikin? He's mine!" And they began to fight each other, each one saying HE was going to eat up Lambikin. But while they fought, sly little Lambikin slipped quietly away. Then he gaily skipped home.

The Drumikin rolled merrily through the forest, with Lambikin snug inside, singing "On, little Drumikin! Tum-pa, tum-too."

THE NEXT READ ALOUD STORIES ARE ON PAGE 755.

The Old Woman and Her Pig

An old woman was sweeping her house, and she found a little crooked sixpence. "What," she said, "shall I do with this little sixpence? I shall go to market and buy a little pig." As she was coming home she came to a stile. The piggy would not go over the stile. She went a little farther, and she met a dog, so she said to the dog:

"Dog, dog, bite pig,
Piggy won't get over the stile,
And I sha'n't get home to-night!"

But the dog would not.

She went a little farther, and she met a stick. So she said:

"Stick, stick, beat dog;
Dog won't bite pig,
Piggy won't get over the stile,
And I sha'n't get home to-night!"

But the stick would not.

She went a little farther, and she met a fire. So she said:

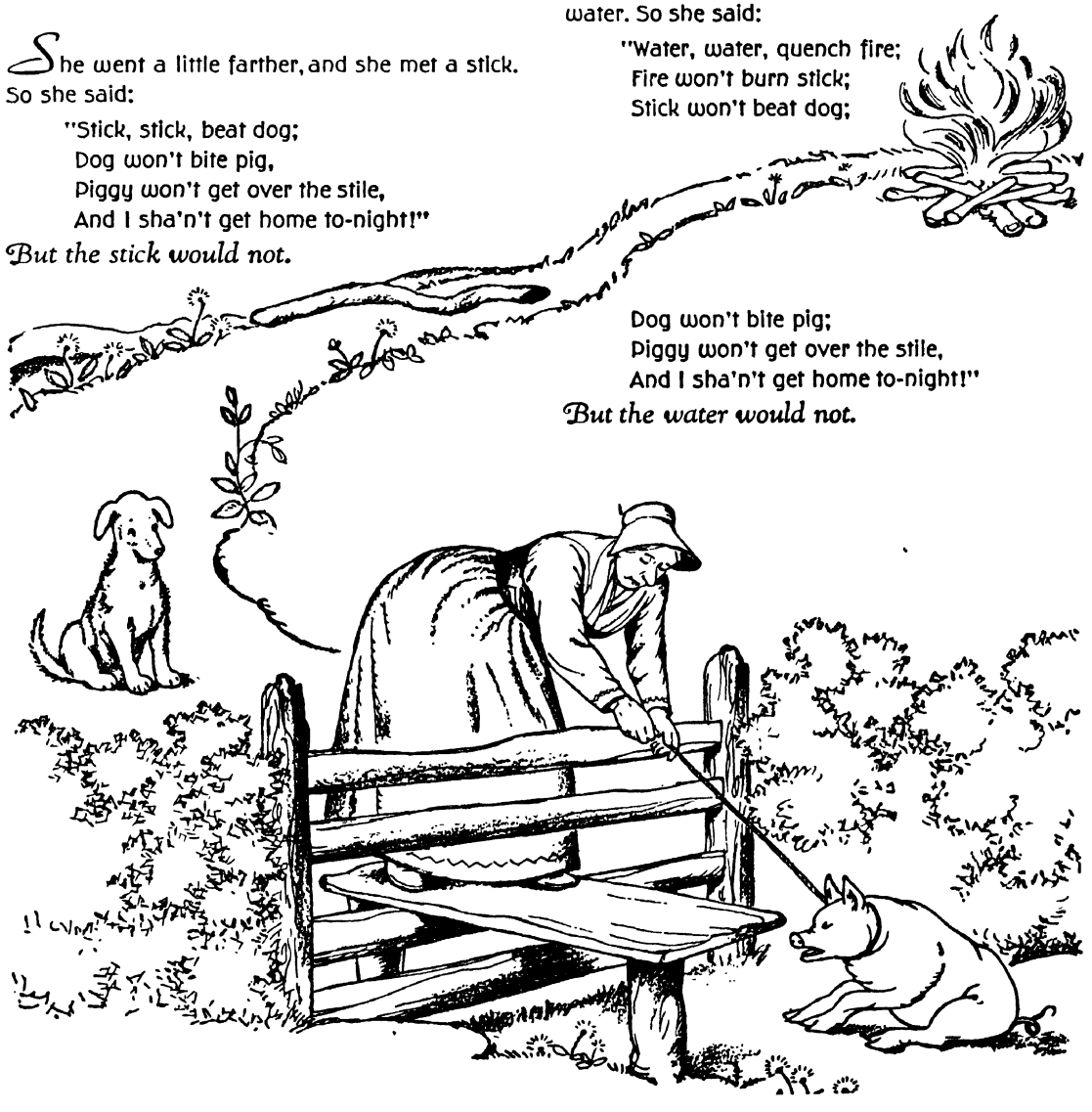
"Fire, fire, burn stick;
Stick won't beat dog;
Dog won't bite pig;
Piggy won't get over the stile,
And I sha'n't get home to-night!"

But the fire would not.

She went a little farther, and she met some water. So she said:

"Water, water, quench fire;
Fire won't burn stick;
Stick won't beat dog;
Dog won't bite pig;
Piggy won't get over the stile,
And I sha'n't get home to-night!"

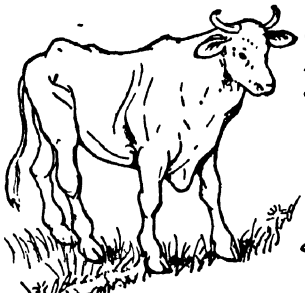
But the water would not.

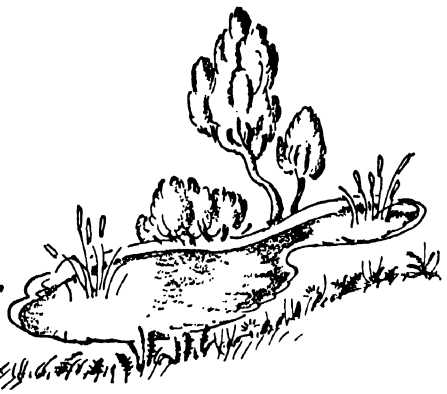


She went a little farther, and she met an ox.
So she said:

"Ox, ox, drink water;
Water won't quench fire;
Fire won't burn stick;
Stick won't beat dog;
Dog won't bite pig;
Piggy won't get over the stile,
And I sha'n't get home to-night!"

But the ox would not.





She went a little farther, and she met a butcher. So she said:

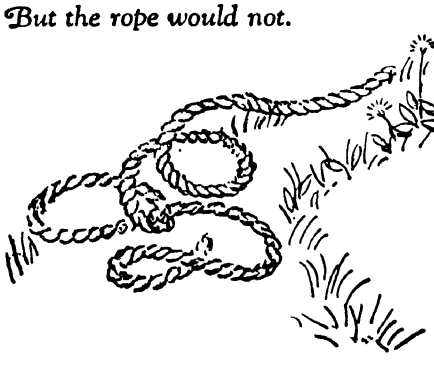
"Butcher, butcher, kill ox;
Ox won't drink water;
Water won't quench fire;
Fire won't burn stick;
Stick won't beat dog;
Dog won't bite pig;
Piggy won't get over the stile,
And I sha'n't get home to-night!"

But the butcher would not.

She went a little farther, and she met a rope. So she said:

"Rope, rope, hang butcher;
Butcher won't kill ox;
Ox won't drink water;
Water won't quench fire;
Fire won't burn stick;
Stick won't beat dog;
Dog won't bite pig;
Piggy won't get over the stile,
And I sha'n't get home to-night!"

But the rope would not.



She went a little farther, and she met a rat.
So she said:

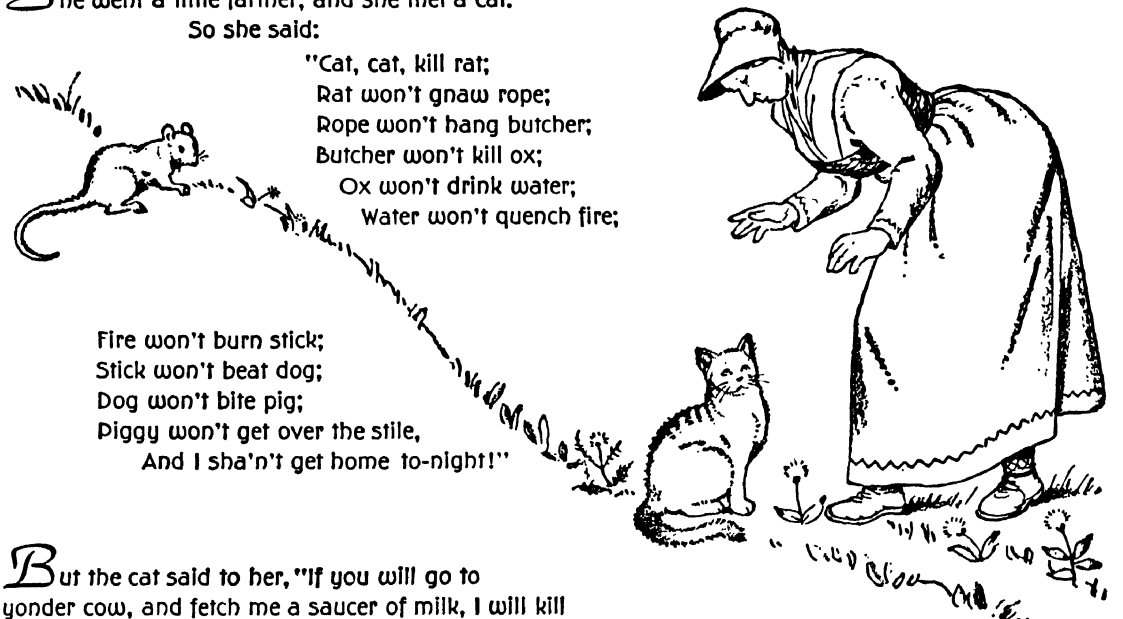
"Rat, rat, gnaw rope;
Rope won't hang butcher;
Butcher won't kill ox;
Ox won't drink water;
Water won't quench fire;
Fire won't burn stick;
Stick won't beat dog;

Dog won't bite pig;
Piggy won't get over the stile,
And I sha'n't get home to-night!"

But the rat would not.

She went a little farther, and she met a cat.
So she said:

"Cat, cat, kill rat;
Rat won't gnaw rope;
Rope won't hang butcher;
Butcher won't kill ox;
Ox won't drink water;
Water won't quench fire;



Fire won't burn stick;
Stick won't beat dog;
Dog won't bite pig;
Piggy won't get over the stile,
And I sha'n't get home to-night!"

But the cat said to her, "If you will go to yonder cow, and fetch me a saucer of milk, I will kill the rat." So away went the old woman to the cow, and said:

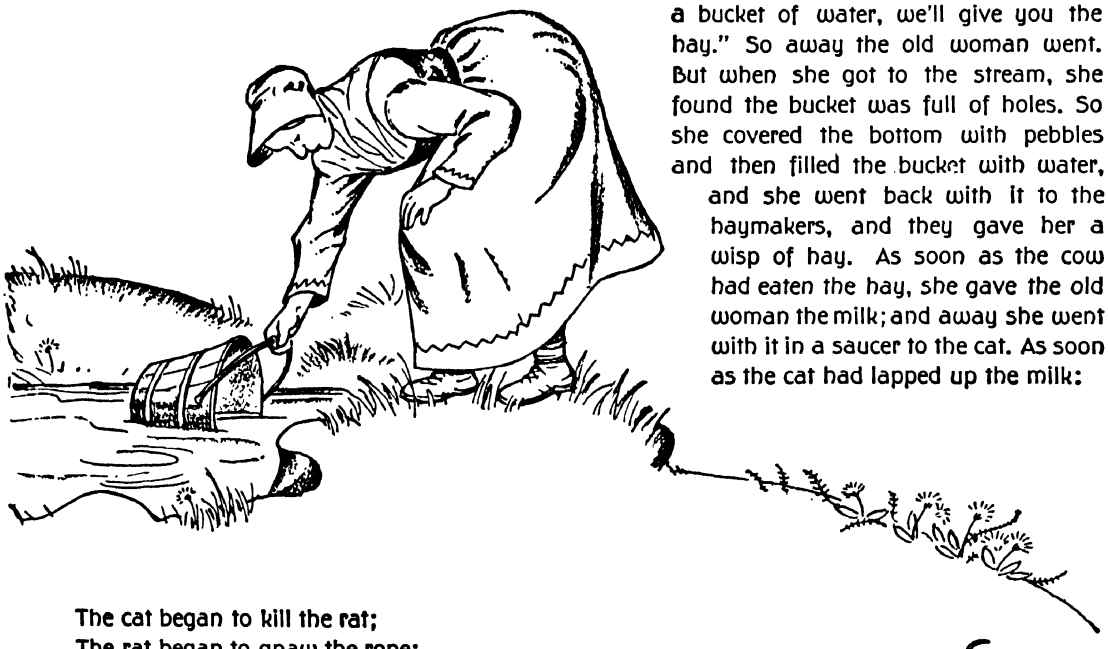
"Cow, cow, give me a saucer of milk;
Cat won't kill rat;
Rat won't gnaw rope;
Rope won't hang butcher;
Butcher won't kill ox;
Ox won't drink water;
Water won't quench fire;
Fire won't burn stick;
Stick won't beat dog;
Dog won't bite pig;

Piggy won't get over the stile,
And I sha'n't get home to-night!"

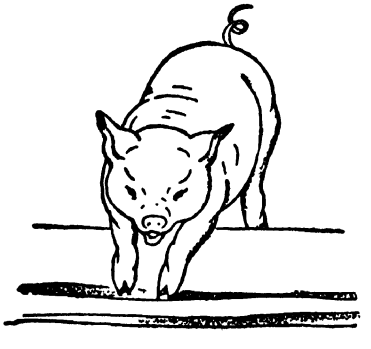
But the cow said to her, "If you will go to yonder haymakers, and fetch me a wisp of hay, I'll give you the milk." So away went the old woman to the haymakers, and said:

"Haymakers, give me a wisp of hay;
Cow won't give milk;
Cat won't kill rat;
Rat won't gnaw rope;
Rope won't hang butcher;
Butcher won't kill ox;
Ox won't drink water;
Water won't quench fire;
Fire won't burn stick;
Stick won't beat dog;
Dog won't bite pig;
Piggy won't get over the stile,
And I sha'n't get home to-night!"

But the haymakers said to her, "If you will go to yonder stream, and fetch us a bucket of water, we'll give you the hay." So away the old woman went. But when she got to the stream, she found the bucket was full of holes. So she covered the bottom with pebbles and then filled the bucket with water, and she went back with it to the haymakers, and they gave her a wisp of hay. As soon as the cow had eaten the hay, she gave the old woman the milk; and away she went with it in a saucer to the cat. As soon as the cat had lapped up the milk:



The cat began to kill the rat;
The rat began to gnaw the rope;
The rope began to hang the butcher;
The butcher began to kill the ox;
The ox began to drink the water;
The water began to quench the fire;
The fire began to burn the stick;
The stick began to beat the dog;
The dog began to bite the pig;
The little pig in a fright jumped over the stile;
SO THE OLD WOMAN GOT HOME THAT NIGHT!



A PLANT'S STRUGGLE FOR LIFE

UP to a certain point the outer world is what we may call a friendly home for living creatures. They are not strangers in a strange land.

Thus the circulation of water by mist and cloud, wind and rain, helps them greatly. The atmosphere is a useful curtain, and it contains the Big Four elements—carbon in the form of carbon dioxid, hydrogen in the form of water-vapor, free oxygen which has been formed for the most part by green leaves, and abundance of free nitrogen which a few plants are able to capture. There are many other ways in which the earth is hospitable to living creatures, and the question rises, Why must plants and animals struggle as they do?

The outer world is, in a measure, friendly to plants, but it is very changeful. Not only are there regular changes to be faced—night after day, winter after summer—but there are irregular happenings, such as tempests, floods, hailstorms, drought and severe frost.

Just as we, in a small way, must change our clothing according to the season and weather, so in a deeper and subtler way the plant must. This is the *struggle with fate;* and a great student of plants pointed out that the plant's struggle with drought at the edge of the desert was as real as the plant's struggle for room and light in the crowded jungle. Where water is abundant at a rainy season, but scarce for a long time, we find water-storing tissue, as in cactuses. There is a thickening of the plant's skin, a reduction of foliage, and the stem becomes green. When the cold is apt to be excessive, we find many precautions, which have become in the course of time established, all without taking thought for the morrow.

The second reason for struggle is to be found in the rate at which many plants multiply. The river of life is always overflowing its banks. A single plant of hedge-mustard may produce 730,000 seeds, and it has been calculated that if each seed germinated and developed into a plant which seeded, the members of the next generation would be touching one another all over the earth. Of course, this does not happen —*because of the struggle for life.* The director of Brooklyn Botanic Garden tells us that a fern of moderate size produces every year about fifty million spores. If each of these spores, he says, ultimately produced a mature fern plant, and if we allowed only one square foot of elbow-room for each plant, the progeny of one parent only, in one season, would require at least fifty million square feet, or nearly two square miles. If each of these plants in turn produced fifty million offspring the next

season, the descendants of only one fern plant would, in only two years, cover the stupendous area of nearly ninety million square miles, or an area greater than the land surface of the globe.

We see, then, that plants have to struggle not only because the outside conditions are very changeful, but also because of the rate at which plants tend to multiply.

THE LIVING CREATURE ROLLS UPHILL AS WELL AS DOWN

But is there not a third reason for the struggle—a reason wrapped up with the central secret of life? Every vigorous living creature is *always asking for more.* It is of the nature of the living creature to assert itself, and to answer-back to difficulties and limitations.

Just as the loosened stone rolls down the hillside, crashing through obstacles until it reaches the level ground or is jammed, so the living creature soon gets some way on and will not be hindered. But the living creature rolls uphill as well as downhill—that is its secret. Plants and animals alike may be compared to clocks that can wind themselves up. We must not dwell on this reason for struggle, for it is very difficult; but the fact is that the more a plant succeeds, the more it asks for. It is a hustler and a jostler, though it looks so quiet. To put it in another way, the plant does not readily submit to being hindered by difficulties and limitations.

John Burroughs tells of a young plant which burst its way through the asphalted hard surface of the pathway on the side of a street. It had been buried alive, but it would not submit. Without any tools or explosives it broke its way out—by the gentle force of growing. So we see that plants must struggle—because the outer world is changeful, because they tend to have such big families, and because it is their very nature to assert themselves against difficulties.

CARING FOR SELF AND FOR OTHERS IS THE BUSINESS OF LIFE

For plants, as for animals, the business of life is twofold—caring for self and caring for others; and the most important part of caring for self is the quest for food.

We have already seen that ordinary green plants feed on carbon dioxid which is part of the atmosphere, and absorbed by the leaves, on water, usually from soil, and on salts like saltpetre, which are taken in by the rootlets along with the soil-water. As there is in all ordinary cases an abundance of this simple kind of food, the struggle must be *in tapping the supply and competing with other plants* which are doing the same. We shall come to this competition later; it is useful, first of all, to notice some of the more or less unusual ways in which plants feed.

In boggy and marshy places the soil is poor in nitrogenous salts like saltpetre, and this makes plant life difficult. For living matter is in part a complicated mixture of nitrogenous carbon compounds called proteins—like the gluten which is a valuable part of bread—and if the living matter is to be kept going and growing, there must obviously be *nitrogenous* food. Therefore, boggy and marshy places cannot be peopled except by plants which have some special fitness for thriving in the poor and peculiar soil. Immediately we see why bogs and marshy places should show so many insect-eating plants, like sundew, butterwort, Venus's fly-trap, bladderwort and some pitcher plants, which are able to eke out the scanty nitrogenous food supplies by capturing insects and other small animals.

THE PLANT WITH HUNDREDS OF LITTLE TRAPS THAT FLOATS IN THE POOL

The bladderwort floats in the pool in the marsh; it has not even roots; it absorbs everything through its green leaves and shoots. But it has hundreds of little traps, each about the size of the head of a blanket-pin, and these serve to capture water-fleas and other small fry. The small animal pushes its head against a swinging door and enters the trap. The door closes automatically behind it, and the prisoner dies, and is digested.

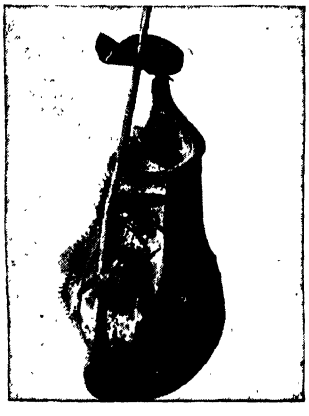
The beautiful sundew spreads its leaves on the bog-moss—each somewhat like a flattish spoon with a narrow handle. The expanded part of the spoon is surrounded by tentacles which are tipped with dew-like drops of sticky secretion. These tentacles are exquisitely sensitive to the touch of a small insect. They bend inward like the fingers of a closing hand. The insect is securely captured, digestive juice is poured out upon the prisoner, and what is useful in its body is dissolved and absorbed. The tentacles then expand again. So the sundew flourishes.

In the same way, but less sensationally, insects are captured by the glistening, light green leaves of the butterwort, which

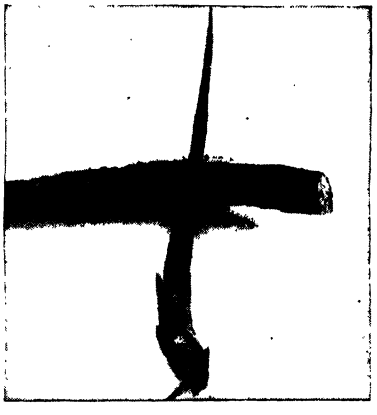
HOW PLANTS MAKE THEIR WAY

The leaves of Venus's fly-trap close like a spring trap over insects that alight on it. The plant then proceeds to digest the body of the insect.

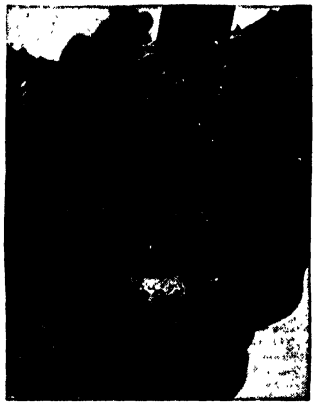
Nature has endowed the British gorse with prickly spikes as a defense against browsing animals. The gorse therefore grows freely on open heaths.



The acids of the pitcher plant digest all the insects attracted into it by the honey glands.



The force exerted by a plant as it grows — a blade of grass that has pushed through a piece of root.



The cup on the stem of a teazel plant fills with rain and drowns all the insects that fall in.

The hairs on the stem of the begonia serve as a rampart against many climbing insects.

Clusters of mistletoe, the parasite that makes its home both on the oak tree and on the apple tree.

The convolvulus, struggling to the sunlight, winds itself around the stem of a neighbor.

are so often spread in starfish-like fashion on the sides of the ditches in the bog. The margins of the sticky leaves curl inward and shut in entangled flies, which are then digested by the secretion of numerous glands on the surface of the leaf. It is interesting to drop a leaf into a test-tube half full of milk to see the changes.

Another mode of life is thievish, or *parasitic,* when one plant filches food-material from another. This is a sort of back-door escape from the struggle for existence. Farmers know that the pasture land is bound to be poor when there is great abundance of the beautiful little flowers called eyebright. And why is this?

The soil does not yield enough to keep ordinary plants going; those that get on there must have some peculiarity, such as very long roots, or very much branched roots, and very much cut-up leaves, as in millfoil, or very long not-overlapping leaves, like grasses. The little eyebright has discovered another way out—hardly worthy of its beauty and its pretty name. It is a root-parasite. Some of its rootlets fit on to the rootlets of the grass like a saddle on a horse, and there is absorption of supplies from the grass. This weakens the grass, of course, but it is also an indication that the soil is far from generous.

THE CLIMBING DODDER AND HOW IT STEALS ITS FOOD

The thievish habit seen in the eyebright is found also in the yellow-rattle and in the louse-wort. Farmers say that sheep get out of condition where the louse-wort is very abundant, and they used to blame the plant for giving the sheep lice! What this means is probably that louse-wort, as a root-parasite, manages to thrive in very poor pasture. It is the poverty of the pasture that weakens the sheep.

The dodder is a rather beautiful climbing plant that has lost the usual green pigment called chlorophyl. It twines round the stems of nettles, hops, wheat and other vigorous plants, and sends its suckers into the zone of the stem—the bast—where the nutritive materials manufactured in the leaves pass down to places of storage. The dodder at first gets its water and salts from the soil, but afterward the connection with the ground withers away, and it lives on its host. Its life is a stratagem.

Very different is the mistletoe, which has plenty of green pigment but no connection with the ground. The thrush eats the white berry with its sticky pulp, and the seed, passed through the bird's food canal undigested, is deposited on the branch of a tree, such as an apple or an oak. Sometimes, perhaps, the thrush, having failed to swallow the sticky fruit, wipes its bill on the branch, and the seed is anchored. In any case, the seed of the mistletoe germinates on the branch of a tree, and sends its rootlets into the wood-zone of the stem, where the crude sap, consisting of soil-water and dissolved salts, passes up. Being green, the mistletoe plant can make plenty of carbon compounds on its own; but, having no connection with the earth, it must steal water and salts from its host. These are but three examples of plant parasites—eyebright, dodder and mistletoe—but they illustrate this seamy side.

THE BIGGEST FLOWER IN THE WORLD AND WHERE IT GROWS

Another possibility in the quest for food is to batten on the dead. Many bacteria, many molds and rusts, besides some big fungi, live on living plants; many bacteria and some molds live on living animals. But others feed on what is dead and rotting, and they are called *saprophytes.* We are familiar with the fungoid plants that feed on decaying leaves and branches, utilizing the ready-made organic matter which, being without green pigment, they cannot make for themselves.

Many of these saprophytes play an important part in keeping the earth clean. Among the saprophytes are some flowering plants of high degree which have lost caste and become, to a greater or less extent, dependent upon rotten vegetable matter. The biggest flower in the world (*Rafflesia*), sometimes three feet across, is the flower of a saprophyte that grows on the floor of the tropical forest.

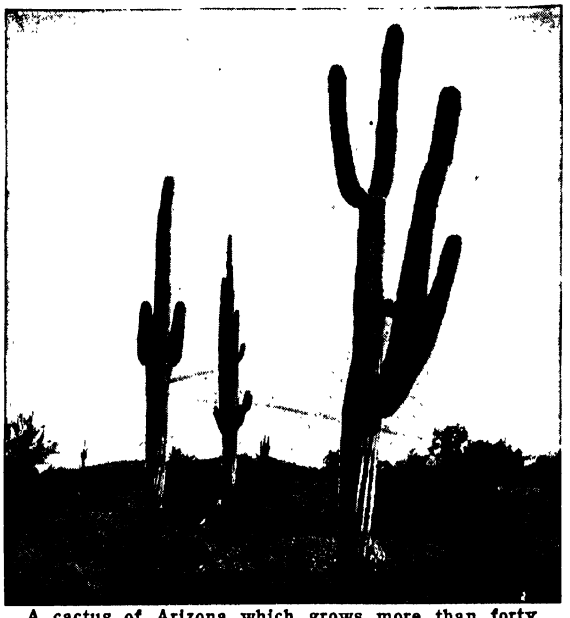
HOW SOME PLANTS ENTER INTO PARTNERSHIP, AND WHY

Let us look for a moment at the very interesting way in which plants enter into partnership with other plants, and occasionally with animals, to the great advantage to both parties; it is one of the alternatives in the quest for food. There are bacteria which form partnerships with the roots of clovers, peas, lupines and other plants of the bean family, and enable them, in some mysterious way, to capture and utilize the free nitrogen of the air. There

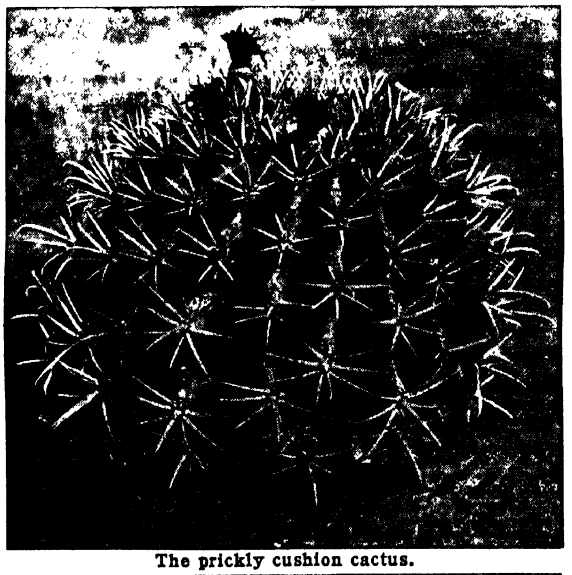
are many fungi which wrap themselves round the roots of plants and form a most useful sponge. The heather gets on well, as we have mentioned, on very poor soil, *because it has a partner-fungus.* This is another solution of natural difficulties.

In the early summer we see men and boys busy thinning the cotton with a hoe, destroying several and leaving one. Sometimes we see gardeners on their knees laboriously thinning or singling out the young carrots. There are too many young plants; they crowd one another and dwarf one another. If the farmer or gardener is to get profitable full-grown plants, he must thin them out. Similarly, in wild nature there is natural thinning. The young plants that get a good start, either through some virtue of their constitution or some accident of environment, elbow out their neighbors. There is ceaseless sifting. As Tennyson said of Nature, "So careful of the race she seems, so careless of the single life."

But while the sifting is often effected in early life by a great "infantile mortality" of seedlings, there are



A cactus of Arizona which grows more than forty feet high.



The prickly cushion cactus.

The prickly flowers of the desert.

sheltered and luxurious places where many plants get past the juvenile stages, and where there is extraordinary crowding, and, therefore, great competition for foothold, for light and for air. Such places are sheltered—self-sown woods, tropical jungles, thick-set hedgerows, and rich meadows. We get a key to what goes on in such places if we realize that plants are struggling, each in its own way and all in the plant's way, to find self-expression, to get on, to obtain satisfaction, or to overcome obstacles and limitations.

What light is shed on the variety of climbing plants when we understand that they are conquerors in a fight! They have remained young and mobile in their stems, or leaf-stalks, or tendrils, or some other part of their body, and they have risen on the shoulders of their neighbors to thrive on fresh air and abundant light.

It is very interesting to think of the different ways in which plants escape from deadly overcrowding and the literal shadow of death. Brambles, with their long shoots and gripping prickles, are

scramblers; and so is the wild mustard, which is helped by the roughness of its rapidly growing shoots. The ivy is a *root-climber,* giving off numerous brown roots on the shady side of the lanky stem. Then there are *twiners,* with stems that encircle the support, as in the case of honeysuckle and dodder, and the lianas of the tropical forest. But the artists in the business are the *leaf-climbers* and the *tendril-bearers,* where the leaf-stalk, or a specialized sensitive filament, bends round a support. Think of clematis, vine, bryony and pea; what masterpieces they are!

We see a new significance in the spiral arrangement of leaves on the stem, for this means that they shadow one another less; in the mosaic of leaves on the horse-chestnut branch, where many leaves make the most of the available light without overlapping; of the success of long, grassy leaves that run parallel without overlapping; of much cut-up leaves, like millfoil, which have an enormous surface for absorption and exposure to light, like countries with a big coast-line. We must realize the intensity of the struggle. Every meadow is like a tropical jungle, every hedgerow like a tropical forest.

THE MONGOOSE THAT FIGHTS A SNAKE WITH TEETH AND WITS

When man struggles with wild beasts or poisonous serpents or injurious insects, his weapons are often *ideas.* His struggle is rational. When a mongoose fights a snake, his weapons are not only teeth but *wits.* His struggle is intelligent. When a mother digger-wasp struggles with a cricket, which she will paralyze to form food for her young ones, her weapons are not only her sting but that inborn power of doing apparently clever things which we call instinct.

Now, the struggles of plants against animals are at a lower level than all these. There is no reason to believe that the plant ever really *knows* what it is doing, even when it catches a fly, and that is the most active answer-back that a plant ever gives to an animal. In most cases all that we can say is that in the course of time some plants have changed in the direction of having stings or poisons, thorns or spines, hard skins or unpalatable crystals, which have turned out to be very profitable—indeed, life-saving—in warding off the attacks of animals.

The answer back is an unconscious constitutional change which pays; and sometimes the change occurs without there being, so far as we can see, any need for it. We must not learn what we shall afterward have to unlearn. The lilies of the field do not toil or spin; and no plant thinks out devices which save its life in the struggle for existence.

THE STRUGGLES OF PLANTS GO ON UNCEASINGLY

To come to the facts of the case, let us give two or three examples of the ways in which many plants are protected from the assaults of animals. Everyone who loves a garden knows that among the worst enemies of plants are the snails and slugs, and their depredations go on all over the world. But there are some plants that snails leave alone, because of hard skins, rough prickles, stiff hairs, poisonous stings, strong odors and other defenses. Thus there are few snails that attack the European plant of the woods called cuckoo-pint, a near relative of our jack-in-the-pulpit; and one good reason for this is that the leaves are crowded with minute sharp crystals which would pierce and irritate the lips of the snail.

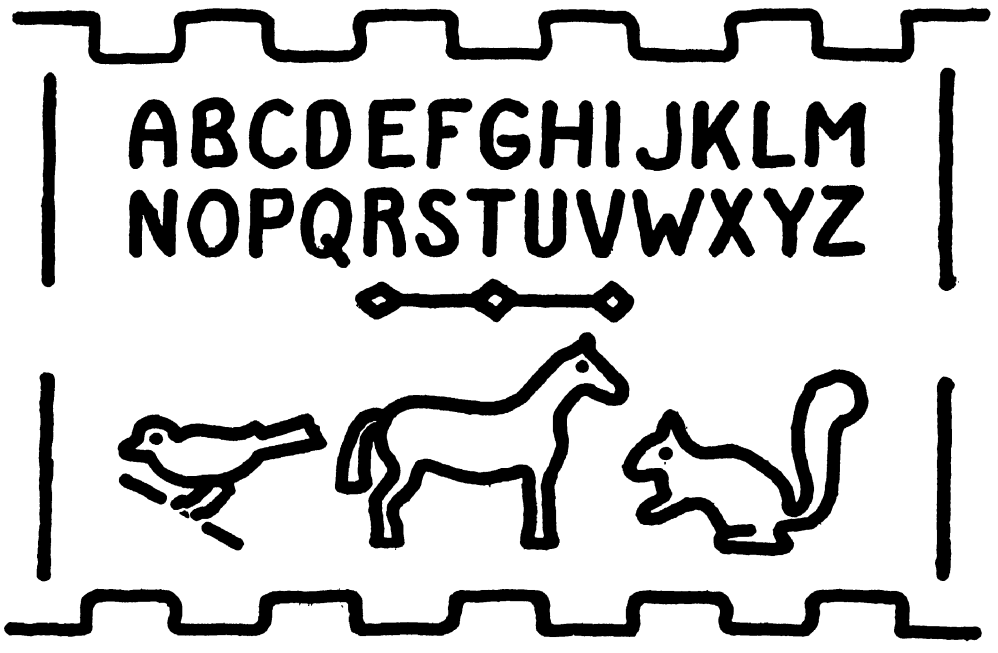
The struggles of plants are world-wide, rarely-ceasing and many-sided. They include all the answers-back, all the thrusts and parries, that plants make against the difficulties and limitations that beset them. There are struggles with fate—the physical world; struggles with fellows—other plants in the crowded area; and struggles with foes—hungry and injurious animals of high and low degree. There is struggle for food, for foothold, for freshness, for light, for moisture—for everything a plant needs. There are ways of evading the intensity of struggle—as, for instance, by becoming a parasite, but this usually means some degree of degeneration.

THE FIGHT FOR THE PLACE OF A PLANT IN THE SUN

The great fact for plants and animals is the same—that success means struggle. Not only must plants struggle to win a place in the sun; they have often to struggle to keep it.

But struggle among plants is usually a dreamy business; it includes all the answers-back that it is in them to make as they care for themselves and for their race. The central principle of all life that goes forward is: *Test all things, and hold fast that which is good.*

THE NEXT STORY OF PLANT LIFE IS ON PAGE 379.



MAKING DESIGNS WITH A LOLLYPOP STICK

ARTISTS sometimes use strange objects to produce striking effects—old tooth-brushes, discarded paint-brushes with the brush portion cut crosswise, window screens and the like. The fact is that what counts is not so much the drawing instrument that you use as the results that are obtained. Very interesting effects indeed may be produced with no other instrument than an ordinary lollypop stick, used with drawing ink or water-colors.

Before you can use your lollypop stick for artistic purposes, you will have to suck off every bit of candy from the business end of the stick. Surely this is one of the pleasantest introductions to artistic work that you could well imagine! When you have finished disposing of the candy on the stick, this should be washed with warm water and soap. Then it should be rubbed vigorously with a soft cloth, in order to get rid of every trace of candy. Otherwise your fingers will become sticky and you may produce unsightly smudges on the drawing paper.

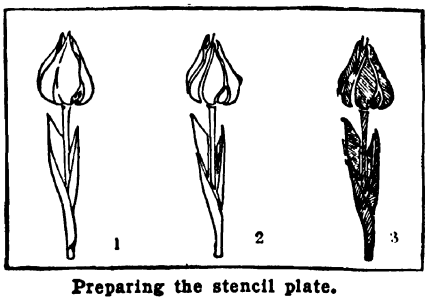
When the stick is quite dry you are ready to prepare your design. This should be as simple as possible. Try to produce bold effects rather than delicate combinations of lines. It would be well first of all to make the design with pencil, drawing very lightly, and then to follow the pencil markings carefully with the lollypop stick. Now you are to dip the stick in black or colored drawing ink or in thin water-color paint. Allow the excess ink or paint to run off and then apply the stick to the drawing paper. The stick should be held straight up, and not at an angle as you would do when writing with a pen.

The designs produced by lollypop sticks are very effective when done on black or white paper. They are as effective when worked out with white ink or water-color on colored paper. Particularly effective work can be turned out by using various combinations of colors: reds, blues, yellows and so on. The colors used should be as bright as possible.

You will find that you will be able to make fine ornamental lettering; also figures and borders for programmes, school projects, covers for scrap-books and albums and what not. In the above illustration we give you an alphabet that can be lettered effectively with your lollypop stick, and we show you other specimens of the work that it can do. Can you think of still others?

HOW TO PAINT WITH STENCILS

STENCIL-painting is a useful form of ornamentation for table-covers, curtains, walls and ceilings, cushions, book-covers and many other objects. The method has several advantages. The outlines are always very neat; the pattern can be endlessly repeated; and beautiful shaded effects may be obtained.

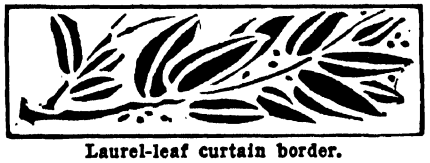


Preparing the stencil plate.

Stencil brush.

First a stencil-plate is needed. This is simply a piece of stiff paper out of which a pattern has been cut in such a way that when the plate is laid against any surface, colors may be painted through the holes right on to the material in the exact shape of the cut-out pattern.

To make a stenciled border, choose a simple flower—say a tulip—and draw it carefully on a piece of stout oiled paper. If you leave out all unnecessary detail, it will look something like picture 1. Now en-

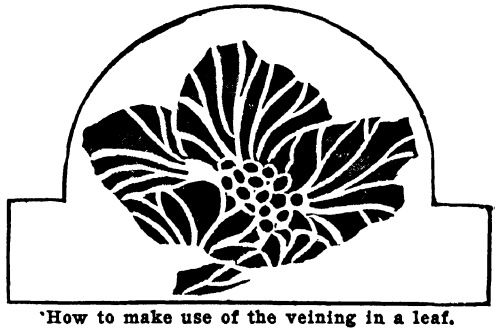


Laurel-leaf curtain border.

close each portion of leaf and petal in a separate space, making the lines in between of even width, as shown in 2. Finally shade the spaces as shown in 3. Next lay the paper on any hard flat surface that will not be spoiled by cutting, and with a sharp penknife cut out the shaded areas.

Paint both sides of the stencil with varnish and hang it up to dry near a window in the open, suspending it from a string threaded through a pin-hole in one corner. When thoroughly dry, the stencil is ready for use. The kind of brushes to use are short stumpy ones of soft hog-hair; they may be purchased at most stores. We can use ordinary water-color paints in pans—blue, red and yellow. Other shades may be mixed from these colors.

We shall now show you how you can paint a table-cover with stencils. First buy a piece of cheesecloth or a nice soft curtain cloth, which can be bought at any dry-goods store. Cut it into a yard square. Straighten out one edge, and with drawing pins fix it to a drawing board or a flat table. Find the middle of the side (that is, 18 inches from the corner). On that point, and about 3 inches away from the edge of the cotton, lay the stencil plate quite straight. The stalk should point toward the edge and the



How to make use of the veining in a leaf.

flower inward. Fix the plate in position *at the top* with two drawing-pins. Slightly moisten the paint in the pan, and rub the brush on it, then with a dabbing motion go over all the holes forming the design. Choose another color (and another brush) for the leaves and stem and do these in the same way. Then from the bottom gently lift the plate a little way and peep underneath. We shall be able to see how it looks, and whether our colors are deep enough.

Here are some things that we must try to remember:

1. Never dip the brush in water, but always moisten the paint itself, then rub the brush on the paint.

2. Always paint with a succession of dabs. Do not use the brush as a house-painter does or you will make a smear and spoil the even edge of the original pattern.

3. Obtain the shaded effect by dabbing more at the base of the tulip petals than at the tip, where the color is naturally paler.

In choosing color, a deep yellow (almost an orange), shading into pale primrose for

the flowers, and a dark green tipped with brown for the leaves, will look well.

Now we have to decide how close we want the next tulip to be, and make a small pencil mark on our cotton the necessary distance away. Space the remainder, along the side, with tiny pencil-marks as a guide. Unpin the plate, replace it over one of the guide-marks, and continue to paint. Probably we shall find that about nine tulips will space out well in a yard length—four on each side of the centre one. When we have done the other sides and hemmed the edge, our cloth will be finished and will look very charming.

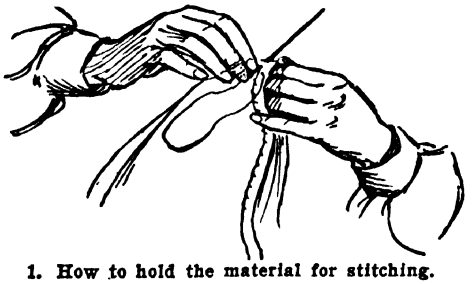
If we keep our stencil-plate carefully pressed between the leaves of an old book, some other time we shall be able to use the design for something else—perhaps a border of tulips for a notebook cover, to be used in connection with a school botany project. Or we may have occasion to use a border of tulips round a bedroom wall, or a single one to decorate a book-cover. Of course it will be better to begin by using our plate on an old piece of cloth, or on a piece of paper, before actually working on our table-cover; then we shall learn how wet the paint should be and also how to dab properly. We might also experiment with a little shading from dark to light tones of color.

There are many ways of using stencils and making elaborate and beautiful patterns with them. Sometimes one is used over another. But these are difficult to make for they require the skill of an artist. Nevertheless, if we follow the directions given above, we shall soon be able to make many useful and beautiful little patterns for ourselves. They will prove to be useful when we begin to make our Christmas presents. A stenciled design that the sender has made herself adds a charming personal note to even the most unpretentious gift.

HOW TO USE A SEWING NEEDLE

WE take it for granted that the girls who read The Book of Knowledge have sewing kits and that they are going to use them to good advantage. First of all they must learn how to make the various stitches that hold the materials together.

We all think that it is the easiest thing in the world to thread a needle, but the right way to do it is to thread it by the end just cut off the spool, making a tiny knot at the other end. If the thread is put through the needle at the opposite end, all the gloss goes out, the thread becomes woolly, knots and breaks off very easily. Always choose a needle that is just a little thicker than the thread. This will open the material enough for the thread to come through without unnecessary pulling and tugging.



1. How to hold the material for stitching.

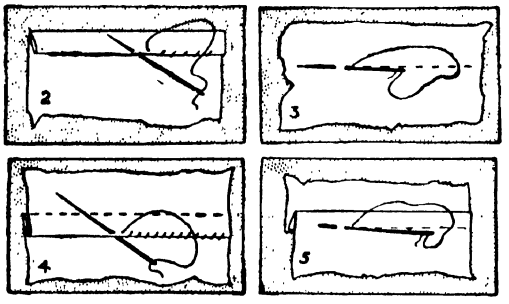
Now if you want to know exactly how to hold the hands to do some good work, look at picture 1. You will see that the left hand holds the piece of material between the thumb and first finger, letting it fall loosely over the back of the hand, the little finger just holding it in place. The right hand holds the needle and pushes it in and out of the material, a thimble on the third finger helping to push the needle through. The picture shows the hands in position when doing a hem—which is, as we all know, a double fold of material, turned down and folded over to protect a raw edge. The width of the first fold of the hem should be about one-third the width of the hem required, but in very narrow hems the first fold is the same width as the second. If, however, you intend to sew very fine material, such as muslin, the fold must be the same size as the hem; otherwise the rough edge will show through.

When you have decided what the size of the hem should be, turn the double fold and press it down firmly with your nail, then baste it, with long, even stitches. This will save a lot of time, for the hem will keep pressed down in position, and it will help to get the work straight and even. The needle is then put in the material, as you can plainly see in picture 2, the stitches being done from right to left in a slanting position.

There are many different kinds of stitches, but for our present purpose it is necessary

to know only a few of them. The running stitch (picture 3) is one of the most useful to learn, for it is with this stitch that seams are made and materials gathered.

If you are anxious to learn how to do really beautiful sewing, try first on fine canvas, or on any other very coarse material, where the threads can be easily seen, taking two threads on the needle and going over two. You will be surprised to find how easily the hand and eyes will be trained to work evenly and regularly, until you can



These sketches show you how to make the different stitches. 2 is a hemming stitch, 3 running, 4 running and felling, and 5 a French seam.

work quite pretty little stitches on any material without counting the threads, which is always a slow and tedious method of working.

When you can do the hemming and running stitches quite evenly, you have mastered the most difficult part of sewing, for all the other stitches are more or less made from these two.

If you look at picture 4, for example, you will see a little pattern of running and felling, which always looks full of difficulties to little girls, although it is simply running and hemming. Two pieces of material are put close together, the back piece slightly over-lapping at the top to allow for the folding over of the raw edge, and joined together, on the wrong side, by running stitches. The material is then opened under the seam, laid flat, and the two edges folded over like an ordinary hem.

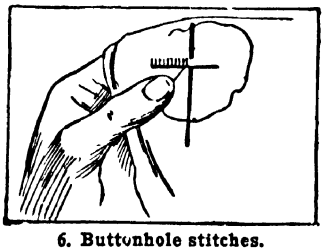
A glance at the picture will show the work far better than it can be explained.

The easiest way for little girls to do running and felling is by French seams. It will probably be the most popular way of doing the seams in dolly's underclothes. If you look at picture 5 you will see that this kind of seam is simply a double row of running stitches. The first row is done in the ordinary way, then the raw edges are cut as short as possible, and the seam turned inside out, a second row of stitching giving perfect neatness in the finished work. You must, however, remember when doing these seams that the first row of running, instead of being done on the wrong side, as for running and felling, is always done on the right side, the second row putting the first one out of sight.

Gathering is done with exactly the same stitches as running, only it must be done with strong cotton so that it will not break. The thread is pulled to gather the fullness. No knots or joins must be allowed in the thread, or it will not come through the material to form the gathers. Measure the piece of stuff you want to gather, and take a piece of thread long enough to leave two or three inches to take hold of when you want to draw it. It is always better to do two or three rows of gathers in case one should break, besides giving more evenness.

If the gathers are done on calico, or any fine material for underclothes, when the thread has been drawn a thick needle should be used to stroke down the material between each gather.

Buttonhole stitches come next, and these are by no means too difficult to be attempted. They are really quite easy when you know the way. Try first on a piece of canvas



6. Buttonhole stitches.

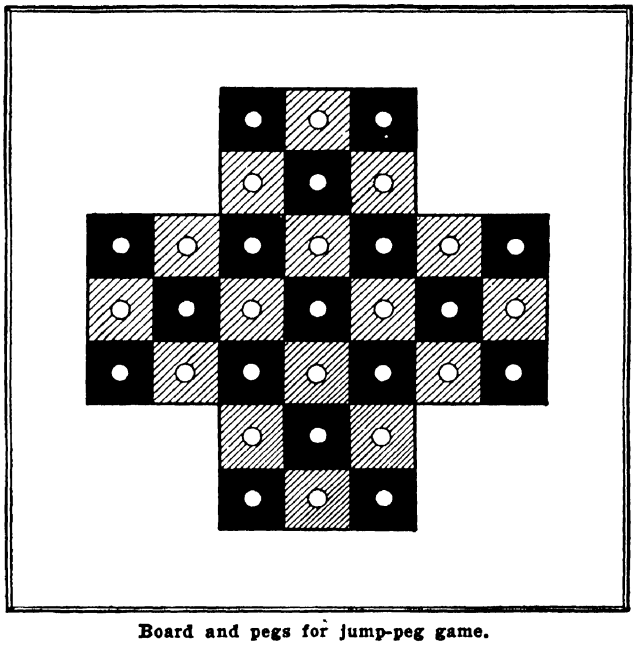
or coarse flannel, and make very even and regular stitches quite close to each other. Picture 6 shows just how the stitches are made. Let the thread go under the point of the needle and pull the needle down gently, letting the thread cross over itself where the needle came out. If you follow these directions, and look at the picture, you will really be surprised how easy the stitch is. It is not only useful for buttonholes, but for embroidering petticoats and other garments.

With a knowledge of these stitches you will be able to do various kinds of repairs and also to make pretty things for your doll. In other chapters of this book we show you how to go about these interesting tasks.

HOW TO MAKE AND PLAY JUMP-PEG GAME

THIS fascinating game is good fun at all times, but it is especially suited for dull afternoons. It is easily made and is played by only one person at a time. The object of the game is to get all of the pegs off the board except one, which should be left in the centre hole. The pegs are removed by jumping with one over another, removing each peg jumped, as is done in playing checkers.

How to Make. Although the jump-peg game may be made from heavy cardboard, the following directions are given for constructing it from poplar or other soft wood because of the lasting qualities of wood. If you prefer the more permanent game secure one piece of poplar or other soft wood either ¾ or ⅞ of an inch by 9½ inches by 9½ inches, and one piece dowel rod ¼ of an inch by 48 inches. After squaring and planing the board as desired, mark off spacing for holes, making them 1 inch apart on centres, as shown in the accompanying drawing. Then bore holes to depth of ½ inch, using ¼ inch bit. Next cut 32 pins from the rod, making each pin 1½ inch long and slightly pointed on both ends. Now sand the board with No. ½ or any fine sandpaper. If desired, the board may be made more attractive by marking off 1 inch squares, as shown in the accompanying drawing. These squares can then be painted with two bright colors, as shown. Either water-colors or paints may be used. Shellac with thin shellac (two coats must be applied) or wax with good furniture or floor wax.



Board and pegs for jump-peg game.

How to Play. The jump-peg game is played by filling with pegs all of the holes except the centre one. The player begins to play by jumping any peg over another into the hole and removing from the board the peg thus jumped. All jumps should be made in straight lines, either in a horizontal or a vertical direction. As explained at the outset, the purpose of this game is to remove all pegs except one from the board. This last peg should be left in the centre hole. This may look very easy, but it is much more difficult than it seems at first sight. The peg sometimes will not jump to the centre hole.

If you wish, you may compare your skill in playing jump-peg with that of your friends by seeing who can remove all the pegs but one in the least possible number of moves.

JELLY CHILDREN CAN MAKE

DID you ever try to make your very own jelly? Some children enjoy making apple jelly for their parties, while others prefer making cranberry jelly for mother's Thanksgiving or Christmas dinner.

Apple jelly is quite easy to make if you have jelly apples at hand. Ask your mother or someone else who knows about this, unless you wish to find out for yourself. First you wash the apples carefully and cut them in pieces (quarters). Then you cook these in a small amount of water until soft. Now pour into a jelly bag (cloth) and allow to drip for some time or even overnight. Measure the strained juice in a cup and boil it for at least ten minutes. At this point add as many cupfuls of sugar as there was juice when you measured it. Then boil this until it jellies—a tiny thread will appear as the liquid drops from the spoon. When you are

certain it has jellied, pour into jelly glasses and allow it to cool. When cool, melt enough paraffin to pour over the tops of each jelly glass.

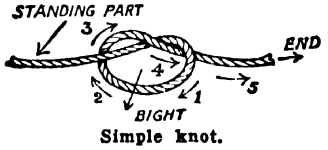
You may make as many glasses of apple jelly as you wish, because the paraffin will keep its contents fresh. The jelly will make a delicious spread on bread or crackers.

Cranberry jelly is also easily made. You first carefully pick over, wash, and measure the cranberries. Then you put these in a kettle, adding about one-half as much water as berries, and cook until the berries burst. After straining you should next measure the juice. You now boil this juice for several minutes, after which you add as much sugar as you had juice when measured. Finally you should cook this until it jellies—it will hang along the edge of your spoon and fall off in heavy drops. It is then ready to be poured into your jelly glasses to cool. A thin coat of melted paraffin can be poured over the tops of these when they have cooled. The paraffin keeps the air away from the jelly.

Of course you may buy jelly at your grocery store. Your home-made jelly, however, will have a delicious flavor that very few store products could possibly equal.

HOW THE SAILOR TIES HIS KNOTS

THERE is usually a time in the life of every boy when he wants to be a sailor. Every boy cannot be a sailor; but one part of a sailor's duties is very interesting, and a knowledge of it is likely to prove useful even to boys and men who are not sailors. That



Simple knot.

part is the making of knots and hitches and the splicing of ropes. It is easy to learn how to do these things. All that is required is a few pieces of string, a stick or a rod of wood or metal to serve the purpose of what sailors call a marlinespike, or a handspike, which is used for some knots, and a little attention.

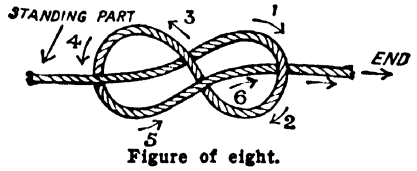
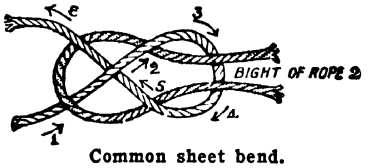


Figure of eight.

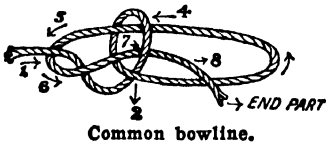
The first knot is the simple, or overhand, knot, seen in the first picture. We notice in the picture that one end of the rope is marked "standing part," the other end is simply marked "end," and the loop is marked "bight." We must remember these names, as we shall use them frequently in our descriptions of knots. The standing part means the part of the rope not right at the end, but a little way up, and in making a knot we always bend the end round the standing part. In some knots we use only one end of a rope; in other knots we use two ropes or the two ends of one rope, and in this case there are two ends and two standing parts. Sailors call a coil or a loop in a rope a bight. Also notice that in our illustrations we have small figures where there are arrows. These arrows indicate how the string or rope is threaded to make the knot or hitch; and we must follow the arrows according to the figure beside it—2 coming after 1, 3 after 2, and so on.

The next knot is what is called the "figure



Common sheet bend.

of eight," and from its appearance we can see that the name is appropriate. In making it, we pass the end of the rope round the standing part, then over "its own part" and through the bight. We understand what is



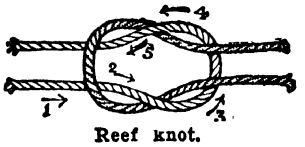
Common bowline.

meant by "the standing part"; and the words "its own part" mean the part of the rope or string that we have already bent around.

The next knot is what sailors call the common sheet bend. It is made with two ropes or with two ends of the same rope. We form a bight with the first end, and pass the other end through this bight, then right over

both parts of the first rope, and then under its own part. By passing the second end under its own part, we jam it against the edge of the bight and prevent its slipping.

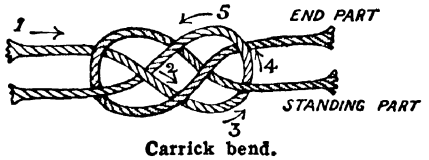
The next is called the common bowline, and is a little more difficult than any we have yet seen. We must follow the arrows in their proper order very carefully. It is made with one rope or one end. Some little distance from the end of the rope we form a bight with a half-twist, thereby making a



Reef knot.

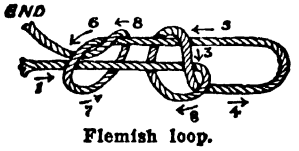
loop. We pass the end up through this loop, round the standing part, and down again through the loop.

The next, probably the most valuable knot of all, is the reef knot. It is commonly used in joining two ropes or two ends of one rope.



Carrick bend.

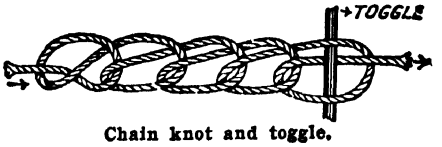
We make a bight of the first end with the end and the standing part side by side. Then we pass the other end up through the bight, round both parts of the first end, and down through the bight again. Another way to make it is to pass the first end round the second end, then bring the two ends back to their standing parts, passing one part round the other so that two parts of each rope



Flemish loop.

pass through the bight in the same direction. If we are not very careful, we shall make the ends come out one under and one over the bight, thereby making a granny knot, which is apt to slip.

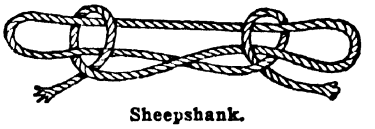
The next picture shows the Carrick bend, which is also rather complicated. It is made with two ropes or with the two ends of one rope. We first make a bight of end No. 1, then pass the end of No. 2 through the bight, over the end of No. 1, round the standing part of No. 1, over the standing part of No. 2, and through the bight again, both parts coming out of the bight at different sides.



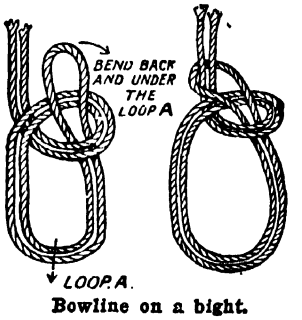
Chain knot and toggle.

The figures in the picture must be followed carefully in making it.

Now we come to the Flemish loop, which is made with one end only. First we make a common slip knot, and then, with the end, make an overhand knot round the standing part away from the loop.


Sheepshank.

The next illustration is what sailors know as the chain knot and toggle. It is really a number of common slip knots, which many schoolboys know as the drummer's knot, or the rat's tail. The toggle is the bar which is passed through the end loop. The chain knot is made by making a bight on the rope and crossing it. Then we pass a hand through



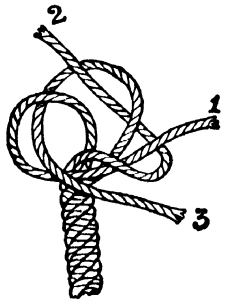
Bowline on a bight.

the bight and catch the standing part, which we pull through, forming a loop. We repeat this to make as many loops in the chain as we may think we want. Then we pass the bar, or toggle, through the last loop, and haul on the end to tighten up all the loops.

The next is a sheepshank, in the language of sailors. It is generally used to shorten a rope on which there is a strain. A piece of

the middle of the rope is held so as to form three parallel strands, or two bights. Round the end of each bight we make a hitch with the part leading to the end. As long as there is a strain the knots hold securely.

The next is what is properly termed a bowline on a bight; and, to indicate clearly how to make it, there are two pictures, one showing it half made and the other showing it completed. We double the rope, and make

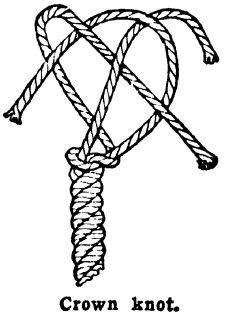


Wall knot.

a bight with it doubled. Then we pass the doubled end under, and up through the bight and back over the whole loop, and up to the part above the bight. The picture shows more clearly than words how this is done.

The wall knot is a neat way of finishing off a rope and of preventing it from unlaying or coming apart. It is made in two stages. We untwist the three strands of which the rope is made for a distance sufficient to give us three cords about 8 inches long. Let us call these strands Nos. 1, 2 and 3. We make a bight with strand No. 1 and pass strand No. 2 round the end of it; then we pass strand No. 3 round the end of No. 2 and through the bight of No. 1. Finally we haul the ends tight, shaping the knot evenly with the fingers as we do it. The wall knot requires a little practice to do it neatly, but it is not so difficult as it looks.

The crown knot is the wall knot carried a little farther. We make a wall knot as already described, and then take strand No. 1 over the centre of the wall. Now we place strand No. 2 over No. 1, and strand No. 3 over No. 2 and under No. 1. Then we pull them all tight.


Crown knot.

In learning to make the knots that we have described above, remember that practice makes perfect. It is not enough to be able to make a given knot by following the instructions that we give. You should learn each knot so thoroughly that you will be able to make it without having to think about each step in the process. Making a sailor's knot should become as automatic a procedure as, say, fastening your shoelaces or your necktie.

You will be able to have a good deal of fun making these knots. You will find, too, that a knowledge of them will prove valuable in case of emergency.

BUILD A HOUSE FOR YOUR FAVORITE BIRD

WHERE is there a boy who isn't interested in birds and who wouldn't like to build a house for a bird? Perhaps you have wanted to build a bird-house for some time but haven't known just what kind of shelter your favorite bird needs. Well, it is found that there are three kinds of protection which birds seek. These are: the nest shelter, the food shelter, and the nest house.

If you were to make a *nest shelter* it would differ quite a good deal from the two other types of bird-houses that we describe in the present article. For one thing it would need to be open on one or more sides, as its roof and sides are intended merely to protect the nest from the rain and wind. In making a *food shelter* you would provide a roof, open sides, and a floor on which food could be placed. In case you decided to construct a *nest house,* you would make a suitable building in which birds might seek protection and rear their young. Of course if you make a nest house you are more likely to attract permanent residents than if you make one of the other two kinds of shelters.

If you wish to make nest houses, one of

the most important things for you to observe from the outset is the kinds of birds which frequent the yards where you are planning to locate your houses. Many boys have failed to house their favorite birds because they did not know that the entrance openings vary with the size of the bird. Farmers' Bulletin 609, of the United States Department of Agriculture, on Bird Houses and How to Make Them, gives the following sizes for entrance openings which have been found highly satisfactory by several boys who have studied the habits and haunts of birds.

The diameters of the openings are as follows (in each case the measurement given represents the *minimum* diameter):

For blue birds, tree-swallows and hairy and downy woodpeckers—2 inches.

For chickadees and Carolina wrens—1⅛ inches.

For house wrens—⅞ inch.

For house-finches, crested fly-catchers and red-headed woodpeckers—2 inches.

For tufted titmouses, white-breasted nuthatches and downy woodpeckers—1¼ inches.

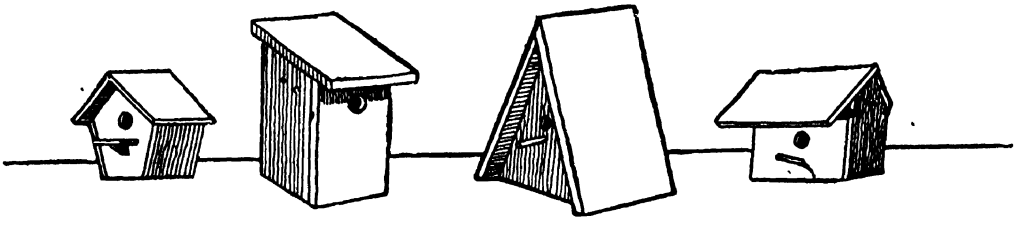
In the case of other species, experience alone will enable you to determine which is the diameter appropriate for each species.

Robins, barn-swallows and phœbes need one or more sides open.

Wood is found to be the most satisfactory material from which to make a bird-house. To avoid having it warp out of shape choose stock which is ⅜ inch, or even ½ inch in thickness. Then, too, you should construct your bird-house so that water will not run inside when it rains.

If possible, first decide upon the kind of bird for which you wish to make a house. The few suggestions which are given for bird-house designs may help you to determine the type of construction you will use. It is best to allow for cleaning through the side, the top or the bottom. Keep in mind that the size of your bird-house will depend upon whether you are making it for one family or for several families. In the latter case, partitions, and sometimes an additional floor, will be needed to separate them.

After you have decided these matters it is more satisfactory to make a working sketch on which you should place the exact dimensions of each piece of wood to be used. Next, select your wood, which should be over ¼ inch in thickness, for the reason mentioned, and shape each part to the desired size. Before making the entrance hole as shown, note, from the suggestions already given, the exact size of the opening which has been found most satisfactory for your favorite bird. For example, the opening for a house wren should be ⅞ inch in diameter. This opening should be placed quite near the roof so that the bird may have ample room to make its nest. To give proper ventilation you will need to make even smaller holes above the entrance and near the roof. Do not forget these ventilation holes. If they are not provided your feathered guests may not desire to remain in their otherwise perfectly comfortable quarters.



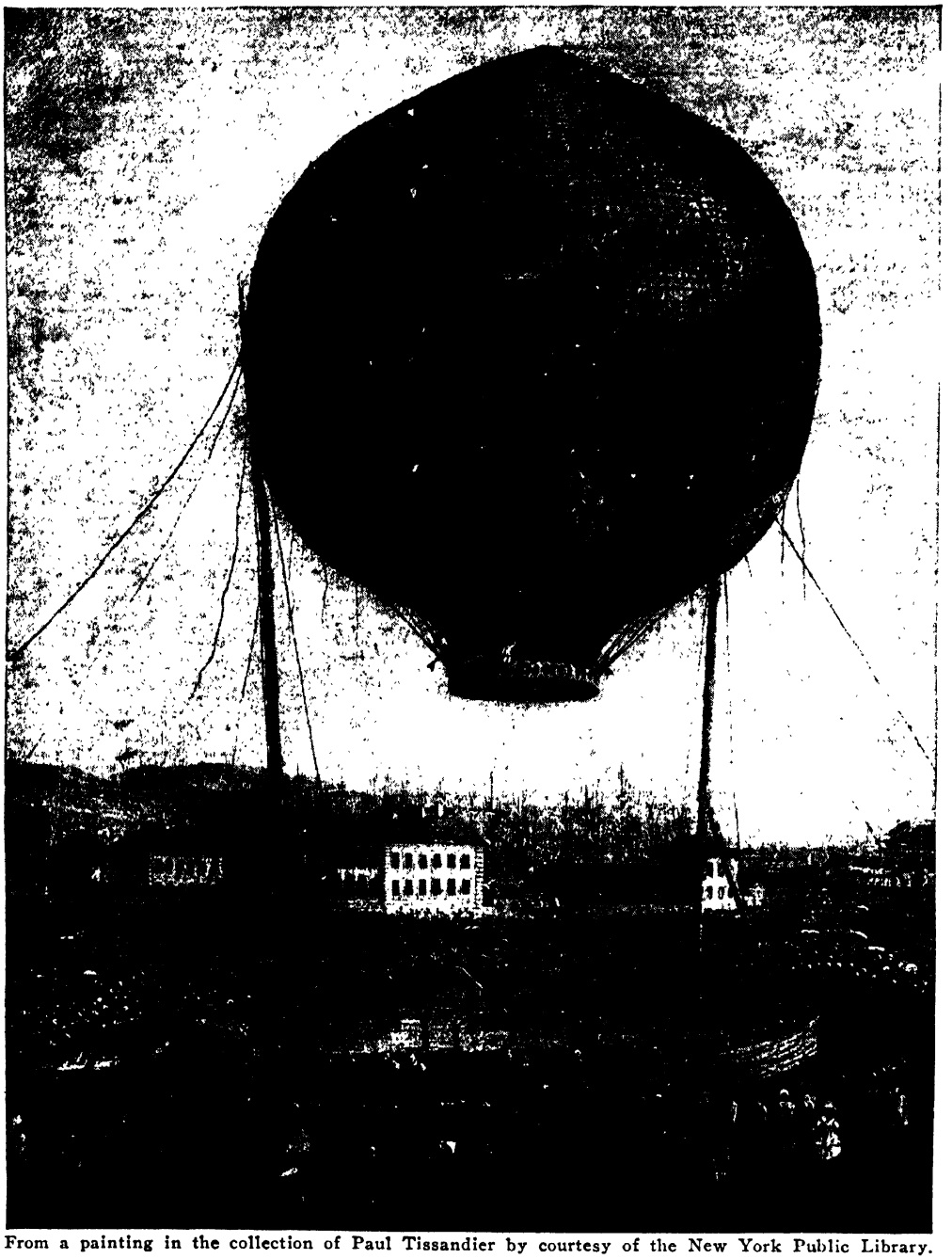
Bird houses that are easy to build.

Regardless of whether you use brads, nails or screws, it is more satisfactory to set or countersink these deep enough that the heads may be covered with putty. Now you are ready to preserve your bird-house and improve its appearance with paint. Having decided about where you will locate it, you will be able to decide if green, brown or another color will harmonize best with the surroundings. When the paint is dry, securely fasten the bird-house to a tree or building, being careful not to have the entrance face the prevailing winds. The house should be placed out of the cat's reach.

The designs that we show in the above illustration are very simple. Any bright boy may make these bird-houses out of odds and ends of wood, using a few simple tools like those which we describe in our article on carpentry (pages 130-31). Boys who have had experience in carpentry may be able to work out more elaborate designs of their own.

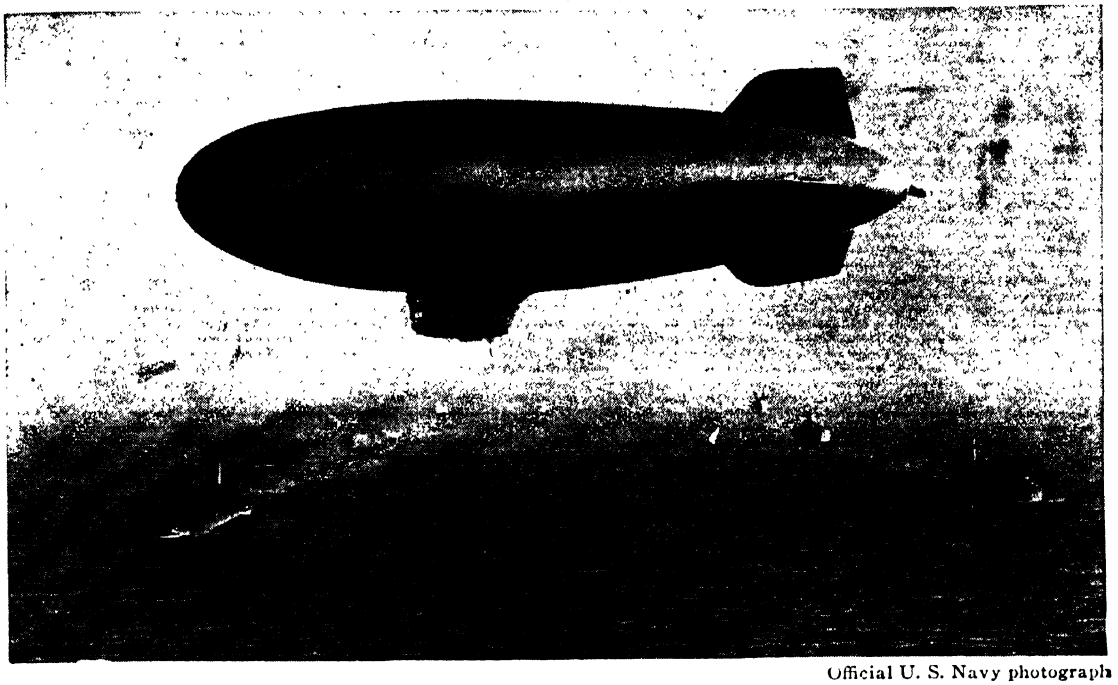
THE NEXT THINGS TO MAKE AND DO ARE ON PAGE 617.

AN EARLY MONTGOLFIER FIRE BALLOON



From a painting in the collection of Paul Tissandier by courtesy of the New York Public Library.

This is the balloon "Le Flesselles," built by one of the Montgolfier brothers, which made an ascent from Lyons, France, on January 19, 1784, only a few months after the balloon had first been demonstrated. It remains even to-day one of the largest free balloons ever made, with a height of 130 feet, a diameter of 100 feet and a volume of about 800,000 cubic feet. The picture illustrates the manner in which such fire balloons were launched. A platform was constructed, with a firing pit in the centre. The balloon was anchored over this by means of two masts. "Le Flesselles" was inflated with a straw fire in 17 minutes. At a given signal the ropes were cast loose and the balloon rose. In the gondola were seven persons, including the brave Pilâtre de Rozier (who may be seen dangling his legs from the railing) and several members of the French nobility. "Le Flesselles" rose to a height of 3,000 feet, but began to descend after fifteen minutes when a large rent appeared in the upper part of the flimsy envelope. Although the shock of landing was violent, none of the aeronauts was seriously injured. They were given an enthusiastic reception by the thousands of people who had watched them ascend. It was an outstanding event in the history of man's conquest of the air.



Official U. S. Navy photograph

A U. S. Navy blimp, on convoy duty, hovering over a brood of merchant ships.

SHIPS THAT SAIL THE SKY

THE great ocean of air which surrounds the earth has weight, just as truly as the oceans of water have weight. Any object lighter in weight than its own volume of air will rise in the atmosphere as surely as a bubble of oil in water.

However, there are few things that are lighter than air. One of them is air itself, when heated. The Chinese knew this centuries ago, and sent aloft paper dragons filled with heated air. In 1783 the brothers Montgolfier in France, who had been wondering what made smoke rise in the air, blew up large paper globes over straw fires, and saw them sail high into the clouds. Afterward they used globes of linen. That same year a young Frenchman, Pilâtre de Rozier, and a companion, were brave enough to intrust their lives to such a flimsy globe. They were the first men to leave the earth in a balloon.

It was soon found that there are some gases that are lighter than air, even when cold. Another Frenchman, J. A. C. Charles, also in 1783, sent up a silk balloon filled with hydrogen, the lightest of all gases, which had only recently been discovered. This ascent at Paris was witnessed by 300,000 people. A little later Charles himself made several balloon flights, with a companion or alone. The news of the invention quickly traveled all over the world. Two years later Jean Pierre Blanchard and Dr. J. Jeffries, an American physician, floated across the English Channel in a hydrogen balloon. Pilâtre de Rozier, who tried to do the same, was killed in the attempt.

Soon balloons were seen in almost every country and some very large ones were constructed. For more than a hundred years, until the airship and the airplane came, the free balloon ruled the skies. (A free balloon is one that can not be steered.) During that time it underwent little change. When illuminating gas began to be made, it was used for balloons, because it was cheaper than hydrogen; but the use of balloons remained limited, chiefly because they could not be steered. They were playthings of the wind.

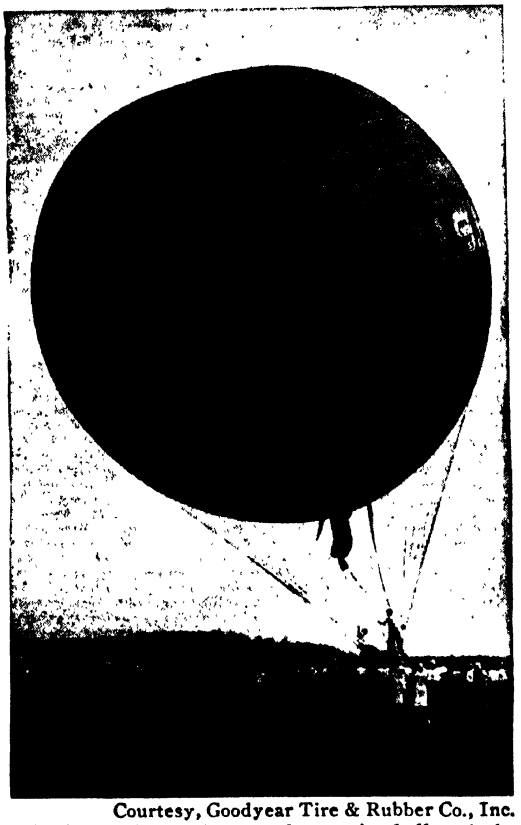
At first balloon ascensions were made only to thrill crowds. Then scientists began to take observations in balloons, and sportsmen began to use them for fun. Finally their

value in warfare was recognized. They were used for war purposes as early as the French Revolution, but not until the Civil War were they similarly used in the United States. When the Germans besieged Paris in 1870, the French sent messages to the provinces by means of balloons. During World War I, captive balloons, the famous "sausages," were especially developed for taking observations.

The free balloon has not been used in warfare for many years. However, up to the outbreak of World War II, many armies and navies, especially those of the United States, kept balloon divisions for their experimental and training value. The famous international balloon races founded by the American newspaper publisher, James Gordon Bennett, did much to keep free-ballooning alive. These races were often won by United States Army and Navy men.

One of the bravest balloon adventures was undertaken in 1897 by the Swedish engineer, Salomon August Andrée, and two companions, who started from Spitsbergen in an attempt to reach the North Pole by air. Their balloon was as perfectly constructed and equipped as was possible at the time; but they were never again seen alive. For thirty-three years their fate was in doubt. Then, in 1930, their remains and much of their equipment were found by chance on White Island, whither the aeronauts had marched across the ice after being forced down, as the accompanying picture shows.

As the distance from the earth increases, the air becomes thinner and thinner, and breathing becomes difficult. The temperature falls below zero. Until recent times these conditions made it difficult for men to ascend to great heights in the open baskets of balloons, even though they had warm clothing and oxygen apparatus. These difficulties were finally overcome by replacing the old-fashioned basket with a hollow globe of aluminum, sealed against the outside air. Such balloons have succeeded in invading the "stratosphere," as scientists call the



Courtesy, Goodyear Tire & Rubber Co., Inc.

This picture shows what a modern racing balloon looks like—the kind that used to compete in the Gordon Bennett races. Balloons of this kind have not changed much since they first were built more than a hundred years ago.

Soyuzphoto

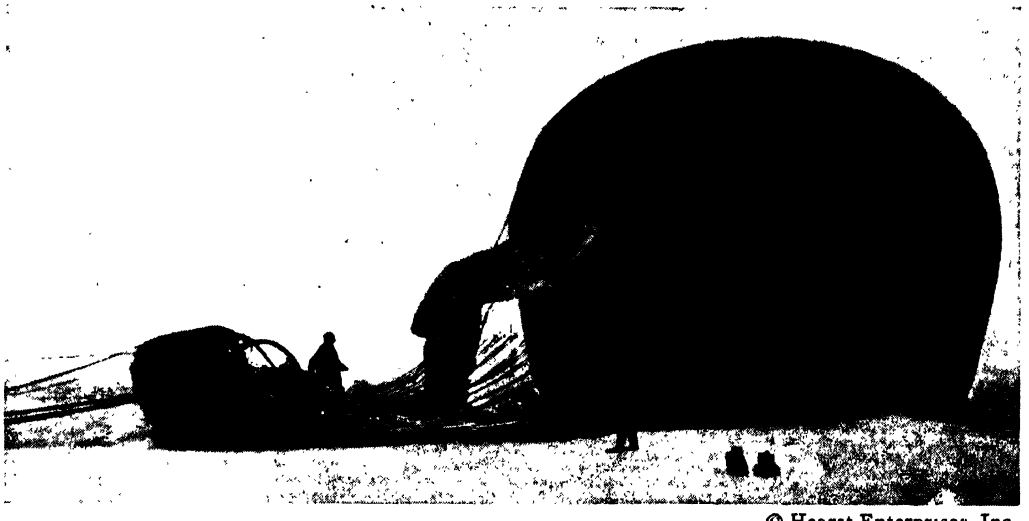
The metal gondola of the Soviet Russian army balloon or "stratostat" U. S. S. R. just before the take-off on the stratosphere flight in 1933 which took the three aeronauts to a height of over 62,000 feet. Balloons of this type have gone even higher.

upper layers of the atmosphere. Observations from the stratosphere have been of great value in the study of the mysterious cosmic rays.

From the very start men sought to free the balloon from the winds of chance. Some thought it could be done with sails and oars and rudders. Andrée invented a special kind of drag-rope to give his balloon direction. All such attempts failed. Later it was realized that only a propeller, an air-screw, worked by some source of power, could move a balloon against the wind. In 1851 Henri Giffard in France fitted a balloon with a small steam engine driving a propeller, and thirty-four years later two other Frenchmen, Rénard and Krebs, actually flew a figure eight in their primitive airship. But the modern airship had to wait for the internal combustion motor which produces much more power for its weight than the steam engine.

The first to use a gasoline engine in a balloon was Alberto Santos-Dumont, a wealthy Brazilian living in Paris. Between 1898 and 1908 he built fourteen dirigibles (steerable balloons) of varying size and performance. With one of these he won a prize of $20,000 for circling the Eiffel Tower and returning to the starting point, a few miles away, within half an hour. His machines, however, were very primitive. They consisted of sausage-shaped gas-bags under which flimsy keels were slung.

Count Ferdinand von Zeppelin, a retired German army officer, who had fought on the Union side in the Civil War, meanwhile worked on a different plan. He made a rigid framework of aluminum for his airship, and divided the interior into compartments which were filled with gas-bags or ballonets (little balloons). Cars for engine and crew were suspended from the framework. The first flight was made in 1900, but several ships had to be built before Zeppelin was successful. Indeed, real success was not attained until the German people in 1906 raised more than $1,000,000 for Count Zeppelin by popular subscription. From then on until World War I Germany was the only country to develop the airship with practical success. Thousands of passengers were carried on the "zeppelins"—as the airships were called in honor of their inventor. Germany was very proud of the great skill which she gained in building and handling these ships.



© Hearst Enterprises, Inc.

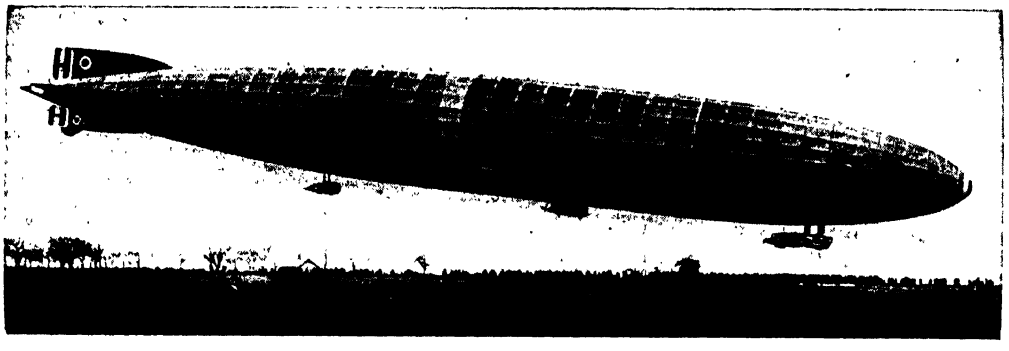
The negative from which this picture was made lay for 33 years in the frozen north. It shows the great balloon with which Andrée and two companions tried to fly across the North Pole in 1897, after it had come down on the ice. This picture was actually taken by one of the explorers. It was found together with much of the expedition's equipment, when the bodies of the three men were discovered on White Island in 1930. Scientific skill was able to develop the negative despite its age. Several expeditions had tried to find the Andrée party in the years immediately after its disappearance, but the discovery years later was accidental.

When World War I began, Germany had a great advantage in airships. Altogether she built more than a hundred zeppelins, and though many of them were destroyed, others were able to inflict much damage behind the Allied lines, even as far away as England. One zeppelin, the L-59, in 1917 flew more than 4,000 miles to Africa and back on a single flight.

After the war the remaining zeppelins were distributed among the Allies, many of

SOME HISTORIC AIRSHIPS

Here we see one of the first steerable balloons invented by Count Ferdinand von Zeppelin of the German army, and named after him. Even these early zeppelins were of large proportions—the one shown above sailing over Zurich, Switzerland, was nearly 500 feet long. The envelope was filled with about twenty gas-filled balloons, and all to hold up two little cars with about twenty passengers! A liner of the same length could carry over 1,000 passengers.



The British dirigible R-34, at the time the largest in the world, on July 6, 1919, became the first airship to cross the Atlantic Ocean. She flew from Scotland to Long Island—3,200 miles—and returned in a few days. Later she was wrecked in a gale, while moored to her mast.

Pictures, Illustrations Bureau, Rol & Co., Underwood & Underwood

The United States naval dirigible Shenandoah, once the ZR-1, was 680 feet long and required a "ground-crew" of 300 to put her into the hangar. Here she is shown moored to the mast at the Naval Air Base at Lakehurst, New Jersey. In 1925 the Shenandoah was wrecked in a storm over Ohio.

whom already had, or were building, airships of their own. But misfortune began to dog the big gas-bags. There was a series of great airship disasters. The table on page 351 lists some of the chief ones. Many will still recall the tragic fate of the American-built Navy airship, the Shenandoah, which, in 1925, broke into two pieces during a storm over Ohio. Fortunately the forward section remained in the air and was brought to earth safely with 27 survivors, so that the actual loss of life was comparatively small. The greatest of all airship disasters occurred when the huge U. S. Navy ship Akron fell into the sea off the coast of New Jersey early in 1933. Only two of the 75 aboard survived. The Akron's sister ship, the Macon, fared no better. Two years later she was wrecked at sea near San Francisco. This time, however, only two out of 83 perished.

THE BRITISH DIRIGIBLE R-34 IS THE FIRST AIRSHIP TO CROSS THE ATLANTIC

These accidents created an unfortunate impression about the safety of airship travel, though many airships meanwhile were piling up excellent records. In 1919 the British dirigible R-34, at the time the largest in the world, had become the first airship to cross the Atlantic. The R-34 unfortunately was later wrecked in a high wind while anchored to her mooring mast, though without loss of life. A few years later Germany, by special arrangement with the Allies, built a great zeppelin for the United States. This ship, the Los Angeles, in 1924 was flown from Germany to the United States in 81 hours. It was turned over to the Navy, which operated it until 1932 when it was decommissioned after having covered 140,000 miles in 250 flights, without mishap.

THE GERMAN AIRSHIP GRAF ZEPPELIN FLIES AROUND THE WORLD

Still more impressive is the record of the German commercial airship, Graf Zeppelin, which, in 1929, flew around the world in something over 21 days. Later the ship engaged in regular passenger service between Germany and South America. It crossed the Atlantic more than 125 times, carrying more than 13,000 passengers. In 1936 a larger sister ship, the Hindenburg, went into service and made 10 round trips to the United States in 1936. But on her first visit of 1937, as she nosed up to the mooring mast at Lakehurst, N. J., the great ship burst into flame and was totally destroyed with a loss of 36 lives.

The rigid airship is the most important, but there are other types. Some armies and navies have airships called non-rigid, because they have no frame-work at all. Sometimes a keel and a few ribs are supplied and the airship is then called semi-rigid. Italy at one time led in the building of such semi-rigid airships. The Norge, in which Roald Amundsen, Lincoln Ellsworth and Umberto Nobile flew across the North Pole in 1926 was a famous example of the semi-rigid ship; so was the Italia, in which Nobile, repeating the flight in 1928, crashed on the ice, later to be rescued. In the United States a whole fleet of small non-rigid and semi-rigid blimps has been built. In peacetime they are used for sight-seeing and advertising. In World War II they proved to be valuable in guarding the sea-lanes against U-boat attack.

THE HISTORY AND MEANING OF THE WORD BLIMP

The history of the word blimp is interesting. It seems that during World War I, England built a certain type of small non-rigid airship. At that time, non-rigid airships were called limp airships by English flying men. This particular type was known as the B-limp, which quickly became blimp.

For years all balloons and airships were inflated with hydrogen or with the cheaper illuminating gas, which contains a large proportion of hydrogen. Hydrogen is the lightest gas known and thus gives the greatest amount of lift for its volume. However, hydrogen is also very dangerous to use, for it easily catches fire. Many balloon and airship disasters have been due to this cause. Even where accidents happened from other causes, hydrogen greatly added to the danger, because the gas generally began to burn when an airship crashed.

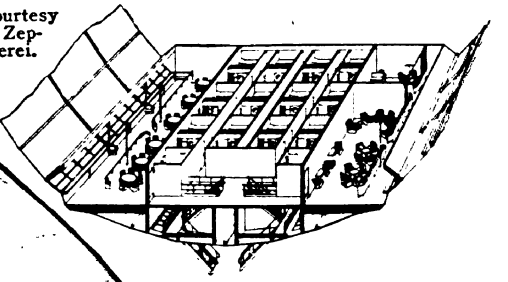
We tell you elsewhere how another gaseous element, helium, was known to exist in the sun before it was discovered on earth. Even after it was found in the atmosphere, it was so rare and hard to get that the price was very high. Later helium was found in natural gas from some Texas wells. A method was developed to extract it at reasonable cost. The United States controls the supply.

HELIUM, A SAFER GAS THAN HYDROGEN, IS USED IN UNITED STATES AIRSHIPS

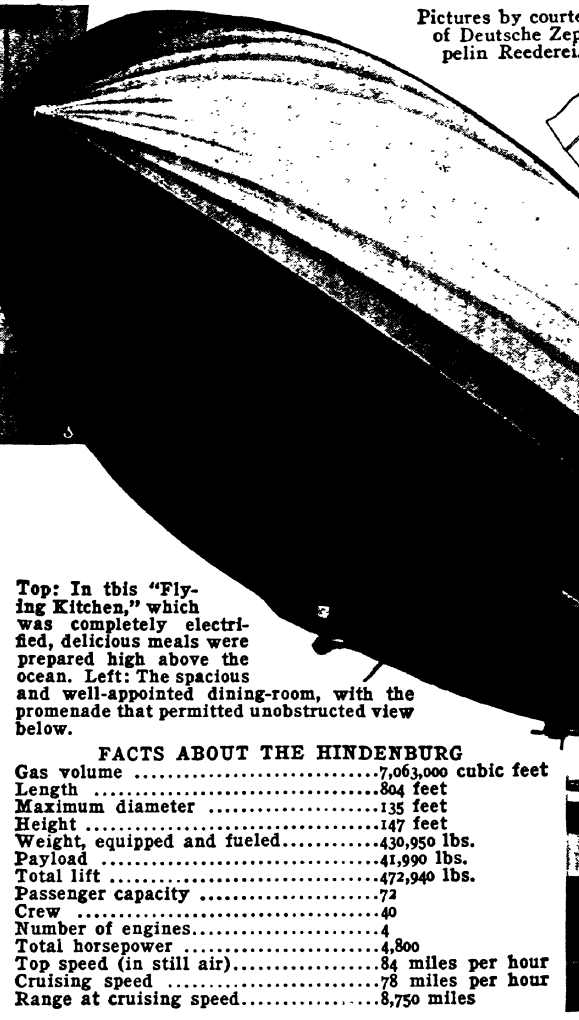
Now helium is, next to hydrogen, the lightest gas known. It has more than 90 per cent of the lifting power of hydrogen. At the same time helium does not catch fire under any circumstances. American airships use helium.

THE HINDENBURG, GIANT AIRSHIP, DESTROYED IN 1937

Pictures by courtesy of Deutsche Zeppelin Reederei.



Here is the great dirigible, just after leaving her hangar at Friedrichshafen. Above, a diagram of the passenger quarters, showing how they were "streamlined" into the hull.



Top: In this "Flying Kitchen," which was completely electrified, delicious meals were prepared high above the ocean. Left: The spacious and well-appointed dining-room, with the promenade that permitted unobstructed view below.

FACTS ABOUT THE HINDENBURG

Gas volume	7,063,000 cubic feet
Length	804 feet
Maximum diameter	135 feet
Height	147 feet
Weight, equipped and fueled	430,950 lbs.
Payload	41,990 lbs.
Total lift	472,940 lbs.
Passenger capacity	72
Crew	40
Number of engines	4
Total horsepower	4,800
Top speed (in still air)	84 miles per hour
Cruising speed	78 miles per hour
Range at cruising speed	8,750 miles

SHIPS THAT SAIL THE SKY

The future of the ships that sail the sky is uncertain. World War II did very little to further their cause. Air power played a most important part in the war; but when we speak of air power here, we have in mind heavier-than-air flying craft.

To be sure, small non-rigid airships were used in spying out and destroying submarines in Caribbean and coastal waters. These airships had one great advantage over the plane; they could stay aloft for several days at a time. Yet their number was very small indeed compared to that of the heavier-than-air craft that took part in the anti-submarine campaign. Balloon barrages proved helpful in defending cities against air raids, and when tied to ships in convoys; but anti-aircraft fire and defending planes proved far more effective against the big bombers. Captive balloons, which were once used in great numbers to direct artillery fire, have been largely replaced by airplanes for this service in modern military practice.

Lighter-than-air craft were not used at all in World War II in air combat or in carrying out raids on enemy territory. Airships are too slow and too clumsy to meet successfully attacks by modern pursuit planes; and they offer a huge target to anti aircraft guns.

Nevertheless, since the end of the war, studies have been made in the possible use of lighter-than-air craft for special military purposes. We must admit that the airship is still in the early experimental stage in comparison with the airplane; and for this very reason the future of the ship can not be foretold. No doubt for years to come the great bulk of the world's passenger and freight traffic in the air will be handled by heavier-than-air craft. The airship is much slower and much more difficult to handle on the ground. It requires more housing space than the plane.

Balloons carrying recording instruments, but no passengers, are sometimes sent aloft by scientists studying the upper atmosphere and cosmic rays.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 369.

GREAT AIRSHIP DISASTERS

August, 1921: The ZR-2 (or R-38), built in England for the United States Navy, exploded over Hull, England. Forty-four lives were lost.

February, 1922: The Roma, built in Italy for the United States Army, crashed at Hampton Roads, Virginia. Thirty-four lives were lost.

December, 1923: The Dixmude, German zeppelin turned over to the French, fell into the Mediterranean off the coast of Sicily during a storm. Fifty-two lives were lost.

September, 1925: The Shenandoah, Navy ship built in the United States, broke up in a storm over Ohio. Fourteen lives were lost.

October, 1930: The R-101, one of two British super-dirigibles, crashed into a hill near Beauvais, France, during a storm. Forty-six lives were lost.

April, 1933: The Akron, one of two huge United States Navy ships, fell into the sea off the coast of New Jersey during a storm. Seventy-three lives were lost.

February, 1935: The Macon, sister ship to the Akron, was disabled near the Pacific Coast and fell into the sea. Two lives were lost.

May, 1937: The Hindenburg, giant transatlantic ship, was totally destroyed by fire while landing at Lakehurst, N. J., with a loss of 36 lives. The cause remains unknown.

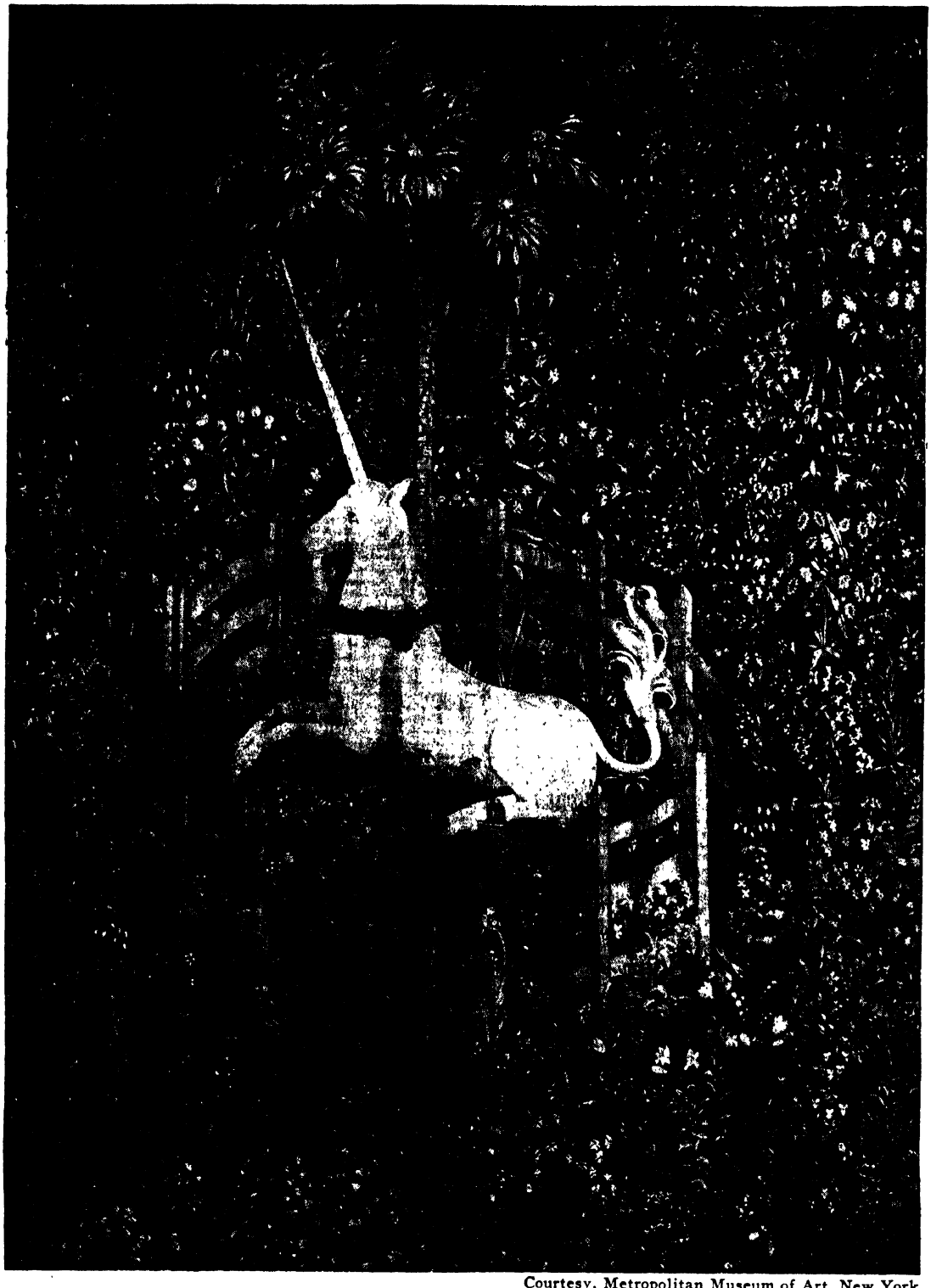
BALLOON RECORDS

Distance: 1,896.9 miles, traveled by the German aeronaut Berliner, in February 1914.

Height: 72,395 feet by Captains Orvil A. Anderson and Albert W. Stevens of the U. S. Army, on November 11, 1935, from near Rapid City, South Dakota, in the largest free balloon ever built, Explorer II, sponsored jointly by the U. S. Army Air Corps and the National Geographic Society, and assisted by the Bureau of Standards and many scientific institutions.

Other Notable High-Altitude Flights: 72,178 feet, in January, 1934, by the Russian "stratostat" Sirius. The three occupants were killed in the descent. Approximately 62,300 feet, in September, 1933, by three Russians in the Russian Army balloon U.S.S.R. (see picture on p. 346), 61,237 feet by Lt.-Com. T. G. W. Settle of the U. S. Navy and Major C. L. Fordney of the U. S. Marine Corps, in November, 1933, from Akron, Ohio. 57,979 feet, by Jean Piccard and wife in October, 1934, from Dearborn, Michigan. 53,152 feet, by Prof. Auguste Piccard, twin brother of the preceding and originator of sealed metal gondola balloons, with a companion, in August, 1932, from Zurich, Switzerland. The highest flight ever made in an open-gondola free balloon exceeded 43,000 feet and was made by Captain Hawthorn C. Gray of the U. S. Army, who perished on the flight, in 1927. Captain Gray had previously reached 42,470 feet. Small, unmanned balloons, equipped only with instruments, have reached heights of over 100,000 feet.

THE UNICORN AND ITS MAGICAL HORN



Courtesy, Metropolitan Museum of Art, New York

A unicorn in an old French tapestry. The unicorn's horn was thought to have magical properties.

From an old print

A sea serpent, drawn in 1743 by Paul Egede. Even to-day some people believe that sea serpents do exist.

ANIMALS THAT NEVER WERE

DO you know anyone who believes that frogs spit poison, or that toads cause warts? Do you believe that ill luck will come if a black cat crosses the path in front of you? Do you make a wish on a load of hay drawn by a white horse?

All these beliefs are old superstitions. They have come down to us through many centuries, from a time when education was limited, and the most impossible fantasies were firmly believed to be true. It is a curious thing that many superstitions have centred about animals. We shall tell you about some of the most interesting of these in the following pages.

Once upon a time it was thought that the toad had a precious stone in its head, and that this stone could cure sickness. Hence so-called toad-stones became common. Indeed, many animals were supposed to have magical powers, and many strange animals that never existed were believed to live in the sea, or in distant lands. The unicorn was a large horse with a single red, black and white horn projecting straight out from its forehead. Men believed the horn had magical properties, and travelers went on long journeys in search of this animal, which was said to roam in India, Arabia and Morocco.

The unicorn could not be hunted or trapped like any other beast. Oh no! No man arrayed as a man could approach it. The hunter must disguise himself as a young girl, perfume his clothes and lie down in the haunts of the unicorn. The unicorn, attracted by the scent, would then approach, and charmed with the sweet odor, would lay his head in the supposed maiden's lap and fall asleep. Thereupon the hunter had to grasp the horn and, with a single powerful wrench, pull it out! Or, if that were too bold a course for one man, then the disguised hunter lured the unicorn to him, while others lay in hiding and dashed up to seize the coveted horn. Out of the horn a drinking cup could be made.

From an old print

Hercules, the Greek hero, slaying the hydra, a dragon with nine heads.

Poisoned wine drunk from it lost its power to harm.

How men of the Middle Ages, and later, managed to impose such a story upon their hearers is not for us to decide. They were bold enough to tell the tale and actually to produce what they called the "horn of the unicorn." A writer of the time of Queen Elizabeth mentioned one which he saw at the Queen's court. It was worth £10,000, he said, which in our time would be about $250,000. What really was this unicorn's horn? It was the spiral horn, or tusk, of our old friend, the narwhal! Of course, it had no magical properties. The rhinoceros was supposed to possess something of the qualities of the unicorn, and brave Marco Polo, the traveler, said that it did no harm with its horn, but with a fearful tongue, all covered with prickles, it rasped the flesh off its victim's bones!

The most astonishing beasts of fable and legend were dragons or huge reptiles, some of which could fly. How did men get their idea of winged dragons? There really were, once upon a time, creatures in some ways resembling those fabled monsters. Among the animals of the Jurassic and the Cretaceous periods were fearful lizards of terrifying size. Some had wings. We know these things from skeletons that have been found in ancient rocks. Certainly no man ever saw the giant reptiles, and their very existence was not known in the days when men believed in dragons.

The fabulous dragons were supposed to be offspring of an eagle and a wolf. They breathed fire and this fiery breath was poisonous. Their bodies were covered with scales forming an armor so tough that is was very hard indeed for a sword to pierce it. Most of the great countries of ancient times used the dragon in art as a symbol of strength. In early Christian legends the dragon (the spirit of evil) was said to have been killed by St. George, St. Martha and others. As the tales of the saints were told and retold they changed gradually into the poetic stories we know. Sometimes we speak of a fiery or a strict person as a dragon.

The dragon was a most important figure in Chinese legends, and to a somewhat smaller degree among Japanese stories. The emblem of the emperors of China was a dragon with five claws on his feet.

There were dragons of the air, land dragons and sea dragons. The unicorn and the rhinoceros were said to free the waters from the poison of the dragons.

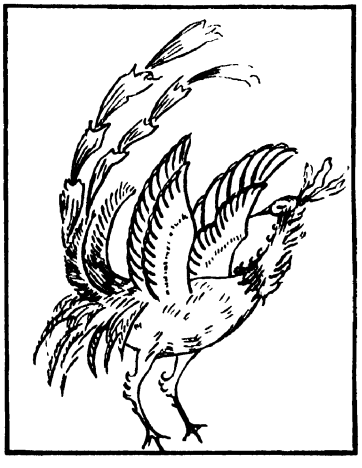
Our ancestors did not waste all their fright over the dragons; they believed that the basilisk was a brute still more to be feared. This reptile, which was considered the king of its order, was supposed to be hatched by a serpent from the egg of a cockerel, and the cockerel was the only

ST. GEORGE'S FIGHT WITH THE DRAGON

The fight of St. George with the dragon is supposed to represent the triumph of Christianity over paganism. However, in the Middle Ages most people believed that a fight with a real dragon actually took place.

creature of which it was afraid. A glance from the basilisk's terrible eye was said to kill a man, while the creature was supposed to be so charged with poison that it infected the air, so that all living things, plants, herbs, beasts and birds fell dead wherever it went. We can guess for ourselves what this frightful monster really was. It was a lizard living upon little insects and small creatures frequenting the water and foliage in which it lived.

That gives us an idea of the power which our ancestors had of frightening themselves over innocent animals. They believed that there were creatures called satyrs, which had the head, horns, legs and feet of goats and the bodies of men. Then there were all manner of stories of hairy men with tails, which we know were distorted accounts of the great apes.



The phœnix, which died in flames and arose again from its own ashes.

A harpy, an ugly creature, half bird, half woman.

Every child to-day is familiar with the idea of the sphinx; but when we speak of the sphinx we think of that great image in the sands of Egypt. In the old days, however, the sphinx was a thing of real terror to men. They thought it was an actual living creature —an animal with a human head and face, the body of a lion, the wings of a giant bird, and the tail of a dragon.

But the griffin was still more to be feared. This was a creature which had the head and neck of an eagle a hundred times enlarged, and the body of a lion eight times as big as that of an ordinary lion. His talons were said to be as long as the horns of an ox, while his bones were so great that his ribs made bows for the stoutest warriors. Alice met a griffin (or gryphon) in Wonderland. There's a picture of him on this page, just below.

We must not forget the phœnix. This was a marvelous bird, sacred to the sun. It was as big as an eagle, with brilliant golden plumage round the neck, while the rest of the body was a purple color. The tail was composed of long and brilliantly colored feathers. Here, undoubtedly, we have the golden pheasant, which we may see any day at the zoo. It is not as big as an eagle; it does not rise alive from its own dead body;

A griffin, or gryphon, had the body of a lion, the head of an eagle.

it does not live 540 years— all of which was believed at one time. But the brilliant golden pheasant otherwise answers the description which the old naturalists gave the phœnix. Probably some one of them did see a golden pheasant, then very rare in Europe, and had to weave a tale of marvel and magic and mystery round it.

Marvelous stories were invented about the fox, the wolf, the hyena, the lion, and so forth. Men were supposed to be turned into wolves, and these "wolves" were supposed to be far more fierce than the ordinary beast of prey. Natives in India still believe that men can be turned into tigers, and the natives of Australia imagine that they themselves are inhabited by the spirit of an animal, or a tree, or a plant. Much the same sort of ideas are to be found among the savages of Africa.

How firmly the old beliefs were held we may know from expressions used to-day. We still speak of a movement which has seen evil days, and comes again to prosperity, as "rising, phœnix-like, from its ashes." We still speak of persons who like heat as "salamanders," because the salamander was be-

lieved to be able to live in fire. We still use the word "gorgon" as a term of terror and horror. The gorgons of the ancients were monsters whose heads were clad with serpents instead of hair. But our later ancestors had a gorgon of quite another kind. Their gorgon was a fearful creature living in Africa. It had the body of a giant armadillo, with a serpent-like tail, and the legs and feet of a pig, but it was all armed with great scales. The head was like an ox's, covered with coarse hair. But the eyes and the breath were the most astonishing and terrible things. Men were not quite sure which did the damage; one or the other sent forth poison which instantly killed men or animals who might attack or even approach the gorgon.

Even a child can laugh to-day at the ridiculous things which frightened the wits out of our greatest scholars and philosophers of olden time. Our ancestors wrote solemn books describing terrible adventures with these imaginary creatures. The list of impossible things in which people believed in those ages is almost endless. There was a certain sort of lamb which grew on a tree. Men drew pictures of the "vegetable lamb of Tartary." They were trying to tell of the cotton plant. There was a tree which grew out of the sea from the timber of wrecked ships and produced geese. There was a frightful thing called the chimera, an awful creature with three heads—those of a lion, a goat and a dragon. There were fabulous creatures called harpies and sirens which drew seamen to destruction. The harpy had a woman's face and body, but the talons of an eagle. The sirens of old time were supposed to have lovely voices, which drew navigators from their course at sea and lured them on to rocks, where their ships were wrecked and the crews perished.

L. Green from Gendreau, N.Y.

The sphinx at Gizeh, Egypt. It has the body of a lion and the head of a man. Once it was painted red.

Homer tells us, in the Odyssey, that the wily Odysseus (or Ulysses) thought of a way to cheat the sirens. He put wax in the ears of his sailors so that they rowed past the rocks of the sirens without hearing the songs. He had himself tied to a mast, for he wanted to listen, and listen he did as the boat went past the singing maidens. He was charmed by their melodies and tried to hurl himself toward them, but he was tied fast to

the mast, and the crew, having wax in their ears, could not hear him order them to cut the cords that bound him.

We need not be surprised that the sea gave our ancestors good scope for nightmare stories in which they could all believe. Even today the vast mysterious ocean has fascination and terror. What secrets does it hold in its deep, cold caverns? We all know the sea lion, which is simply a big seal. But it used to be considered a monster of the deep like a real lion, clad in mail. The idea must have come from some observer noticing that this seal, when dry, shows a good mane, giving it rather a lion-like look.

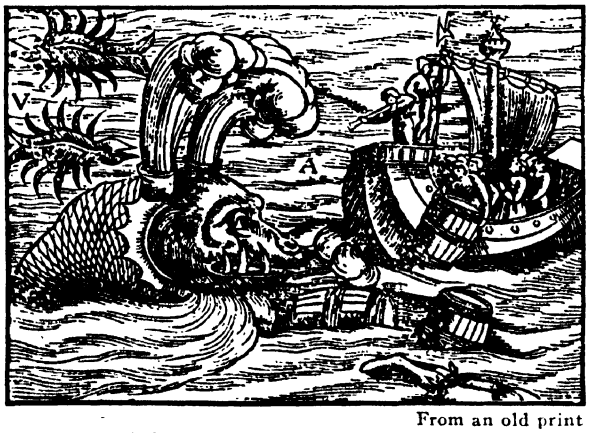
Dragon with horns and pointed tongue.

Then somebody would argue from this description that the sea really had a lion, and would add the coat of mail as an ornament to his story. We have also the sea elephant, a huge, funny-looking seal, with a snout something like a small elephant's trunk. Long ago men wrote about a sea elephant, and drew pictures of it, making it appear that the animal had the head, trunk, tusks and front legs of an elephant, the hind quarters being simply the body of a fish.

The size and strength of the whale should be enough to satisfy anybody. Many whales are more than 50 feet long; some are more than 100 feet in length. But this was not enough for our ancestors. They described the whale as being about 960 feet long and 480 feet broad. The teeth were said to be 12 feet in length, and the eyes were so big that twenty men could sit in the space of one eye.

The whale was said to have two horns, or tubes, through which it sent great columns of water that would sink any ship. Then the whale was declared to rise above the clouds and, descending upon the ship, sink it. Waterspouts may have been the real basis for this idea. Further, its head was armed with a great number of prickly horns. We can see here, through the exaggeration, that someone had tried to describe a toothed whale, but the idea of the horns about the head had arisen from the plates of baleen in the mouth of the whalebone whale, which act as a sieve for straining food. This monster was said to come up to the surface of the water, bearing quantities of sand upon its back. Sailors would approach in their ships, and, mistaking it for an island, would cast anchor in its back, land, and make a fire on it to cook their meals; then the whale, feeling the heat, would dart down into the sea, carrying men and ship.

There remains the kraken to describe. Now, the kraken was the most terrible of sea beasts. There were supposed to be sea bishops and sea monks who did all sorts of alarming things for the terrifying of unhappy mariners, but the kraken was the worst of all. It was a creature whose back measured a mile and a half in circumference, so that, as it floated on the crest of the waves, sailors mistook it, as they mistook the whale, for an island. But the kraken had arms like the tallest masts of ships, and with these it could seize the greatest vessel and pull it down beneath the waves. When the kraken sank, it was supposed to create such a whirlpool that all ships near were sucked under, and the crews drowned. It was a Norwegian who first spread the story of this monster. There can be no doubt that he really did see a very large cuttlefish. Nobody knows how big the biggest of these really is, but we know that its body is nothing like what the frightened man thought he saw, nor are its arms capable of upsetting a ship, even the small ships of those days.



From an old print

Gigantic whale with tusks and hollow tubes in its head.

The stories of the kraken grew rapidly, but they became mixed up with stories of the sea serpent, of which the

most fanciful tales were told. Probably there were sea serpents once, and it is just possible that they yet exist in the great depths of the sea, but, so far, no story about them has managed to stand unshaken. Ribbon-fishes have been mistaken for sea serpents, a line of whales or of dolphins with peculiarly shaped backs has had the same effect, and many other curious sights have misled men into telling the same old story.

Then there were the mermaids and the mermen. Poets have helped to keep the belief alive, and Matthew Arnold wrote a lovely poem on the subject, which you may read on page 484. The mermaids were supposed to be beautiful women having the tail of a fish, and the mermen were the male members of the family. The mermaids and their lords and lovers are only manatees and dugongs, or sea cows. All the mermaids of our poems and stories are lovely in feature, but the animals themselves are rather hideous, and dull, stupid things, too. They are about ten feet long, with curious fleshy muzzles ending in a sort of disc. The great virtue of the mother manatee or dugong is her love for her little one. She tends it with all the care and affection possible. When she feeds it, she raises herself in the water and clasps the little one to her, holding it with one flipper, while she swims with the other. Thus, at a distance, a sailor might imagine the pair to be a human mother and her small baby in the open water. The legend of the streaming hair could scarcely come from the bristles with which her head and face are surrounded. The manatees and dugongs live on seaweed, and no doubt observers thought that this seaweed was mermaid's hair. One kind of merman was called a sea bishop, because it was supposed to have a mitre-shaped head.

From an old print

Imaginary sea bishops. One has a mitre-shaped head. The other has "vestments" of scales.

The list of absurd things in which our forefathers believed is not nearly exhausted, but those at which we have glanced help us to understand the strange world of thought and fancy in which they lived.

There are many superstitions about snakes. People once believed that hairs from the mane or tail of a horse placed in stagnant water would turn into slender snakes. It was believed that a certain snake would steal milk from cows. You may have heard of the "hoop-snake," which takes its tail in its mouth and rolls along the path, or the "glass snake," which can be broken into pieces, but if left alone will come together again. There is a little truth in this. There is a lizard without legs which looks like a snake, but when the tail breaks off it must grow another. Oil from the fat of snakes is supposed to be good for rheumatism. This is still believed by some people; and other superstitions about animals live on, even to-day.

Many of the fabulous animals we have described in this chapter have won a place in the literature of our race. Alice, in Wonderland, met a gryphon who danced. Alice never did feel entirely at ease with him, yet he was a harmless, awkward fellow.

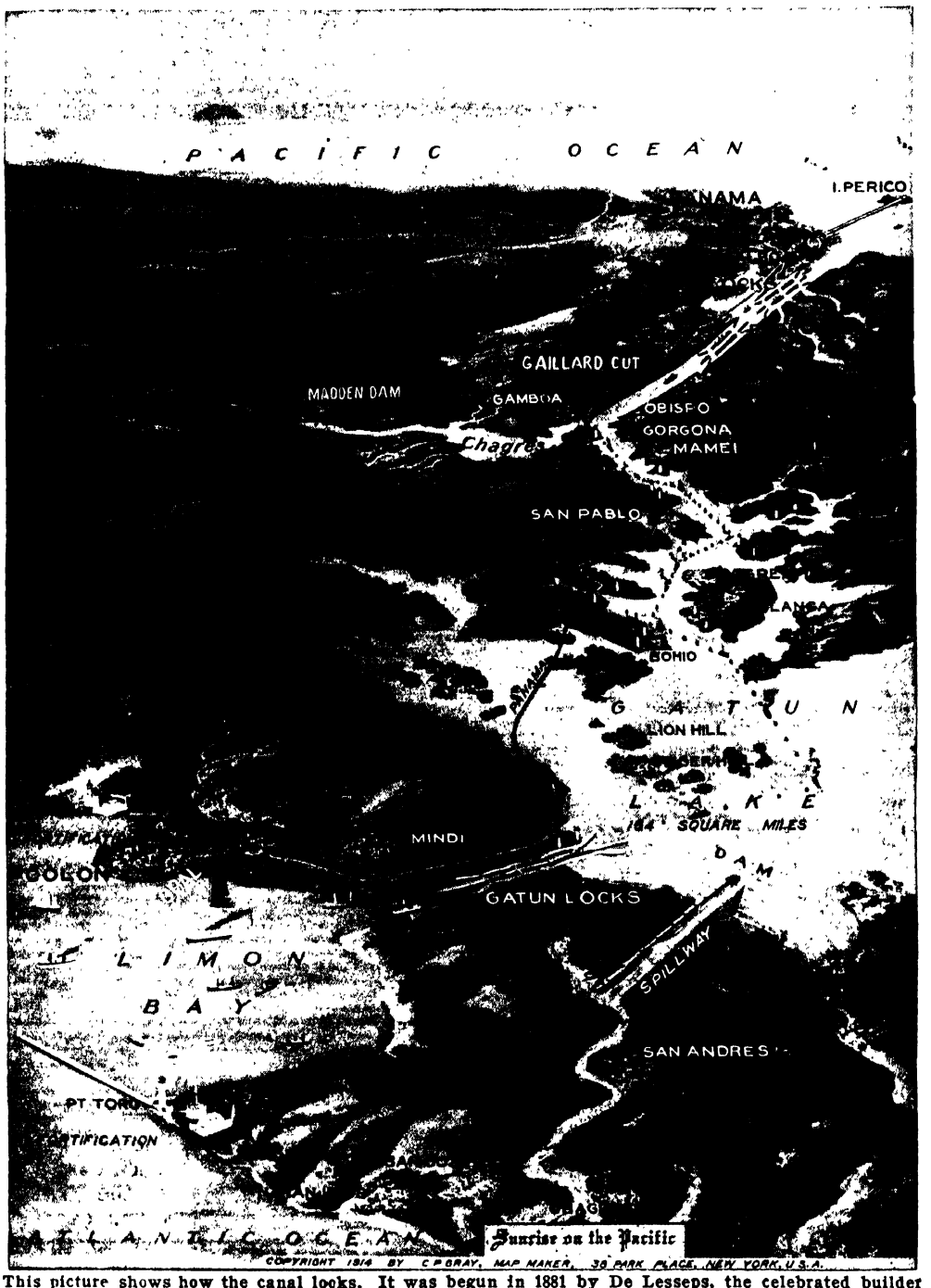
The mermaids and dragons used to be favorite subjects for poets, as we have already said. Artists loved to paint unicorns. A modern picture of unicorns, by Arthur B. Davies, is shown on page 3511.

Fantasia, the musical animation by Disney, had winged horses, unicorns, centaurs and mermaids.

The Reluctant Dragon was a story animation about a good-tempered dragon that did not want to fight mortals, but wished earnestly for a quiet home life.

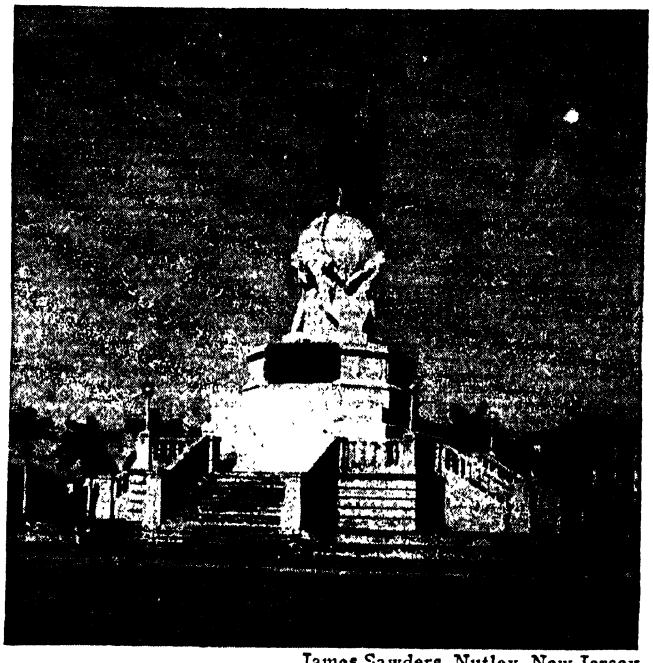
THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 490.

CUTTING THE NEW WORLD IN TWO



This picture shows how the canal looks. It was begun in 1881 by De Lesseps, the celebrated builder of the Suez Canal, but had to be abandoned after $350,000,000 had been wasted. The United States took over the work in 1903. In 1907 Colonel George W. Goethals was placed in charge. This great man put a huge army of men to work, and the big task of cutting the New World in two was completed, so that on August 13, 1914, the steamer Cristobal made a trial trip and two days later the Ancon opened the canal to the world by carrying its passengers and cargo to Balboa on the Pacific side. Now a number of great ships pass through every day, particularly tankers carrying oil from the California oil-fields. A great exposition at San Francisco, to celebrate the completion of the canal, was opened on February 20, 1915, by President Wilson pressing a button at Washington and sending a message by wireless.

THE PANAMA CANAL



James Sawders, Nutley, New Jersey
At Panama City is this statue of Balboa looking westward.

EVER since explorers found that only a few miles of land separated the Atlantic and Pacific oceans between the two continents, men had spoken of joining these two oceans by digging a canal. It was evidently so expensive and so difficult that no real attempt was made until the year 1878, when a French company secured from the Republic of Colombia the right to dig a canal through the Isthmus of Panama. At the head of the company was Ferdinand de Lesseps, who had succeeded in separating Africa from Asia by means of the Suez Canal. Spurred on by his success in this great work, he felt sure that he could accomplish this task on the other side of the world quite as easily.

It was found, however, that the two pieces of work could not be compared. The Suez Canal is only a great ditch through the land or through shallow lakes. While the weather is hot, the climate is not particularly unhealthful for Europeans, and workmen could be secured from the neighboring peoples.

In Panama tropical conditions prevail. During the rainy season vegetation grows up almost in a night, and drainage is difficult. Moreover, it used to be unhealthful, and many men engaged on the work died. Mountains had to be dug through. The attempt to get the inhabitants of the district to work was unsuccessful. The soil is so rich that a few hours work in the course of a month furnished abundant food, and therefore they could see no reason why they should work, hour after hour, in the rain or the sun, carrying away soil, blasting the rock, and doing the other hard tasks which are necessary to be done in cutting a canal.

At first it had been announced that $127,000,000 would be sufficient; then the larger sum of $180,000,000 was called for, and finally it was seen that this latter sum would not begin to see the canal completed. Though De Lesseps' plans were good, and though much of the work done was well done, some bad men got control of the company, much money was stolen and the company was thrown into debt. Finally De Lesseps was arrested, though he himself had not been guilty of dishonesty. The French people would not put any more money into the canal, and so for several years the whole plant lay idle. The houses of the canal workmen were hidden in the undergrowth which sprang up. It seemed that all traces of the French attempt were to be wiped out.

Meanwhile in the United States there was interest in the canal, and this interest grew as the western states developed. Some men wished to buy out the French company and continue the work across the Isthmus of Panama. Others preferred to cross the Isthmus of Nicaragua, farther to the north. Here the distance between the Atlantic and Pacific was much wider, but the plans included the use of a large lake and a river as part of the canal.

Another marvelous project was to cross the isthmus by means of a ship railway. An immense frame, or cradle, capable of receiving the largest ship was to be constructed.

A SHIP GOES DOWN OR UP STAIRS THROUGH LOCKS IN A CANAL

As a ship is towed into the lock, gates close behind it and some water is drawn out of the lock through pipes. This lowers the ship. Then the forward gates are opened and it is towed into the next lock. In the small picture, a ship has gone upstairs. Water, forced into the locks through pipes, lifted the ship.

This was to be mounted upon many-wheeled trucks running upon several railway tracks. These tracks on each side of the isthmus were to extend into the sea. The cradle would be pushed out into the water, the ship was to sail in, and the powerful engines would then draw the trucks out upon the land and carry the ship over to the other side of the isthmus, where it would be lowered into the sea.

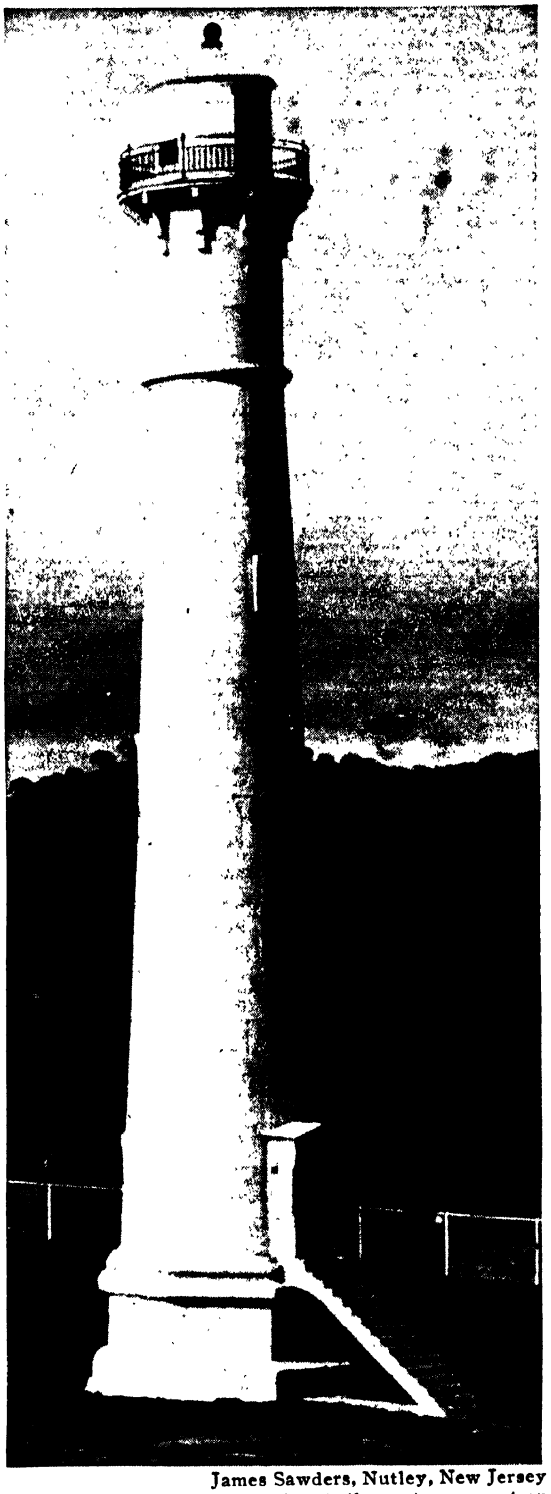
THE REPUBLIC OF PANAMA IS CREATED AND AGREES TO THE CANAL PROJECT

Finally, after much discussion, the Panama route was chosen, the French company was bought out for $40,000,000, and the United States was ready to begin. Just then the Republic of Colombia seemed to repent the bargain it had made, and to be on the point of canceling the plan. The citizens of the isthmus then declared themselves independent of Colombia (in 1903) and created the Republic of Panama. An agreement was immediately made with the new republic by which the United States agreed to pay $10,000,000, and, after ten years, $250,000 a year. More than thirty years later the annual rental was increased, by treaty, to 430-000 balboas. A balboa is about equal in value to a United States dollar.

THE LOCK CANAL IS DECIDED UPON

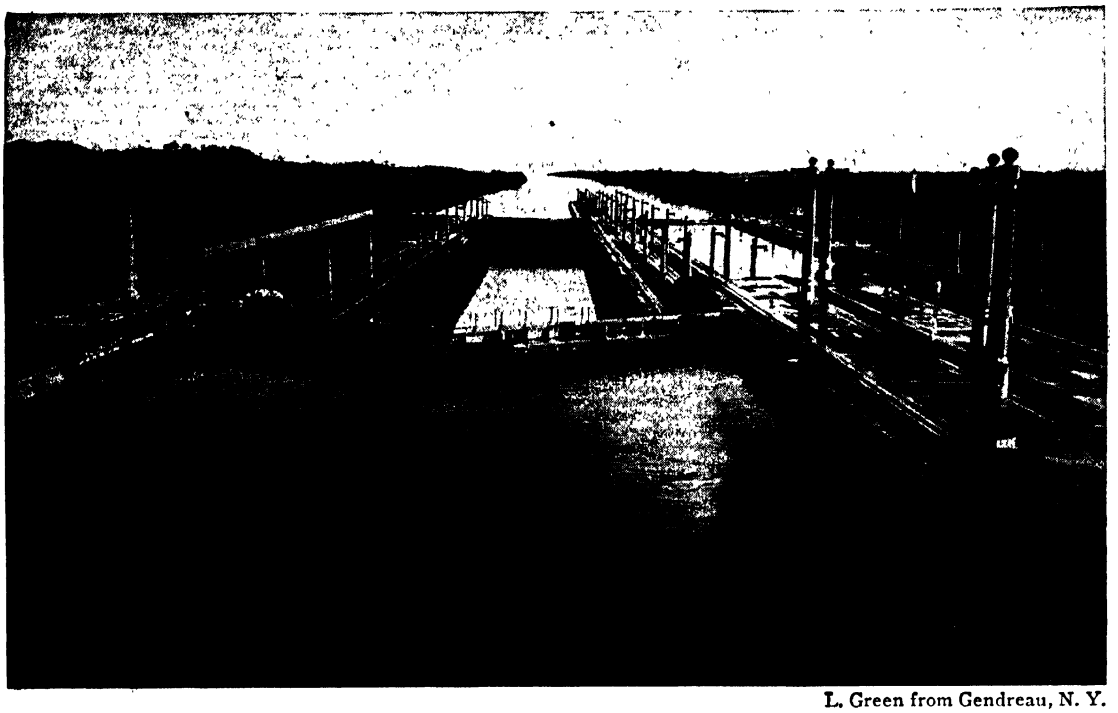
The building of a sea-level canal was at first mentioned, but soon, though less than half of the committee which had charge of the work reported in favor of a lock canal, it was decided to build the latter type, that is to say, a canal which is not level all the way across but one in which the boats are raised from one level to another by means of locks. The Republic of Panama granted to the United States a strip of land five miles wide on each side of the canal. This is called the Canal Zone. Also the privilege of controlling the health conditions of the cities of Colon and Panama was granted. At first civilian engineers were appointed, but in 1907 the entire work was placed in charge of Colonel George W. Goethals, United States Army.

Now let us see what has been done. We will imagine ourselves on board a ship in Limon Bay at the port of Colon on the Atlantic side. The map on page 360 lies open before us. "Terminal facilities," or conveniences for ships, such as safe harbors, docks, repair shops, cranes, storehouses and fuel plants were all included in the canal construction, and those at Colon and Balboa



James Sawders, Nutley, New Jersey

This beautiful lighthouse is at the extreme eastern end of the Panama Canal. Its great beacon light serves to guide ships approaching the canal at night. In the background is seen the hilly, vegetation-clad country that is typical of the canal area.



L. Green from Gendreau, N. Y.

The Gatun Locks, near the Atlantic end of the canal, have a lift of eighty-five feet. The canal cuts through the mountainous backbone of the isthmus. Ships going from either ocean first go upstairs, then through the major length of canal, then descend again to the sea.

to-day are marvels of convenience. Because of the strong "Northers," or periodic storms sweeping in from the Caribbean, two breakwaters have been built across the bay to protect ships at anchorage. At the Pacific end, freedom from storms makes this protection unnecessary, but there, as cross-currents brought silt into the dredged channel, a breakwater consisting of a soil dike was built from the mainland to Neos Island. The soil for this dike was brought from the great Culebra, or Gaillard, Cut.

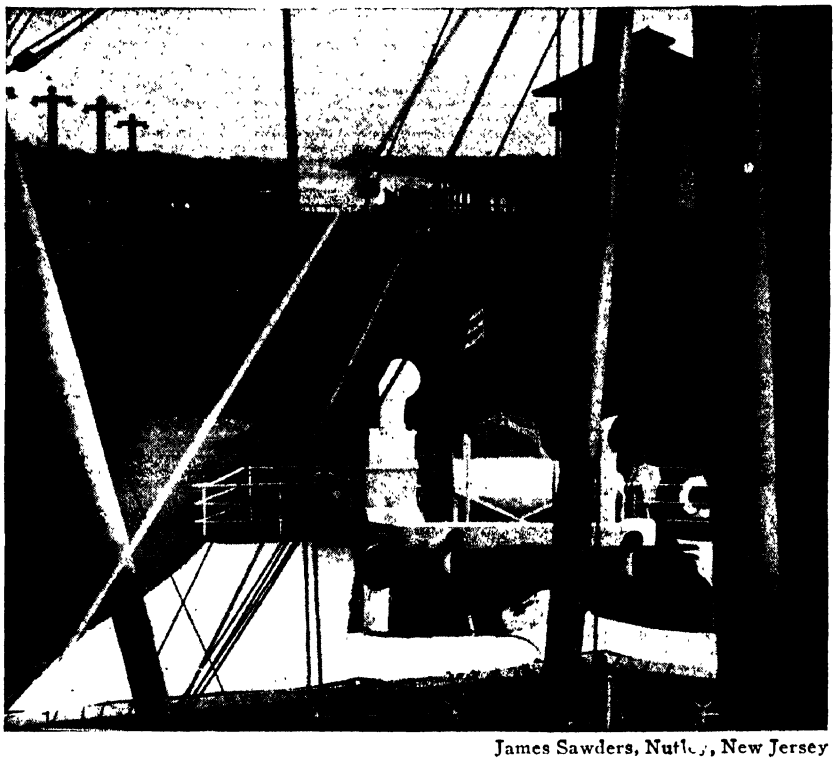
THE ACTUAL CANAL AND THE GATUN LOCKS

After reaching the sheltered water behind the breakwaters in Limon Bay our ship follows a dredged but invisible channel to a place where, with low jungle-clad banks, the canal visibly begins. Steaming slowly now, we proceed in a sea-level channel five hundred feet wide toward the great Gatun Locks seven miles inland. Dense, brilliantly green jungle begins at the water's edge; overhead black buzzards hang against the blue sky, queer pelicans solemnly bestride every post in the channel and slim herons, gray-green or blue, are fishing industriously.

As we approach Gatun Locks a huge arrow on the end of the central wall between the two tiers of chambers swings to the right and our ship slips slowly and gently into the right-hand chamber. From close quarters we can hang over the ship's side and get our impressions of the great engineering feat which is going to lift us and our thousands-of-ton ship eighty-five feet to the lake above. We can hear that our engines have stopped, and see that little electric locomotives are being fastened by gangs of colored men to our bow, centre and stern on both sides. The locks are in three steps, or flights; they are also double-chambered, and another ship is being put through at the same time as ours. Now the "mules," or locomotives, are harnessed, a great gate swings to behind us and the water boils up from a score of invisible openings operated by an invisible power hidden in the great stone walls and raising our ship to a new level. The gate ahead of us opens and we are towed into a second chamber; again the water rises; we pass into a third chamber and the process is repeated. The last gate opens and we emerge at last and look down and back to the canal eighty-five feet below.

We are in Gatun Lake now: to the right a long green mound stretches away to the hills, in its centre a stone part with gates. The mound is the great dam which at the

Atlantic end confines the waters of the Chagres River, forming the great artificial Gatun Lake which has an area of more than 164 square miles. On the Pacific side the dam is made by the Pedro Miguel Locks. Tropical rains cause a great rise in the rivers in Central America, and the only way to overcome this difficulty with the Chagres (which sometimes rises twenty-five feet in twenty-four hours) was to allow it to form into a great lake, beneath whose waters lie the sites of villages, construction camps and the former right-of-way of the Panama Railroad. At present the lake serves, when the dry season is at hand, as a reservoir from which to supply the water needed in the canal and locks, and also for the electric plant which generates the power used in the Zone.



James Sawders, Nutley, New Jersey

A freighter locked in at Gatun. The water has been lowered and the ship can go forward.

In 1935 a concrete dam, Madden Dam, was completed, across the Chagres River north of the Canal Zone boundary. This forms Madden Lake, which is used as a storage basin for water, to maintain the level in Gatun Lake during dry seasons. Beside the dam is an electric power plant.

THE VIVIDLY COLORED CLIFFS OF THE GAILLARD CUT

After leaving Gatun Lake our ship steams quickly on for thirty-two miles; here the channel is a thousand feet wide and the banks far off. Then we enter a waterway so straight and narrow that we can have no doubt that we are in the canal itself. At the Atlantic end the hills were distant and blue, now they are close upon us, not in regular formation, but as single queer green bumps rising from the plain and inclosing wide valleys. We reduce our speed to avoid washing the banks as we approach the great Gaillard Cut, usually called the Culebra Cut. It is the deepest in the canal, with a depth of 495 feet cut sheer through great hills. It is difficult as we steam slowly past the vividly colored cliffs to believe that the cut is not natural but the work of great earth-gobbling monsters, who, following in the wake of sticks of dynamite, scooped up the hills in great mouthfuls and dropped them into waiting cars to be dumped elsewhere. It is not possible to build concrete supports for these carved hillsides, for there is no rock foundation to build upon. The hills here are of curious formation, loosely packed shale which crumbles when exposed to the air. Time and time again has this loosely packed soil caused trouble. Sometimes the surface has slid right down over hard-packed rock and choked the canal with tons of soil. Sometimes the slides have gone only part way down and added weight to the bank of the canal so that the bottom has bulged upward like a dome. Giant dredges are ever at work in the channel, and now slides are lessening all the time; on the hillsides above workmen play powerful streams of water, as in placer mining, to wash material down to be dredged away, in order that the weight of rock may be reduced and the balance which the excavation disturbed restored. Then all will be smooth sailing.

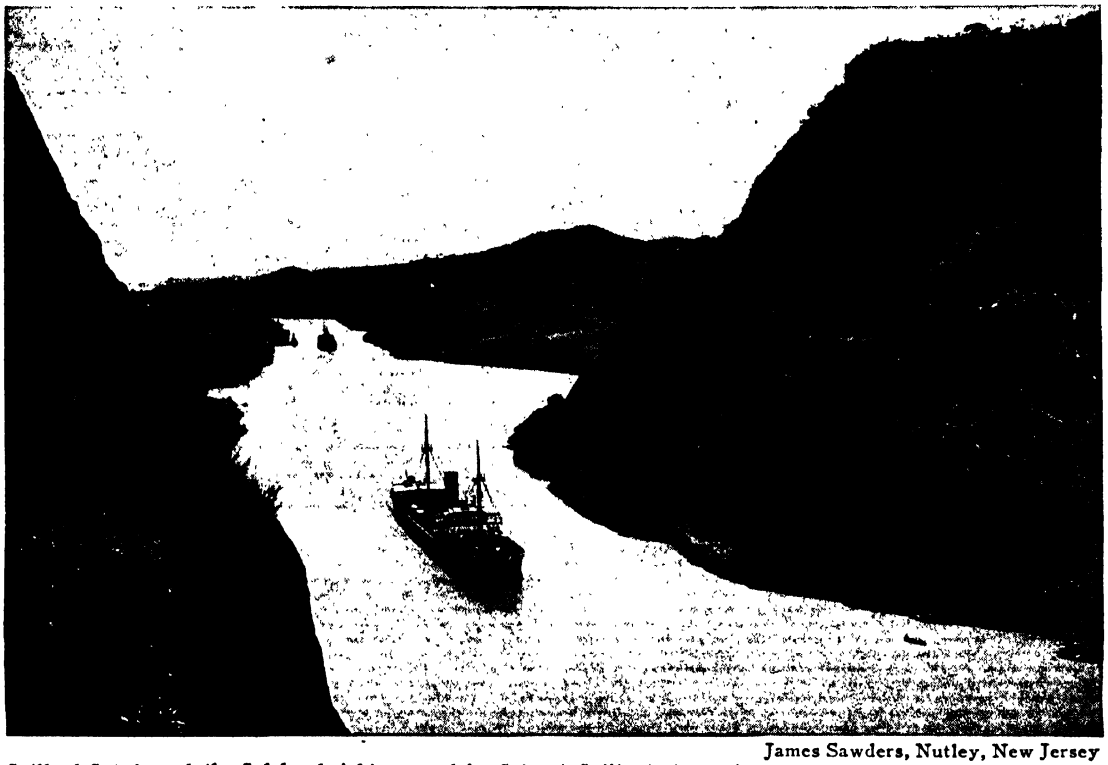
PEDRO MIGUEL LOCKS, MIRAFLORES LAKE AND LOCKS

A swing round another curve (no one must imagine that the canal runs straight) and we enter Pedro Miguel Locks, which, in single flight only, drop our ship thirty feet down to the lower level of Miraflores Lake. On the Atlantic side the difference of level is overcome by three pairs of locks in continuous flight; on the Pacific, adequate rock foundation could not be found for all three steps, so one pair is at Pedro Miguel and two others at Miraflores, a mile and a half away. When we have accomplished the descent of the last lock at Miraflores (fifty feet) our ship is on sea level once more, and proceeds for seven miles to the Pacific terminal at Balboa, the port for Panama City and Ancon. Here are the chief administrative offices of the Zone, and commercial activities are less important than at Colon, although there are fueling plants and large drydocks.

In 1855 a railroad was constructed across the isthmus, and this road is now owned by the Government. The change in the plan of the canal route put a large part of the tracks under water, and therefore a new line was laid out. Much of the material taken from the great cuts was used to make embankments for this road. When enough material had been dumped in any one place, by a very ingenious contrivance the whole railroad was lifted and moved several feet to the right or left as the case might be. Of course this work was slow, and the track was not very smooth at first. There were dozens of these temporary railroad tracks along the canal occupying one position one day and another a week later. To-day the road is beautifully smooth and the working of traffic —passenger and freight—runs on regular schedule.

SANITATION AND ORGANIZATION THE GREATEST FACTORS

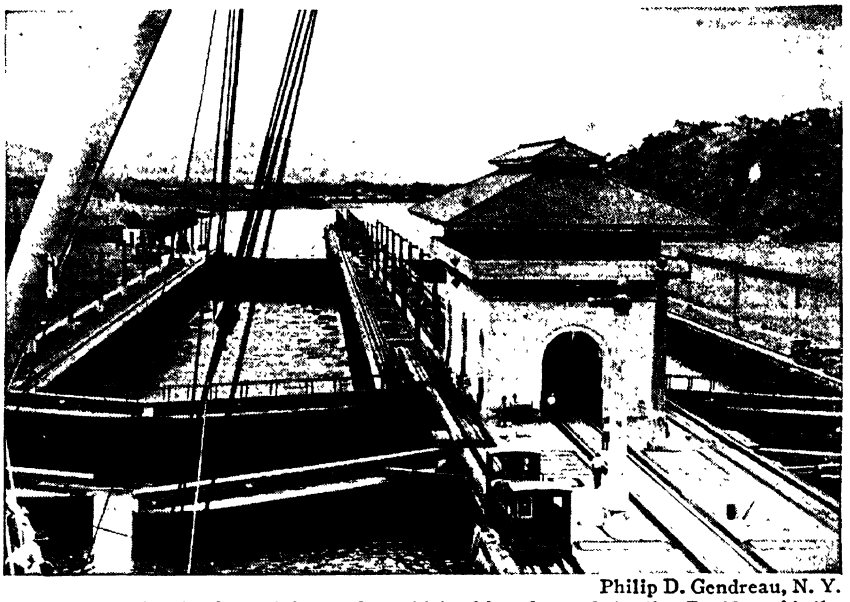
Though the actual work in digging the canal was wonderful, far surpassing anything that had ever been accomplished before in the history of mankind, the work of the United States Government in making the isthmus healthful and in taking care of its army of laborers was an even greater feat. Years ago both Panama and Colon were subject to yellow fever, which at times almost paralyzed business. Since it had been discovered that yellow fever is always caused by the bite of a particular kind of mosquito, the government engineers had a basis upon



James Sawders, Nutley, New Jersey

Gaillard Cut through the Culebra heights, named for Colonel Gaillard, the engineer in charge of this part of the work.

which to work. The sanitary force, under Dr. W. C. Gorgas, installed a system of sewerage in the two cities, caused the streets to be paved, and prevented the collection of heaps of garbage and stagnant water in which mosquitoes might breed. They kept the undergrowth cut down along the canal and sprayed the ditches with crude oil, thus killing the young mosquitoes. As a result, yellow fever has become almost unknown. Before any actual work was done upon the canal, nearly two and a half years were spent in making the region healthful.



Philip D. Gendreau, N. Y.

Miraflores Lock, the last stairway by which ships descend to the Pacific. At the right is one of the "mules," or electric locomotives, that draw the boats.

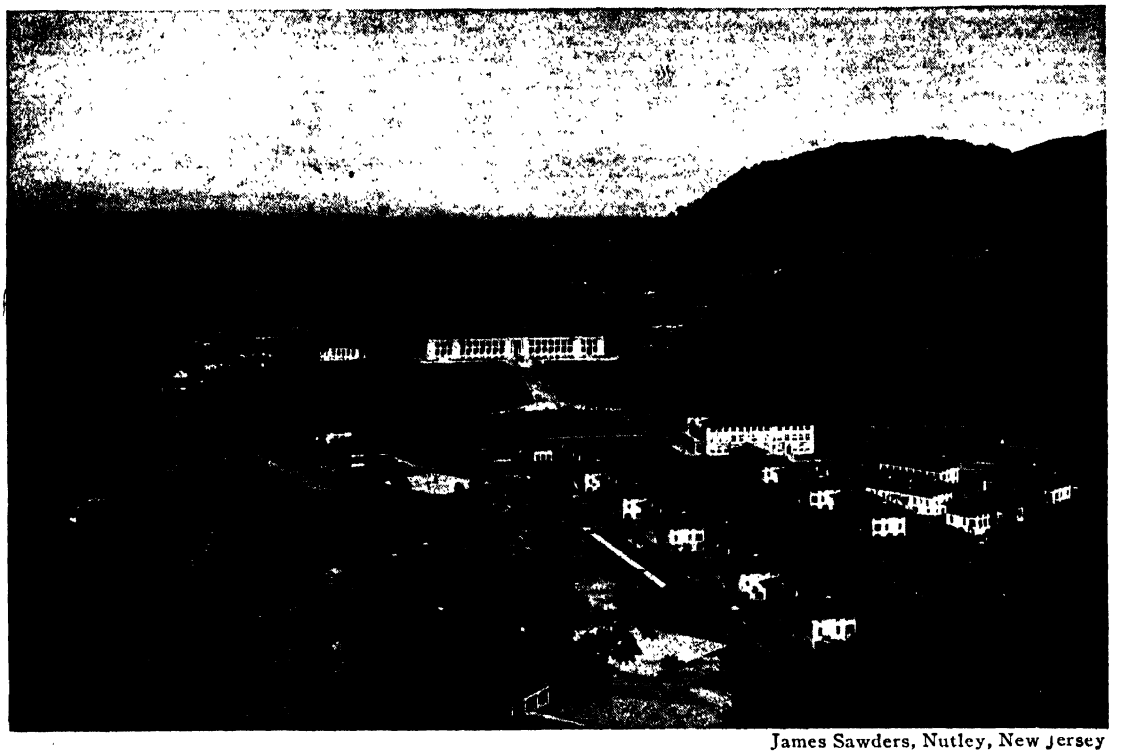
THE HOUSING AND FEEDING OF THE CANAL FORCE

Over two thousand buildings were constructed, including offices, hospitals, hotels, kitchens, shops and barracks. Many of the buildings left by the French company were repaired and made of use. It was decided, in order to be sure that the men should have a supply of well-cooked and suitable food, that the Government must undertake the work. Good wages were paid to the laborers, and they were furnished with excellent meals at low prices. Provision was also made for the men who occupied more responsible positions. They were encouraged to bring out their families. The single men lived in barracks or cottages and boarded at the hotels under government supervision. The married men were furnished with quarters and had the privilege of buying direct from the Commissary Department. This Commissary Department was very important and controlled several important manufacturing plants. It was in reality a great department store. It controlled an ice-plant which turned out about 90 tons of ice a day. It baked 14,000 loaves of bread, made 250 gallons of ice cream, roasted 1,000 pounds of coffee and was able to take care of 7,500 pieces of laundry a day. Refrigerator cars ran from its cold-storage warehouses to different parts of the Zone, and every morning the supply train left the central point, depositing such goods as were wanted at the local commissary stations, where the employees and hotels made their purchases. Excellent hospital accommodations were provided at Ancon and Colon.

In the messes arranged for the men the division was by the coin in which the men were paid. One set of accommodations was provided for those on the "gold roll" and another for those on the "silver roll." Generally Americans and Europeans were on the gold roll and the West Indians and the residents of the Zone on the silver roll. This distinction was used to avoid stressing the color line. The meals of those on the silver roll were charged for at one price, and those on the gold roll at another. In most of the mess halls for the gold-roll employees there were two dining-rooms, in one of which the employees might eat without their coats.

THE CANAL A GOOD INVESTMENT FINANCIALLY AND COMMERCIALLY

It is estimated that the canal has cost over $500,000,000. Since 1917 the tolls have been greater than the running expenses, but in only a few years have they been large enough to pay full interest on the capital invested. The average time for filling and emptying a lock chamber is fifteen minutes, but it takes between five and eight hours to



James Sawders, Nutley, New Jersey

This is the Administration Building of the canal management, in Balboa, at the Pacific end.

pass a ship through the entire length of the canal. In 1928-29, the largest year, 6,289 ships passed through. The canal is so brilliantly lighted that ships can pass through by night as well as by day. The canal can accommodate 48 ships a day, or 17,000 a year. The tolls charged are according to tonnage.

The first boat to go through any lock on the canal was the little tugboat Gatun, which was lifted through the three Gatun Locks on September 26, 1913. This was a great day for all engaged in the work, for it showed that the end of their labors was at last in sight. Soon larger ships went through. It is a difficult thing to appreciate the largeness of the task accomplished when one sees the finished canal to-day: the actual passage through goes with such smoothness and with the precision of a good watch. Jungle has covered the scars of ravaged forests and hillsides. Tropical rains and sun have sown green links and flowering hedges beside the locks, and decorated the military-looking buildings and streets of Panama and Colon with gorgeous creepers and stately palms. Everywhere there is order, cleanliness, beauty. Yet, if to-day we would truly value the achievements wrought in the Zone, we should keep ever fresh in our hearts and minds how gallantly the forces of death were faced and conquered, the difficulties of construction overcome, and the equipment, provisioning and housing of an "army in the field"—far from its base and in a strange land—organized by the indomitable men sent by the Government. The names of Goethals, Gorgas, Gaillard and Sibert have been added to the rôle of those who valiantly served their country, and more than their own country—the whole world.

Serious accident to the existing locks would, of course, close the canal to traffic until the damage could be repaired. This would be bad enough in time of peace; but if the accident happened in wartime, the United States fleet, or part of it, might be held up at one side of the canal when it was most urgently needed at the other in order to repel an enemy invasion fleet.

To avoid such an emergency work was begun, in 1940, on another set of locks about half a mile away from the present ones. They may cost as much as $277,000,000, and are intended primarily for the use of the United States Navy, but will probably take other ships as well.

THE NEXT STORY OF THE UNITED STATES IS IN VOLUME 2.

THE WORLD'S BREAD And BUTTER

Pictures on this page, courtesy, General Mills, Inc.
A masterpiece of the modern baker's art—bread that is firm in texture, with a crust that is deliciously crisp.

CEREAL grains, made into bread and other foods, provide the mainstay in the food supply of the civilized world. Famines and severe food shortages are usually closely concerned with the failure of grain crops, which give both man and domestic livestock a large part of their total food supply. The rise of Western civilization is said to have been made possible largely because man learned to cultivate wheat and other small grains. Prehistoric men could not give up their wanderings in quest of food until they had learned to cultivate cereals, which could be stored from one harvest to the next. Only then could they settle down and begin to develop agriculture, the first step in our civilization.

In the Stone Age people ate roasted or parched grains and a very heavy, unleavened flatbread made from coarsely ground meal. Among the ruins of the ancient Swiss lake-dwellers, who lived six thousand or seven thousand years ago, and in the tombs of the ancient Egyptians these round slabs of bread have been found, along with parched or uncooked stores of wheat, barley and millet. These slabs of bread and stores of grain were buried with the Egyptians to provide food for the dead in the after-life.

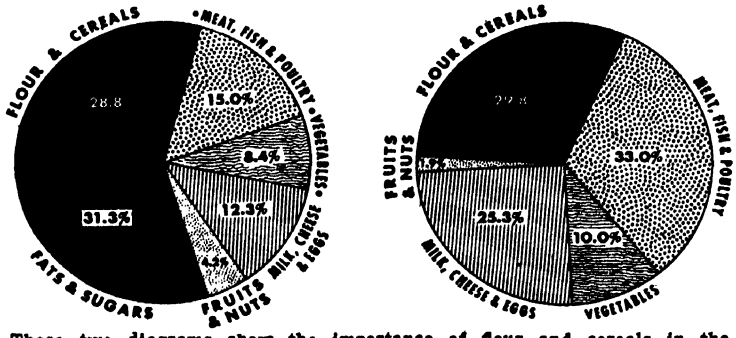
Leavened (raised) breads were also used by the Egyptians and in other early civilizations in the region of the eastern Mediterranean at least 4,000 years ago.

Many people suppose that white flour, used to make white bread, came about as a result of modern milling with steel rollers. Actually, white or nearly white bread was known thousands of years ago and was the choice bread in ancient Egypt, Greece and Rome. Popular preference for white bread continued and increased through the years.

Although there are many cereal grains—barley, rye, oats, wheat, buckwheat, corn, rice — only wheat and rye are classed as bread-grains. About four out of five of the world's inhabitants prefer and consume predominantly wheat or rice, but very little rice is consumed in the form of baked products.

Corn bread, which is popular in some parts of the United States, is made without leaven. While there is gluten in corn, it is not the same as in wheat, and a loaf can not be made from corn; but some kinds of bread made from corn are not only delicious but also are very nourishing. Corn is sometimes mixed with rye or wheat, and a good cheap bread is made of this flour.

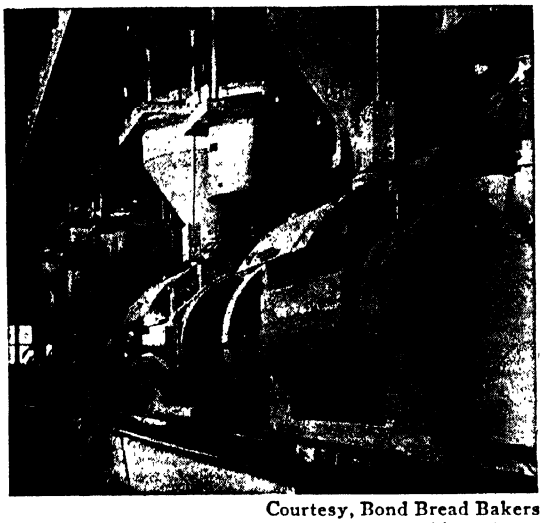
Scotch oatcakes are made from oats roughly ground be-



These two diagrams show the importance of flour and cereals in the average peacetime diet of Americans. Left: the calorie contributions of various foods. Right: the protein contributions of various foods.

tween two stones. In that way the Israelites made their bread when following Moses through the wilderness. It was unleavened, as are the Scotch oatcakes to-day. In the same way the East Indians and the people of Afghanistan still make their bread.

The principal form in which we eat unleavened bread is in hard crackers or biscuits. Some of these are very good, but they



Courtesy, Bond Bread Bakers

Mixing dough for bread. Each of the big mixing machines shown here mixes enough dough in a single operation to make a thousand loaves of bread.

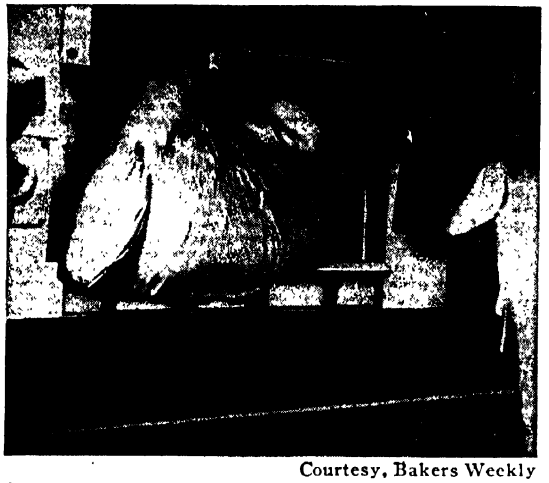
are rather dry. The Jewish people eat unleavened bread at the Passover as a reminder of former days. This bread is called Matzoh.

A very large part of the wheat in our own diet is eaten in the form of products made with white flours. These include bread, rolls, biscuits, muffins, waffles, pies, cakes, cookies, macaroni, spaghetti, noodles, crackers, etc. The use of whole-wheat flour, in which all of the wheat berry is included, is limited; flour mills provide it according to the demand. Bakers offer a variety of breads made with dark flours (wheat and rye), usually combined with varying amounts of white flours. Bread made entirely from whole-wheat flour is also on the market, although the demand for it is small in our country at the present time.

The modern baker is just as particular about the quality of his flour as the most fastidious homemaker. But because the baker makes larger amounts of dough which must be handled differently, bakers' flours are made especially to meet bakers' requirements. Over 50 per cent of the flour milled is sold to bakers. Let us see how the loaves of bread are made in a great modern bakery.

Most breads are made from flour, liquid (milk or water), yeast, sugar, salt and shortening. The special type of protein in wheat, known as gluten, is the substance which gives the soft springy quality to bread doughs when they are being kneaded, and which enables the doughs to retain the gases produced by yeast fermentation. Because of this, wheat flours can be made into soft, light, finely textured loaves of bread. Flours made from other grains do not have this type of protein and only rather heavy, solid loaves can be made from them.

The first thing the baker does is sift his flour in a huge revolving sifter. The flour comes out light and airy and ready to be mixed into a dough. In larger bakeries, the flour is sifted and aerated in a special flour-storage room and carried by flour conveyors to the mixing room, where we find the baker's dough mixer—a huge bowl, often capable of holding as much as 1,000 pounds



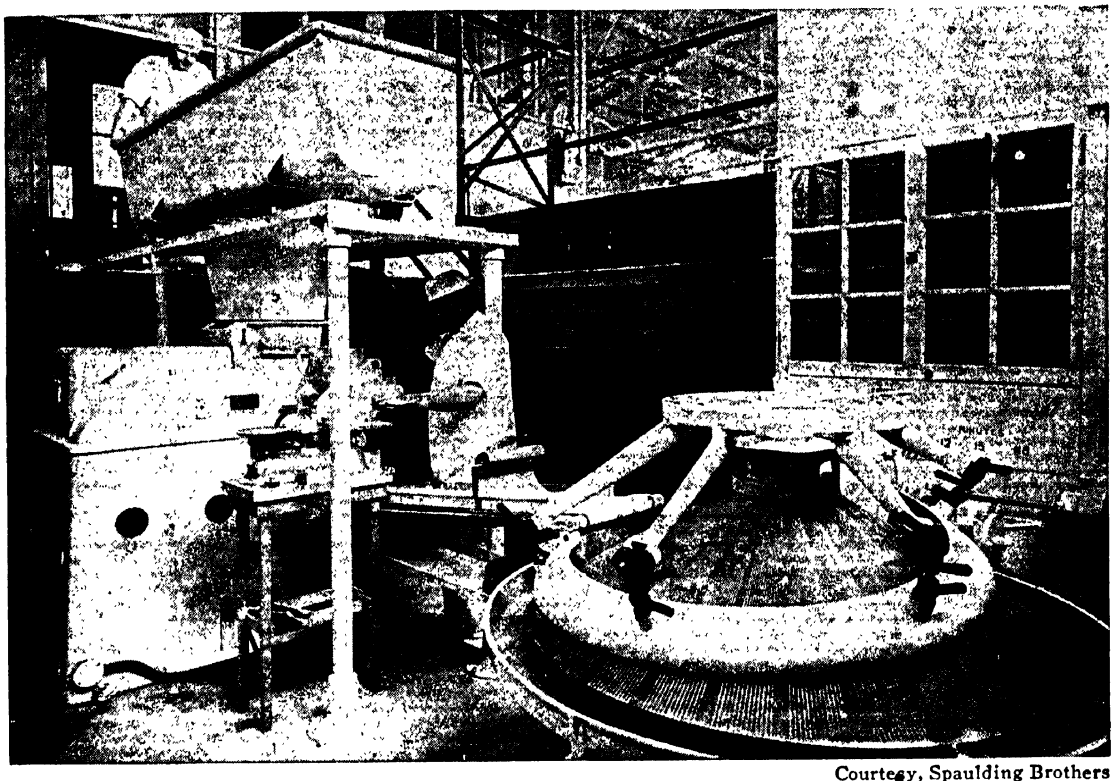
Courtesy, Bakers Weekly

When the dough has been mixed, the attendant pushes a button; the big mixer opens and the dough falls into a trough. It is now ready to prove, or rise.

or more. In this bowl there are revolving metal arms which mix the dough together and then knead and work it until the dough is smooth. The baker has learned by experience just how long each dough must be mixed for best results, and he carefully controls both the mixing time and the temperature, so as to produce a perfect loaf. The rooms and utensils are immaculately clean.

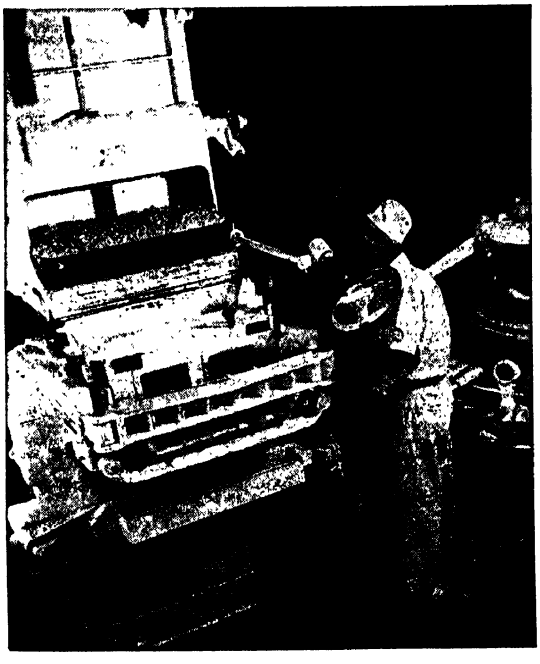
The mixed dough is then allowed to ferment—here, again, time, temperature and humidity are carefully controlled. After the dough has been properly fermented, it is placed in a machine called a divider, which

DIVIDER, ROUNDER AND MOLDER



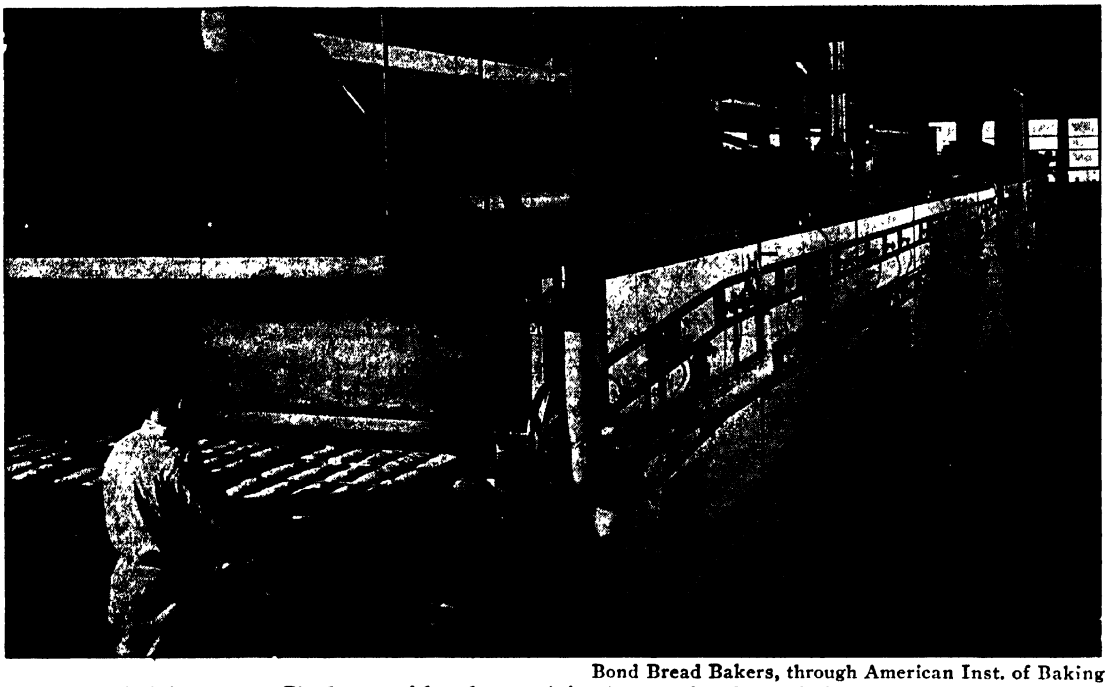
Courtesy, Spaulding Brothers

After the dough has risen, it is placed in a divider (left), where it is cut into pieces of accurate weight. It is then transferred by a conveyor belt to the rounder (right), which rolls each portion into a sphere.



Both pictures, courtesy, American Inst. of Baking

On the left we have a close-up view of the divider, which cuts dough into loaf-size portions. On the right is the molding machine, where the bread is kneaded and shaped into loaves to fit the baking pans. The pans shown here then go to the proof rooms, where the dough is given a carefully controlled second rising. A large modern bakery, where many thousands of loaves are baked each day, is a sunny, airy place, always spotlessly clean.



Bond Bread Bakers, through American Inst. of Baking

Here is a block-long oven. The loaves of bread are put in at one end and travel slowly through the oven, with its accurately regulated temperatures. By the time they reach the other end, the loaves are baked perfectly.

cuts the dough into pieces of accurate weight; usually about 18½ ounces are allowed for each 16-ounce loaf. The extra 2½ ounces provide for the loss of moisture during baking and cooling. The weighed pieces of dough are rounded into balls by a machine; then they travel on an endless belt where they again become light and fluffy. When sufficiently light, they are shaped into loaf forms and placed in baking pans.

The baker's bread pans are placed on large, movable racks, which, after they have been filled, are taken into the proofing room. This is a large cabinet supplied with washed air of a proper temperature and humidity. After about an hour, or a few minutes more, in this proofing room the loaves are properly raised and are ready for the oven.

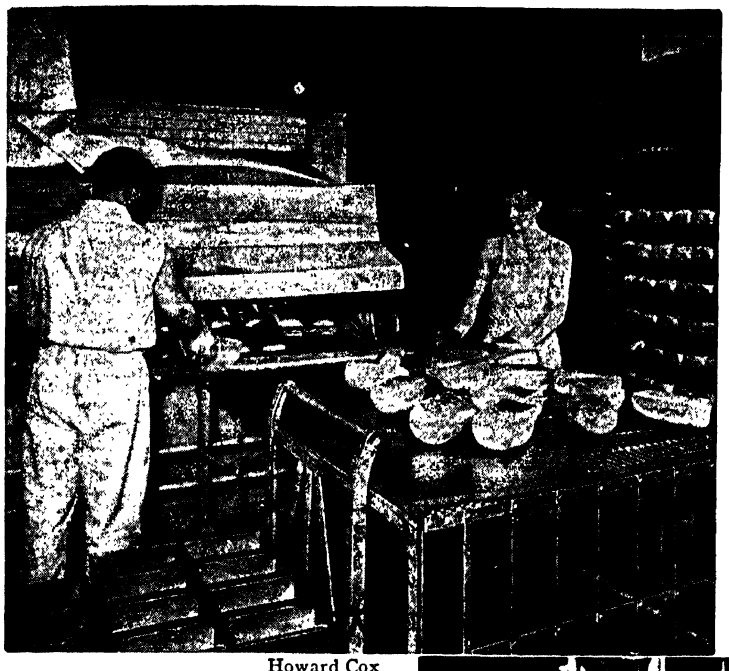
Many bakers have modern traveling ovens of various types which are so designed that each loaf of bread is baked for a definite period of time at suitable controlled temperatures, usually about 425 degrees F. to 450 degrees F. Some of these ovens remind us of a Ferris wheel, since the loaves are carried around and around on shelves until they are thoroughly baked. Other traveling ovens look very much like a huge tunnel, with the unbaked bread going in at one end and coming out at the other end, a rich golden brown, each loaf perfectly baked and each exactly like the rest of the loaves.

After baking, the loaves are properly cooled to a definite temperature which the baker has found best for slicing and wrapping. In the slicing and wrapping operation the whole loaf of bread is fed in at one end of the machine and comes out at the other end as packaged slices ready for the table.

In the smaller bakeries many of the operations described above are performed by hand, the baker substituting his personal skill and craftsmanship for the mechanical equipment used in the larger shop.

Knowledge of nutrition has been unfolding steadily in recent years. So it was learned that in the established methods of milling, sufficient amounts of important vitamins and minerals naturally in the wheat grain were removed in making the white flour. Happily, at about the same time science found out how to enrich the white flour and bread with minerals and vitamins. Enriched bread can be made by using flour enriched at the mill for bread-making; or in commercial bread-making the four essential nutrients required for enrichment can be added to white-bread doughs.

Thiamin, niacin, riboflavin and iron, all of which are normally present in the wheat grains, are the four essentials required. Two other nutrients not present or not prominent



Howard Cox

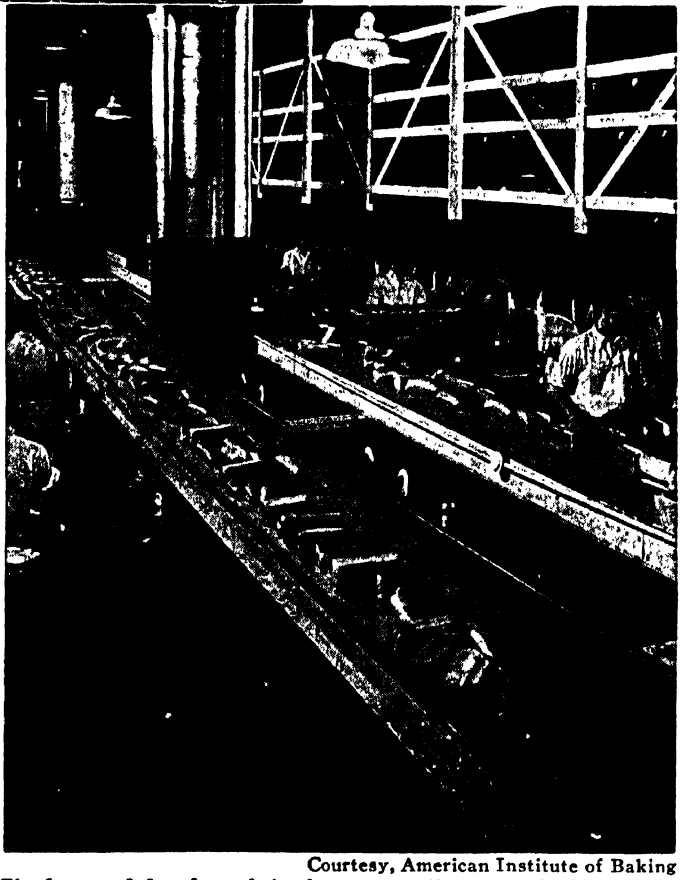
Along the walls of the oven are glass panels, and inside are electric lights, so that attendants can keep an eye on the baking. Here we see the loaves leaving the oven at last.

in the original grains, namely Vitamin D and calcium, may also be added. Neither the taste nor the baking quality of white flour is altered by enrichment.

Although the enrichment of white flour and white bread is a relatively new development in the food industry, all indications give promise that the use of such products will substantially improve the diet. Since white flour in the form of bread and other baked goods provides relatively inexpensive foods which are consumed daily and at almost every meal, it is apparent that the enrichment of these products will greatly benefit the people, and especially the poorer people whose diets are in greatest need of improvement, and who rely most on bread and other baked goods.

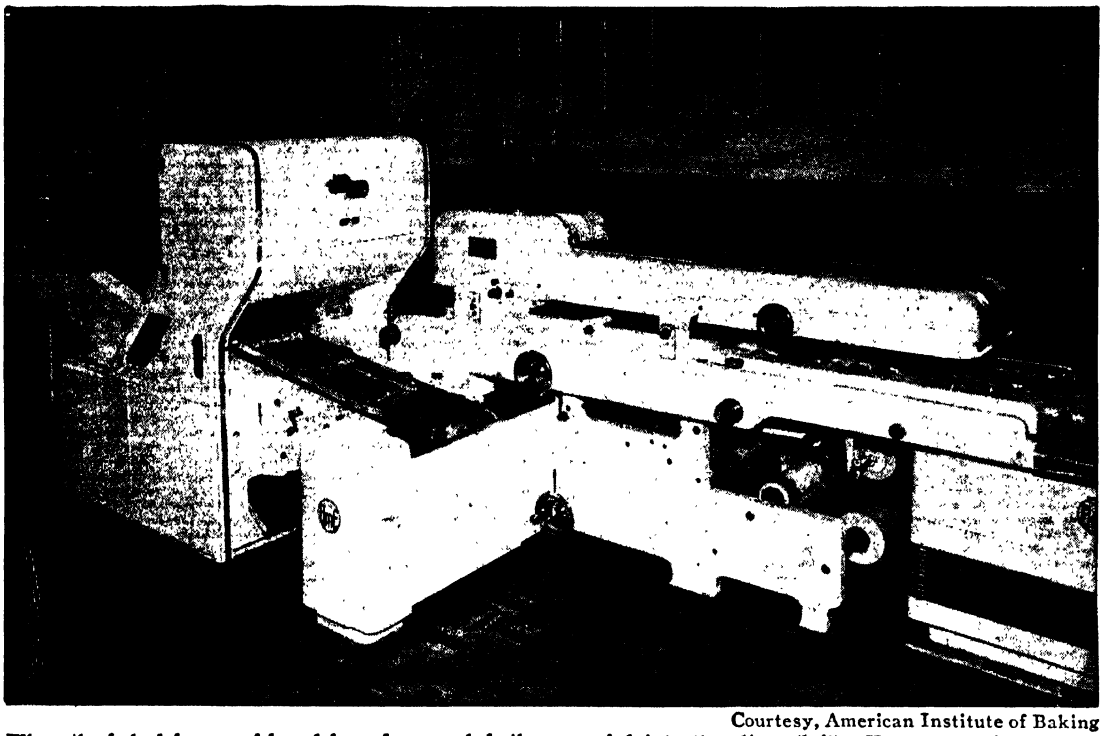
Bread is an excellent food, our best and cheapest source of necessary food energy, but it needs something else to make a perfect food. That something is milk or butter. To be sure, a glass of milk does not look very much like butter, but the butter is there, nevertheless. The milk is full of the tiniest particles of fat. It is in many tiny globules, and each globule is neatly packed up in a thin skin, or membrane. These globules are lighter than the milk, and most of them finally rise to the top. This thick layer at the top of the milk we call cream.

When the milk is churned, it is so violently knocked about that the tiny skins holding the fat break. The fat floats out, and the churning causes the little drops of fat to become joined together. That mass of fat, after proper treatment, becomes the butter that we eat. In some parts of Europe



Courtesy, American Institute of Baking

The loaves of bread are hot, of course, as they come from the oven. They cool as they travel for two hours on a slowly moving conveyor.



Courtesy, American Institute of Baking

When the baked loaves of bread have been cooled, they are fed into the slicer (left). Here a set of knives or saws, spaced to give slices as thick as desired, cuts the entire loaf in a single operation. From the slicer the loaves are conveyed automatically to the wrapping machine (right), where they are wrapped in paraffined paper or transparent cellulose film. The wrapper is sealed, and the bread is then ready for the customer.

people do not use butter as food. They use it as an ointment, but take olive oil instead of butter for food. Long ago all the people who had butter used it as ointment.

It is supposed that the Arabs first learned how to make butter. They put milk into skins and carried it on the backs of camels through the desert; but the milk was so jolted about that the fat became churned into butter, and by accident the Arabs learned how to make this valuable food. In India, country butter quickly goes bad, and so it has to be made each day. An Englishman in India usually has his supply of butter made fresh every morning by a servant who churns cow's milk in a bottle.

In southeastern Europe peasants make butter by churning milk in goatskins. The women of Armenia put milk into a sort of cradle made of goatskin. This cradle is hung upon a frame and rocked until the fat of the milk becomes butter.

The old-fashioned churn was a slender vessel with a cover in which there was a round hole. The churn-dasher was a rod with crosspieces, or else a round board at one end. This was placed in the churn, and the rod was slipped through the hole in the cover. The rod was lifted up and down regularly, and at every stroke the milk was stirred and beaten. After a time the "butter would come," and the particles could be seen floating on the milk. When they were taken out, the milk was called buttermilk.

Other forms of churns were invented which made the work easier. Most of these were made with a sort of revolving barrel, worked by turning a crank. From these it was only a step to the great churns holding many gallons and turned by machinery.

In the great dairies the cream is separated from the milk and only the cream is churned. The separator is a wonderful little machine which gets nearly all the fat from the milk. Many farmers own separators and either churn their own cream or else sell it to the butter-makers.

We show you some pictures of a great dairy, which supplies thousands of families with whole milk, buttermilk, cream and butter. It requires the milk of thousands of cows to supply its customers. Much of the milk used in a great city may come from farms a hundred or more miles away.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 405.

BREADS OF OTHER COUNTRIES

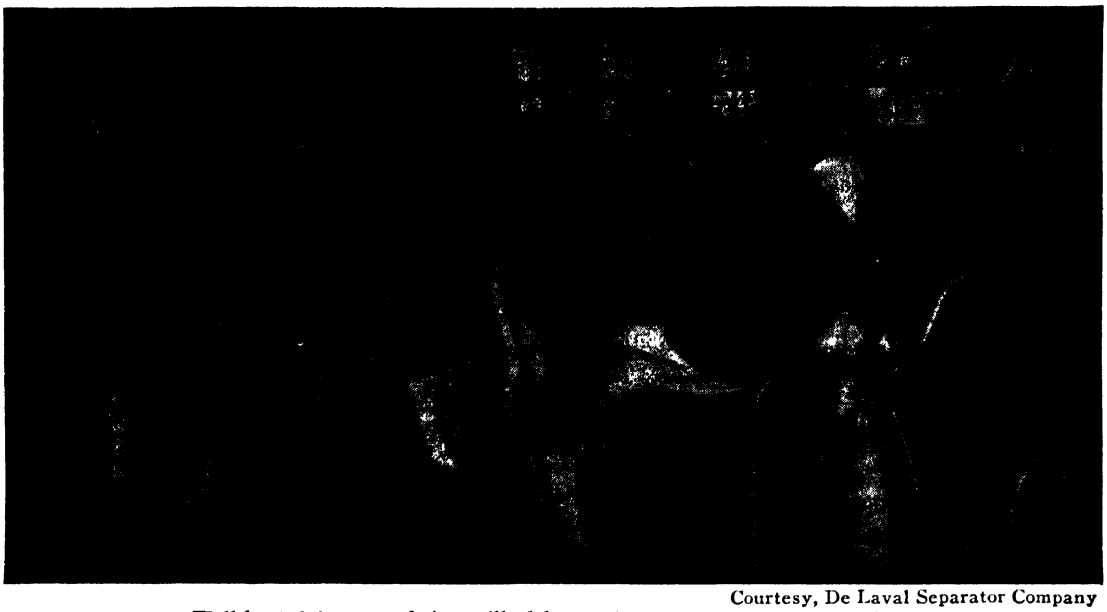
The strange animal bread is from Italy. The Scotch oatcakes next to it are unleavened.

Flat, unleavened cakes from the Near East; chain-bread from Russia; cracker-like black bread from Scandinavia.

Courtesy, Bakers Weekly

Long loaves of crusty bread covered with sesame seeds are favorites in Italy and some other countries.

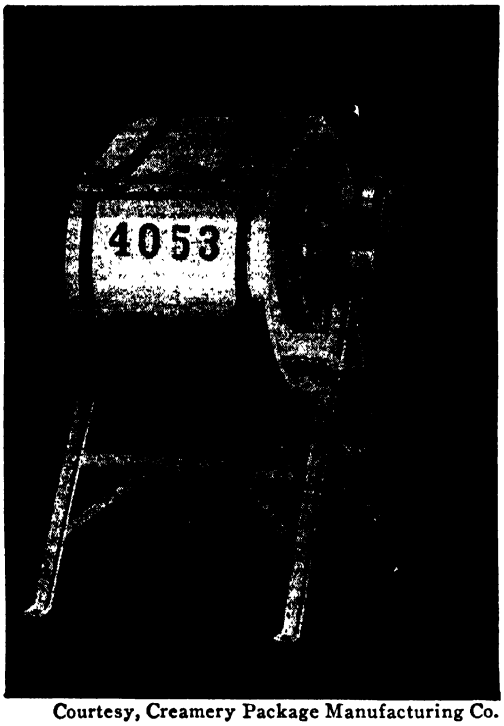
WHERE THE BUTTER COMES FROM



Courtesy, De Laval Separator Company

Well-kept dairy cows being milked by machinery in a clean modern barn.

Courtesy, De Laval Separator Company



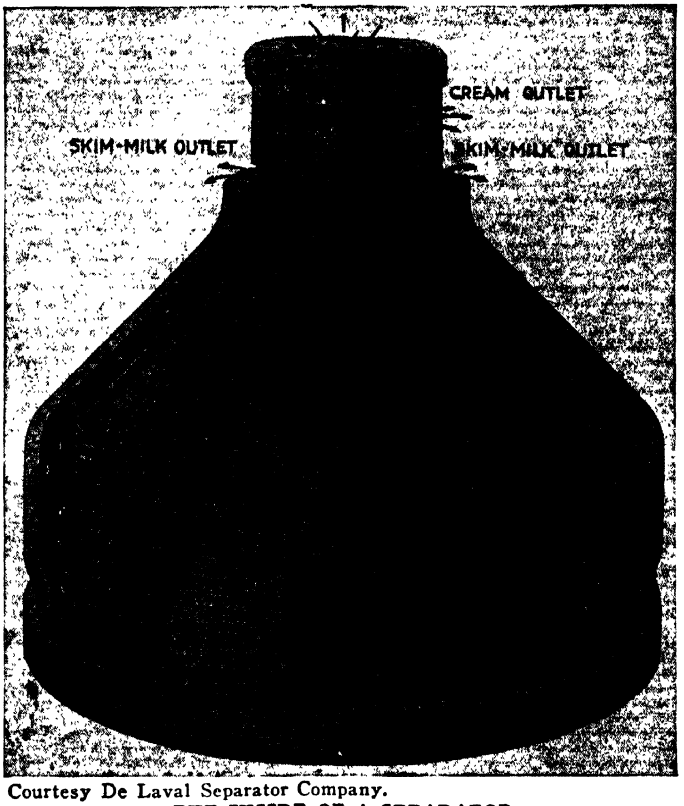
Courtesy, Creamery Package Manufacturing Co.

At the left is an "air tight" cream separator. The milk enters through the pipe at the bottom, the cream is drawn away through a pipe at the very top and the skim milk is discharged just below the cream pipe. On the next page you may read how the cream separator works. The hand churn above, or a similar churn operated by electric motor or some other form of power, is used for making butter on many farms. A great deal of our butter, however, is made in large quantities in factories to which the farmer's cream is shipped.

HOW A CREAM-SEPARATOR WORKS

WE have already told you in the story that the fat in the milk is lighter than the milk itself and therefore has a tendency to rise toward the top. When the cream has risen, it can then be poured or skimmed off. However, all of the fat does not find its way to the top, and no matter how carefully the milk is skimmed, some of the cream is always left in the milk. Then, too, the cream rises very slowly and often becomes sour before it has come to the top.

Where dairies sell most of their milk for drinking they do not run very much of their milk through a separator, unless they happen to have more milk than they can sell, at certain seasons of the year. Their customers demand the whole food value of the milk and can see the amount of cream which rises to the top of the milk through the bottle. If the amount is too small they refuse to buy the milk. Many dairies, however, find it more convenient or more profitable to sell cream or butter than whole milk, and they wish to get every particle of the cream from the milk. On such farms a separator is a necessity. For this reason several millions of these machines are in use in all parts of this and other countries.



Courtesy De Laval Separator Company.
THE INSIDE OF A SEPARATOR

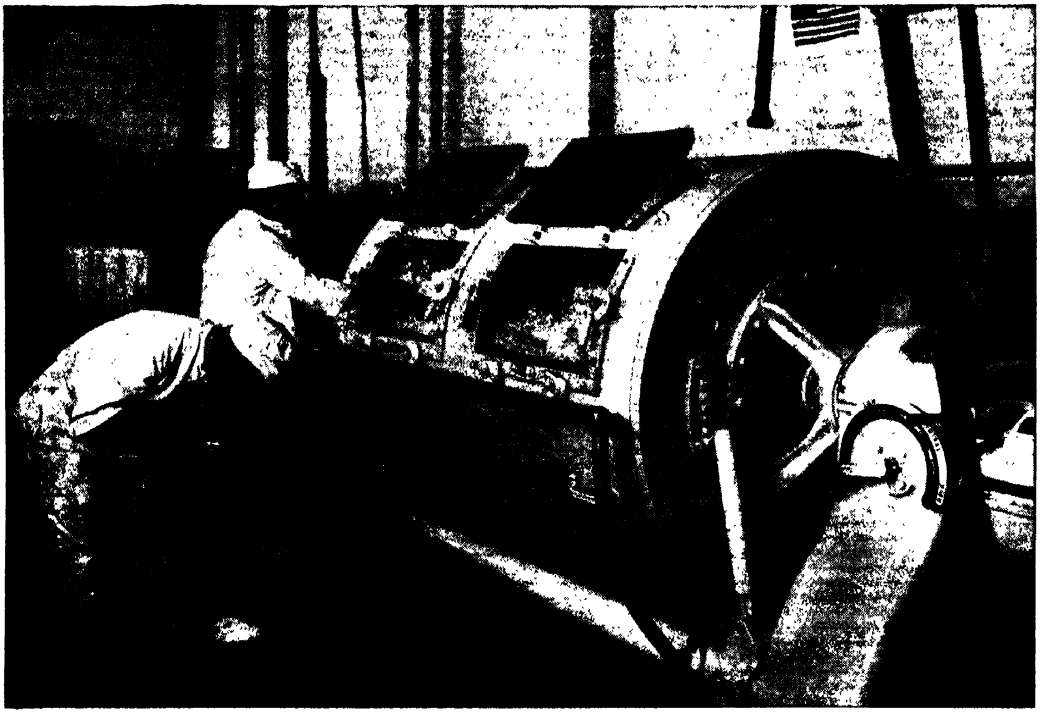
The principle of the separator is very simple. You know that when anything is whirled around in a circle the heavier parts struggle hardest to get away from the centre. Nearly seventy-five years ago men began to experiment with the idea of separating the cream from the milk on this idea, but success did not come until later. In 1877 Dr. Carl Gustaf Patrick De Laval, a young Swedish engineer, invented the first continuous cream-separator based upon this principle. Many improvements have been made since, and the separator of to-day looks quite unlike the first one, though the principle is the same.

Now let us see how one type of separator works. This is a simple hand separator but the principle is the same as that of the large machine opposite, though the milk enters from the top. The outer can, which protects the working parts and to which the spouts are attached, has been removed. What you see is the lower bowl with nearly half of the side and a little less than half of the disks cut away. These disks are really circular and are shaped like funnels, with a little space between. Now read the description in the next paragraph. Notice carefully the figures, the lettering on the picture and the direction of the arrows.

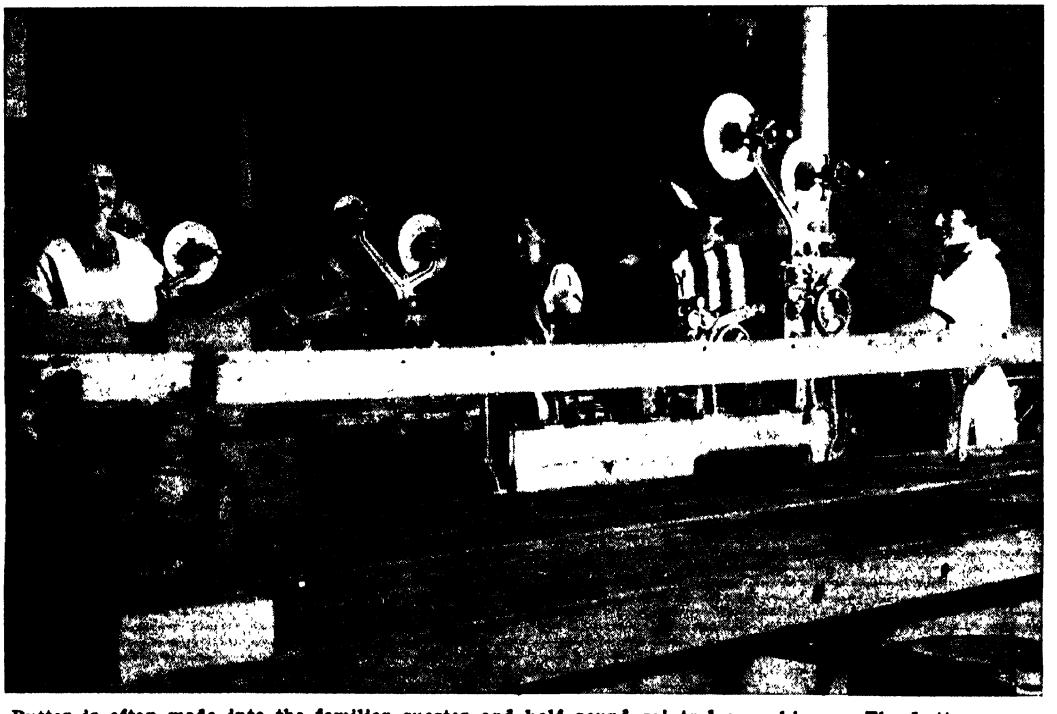
The milk is poured into the upper bowl (not shown in this picture) from the cans or pails into which it was milked. It must flow regularly and not too rapidly into the lower bowl. The flow of the milk into the lower bowl is controlled by a faucet. It is important that the milk flow evenly into the lower bowl through the channel 1, as the arrows in the picture show. This lower bowl should revolve about 6,000 revolutions per minute. If it runs too slowly a warning bell rings. The plates, or disks, in the bowl, except the top one, have large holes in them, and through these the milk gets into the spaces between the disks. Notice the figure 2 in the cut which shows the path of the milk from 1. The terrific speed has a tendency to drive the heavier part of the milk away from the centre. It follows the bottoms of the disks and reaches the outside shell. It cannot stay there because it is being pushed from behind by the milk which is running into the bowl. So it follows the line of arrows marked with the figure 4 and escapes through the skim-milk outlet. Meanwhile the lighter cream has been pushed toward the centre and goes through the holes marked 3 into a separate chamber, and escapes through the cream outlet. The cream also is being pushed from behind, and escapes through the outlet at the top. Now perhaps you can understand why the milk must pour in fast enough to create pressure.

Few machines ever invented have been of more value to the dairy farmer than the separator. The saving of both time and labor made possible by its common use is truly enormous.

MAKING BUTTER BY MACHINERY



On another page you saw how butter is made on a farm or in a small dairy. In this large factory the cream is first pasteurized and then is run into the great churns which break up the fat globules and collect them as butter. The moisture is worked out by machinery, the butter is removed from the churns and then goes to the next room to be packed for market.



Butter is often made into the familiar quarter and half pound prints by machinery. The butter moves down a conveyor channel, such as is visible in the foreground, to the kind of machine seen in the back. There it is cut, shaped, wrapped in parchment paper from the roll on top and placed in cardboard containers, a pile of which appears on the machine.

CONSERVATION

ONE of the most important problems of any civilized country is the conservation of natural resources, soil, water supplies, forests, birds and wild animals, and minerals of all kinds. Conservation, saving from waste or injury, is simply good housekeeping on a vast scale. Just as a house that is neglected and abused will eventually become ruined and uninhabitable, so a country will become impoverished and unlivable if its forests are destroyed, its streams polluted, its soil washed or blown away and its minerals wasted. There have been many examples of this. One of the best known is China, where centuries of working the soil without conservation have impoverished land and people.

Nature, left to herself, has ways of preserving and restoring her resources. The loose earth is tied down by a covering of grass, or by the matted roots of trees, and these not only keep the soil from being washed or blown away, but hold its moisture. The dead leaves and plants give back to the soil food that the living plants have drawn from it. Birds, animals and insects have enemies that prey upon them, but these destructive forces usually serve only to keep a just balance between them. Civilization upsets this balance of nature, for Man destroys without rebuilding, and often does away with the very forces that Nature has used to keep her scheme of things in balance. Thus, when too many trees are cut down and birds are killed or driven away, the insects and caterpillars that destroy crops and other plant life multiply greatly, for birds are more destructive to such pests than insect poisons.

When forests are ruthlessly destroyed without saving the young trees or planting new ones, we lose not only a future source of lumber, but all of the game and bird life that the forest had sheltered and fed. Cutting off the forests also affects our water sources: little springs dry up or retreat underground; the water that the roots of the trees held in the ground runs off the surface into the streams, carrying bits of the top soil with it. This water adds to the burden of the streams and rivers during the spring thaws and autumn rains, and causes disastrous floods. The soil that it carries away leaves the land impoverished and is deposited by the streams in shallow places and around the mouths of rivers, choking them and filling up their channels. This makes navigation difficult, and millions of dollars must be spent to dredge the rivers and harbors.

When the white men first came to our continent they found the greatest abundance of all kinds of animal and plant life. Forests

clothed the hills and valleys for many miles inland, and on the level inland plains where the rainfall is slight, grass spread its protecting mat over the soil and furnished food to vast herds of buffalo and smaller animals. Game was so plentiful that it seemed impossible that it could ever be exhausted. The pioneers and the generations of builders that came after them cleared the forests for farmland and for lumber, built cities and factories, diverted and dammed streams. They killed the birds and animals for food and to sell their skins and feathers, and sometimes just for sport. The streams were polluted by

Above, planting a shelterbelt; and below, the trees, after four years of growth, are over twenty feet high.

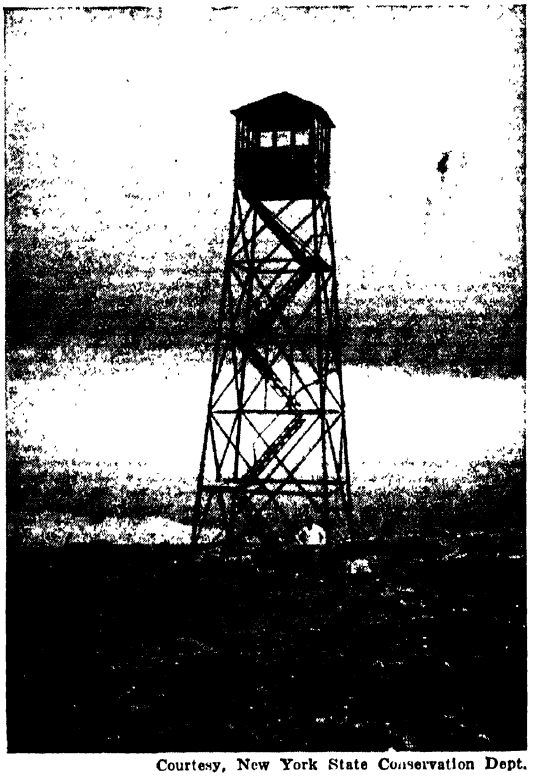
mine and factory waste and sewage, and the fish were destroyed. Of course this destruction was not carried on wilfully; people just did not realize how much was being lost that could never be replaced.

THE BEGINNING OF CONSERVATION IN NORTH AMERICA

It was not until after the middle of the 19th century that people began to make serious efforts to stop the waste of natural resources on our continent. The decline of the fisheries and the destruction of the forests were the first to be brought to the attention of the public. In 1871 the United States Government created the Commission of Fish and Fisheries, and two years later the American Association for the Advancement of Science began a movement that led to the establishment of the United States Forest Service and the creation in 1891 of the first national forest reserves. Another early conservation agency was the United States Geological Survey, which had the task of cataloguing and classifying the resources of the public domain. To this were added, in 1888, the irrigation division, and in 1907, the mining technology division which later became the Bureau of Mines. It was, however, during the administration of President Theodore Roosevelt that conservation became a living issue. President Roosevelt was himself greatly interested in the preservation of forests and wild life, and in protecting the public lands of the United States from wasteful exploitation by private interests. Other great leaders in the conservation movement at that time were Gifford Pinchot, later governor of Pennsylvania, who began the first scientific forest work in the United States at Biltmore, North Carolina,, in 1892 and headed the United States Forestry Division under Roosevelt and Taft; Major John W. Powell and Charles R. Van Hise of the Geological Survey. Daniel Carter Beard, founder of the Boy Scouts of America, the famous Canadian Naturalist, Ernest Thompson Seton and others helped.

AMERICA HAS AWAKENED TO THE NEED

This great movement, once started, has continued to increase in scope and extent down to the present. Individual states now maintain conservation agencies which cooperate with those of the Federal government, and many private organizations and societies and even individuals work with the governments in the cause of preserving for the American people their natural heritage.



Courtesy, New York State Conservation Dept.

This observation tower overlooks a forest.

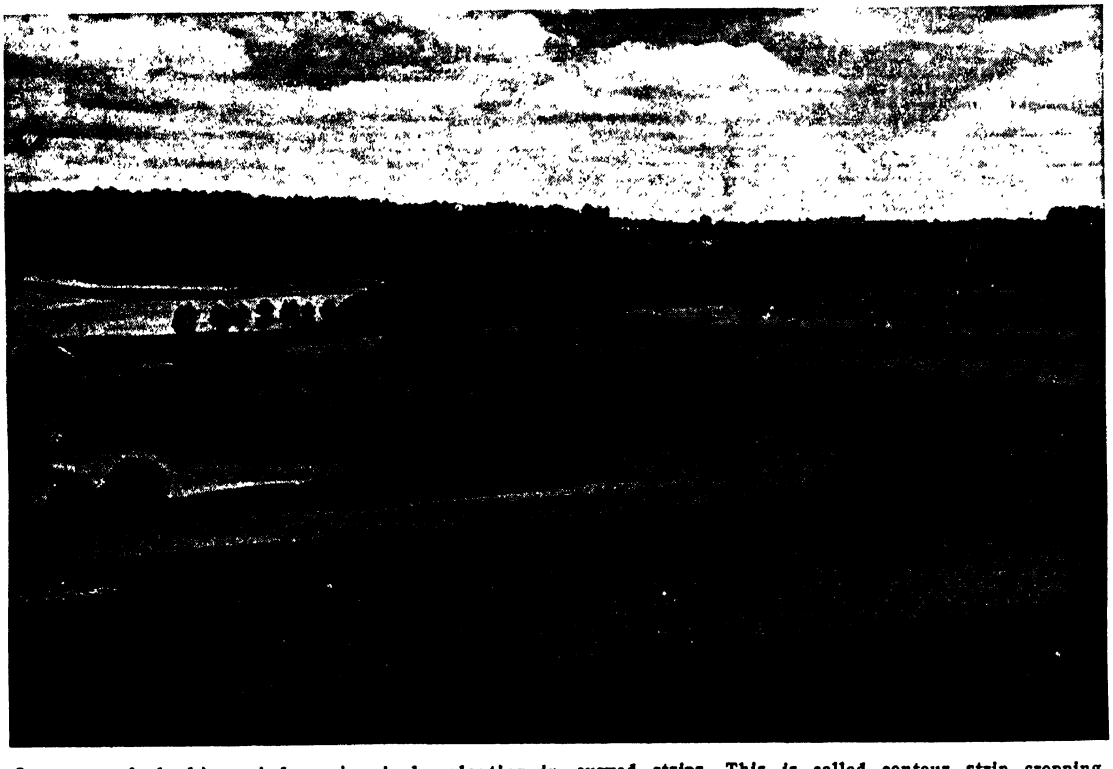
During the administration of President Franklin Delano Roosevelt the conservation movement received a great impetus. It is recognized that any genuine reform must make use of education in order to be lasting, and that a conservation program must include not only wild life, forests and fisheries, but waterways, irrigation, drainage and reclamation of the soil, for all of these are closely inter-related. When the western plains were broken by the plow and the protective web of grass stripped from the soil the farmers did not realize that strong winds blowing over the dry, level land would lift the top soil and carry it away in great dust storms, and that the rain, instead of sinking into the fields, would run off the surface, carving little gulleys and washing countless grains of rich earth down the creeks in flood-time, wasting the good farmland and making a desert of what had once been a fertile land. In the East the slopes of the Appalachian Mountains had for years been undergoing a similar process of erosion, and there are many other parts of the country where it has been going on, on a smaller scale. The conservation program with which the Federal government is fighting these

conditions is vast and complex, but it is already showing encouraging results. Undertakings such as the Hoover Dam in the Southwest, the Grand Coulee Dam in the Northwest and the Tennessee Valley Authority in the East are all designed to conserve and control water, prevent floods, reclaim the soil, aid navigation and provide power. Reforestation is a part of this work, and also the teaching of proper methods of cultivating the soil to prevent erosion and waste. One of the most interesting of the measures that have been taken is the planting of shelterbelts of trees in the Great Plains region, stretching from the Canadian border to the Panhandle of Texas. These trees protect farmlands from the wind, and conserve moisture and prevent quick drying of the soil. More than 85,000,000 trees have been planted since 1935 and more than 70 per cent of them have survived.

Among the agencies of the Federal government which co-operate with the public in conservation activities are the following: In the Department of Agriculture, the Bureau of Biological Survey, which is concerned with the preservation of wild life; the Extension Service, which sponsors the educational work of the 4-H Clubs; the Forest Service; and the Soil Conservation Service. In the Department of Commerce, the Bureau of Fisheries, which includes in its duties the administration of the Alaska fisheries and fur-seal industries. In the Department of the Interior, the Bureau of Mines; the Bureau of Reclamation, which manages irrigation projects; the Geological Survey; the National Park Service; and the Petroleum Conservation Division. In the Army Department are the Office of Chief of Engineers; the Board of Engineers for Rivers and Harbors; and the National Forest Reservation Commission; all of which have to do with matters affecting rivers and harbors and their watersheds.

In 1937 the government agency known as the CCC (Civilian Conservation Corps) was created. It set unemployed young men to work conserving and developing the natural resources of the United States. The CCC, which did much to aid the conservation program, was abolished in 1942 because of the great decrease in unemployment.

Among the private organizations that carry on a good deal of fine educational work in connection with conservation, the follow-



One way of checking wind erosion is by planting in curved strips. This is called contour strip cropping.

CCC boys are planting trees in contour strips on a steep slope, to check erosion.

ing should be mentioned: the Izaak Walton League (Junior Division), the Camp Fire Girls, Inc., the Boy Scouts of America, the Girl Scouts, Inc., the National Association of Audubon Societies, and the American Nature Association.

Canada has been fortunate in that the more intensive development of her natural resources has taken place since the need for conservation has been recognized, and she has therefore been able to profit to a large extent by the mistakes of her neighbor to the south and take measures to protect her great natural wealth before it became too late. In 1909 a Commission of Conservation was created by the Dominion Parliament. This commission of thirty-two members was charged with the duty of dealing with all questions concerning the preservation and better utilization of natural resources, with the making of investigations, inventories and recommendations to this end. Among its most important purposes are the protection of forests, supervision of fish and game, conservation of the water supply, mineral resources and products of the soil. The Advisory Board on Wild Life Protection, organized in 1916, co-ordinates the efforts of the various government departments in the preservation of wild life, particularly with respect to the Dominion acts concerning migratory birds and the game of the Northwest. The provincial governments undertake much of the conservation work within their borders, but their efforts are co-ordinated by means of conferences held under the auspices of the Dominion Department of Mines and Resources. The Dominion Department of Fisheries regulates the catch and operates hatcheries, retaining ponds and egg collecting stations for lake, river and sea fish. The publications of the Dominion Bureau of Statistics are of great assistance in the dissemination of information on natural resources. Canada has set aside vast forest areas and has established many National and Provincial Parks, game refuges and bird sanctuaries.

Although it is probable that no country has ever undertaken a conservation program on as large a scale as that which is now being carried on in the United States, conservation is by no means a new thing, especially in the field of forestry. France and Germany have had systematic forest management for two hundred years, and in the Middle Ages great attention was paid to the proper use of forests. The first university courses in forestry were given in Germany.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 503.

MAKING AN IRRIGATION DITCH

The channel of a main drainage ditch is here being dug out by machinery. Thousands of acres of semi-arid land have been made fertile by irrigation in the past few years, but much still remains to be done.

Pictures, courtesy, U. S. Department of Agriculture

The completed ditch, to conserve and control water for a large area. Government projects such as this can mean the difference between prosperity and poverty in a section. The CCC has helped many farmers.

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VOLUME II

The Book of Knowledge

The Children's Encyclopedia

THAT LEADS TO LOVE OF LEARNING

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With an Introduction by

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BOOK OF KNOWLEDGE

The Children's Encyclopedia

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E

Contents of Volume II

This is a guide to the principal contents of this volume. It is not possible to give all of the questions in the Department of Wonder, but the pages are given where such sections begin. The big Index in Volume 20 is a guide to your whole set. There you will find every subject that is in THE BOOK OF KNOWLEDGE.

The Earth

PAGE

Nature's Excavators 385
The Rocky Foundations of the Continents 513
The Earth's Rock Skeleton 629

Science

How Atoms Combine to Form Molecules 524
Molecules—Building Blocks of Matter 609
Gravitation 739

Wonder Questions

Does a plumb line always hang straight? 455
Why is so much of nature green? . . 456
What happens to our skin when we blush? 457
How does a magnifying glass make things bigger? 458
What is an aptitude test? 459
Why are there some illnesses that we can not get twice? 460
Can any plant grow under ice? . . . 461
How does a fly walk on the ceiling? . 462
How is it that a worm lives when cut in two? 463
Where is the Holland Tunnel? . . . 519
Why have the eggs of birds so many colors? 583
What is the Singing Tower? 584
Why does an owl come out by night? . 585
What bird has the longest wings? . . 586
What does a bird sing about? . . . 587
Can a fish see and hear us? 684
What is there inside the jumping bean? 685
What does the word "Eureka" mean? . 686
What makes us sneeze? 687
Why are tears salty? 688
What does horse-power mean? . . . 689

Animal Life

PAGE

Big Cats and Little Cats 490
The Wild Dogs 597
The Friendly Dogs 710
The Short-Legged Weasel Family . . 767

Plant Life

Birth, Life and Death of a Plant . . 503
How Plants Work, Move and Feel . 744

Our Own Life

The Cell, the Seat of Life 557
The Tiniest Living Things 661

Familiar Things

The Wonder of a Train 405
The Story of Oriental Rugs 441
Ice—and Machines That Make Cold . 528
By-Products 633
The Story in a Teacup 760

All Countries

The Chinese Republic 420
The Continent of Africa 464
The Rise and Fall of Japan 560
Korea 573
Ancient Empires: Sumer, Babylonia, Assyria and Chaldea 649

The United States

Explorers of North America 390
Building Homes in the New Land . . 542
Yellowstone Park, Wonderland of the West 728

The Dominion of Canada

French Canada Before the Conquest . 676

Contents of Volume II—continued

Fine Arts

	PAGE
Aegean and Classical Painting	447
A Great Light Shines	575
The Wonder Men of Florence	690

Literature

The Greatest Book in English	475
From Chaucer to Shakespeare	720

Famous Books

Robinson Crusoe	665

Stories

Robin Hood and His Merry Men	397
Robin and the Merry Little Old Woman	398
The Discontented Fir Tree	536
Read-Aloud Stories	
Pelle's New Suit	755
Little Black Sambo	756

Poetry

Fairy Songs from Midsummer Night's Dream	481
The Lepracaun; or, Fairy Shoemaker	481
Thomas the Rimer	482
The Forsaken Merman	484
The Fairies of the Caldon-Low	486
La Belle Dame sans Merci	487
Little Orphant Annie	488
The Fairies	489
The Diverting History of John Gilpin	605
My Old Kentucky Home	734
An Old Woman of the Roads	734
A Canadian Boat Song	735
The Hills of Skye	735
Hame, Hame, Hame	736
The Lake Isle of Innisfree	736
Home No More Home to Me	737
My House	737
I Remember, I Remember	738
Home, Sweet Home	738

Poetry—continued

	PAGE
Read-Aloud Poems	
My Shadow	759
The Swing	759

Golden Deeds

Bayard, the Flower of Chivalry	402

Men and Women

Men of Science	
I. Ancient and Medieval Times	588
II. The Renaissance and After	641
III. The Giants of the 1700's	700

Things to Make and Things to Do

Making a model airplane	617
The magic of a glass of water	622
The ball that answers questions	624
Knotty problems to solve	625
Suggestions for young mechanics	625
How to renew the edge of your screw-driver	626
Make and use a simple booklet	627
A fairy fountain experiment	627
A Chinaman made of peanuts	628
Can you tell what is wrong?	748
A stippled silhouette	749
A trick you can play with a book	750
May baskets made with paper strips	750
How to make a crossbow	751
Recipes for candy	752
The mystery of telegraphing thought	753

Colored Plates

The Wonder of a Train	405-408
Pictures of China	425-428
The Lovely Books of Long Ago	477-480
Members of the Great Cat Family	497-500
Crumpling and Wearing of the Earth	facing 630
How Mountain Ranges Are Formed	facing 631
The Dawn of Italy's Golden Age	693-696
A Kennelful of Dogs	713-716

The surface of the moon with its jagged mountains and its enormous craters. This is how the surface of the earth probably looked when our planet first became solid. The great changes that have taken place since that time have been due to the presence of atmosphere and of water, neither of which are to be found on the moon.

NATURE'S EXCAVATORS

HOW AIR AND WATER HAVE MADE OVER THE LAND

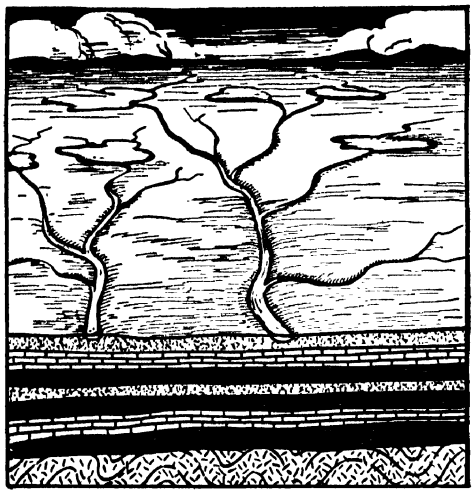
WE have seen how the earth formed and became solid and how it developed the series of shells which we know as the atmosphere, the hydrosphere, the lithosphere and the centrosphere. More than three-quarters of the earth's surface is covered by the hydrosphere, the waters of the oceans; and to this amount we must add the water of lakes and rivers.

We live on the crust of the lithosphere, a crust that is today covered with grassy plains, gardens and crop lands, forests and sandy deserts and other kinds of surface. This article will tell you how the lovely and varied surface was formed. When the earth first became solid, the land surface looked very different from the way it looks now. It probably resembled the moon's surface, with great volcanic peaks and rough craters gouged out. There were no green growing things, no soil, no sandy beaches.

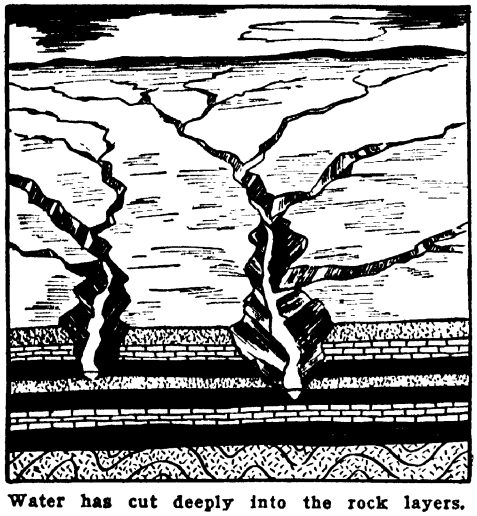
Why is the land so different today? The answer lies in the presence on the earth of the atmosphere and the water, neither of which are found upon the moon. The action of air and water—the steadily sweeping wind, the flowing streams, the expanding ice, the active oxygen, water vapor and carbon dioxide—have worked on the surface of the earth, breaking it up into fragments and carrying it here and there, until none of the early surface is left. This happened long, long ago, for the earth may be two billion years old. The changes of the pristine (first) surface which went on as the earth cooled were not seen by man. We can only infer the pristine appearance of the earth from our observations of the moon.

Air and water are the two most important geological instruments. They work so slowly that we can not perceive the changes in most cases, but they do their tasks thoroughly. The wind and the rain wear down the mountains and carry them off to the sea. The seas cut away at the shores and wear the rocks down to sandy beaches and bars. Many forces in nature are tending to remove the heights and to fill up the low places; but there are other forces which work in opposite directions.

The work of the atmosphere is twofold; it is both a chemical agent and a carrier. First let us consider its chemical work upon the rocks. As we learned in a previous



These six pictures show the effects of erosion.



Water has cut deeply into the rock layers.

The topmost sandstone surface has disappeared.

chapter, about one-fifth of air is oxygen, an active chemical agent, and there are also small amounts of carbon dioxide and water vapor which are part oxygen. As we can readily see, the conditions on the cool surface of our earth today are very different from those of long ago, when the molten rocks were just becoming solid. It was easy, then, for various forces to work upon them and change them. Many of the rock materials could leave the rock and combine with oxygen and water or with carbon dioxide.

THE BIGGEST ROCKS CAN BE CRACKED BY THE ACTION OF SUN AND RAIN

Carbon dioxide in water makes a weak acid solution, which attacks and dissolves some rocks. Then too, the sun shines daily on the exposed rocks, heating them; sudden showers quickly cool the heated surfaces and at nightfall they are cool again. When rock is heated it expands, and when it cools it contracts. Since only the surface feels these effects, the surface will often crack free from the unheated rock below. Water works its way into cracks; it freezes, and on freezing it expands and wedges the cracks a little wider.

All of these forces are at work today just as they were two billion years ago, and all of them break down the rocks and in time will wear away the mightiest of mountains. But we must get back to our original earth and see how its surface was changed from a lifeless moonscape to its present greenness.

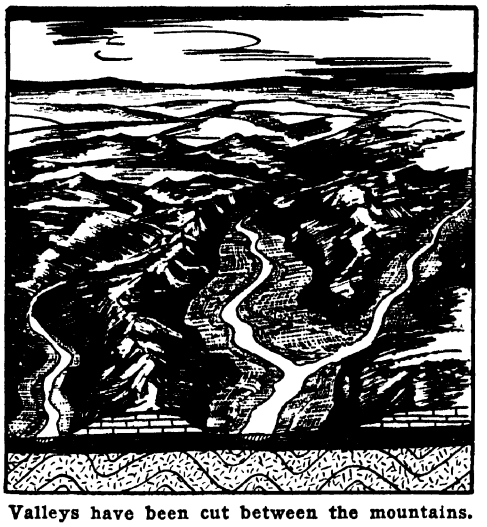
We have said that the air worked upon the rocks, breaking them down into small particles. This wearing away of the rocks is called erosion. But erosion by air alone would not be enough to wear the mountains entirely away; we should find them as vast heaps of rubble, were it not for the other geological servant, running water. The rock particles became dirt, and eventually dirt mantled the bare rock faces, making a foothold for the higher plants soon to appear on the earth.

THE RAIN PLAYS A GREAT PART IN THE LEVELING AWAY OF THE LAND SURFACE

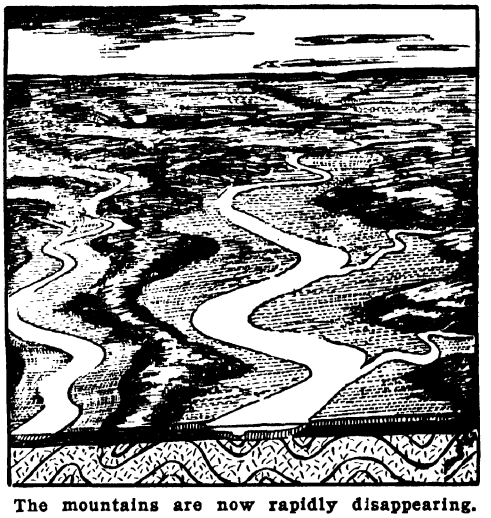
The work of running water is still going on today. When rain falls upon the land there is usually far more than enough to wet the surface, or to soak into the soil. The surplus runs off, and evenutally works its way to the sea. But as it goes, it picks up and carries along the decomposed (broken down) rock fragments from the hills. The higher the hills are, and the steeper the slope, the more the stream of water can carry. On steep slopes this leaves fresh rock exposed again to the sun and the air and the rain; and the decomposition of the surface starts over again. The water reaches a lower level, where it is joined by other water from other hills and it tries to find

its way, following the low places, to the sea.

That is just what happened to the pristine surface of the earth. As the water made its way over the uneven surface, some of the low places were deep enough to hold some of it; and in this manner lakes were formed. When a running stream filled with the mud of decomposed rock struck such a still body of water, it would naturally deposit its burden of mud; and the mud settled to the bottom of the lake, and the lake water rose until it spilled over the next hump to fill another hollow. Such a series of connected lakes would develop into a river that found its way to the sea. Sand grains and mud and boulders carried or rolled along by the flowing stream wore away the rocky floor and deepened the river's channel. Thus gradually, over a period of millions of years, the earth's surface changed from a jagged, rocky landscape, dotted with sharp peaks and lakes, into a soil-covered, rounded, rolling region, with rivers running off in a typical branching pattern.



Valleys have been cut between the mountains.



The mountains are now rapidly disappearing.

Seven of the old layers have been worn away.

THE WIND WEARS AWAY ROCKS BY FLINGING TINY GRAINS OF SAND AGAINST THEM

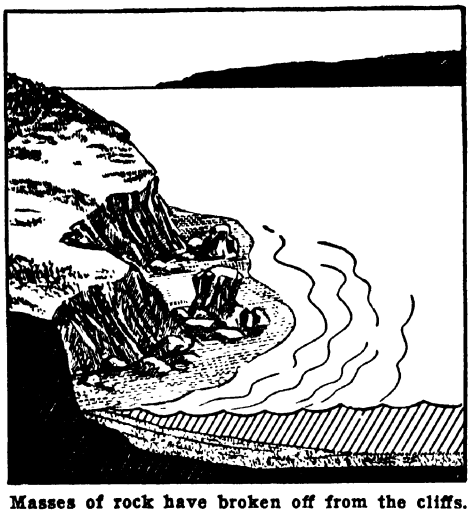
There were other agents of transportation and erosion, and they used the tools supplied by nature. Wind was one; it was, as it is today, especially effective in desert regions, where there is little vegetation to cover and hold down the rock particles. Tiny sand grains were picked up and flung against the rocks, gradually wearing them away. Anyone who has stood on a beach on a windy day knows with what force the tiny stinging grains of sand strike his ankles. Think of the work these grains can do in a thousand years.

Ice was another breaker of rocks. Slowly moving, ponderous glaciers carried tremendous boulders, dragging them along, gouging out basins in the earth floor, and widening out the valleys through which they passed. Glaciated valleys are typically U-shaped, broad and flat, with vertical walls. Stream-formed mountain valleys are V-shaped for the rapidly flowing streams cut only at the bottom.

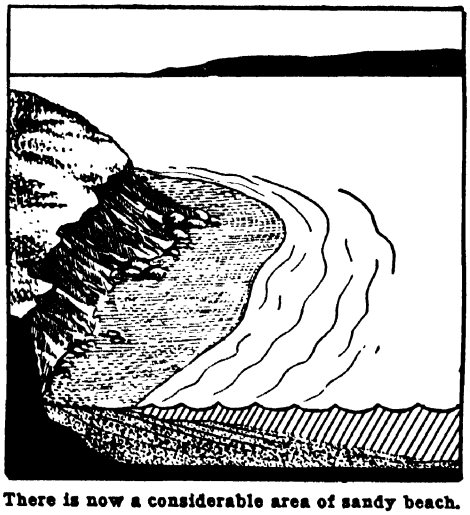
UNDERGROUND WATER BRINGS ABOUT MANY CHANGES UNDER THE SURFACE OF THE EARTH

Underground water also helped to break the early rocks into soil. It worked mostly by chemical action, dissolving away here, depositing there. It made caves and cemented the rocks, it rose to the surface to make springs, it fed the rivers, and it watered the land; and it still does all these things today. Underground water comes, of course, from snow and rain water which have seeped into the ground; and it fills the pores in the rock down to some depth beneath the surface, down to where the rock is so compressed that there is no longer any space for pores. Some of the underground

The waves are pounding away at the steep cliffs.



Masses of rock have broken off from the cliffs.



There is now a considerable area of sandy beach.

water gradually comes back up to the surface where the plant roots can reach it, carrying with it various substances needed by the plants to make their growth.

Lastly, we should think a moment of the oceans themselves as geological tools of erosion and transportation. The ceaseless activity of the waves and changes of level caused by the tides twice every day wear away at the land, cutting it down to sea level. Whenever we see high cliffs along the shore we see the effects of fairly rapid wear. Often house owners near the shore must erect walls to slow up the action of the waves and thus prevent their homes from being undermined. The famous Dover cliffs of England are kept fresh and white by the steady wear of the waves which keep them crumbling away, steadily exposing fresh chalk to the surface. Where there are beaches, they protect the shore, absorbing the shock of the breaking waves and preventing the rapid wear of the high land beyond.

The seas are carriers, too, for the currents sweeping along the beaches carry away sand and deposit it in spits and bars. Sandy Hook, at the mouth of New York Harbor, is such a spit built up by ocean current. Rockaway Beach has grown two miles southward in a very few years in the same way.

Thus wind and water and heat and cold and other forces of nature have changed the rocky barren primeval earth into the pleasant land-and-water combination on which we live.

By FREDERICK POUGH.

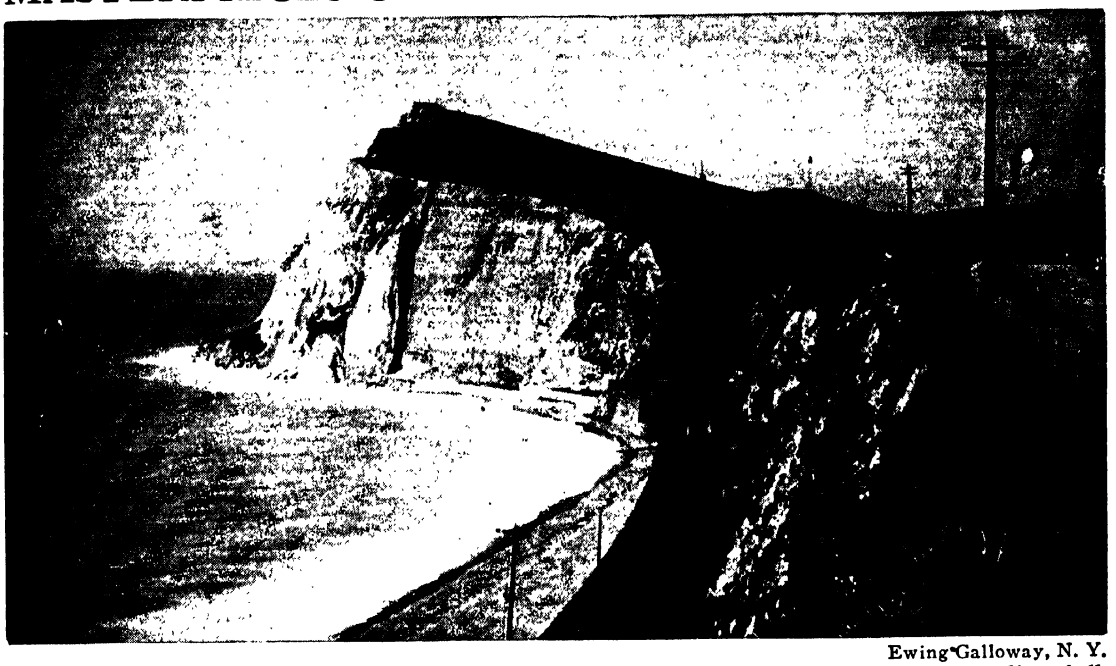
Illustrated by Thomas W. Voter

SOME WORDS WE USE IN SPEAKING OF NATURE'S EXCAVATORS

Excavators—diggers.
Erosion—wearing away.
Decomposition—breaking down of rocks into smaller pieces.
Gradation—leveling, that is, wearing down of high places and building up of low places.
Degradation—wearing down of high places.
Aggradation—building up of low places.
Pristine surface—the bare, rocky first surface of the earth.
Rubble—heaps of stones.
Glacier—a field or body of ice formed in a place where the rate of snowfall is greater than the rate of melting. Glaciers move slowly down a valley or mountain slope, as in the Alps Mountains, or over an extensive area, as in Greenland.
Glaciated valleys—valleys carved out by advancing glaciers.
Spits—points or narrow bars of land extending from a shore into the water.

THE NEXT STORY OF THE EARTH IS ON PAGE 513.

MASTERPIECES CREATED BY WIND AND WATER



Ewing Galloway, N. Y.

This picture shows Shakespeare Cliff, one of the famous Chalk Cliffs of Dover. There are corresponding chalk cliffs on the French side of the Channel, directly opposite Dover. The rock layers of the English and French cliffs correspond, showing that they were once united. The constant hammering of the waves causes the surface to keep crumbling away, continually exposing fresh chalk. That is why the cliffs always look gleaming white.

American Museum of Natural History, N. Y.

View from the top of Sheep Mountain, Montana, showing the effect of erosion in what is known as the Brule Formation. Wind and water have carved out pinnacles and columns, which look as if they must have been the work of some giant sculptor of long ago. There are few more beautiful spectacles than the play of sunlight and shadow upon these rocks, with their gorgeous coloring, ranging from dazzling white to deep red. There are somewhat similar rock formations in Bryce Canyon National Park and in Zion National Park, both in the state of Utah.

ROUTES OF EARLY EXPLORERS

This map shows you the routes taken by some of the explorers mentioned in the present article. The key at the lower left corner of the map indicates the symbol used to show the route taken by a given explorer. We also place the name of the explorer somewhere along the route shown. In certain cases authorities are not agreed as to the exact routes taken. We have chosen those accepted by a majority of scholars.

Culver Service

Leif Ericson off the coast of Wineland.

EXPLORERS OF NORTH AMERICA

JUST before the year 1,000 the Norsemen, or Northmen or Vikings, as the inhabitants of Norway, Sweden and Denmark were called, were the most skillful and daring sailors of the world. These strong, fair, blue-eyed men, wearing on their helmets the wings of birds or the horns of beasts, drove their dragon-boats into almost every harbor of Europe, and into the western seas.

They settled on the Shetland Isles, the Faroe Isles and on Ireland. In about 874 they planted a colony on Iceland and in a year or two they had discovered Greenland. Around 984, Eric the Red went across from Iceland to Greenland and started a settlement there. Thus by easy stepping-stones the Vikings came close to North America. One step more was needed.

Leif Ericson, son of Eric of the red beard, took the step in about 1,000. Exactly where he landed we do not know; he called the spot Wineland (or Vinland), because there were so many "wineberries" to be seen. Probably these were cranberries. Perhaps Wineland was on the Massachusetts coast; some historians think it may have been on Nova Scotia. Leif spent the winter at Wineland, then, in spring, loaded his vessel with timber and returned to Greenland.

Leif's brother-in-law, Thorfinn Karlsefni, took three ships and 160 people, to start a colony in Wineland. Where they landed, we do not know. One story tells us that Thorfinn's son Snorro was born in the colony, the first white child born in America. However, unfriendly Indians forced the little band to return to Greenland. Soon even the Greenland settlement was abandoned and the memory of a land to the west faded.

The great discovery of America came almost five hundred years later. From the thirteenth century on, there was a good market in Europe for spices, rare woods, precious stones and drugs from the Far East. These luxuries were usually sold through the Arabs to the Italians, who sold them to the other Europeans. Marco Polo's family were Italian traders in eastern goods (see page 80). In the fourteenth century, the usual land route to the East began to be unsafe because of the warlike Ottoman Turks. So a new way to the East was sought.

In the fifteenth century man's knowledge of geography increased greatly. The compass, the astrolabe and sailing charts and maps enabled seamen to travel with some security out of sight of land. They knew that if they could get around Africa they could find a

sea-route to Asia by the south; if they could find a passage to the east around northern Europe they would have a northern route; and if, they reasoned, the world was round, then by sailing west they should also reach China and India.

First they tried to get around Africa; and in 1488 a Portuguese sailor, Bartholomew

From an old print

Balboa "taking possession" of the Pacific Ocean.

Diaz, rounded the Cape of Good Hope. Nine years later Vasco da Gama, another Portuguese, reached India by that route.

Spain was not to be outdone. She decided to try the westward route to Asia; and on August 3, 1492, dispatched a sailor of Genoa, Christopher Columbus, with three small ships, eighty-seven men and a letter of introduction to the Khan of Cathay. On October 11, land was sighted. The story of Columbus is told on page 84.

Columbus made three other trips to America, always supposing that it was Asia. The natives he called "Indians." Europeans had reached America before Columbus, but their explorations had left no influence. Columbus was the true discoverer, for from his time on communications were kept open between Europe and America.

A second sailor of Genoese birth, John Cabot, gained permission from King Henry VII of England to seek the westward route to the Orient, claiming for England any lands he might discover on the way, or, as his commission read, "to seeke out, discover, and find whatsoever isles, countrys, regions or provinces of the heathen and infidels whatsoever they be and in what part of the world soever they be, which before this time has been unknown to all Christians." He and his three sons followed a northerly route and reached the coast of North America in 1497, somewhere in Labrador, Newfoundland or Cape Breton. In the following year they made another voyage and sailed along the coast, perhaps as far south as Chesapeake Bay; and although they did not find the spices and metals they sought, they brought back the news of the great fishing wealth of this region. Since fish was an important item of diet, fishermen from Europe were soon setting out for the cod from Newfoundland and the Grand Banks. Cabot's journeys were also important because they led to the exploration of the northern part of the continent, and because they gave England her claims to North America.

Next Portugal sent out an expedition under Gaspar Corte-Real, a slave trader. He made two voyages to Greenland and Labrador, in 1500 and 1501, but his own ship went down, and his brother, who went to find him, was drowned also.

These explorers and the people to whom they described their discoveries at home still thought that they had reached Asia. In about 1503 Amerigo Vespucci, or Americus Vespucius, who had made some trips to South America, wrote a letter in which he claimed the honor of having discovered "a new world." Four years later a German monk who was writing a book about geography decided to call this "fourth part of the world" America, after Vespucci, and America it became. (Europe, Asia and Africa were the three parts known before this.)

FERDINAND MAGELLAN, WHOSE MEN WERE THE FIRST TO SAIL AROUND THE WORLD

People still thought that the new land was near Asia and, not knowing its size, tried to get across or around it to reach the wealth of the Orient. They were partly successful. The Spaniard Balboa in 1513 crossed the Isthmus of Panama, or Darien as it used to be called, and found the Pacific Ocean. Ferdinand Magellan, a Portuguese navigator in Spanish employ, sailed around the southern end of America, and, continuing west, reached the island of Guam and then the Philippines, where he was killed. One shipload of his men went on to the Indian Ocean, around the Cape of Good Hope and home to Spain. They had circumnavigated, or sailed around, the globe!

The Spanish and Portuguese were not

satisfied merely to explore these new lands. They wanted to find ways to make their journeys pay; they wanted to plant colonies, and spread the Christian faith. As early as 1494 the Pope had drawn a line between the lands which might belong to Spain and those which Portugal might claim. Although Spain thus gained most of America as her prize, Portugal kept Brazil.

PONCE DE LEON, WHO HOPED TO FIND THE FOUNTAIN OF YOUTH

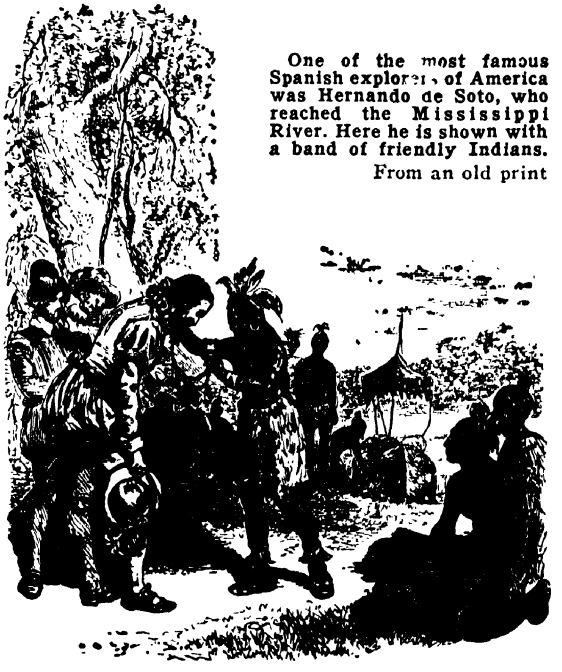
Spain explored the coast of America from Florida to Venezuela and most of the Caribbean Islands, planting many colonies. She began to work the mines, raise cattle and develop plantations. In 1513, aging Ponce de Leon, the Spanish Governor of Puerto Rico set off, so we are told, to find a spring of eternal youth of which the Indians had spoken. His search led him to a fair land that he called Florida, which means flowery. He searched everywhere for the magic fountain, drinking from every spring he found, but he remained old and his wounds still pained him. He made another trip to Florida, in 1521, to plan a colony of which he should be governor. But an Indian shot him in the thigh with a poisoned arrow, and the heartbroken old man returned to Cuba to die.

Spanish soldiers were sent out from the colonies to subdue the Indians and find more precious metals. Hernando Cortez landed in Mexico in 1519 with between 6,000 and 7,000 soldiers. After landing his troops he destroyed the ships, to make sure that the soldiers would not desert him. Then he started inland through the territory of the Aztecs. Finally he reached what is now Mexico City where Montezuma, king of the Aztecs and emperor of other Mexican peoples, paid homage to him. Later Cortez, suspecting treachery, made Montezuma a prisoner. The Mexicans then rebelled against their ruler, probably believing that Montezuma had gone over to the side of the white men. In the struggle Montezuma was killed by his own men, who elected another ruler. The fight with the white men went on. The weapons of the Spanish were too much for the Mexicans, however, and Aztec gold and jewels were soon grasped by Spanish hands; and in a similar manner a good deal of South America fell into Spanish hands. (See page 6862.)

It is estimated that by 1575 there were 175,000 Spaniards in the New World, over half in the West Indies and Mexico and the rest in Central and South America.

Another famous explorer was Hernando de Soto, who had helped to conquer Peru. When he returned to Spain the king made him governor of Cuba and gave him permission to conquer Florida. He landed in 1539 with 570 men and 223 horses, and marched into the country. De Soto treated the Indians very cruelly and made many of them march with him wearing iron chains around their necks. There were no roads, and as the Spaniards were crossing streams or swamps, the Indians would attack them.

To get rid of them the Indians said that there was much gold further north, in what is now Georgia, but they could not find it and the Indians fought them all the time. In one great battle they killed 170 Spaniards. De Soto wandered far, but found no gold. His men begged him to turn back but he refused, and after much toil and trouble reached the Mississippi River near where the city of Memphis now stands, in 1541. They thought they were the first white men to see this great stream, but we know now



One of the most famous Spanish explorers of America was Hernando de Soto, who reached the Mississippi River. Here he is shown with a band of friendly Indians. From an old print

that another Spaniard, named Pineda, had sailed into it from the Gulf of Mexico in 1519, and that Narvaez and Cabeza de Vaca had crossed it in 1528. De Soto and his men were very much amazed at its size. Finally they made boats and crossed it. They wandered along the west bank, but still could find no gold. At last the brave but cruel commander died of a fever. His companions feared to let the Indians know that he was

dead, and so one night they buried him in the great river and told the Indians that he had gone to visit the sky for a time. They then built crude boats, floated downstream, and some of them at last reached the Spanish settlement in Mexico.

FRANCISCO CORONADO, WHO CALLED THE AMERICAN BUFFALO "CROOK-BACKED COWS"

As yet there was not a single permanent settlement in what is now the United States, though Spaniards had explored all of the southern part of the country. Francisco Coronado, in 1540, had gone north from Mexico to find "cities of gold" that he had heard of. He did not find any rich cities, only Indian villages, but in the country which he called Quivira (possibly Kansas) he saw strange "crook-backed cows." These, as you can guess, were our American buffalo.

Finally Menendez, in 1565, founded the town of St. Augustine in Florida, which is therefore the oldest town in the United States. Another Spanish party founded Santa Fé in New Mexico about 1605, or a little earlier, the second oldest town.

Spain and Portugal had aided world exploration very much. Largely through their efforts two new southern routes to the Orient had been found, around Africa and around South America; and the southern part of the new continent had been explored and large areas colonized. They had found the most important entrances to South America—the Amazon and La Plata rivers—and had discovered the narrow Isthmus of Panama separating the Atlantic and Pacific oceans and linking North and South America. Moreover, they had also found the Mississippi River, the great southern entrance to North America.

THE SEARCH FOR A NORTHWESTERN PASSAGE ACROSS AMERICA TO INDIA

For many years Spain and Portugal kept the supremacy from Florida southward, but they could not prevent other nations from carrying on explorations north of Florida. France, England and Holland, who were also anxious to find a route to India, had to be content to seek a northwestern passage. This led them to the northeastern shores of North America.

In 1524 the French king sent an Italian sailor, Verrazano, in search of the passage to Asia. He reached what is now Carolina and sailed up along the coast, probably to Nova Scotia, but left no settlements; nor did he follow the course of the Hudson River, which he must have seen.

Ten years later, in 1534, a French explorer, Jacques Cartier, sailed from St. Malo for the French king. He found his way through the Strait of Belle Isle into the Gulf of St. Lawrence, and landed on the Gaspé coast, where to-day an illuminated cross marks the spot where he planted a wooden one claiming the land for France. The next year he returned and discovered the entrance to the St. Lawrence River, sailing up it to the tiny Indian village of Stadacona, where the city of Quebec now stands. There he was welcomed by the Indian chief Donnacona, who guided him further up the St. Lawrence to Hochelaga, where he named the mountain behind the village Mount Royal. Cartier's story is told more fully elsewhere. Again, in 1541, Cartier was sent out with Sieur de Roberval to found a colony on the St. Lawrence, but this attempt failed.

Cartier's voyages were very important. He mapped out the St. Lawrence River and Gulf, thus charting the great central entrance into North America which could lead by a water route almost across the continent. Moreover, his exciting descriptions of his journeys supplied the information and enthusiasm for further explorations. He had given France her claim in the New World, and, as a result of his discoveries, French fishermen began to ply their trade up the St. Lawrence River.

A second attempt at colonization by the French in North America was equally unsuccessful. In 1562 a group of French Protestants (called Huguenots) started a settlement in what is now South Carolina, but were forced to abandon it. Two years later they settled at a place which they named Carolina in Florida. After horrible hardships they began to get established and shiploads of immigrants arrived. This alarmed the Spanish, who claimed Florida. Finally a Spanish captain, Menendez, destroyed the settlement and slaughtered its people. This was the man who founded St. Augustine.

SAMUEL DE CHAMPLAIN AND THE UNHAPPY MISTAKE THAT HE MADE

The most important of all the French explorers was Samuel de Champlain, "the Father of New France." He had been a good soldier and a fine sailor, and now he made up his mind to help France to gain a part of the New World. He made two voyages in order to get knowledge, and then in 1608 led a party and founded what is now the great city of Quebec in Canada.

Now he made a great mistake which many years afterward caused the French to lose

all the land they had in America. He had heard of a great lake in the south and wished to see it. Some Indians who lived near him were going to fight the Indians who lived near the lake, and Champlain and two companions joined them. Finally they reached the great lake, which is now called Lake Champlain. They paddled on this until they met a large band of Indians near Ticonderoga. When the battle began, the Indians with Champlain would have been defeated if he had not fired his gun and killed some of the bravest war chiefs of the other side. The strange Indians had never seen a white man or heard a gun.

These Indians were Iroquois, of the Mohawk tribe, which was one of the Five Nations. They told the other tribes about the disgrace which had come to them because of the French, and all the Five Nations swore undying hatred toward that nation. They never forgave the French and, years later, when France and England were at war, they helped the English.

Champlain also explored the country to the north of the St. Lawrence River, and helped to build up the fur trade, which later brought in so much money to the French.

Father Marquette was a Jesuit missionary who came over to convert the Indians. He heard of a great river in the west and joined Louis Joliet, who was sent to find it by the governor of Canada. They started in 1673, crossed Lake Michigan, paddled up the Fox River, carried their canoes to the Wisconsin River and floated down it to the Mississippi. They followed the Mississippi down as far as the mouth of the Arkansas.

ROBERT CAVELIER, SIEUR DE LA SALLE, ONE OF THE BRAVEST MEN WHO EVER LIVED

There is one more French explorer of whom we must speak. This was Robert Cavelier, who is generally called La Salle. He seems to have been one of the bravest men that ever lived. He settled in Canada when he was only twenty-three years old, in 1666. After he determined to explore the Mississippi to its mouth, luck seemed to be against him. A ship called the Griffon, which he built in the Niagara River, was lost with valuable furs. The garrison of a fort he built mutinied and tried to kill him, but he beat them and sent them back to be punished. His best friend, Tonty, who was waiting for him in an Indian village, was almost captured by other Indians and was forced to wander in the woods. A ship bringing money to him from France was lost.

None of these misfortunes had any effect upon his spirit. When he found that he could not get a vessel to sail down the river, he said that he would go in canoes. These he and his companions carried across from the Chicago River to the Illinois River. They floated down this to the Mississippi and then started on their long journey to the Gulf of Mexico in February, 1682. The party consisted of twenty-three Frenchmen, and thirty-one Indian men, squaws and children.

LA SALLE NAMED A GREAT TERRITORY LOUISIANA, AFTER KING LOUIS XIV

They paddled on, passed the point where Marquette and Joliet had turned back, and finally reached the Gulf of Mexico. At the mouth of the river, on the 9th of April, 1682, La Salle erected a stone declaring that all the country through which the river ran was the property of France, and named it Louisiana in honor of the French king. The French claimed that this exploration of the river gave them the right to all the country drained by that river, just as they said that the exploration of the St. Lawrence gave them the right to all the country from which water flowed into that stream.

La Salle later tried to found a colony near the mouth of the Mississippi, but lost his way and landed in Texas. The explorer started by land for Canada to get help for the colony, but some of his party, bad men whom he had to punish, shot and killed him. He was only forty-four years old.

Now let us turn to the English explorers. You remember that John Cabot made two voyages for Henry VII, but that the English did not follow them up. Still the hope of finding a northwest passage to Asia did not die out entirely. After the great Queen Elizabeth came to the throne of England, that country and Spain were not friendly. One of the best ways to hurt Spain was to capture the ships bringing treasure from Mexico or South America. With light ships, but with good cannon, the Englishmen sailed about, looking for the heavy, clumsy treasure ships which were called galleons.

SIR FRANCIS DRAKE, THE ENGLISH PRIVATEER WHO SAILED AROUND THE WORLD

One of the most famous of the privateers, as the English called them, or pirates, as the Spanish called them, was Francis Drake. Like Balboa he had reached Panama and seen the Pacific, where he realized that Spanish ships were sailing. Returning to England, he fitted out a fleet of five ships and in 1577 started out for the Pacific by way of

South America. Four of his ships were lost on the way, but his own, the Golden Hind, got through the Straits of Magellan and sailed up the west coast of America, putting in at various harbors to surprise Spanish ships or stopping them on the high seas. Going as far north along the western coast as the present city of San Francisco, Drake landed and claimed the land for England, calling it "New Albion." Then, to avoid the Spanish who, he knew, would be looking for him, he started home across the Pacific. Like Magellan he stopped at the Philippines for provisions, but unlike him reached home after a three-years' round-the-world cruise.

SIR HUMPHREY GILBERT AND HIS HALF-BROTHER, SIR WALTER RALEIGH

Other British explorers were still intent upon finding the Northwest Passage. Among these was Sir Humphrey Gilbert, the half-brother of Sir Walter Raleigh. These brothers wanted not only to explore but also to found British colonies. Sir Walter gained a charter for a colony in America, and an expedition was fitted out which Sir Humphrey led in 1583. They landed in St. John's harbor in Newfoundland and, claiming the territory for England, forced the fishermen of other nations to acknowledge British rule. By fall, however, since supplies had grown low, they decided to return to England. On the way home a terrible hurricane capsized the tiny ship, the Squirrel, and Sir Humphrey was drowned. In the following year Sir Walter sent out another expedition which claimed the territory near what is now North Carolina for England under the name of Virginia. But attempts to start colonies failed.

In 1576 an Englishman, Martin Frobisher, had determined to try a more northerly route around America than had yet been followed. The story of his brave effort is told elsewhere in our book. (See Index.)

Another British explorer, John Davis, followed in Frobisher's path in 1585; only instead of going south of Baffin Land he turned north, through the strait which now bears his name.

More important than either for the future history of America was Henry Hudson. An Englishman, he was in 1609 employed by a Dutch trading company, which sent him to find the northern passage to India. His ship was the Half Moon. Finally he reached the harbor of what is now New York City, and because the river which entered there tasted salty he thought that it must have come from the Pacific. He followed it to the point where the city of Albany now stands, only to find that the stream grew narrow. Hudson returned to Holland, a disappointed man; but with him he carried furs which he had bought from the Indians. The Dutch soon sent out trading ships and established a trading post at the harbor which they called New Amsterdam and which the British later called New York.

However, Henry Hudson was still bent on finding the way to India and, in 1612, this time for an English company, he again crossed the Atlantic. His ship was the Discovery. Going north he found his way through Hudson Strait into the great inland sea which has also been called after him, Hudson Bay. It was here that Henry Hudson met his tragic end. But it was through his great work that the northern entrance to North America had been found, and Britain could lay claim to a vast territory.

WHAT THE CENTURY OF EXPLORATION IN AMERICA HAD ACCOMPLISHED

What had been gained by the first century of exploration in America? Men's knowledge of the world had been enormously increased. At the end of it they knew the general outline of South America and the entrances into the interior of that continent; they had crossed the Isthmus of Panama and sailed around the south to the Pacific, thus gaining a southern route to Asia. They had sailed up the Pacific coast of North America to San Francisco, and had crossed from Florida to California. They had discovered the three great entrances to North America—the Mississippi and St. Lawrence rivers, and Hudson Bay; and in the interior they had found the routes from the St. Lawrence to Lake Huron. The great gap in their knowledge was that they still had no idea of the immense width of North America and still hoped for a short route to the Orient either across or around it.

Besides increasing man's knowledge of geography, exploration had led to trade. Spain and Portugal took precious metals and semi-tropical products to Europe from Central and South America and carried on a trade in slaves between Africa and America; Spanish and Portuguese fishermen and those of France and England made yearly trips to Newfoundland for fish; and the Dutch collected furs from the Indians.

A third result of the exploration was the European settlement of America. In the article beginning on page 543 we take up that part of America's story.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 543.

ROBIN HOOD AND HIS MERRY MEN

ADAPTED FROM ROBIN HOOD: HIS BOOK, *By* EVA MARCH TAPPAN

IN THE green forest of Sherwood, near the town of Nottingham—so say the old English legends—there once lived a bold outlaw whose name was Robin Hood. He was leader of a band of stout cheerful bowmen who spent their days robbing the rich and befriending the poor, and their fame spread throughout the countryside. The Sheriff of Nottingham tried hard to catch Robin and his men and to punish them for taking the law into their own hands. But they were too clever for him; and many a trick was played on the slow-witted sheriff by Robin, who dearly loved a joke.

In all English history, be it true or be it legendary, no hero stands out in bolder, clearer relief than the outlaw, Robin Hood. Was he a real Englishman, the tales of whose achievements are based upon real deeds? Is Robin but a personified reminiscence of the Maytime games and the restless joy that is felt at the coming of springtime? What does it matter? Why should one care?

Robin is a ranger of the forest, an outlaw; not for crime as we count crime, but for shooting the king's deer, a "naughtiness" for which there was no atonement save that of the gallows tree. He is no rebel, he loves his king, and he is a devout attendant at church whenever the absence of the proud sheriff will permit. Of gentle birth is Robin, but far more admirable than the servility that "dearly loves a lord" is the submission of his good bowmen, not to their master's noble descent, nor even to his physical strength, for in a fair contest many a one among them is more than his match, but to some intellectual quality which makes him superior to themselves, and calls forth their unquestioning obedience.

Robin Hood as a beggar.

Robin Hood as a potter.

Robin Hood's charity.

Though he abhors the nobles as a class, he is ready to give most generously to aid the knight who in sorest distress chances to fall into the hands of the dreaded outlaw. He robs with complacence the greedy sheriff who hangs men "to get their gold and gear," but he delights in tossing a silver shilling over the shoulder of the hard-working husbandman at the plough.

His influence upon the English nation can hardly be estimated. Faithfulness to the king, love of the out-of-doors, willingness to aid whoever is in need, bravery in redressing the wrongs of the helpless—these are not qualities of the hero of romance whose example will lead the people very far astray. The king has become less arbitrary, hours of labor have been shortened that toilers may have more leisure, the moneybags of the rich have opened to aid the poor, even without the compulsory appeal of the highway robber, and the wrongs of the helpless have been more surely redressed by

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other means than the sword; but the spirit that reveals itself in this growing thoughtfulness of one for another is the same spirit whose crude manifestation centuries ago inspired the ballads of Robin and his followers and their merry life in the good greenwood.

ROBIN AND THE MERRY LITTLE OLD WOMAN

"Monday I wash and Tuesday I iron,
Wednesday I cook and I mend;
Thursday I brew and Friday I sweep,
And baking day brings the end."

SO SANG the merry little old woman as she sat at her wheel and spun; but when she came to the last line she really could not help pushing back the flaxwheel and springing to her feet. Then she held out her skirt and danced a gay little jig as she sang,—"Hey down, down, an a down!"

She curtseyed to one side of the room and then to another, and before she knew it she was curtseying to a man who stood in the open door.

"Oh, but it's Master Robin! Glad am I to set eyes on you, Master Robin. Come in, and I'll throw my best cloak over the little stool for a cushion. Don't be long standing on the threshold, Master Robin."

"It'll mayhap come to pass that I'll wish I had something to stand on," said Robin, grimly, "for the proud bishop is in the forest, and he's after me with all his men. You've no meal chest, have you, and you've no press, and you've no featherbed that'll hide me? There's but the one wee bit room, and there's not even a mousehole."

The little woman's heart beat fast. What could she do?

"I mind me well of a Saturday night," said she, "when I'd but little firewood and it was bitter cold, that you and your men brought me fine logs and then you came in yourself and gave me a pair of shoon and some brand-new hosen —oh, Master Robin, I've thought of something! Give me your mantle of green and your fine gray tunic, and do you put on my kirtle and jacket and gown, and tie my red and blue kerchief over your head—you gave it to me yourself, you did; it was on Easter Day in the morning—and do you sit down at the wheel and spin. See, you put your foot on the treadle *so*, to turn the wheel, and you twist the flax with your fingers so. Don't you get up, but just turn the wheel and grumble and mumble to yourself."

He gave the butler such a rap
His back nigh went in two,
Though he lived an hundred winters
The worse for it he would go.

It was not long before the bishop and all his men came riding up to the little old woman's house. The bishop thrust open the door and called:

"Old woman, what have you done with Robin Hood?" But Robin sat grumbling and mumbling at the wheel and answered never a word to the proud bishop.

"She's mayhap daft," said one of the bishop's men. "We'll soon find him"; and in a minute he had looked up the chimney and behind the dresser and under the wooden bedstead. Then he turned to the corner cupboard.

"You're daft yourself," said the bishop, "to look in that little place for a strong man like Robin." And all the time the spinner at the wheel sat grumbling and mumbling. It was a queer thread that was wound on the spool, but no one thought of that. It was Robin that they wanted, and they cared little what kind of thread an old woman in a cottage was a-spinning.

"He's here, your Reverence," called a man who had opened the lower door of the corner cupboard.

"Bring him out and set him on the horse," ordered the bishop, "and see to it that you treat him like a wax candle in the church. The king's bidden that the thief and outlaw be brought to him, and I well know he'll hang the rogue on a gallows so high that it will show over the whole kingdom; but he has given orders that no one shall have the

reward if the rascal has but a bruise on his finger, save that it came in a fair fight."

So the merry little old woman in Robin's tunic and Robin's green cloak was set gently on a milk-white steed. The bishop himself mounted a dapple-gray, and down the road they went.

It was the cheeriest party that one can imagine. The bishop went laughing all the way for pure delight that he had caught Robin Hood. He told more stories than one could make up in an age of leap years, and they were all about where he went and what he did in the days before he became bishop. The men were so happy at the thought of having the great reward the king had offered that they laughed at the bishop's stories louder than any one had ever laughed at them before. And as for the merry little old woman, she had the gayest time of all, though she had to keep her face muffled in her hood, and couldn't laugh aloud the least bit.

While the merry little old woman was riding off with the bishop and his men, Robin sat at the flax-wheel and spun and spun till he could no longer hear the beat of the horses' hoofs on the hard ground. No time had he to take off the kirtle and the jacket and the kerchief of red and blue, for no one knew when the proud bishop might find out that he had the wrong prisoner, and would come galloping back to the cottage on the border of the forest.

"If I can only get to my good men and true!" thought Robin; and he sprang up from the little flax-wheel with the distaff in his hand, and ran out of the open door.

All the long day had Robin been away from his bowmen, and as the twilight time drew near, they were more and more fearful of what might have befallen him. They went to the edge of the forest, and there they sat with troubled faces.

"I've heard that the sheriff was seen but two days ago on the eastern side of the wood," said Much the miller's son.

"And the proud bishop's not in his palace," muttered Will Scarlet. "Where he's gone I know not, but may the saints keep Master Robin from meeting him. He hates us men of the greenwood worse than the sheriff does, and he'd hang any one of us to the nearest oak."

"He'd not hang Master Robin," declared Much the miller's son, "for the bishop likes good red gold, and the king's offered a great reward for him alive and unhurt." The others laughed, but in a moment they were grave again, and peered anxiously through the trees in one way and then in another, while nearer came the twilight.

"What's that?" whispered Much the miller's son softly, and he fitted an arrow to the string.

"Wait; make a cross on it first," said Little John.

Something was flitting over the little moor. The soft gray mist hid the lower part of it, but the men could see what looked like the upper part of a woman's body, scurrying along through the fog in some mysterious fashion. Its arms were tossing wildly about, and it seemed to be beckoning. The head was covered with what might have been a kerchief, but it was too dusky to see clearly.

"Why, it's Master Robin!" shouted Much the miller's son. "It's Master Robin himself"; and so it was.

Meanwhile the bishop was still telling stories of what he did before he was a bishop, and the men were laughing at them, and the merry little old woman was having the gayest time of all, even though she dared not laugh out loud.

Now that the bishop had caught Robin Hood he had no fear of the greenwood rangers; and as the forest road was much nearer than the highway, down the forest road the happy company went. The merry little old woman had sometimes sat on a pillion and ridden a farm beast from the plough; but to be on a great horse like this, one that held his head so high and stepped so carefully

So while the tinker fell asleep,
Robin made haste away,
And left the tinker in the lurch
For the great shot to pay.

The butcher he answer'd jolly Robin,
"No matter where I dwell;
For a butcher I am, and to Nottingham
I am going, my flesh to sell."

Up he took him on his back,
And bare him well a mile,
Many a time he laid him down,
And shot another while.

One of his best arrows under his belt
At the friar he let fly;
The curtal friar, with his steel buckler
Did put that arrow by.

where it was rough, and galloped so lightly and easily where it was smooth — why, she had never even dreamed of such a magnificent ride. Not a word did she speak, not even when the bishop began to tell her that no gallows would be high enough to hang such a wicked outlaw. "You've stolen gold from the knights," said he, "you've stolen from the Sheriff of Nottingham, and you've even stolen from me. Glad am I to see Robin Hood—but what's that?" the bishop cried. "Who are those men, and who is their leader? And who are you?" he demanded of the merry little old woman.

Now the little woman had been taught to order herself lowly and reverently to all her betters, so before she answered the bishop she slipped down from the tall white horse and made a deep curtsey to the great man.

"If you please, sir," said she, "I think it's Robin Hood and his men."

"And who are you?" he demanded again.

"Oh, I'm nobody but a little old woman that lives in a cottage alone and spins," and then she sang in a lightsome little chirrup of a voice:—

"Monday I wash and Tuesday I iron,
Wednesday I cook and I mend;
Thursday I brew and Friday I sweep,
And baking day brings the end."

I fear that the bishop did not hear the little song, for the arrows were flying thick and fast. The little old woman slipped behind a big tree, and there she danced her

"Hey down, down, an a down!"

to her heart's content, while the fight went on.

It was not long before the great bishop was Robin's prisoner, and ere he could go free, he had to open his strong leather wallet and count out more gold than the moon had shone on in the forest for many and many a night. He laid down the goldpieces one by one, and at every piece he gave a groan that seemed to come from the very bottom of his boots.

"That's for all the world like the cry I heard from the little black pond to the westward," said Little John. "It wasn't like bird and it wasn't like beast, and now I know what it was; it was the soul of a stingy man, and he had to count over and over the money that he ought to have given away when he was alive."

As for the merry little old woman, she was a prisoner too, and such a time as she had! First there was a bigger feast than she had ever dreamed of before, and every man of Robin's followers was bound that she should eat the bit that he thought was nicest. They made her a little throne of soft green moss, and on it they laid their hunting cloaks. They built a shelter of

fresh boughs over her head, and then they sang songs to her. They set up great torches all round about the glade. They wrestled and they vaulted and they climbed. They played every game that could be played by torchlight, and it was all to please the kind little woman who had saved the life of their master.

The merry little woman sat and clapped her hands at all their feats, and she laughed until she cried. Then she wiped her eyes and sang them her one little song.

The men shouted and cheered, and cheered and shouted, and the woods echoed so long and so loud that one would have thought they, too, were trying to shout.

By and by the company all set out together to carry the little old woman to her cottage. She was put upon their very best and safest horse, and Robin Hood would have none lead it but himself. After the horse came a long line of good bowmen and true. One carried a new cloak of the finest wool. Another bore a whole armful of silken kerchiefs to make up for the one that Robin had worn away. There were "shoon and hosen," and there was cloth of scarlet and of blue, and there were soft, warm blankets for her bed. There were so many things that when they were all piled up in the little cottage, there was no chance for one tenth of the men to get into the room. Those that were outside pushed up to the window and stretched their heads in at the door: and they tried their best to pile up the great heap of things so she could have room to go to bed that night and to cook her breakfast in the morning.

"And to-morrow's sweeping day," cried Robin. " 'Thursday I brew and Friday I sweep,' and how'll she sweep if she has no floor?"

"We'll have to make her a floor," declared Friar Tuck.

"So we will," said Robin. "There's a good man not far away who can work in wood, and he shall come in the morning and build her another room."

"Oh, oh!" cried the merry little old woman with delight, "I never thought I should have a house with two rooms; but I'll always care for this room the most, for there's just where Master Robin stood when he came in at the door, and there's where he sat when he was spinning the flax. But, Master Robin, Master Robin, did anyone ever see such a thread as you've left on the spool!"

It was so funny that the merry little old woman really couldn't help jumping up and dancing.

"Hey down, down, an a down!"

And then the brave men and true all said good-night and went back to the forest.

Many attempts have been made to prove that Robin Hood was a real person, but without success. His story is told in a group of fifteenth century ballads, but he may have lived at an earlier time.

THE NEXT STORIES ARE ON PAGE 536.

He took him to a board anon,
To a table round,
And then he shook out of a bag
Even four hundred pound.

And such a buffet he gave Robin,
To ground he went full near;
"I do avow to Heaven," said Robin.
"Thou art a stalwart frere."

Robin saw some young men shoot,
Full fair upon a day,
"Alas, alas," said good Robin,
"My joy is gone away."

BAYARD, THE FLOWER OF CHIVALRY

THE KNIGHT BEYOND FEAR AND BEYOND REPROACH

ON a spring day in the year 1487, a twelve-year-old lad, Pierre Terrail Bayard, was playing with his brothers in the courtyard of their home, a castle built upon a rocky hill in Dauphiné, France.

Their father was sitting by the fireside in the castle hall. Once in a while he would look around the big room at the coats-of-arms and the trophies on the walls, proud reminders of the brave deeds of the Bayard family for generations. He was growing old; he knew that he did not have long to live. He said suddenly to his wife who was sitting quietly with her needlework, "I will send for my sons and find out how they plan to spend their lives."

The four sturdy, ruddy-faced boys came and respectfully stood before their father. The old man asked each one, "When I am gone, what will you do?" The oldest son, Georges, replied, "I shall stay here and care for the home." The two younger sons answered that they would live religious lives.

Pierre was a lively lad of gay disposition, with a bright laughing face. Now he answered with unusual seriousness, "I should like to remain with you, my father, to the end of your days; but all your stories about the brave deeds of my ancestors inspire me to become a soldier, too."

The old father was delighted with his son's choice. Immediately, he set about preparations for training Pierre as a soldier. First, the boy must go away from home and serve as a page at the castle of a friendly nobleman. The Duke of Savoy consented to accept the lad in his household.

And so Bayard went to serve the Duke of Savoy. The lad was such an unusually fine horseman that the Duke determined to take the young page before the king of France, Charles VIII, for an exhibition of his skill. What an exciting day it was when Bayard mounted his beautifully groomed steed and rode for King Charles. After the performance, he galloped up before the King, reined in sharply, and waited for the King to speak.

"It would be impossible to handle a horse with more grace and ease!" the King said warmly. Then he called out, "Piquez! Piquez! Spur the horse again!" The others who were watching also cried to Bayard, "Piquez! Piquez!" Thus Pierre won the nickname Picquet. He was later to win finer titles—The Good Knight, The Flower of Chivalry and The Knight Beyond Fear and Beyond Reproach.

After the boy's exhibition before Charles, the King decided that this likely lad should be given a chance to enter the royal service, to be one of the King's own knights. That was just what the friendly old Duke of Savoy had hoped. Picquet was placed under the care of the Count of Ligny, to be trained.

The story of Feudal Times tells you that in much of Europe during these ages, a young man of good family who chose the career of soldier was given a chance to become a knight. Knighthood had to be earned. First the boy was sent to the court of some baron or noble when he was twelve or thirteen years old. There he became a page to one of the ladies of the court; and when he was not busy serving his mistress, he learned to ride, to take care of armor and to use a sword; and he learned also the ideals and rules of the knightly order.

When age and experience had qualified the page for war, he became a squire, and followed his lord to battle if there should be a war. You will soon see that Bayard became a squire when he was seventeen years old. The third, and highest, rank was knighthood, which was not conferred before the squire became twenty-one years old, except in the case of royal birth or very great achievements. It was a solemn and proud day for the squire when he was knighted. After an all-night vigil, spent alone in prayer, he would kneel and receive a light blow on the neck or shoulder from the flat side of the sword (or from the fist) of the officiating knight. At the same time the officiating knight would say, "I dub (name) thee knight in the name of God, St. Michael and St. George! Be faithful, bold and fortunate!" Only a knight or a priest could dub a knight.

The knights of those days were horsemen all, and so, from the French word for horse, *cheval,* they were said to belong to the order of chivalry. Their times are even now called the Age of Chivalry; and our word chival-

rous, which means gentle and polite and generous to weaker ones, comes from one of the rules of the order.

Only three days after Picquet became a knight, a great tournament, or play war, was planned, called a *pas d'armes,* a passage of arms. The tournament was to be a test of chivalry for the young gentlemen of the court of King Charles VIII. Each knight hung up his shield on a tree or post and whoever wished to challenge the owner of a shield had only to touch it with his sword and his name would be written down in a big book. The news soon spread through Lyons that young Picquet had touched the shield of Messire Claude, one of the most valiant fighters of all France.

THE KNIGHTS WORE SUITS OF POLISHED ARMOR AND SHINING HELMETS

The tournament was a gorgeous and brilliant spectacle. Each gallant knight who actually took part in the fighting wore a suit of polished armor; many of the suits were inlaid with gold and silver. Knotted around his arm the knight wore a brightly colored silk scarf, richly embroidered with his coat-of-arms or with the device of his lady. On his head he wore a shining helmet, sometimes with a great tuft of flowing plumes.

Young Bayard's rich uncle, the Abbé of Ainay, supplied the money for Picquet's armor and equipment. Even the horses wore rich trappings of velvet and satin.

With splendid courage and gallant spirit, Bayard entered the tournament facing one of the finest warriors in the world. But no man showed more bravery or skill than Picquet. When it was all over, and he raised his visor to uncover his face, and rode the whole length of the lists (the fighting grounds), the ladies of Lyons openly praised him as the finest champion of all.

Bayard is remembered by the people of France for his brave leadership of the armies of three French kings: Charles VIII, Louis XII and Francis I. His gallant victories over the Spaniards, Italians and English made him respected and loved by his countrymen and feared by his enemies. His enemies admired him, too. Twice he was taken prisoner in fair fight, by the English and by the men of Milan; and both times he was released without having to pay ransom. To the English King Henry VIII and the Duke of Milan, Ludovico Sforza, the Good Knight Bayard might be an enemy but he was still an honored guest—no prisoner of war.

In the dead of winter in 1503, the army of Don Pedro de Pas, a Spanish captain, was massed against the company of Bayard. The French had possession of the right bank of the River Liris (now the Garigliano), and on the other bank the Spanish forces were camped. There was a bridge across the river, and it was in the hands of the French. One day the Spanish captain, Don Pedro de Pas, conceived a plan to capture the bridge. With about a hundred horsemen and a hundred foot-soldiers, he set off to ford the river lower down. Don Pedro did this to raise an alarm in the French camp, hoping that the whole army might rush to defend the camp and leave the bridge unprotected.

Bayard, who always chose the most dangerous post, was stationed on the bridge with another French soldier. When they heard the noise, they armed themselves at once and mounted their horses in hasty excitement to rush to the aid of their camp. But the Good Knight suddenly caught sight of two hundred Spanish horsemen riding straight toward the narrow bridge. The loss of the bridge would mean the total destruction of the French army!

The Good Knight cried to his companion: "Go bring a detail of men to guard this bridge! I will do my best to amuse these Spaniards until you come."

The soldier rushed away. Alone, the Good Knight fixed his lance, galloped across the bridge to the other end where the Spaniards were approaching. Bayard rushed at them so furiously that three of the foremost soldiers were thrown from their horses and hurled into the water. The river was wide and deep, and the men were drowned.

HOW BAYARD ALONE HELD THE BRIDGE AGAINST THE SPANIARDS

For a moment the Spaniards were driven back, but when they realized that there was but a lone knight defending the bridge, they attacked him with furious might. Bayard took a stand against a barrier, so that no Spaniard could get behind him; and now he fought so desperately with his sword, raining blows on all near him, that miraculously he was able to keep back two hundred soldiers at the narrow entrance of the bridge! For a full half-hour, Bayard stood off the attack by himself, until at last he heard the shouts of his companions coming to his aid.

The Frenchmen drove the Spaniards back from the bridge and pursued them for more than a mile. Then the Good Knight gave

the command to retreat; and in good order, the French began to return to their camp. As usual, Bayard remained the last and bore the brunt of the rear attack.

Suddenly Bayard found himself completely surrounded by twenty or thirty Spanish horsemen who cried, "Surrender! Surrender, my lord!"

Bayard had no choice. He could only reply: "Gentlemen, I must yield to you, for being alone, I can no longer fight."

Bayard's horse, on which he had fought all day, was so worn out that it could hardly stand.

Meantime, all Bayard's companions had galloped straight to their bridge, believing that the Good Knight was among them, but suddenly one of the men cried out, "Bayard! Where is Bayard?"

When the French soldiers heard this cry, the whole troop turned their horses and galloped back at full speed after the Spaniards who had taken prisoner the Flower of All Chivalry, the Good Knight. Now the Spaniards did not know who it was they held, for Bayard was aware that if they learned his identity he would never escape alive. To all their questions, he replied only that he was a gentleman. Luckily, they did not take the trouble to disarm him.

Suddenly Bayard's sharp ears picked up the sounds of his comrades pursuing him, shouting. Taken by surprise, the enemy received the French charge in disorder. As men and horses gave way, the Good Knight saw his opportunity, sprang from his weary horse, and without putting foot in the stirrup, mounted a spirited steed whose rider had been thrown. As soon as he was mounted, he cried, "France! France! Bayard! Bayard, whom you have let go!"

When the Spaniards heard the name, they realized what a mistake they had made to leave the prisoner his arms, without even forcing him to give his knightly word not to escape. The men of Don Pedro lost heart and turned away, and the Frenchmen galloped back to camp.

THE GOOD KNIGHT'S COURTESY TO WOMEN, EVEN WHEN THEY WERE ENEMIES

Among the stories most often told about Bayard are those recounting the gentle courtesy he showed to women. In the year 1512, at the assault of Brescia, Bayard had a chance to be gallant to a lady who was not of his friends but of his enemies.

Here, in a battle between the French and the Venetians, Bayard was painfully wounded in the thigh. Two of his men carried him to the best mansion in the neighborhood, the home of a rich man who had fled to a safe place, leaving to their fate his wife and two beautiful daughters. The daughters were hidden in a hayloft under the hay. Trembling, the mother opened the door to Bayard and his two men. She fell on her knees and said in French: "Noble lord, I present to you this house and all therein, for I well know the rules of war. But be pleased to spare our honor and our lives—my own and those of my two daughters."

THE STORY OF BAYARD AND THE BOX OF DUCATS

The Good Knight assured her, "Madame, while I live no wrong shall be done either to you or to your daughters." They nursed him tenderly until he was well again and ready to leave. On the morning of his departure, the lady came to him and said, "My lord, I know well that we and all this household are your prisoners, to deal with according to your pleasure. I bring you a little present." She handed the Good Knight a small steel box containing money.

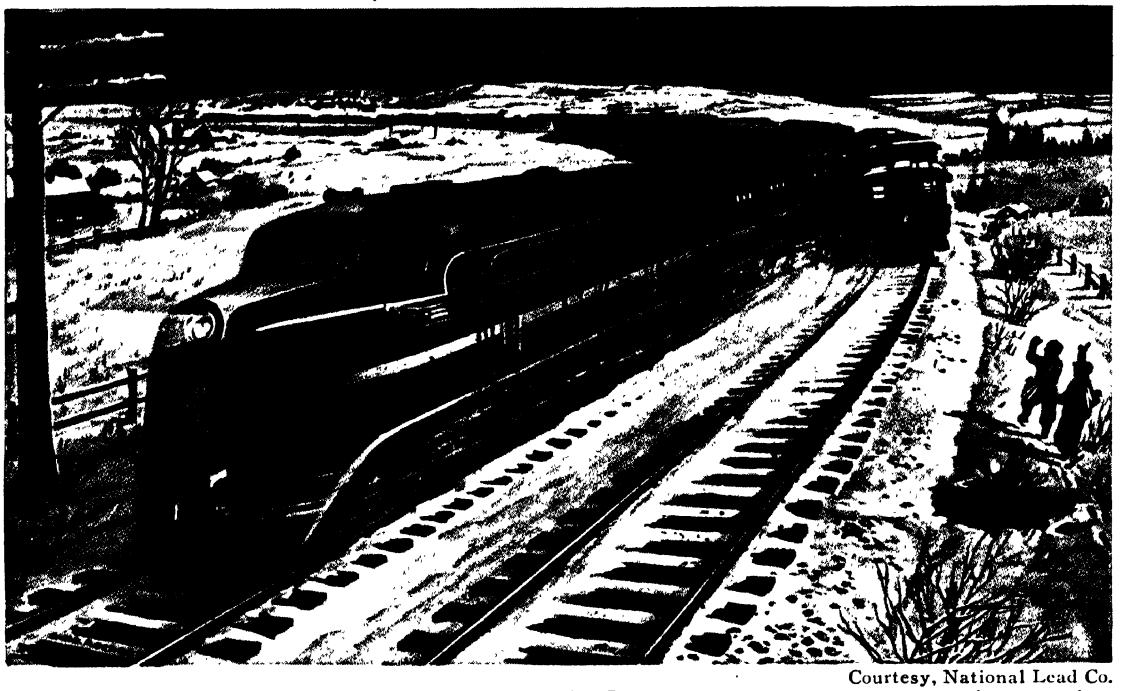
Bayard, who never in his life set any value on money, laughed heartily and said, "Madame, how many ducats are there in this box?"

The unhappy lady replied, "Two thousand five hundred."

The two daughters came to bid Bayard farewell, and the Good Knight thanked them for entertaining him with their songs and their playing upon the lute during his illness. Then he said, "The good lady, your mother, has given me these ducats. I present each of you with a thousand to aid you in marrying; these other five hundred ducats are to be distributed among the poor. I give you charge of them, as you know where they are most needed."

In the Middle Ages, chivalry was a way of living, an ardent attempt to save Europe from barbarism, even when nations were constantly at war with one another. The main principles of chivalry—the main ideals that Bayard stood for—are still the ideals of great people today: First, Service, in peace and war, in love and religion. Secondly, Brotherhood and Equality. Thirdly, a Right Pride—that is, not pride in yourself, but in your order, your country, your ideals. Fourthly, Reverence for love and women. Fifthly, Help and Defense of the weak, the suffering and the oppressed.

THE NEXT STORY OF GOLDEN DEEDS IS ON PAGE 887.



Courtesy, National Lead Co.

A modern streamlined train skims through the countryside. It can carry us everywhere with speed and comfort.

THE WONDER *of a* TRAIN

THE OBLIGING IRON MONSTER OF THE RAILS

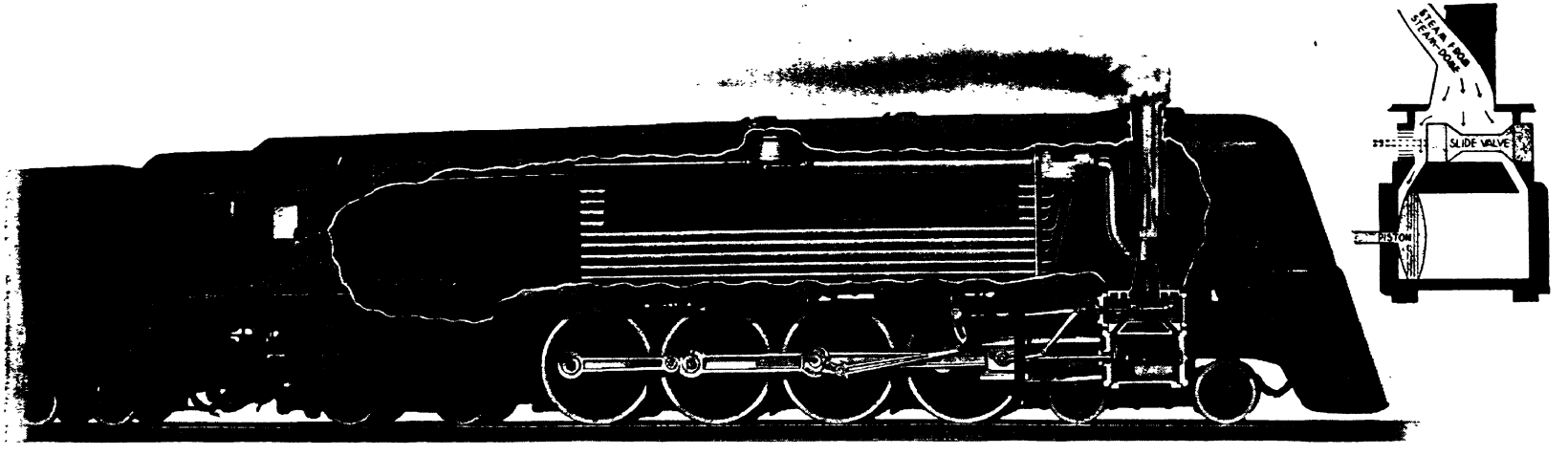
THERE were railways in the mining areas of England as early as the seventeenth century, some 200 years before the invention of the steam locomotive. Over them ran heavy wagons transporting the coal from the mine to the nearest river or coastal port. Some mine owner, whose name we do not know, thought of a way to overcome the breaking down of dirt roads by these heavy wagons. He had logs placed at three- or four-foot intervals, to which big planks were nailed. The wagon wheels ran over the planks. The horses walked between the rails. Soon other miners were building such plank roads. This forerunner of the modern railroad made it possible to haul a heavily loaded wagon with no more effort than was formerly required of three teams. However, horse-power and mule-power could never have made the railroads very important. The steam engine, developed by James Watt (1736-1819), pointed the way to a new era of travel. Watt's engines were used first to pump water out of some English coal mines. These were, of course, stationary engines.

In 1769 a Frenchman named Cugnot constructed a three-wheeled steam vehicle that would travel over the road at the rate of three miles an hour.

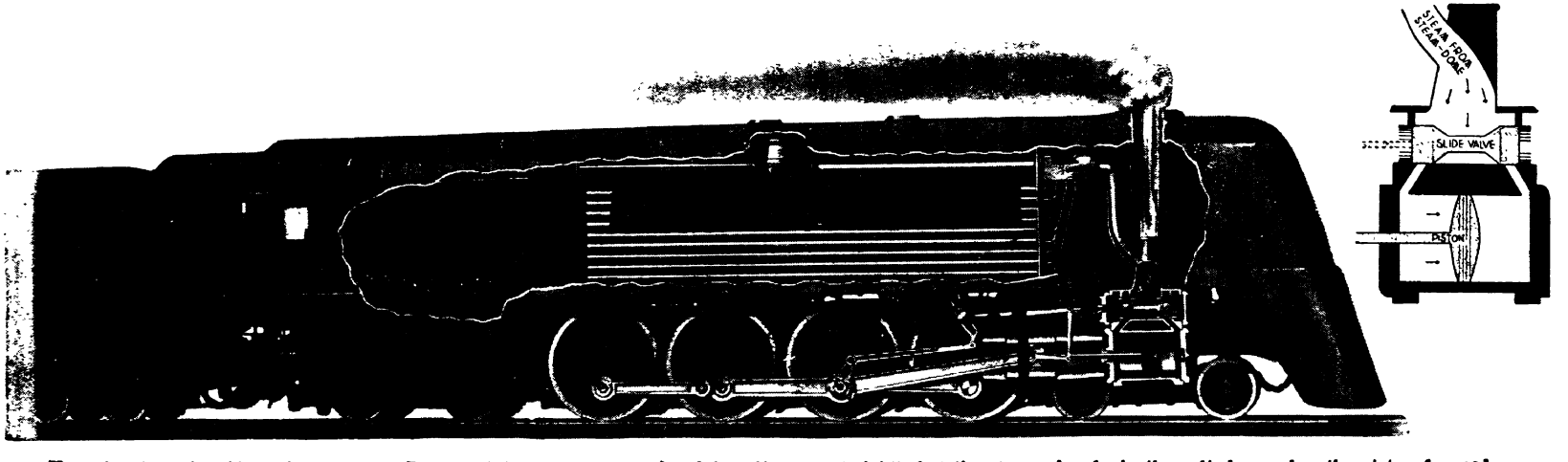
The first steam railway ran at the bottom of a coal mine. It was built by George Stephenson. George was born in 1781, in the little English village of Wylam, near Newcastle-on-Tyne. He was one of six children in a poor family. His father worked in the mines and made very little money, so that George was not sent to school. When he was still a child he was put to work, and before long was given the job of tending one of Watt's engines which pumped water out of a mine. George was fascinated by the engine and wanted to learn all about it. But he had no one to teach him, and no books; and even if he had had books, he could not read. Not until he was a grown man did he learn how to read and write; but he came to know a great deal about the use of steam for power by working with colliery engines.

Meanwhile, two other men, William Mur-

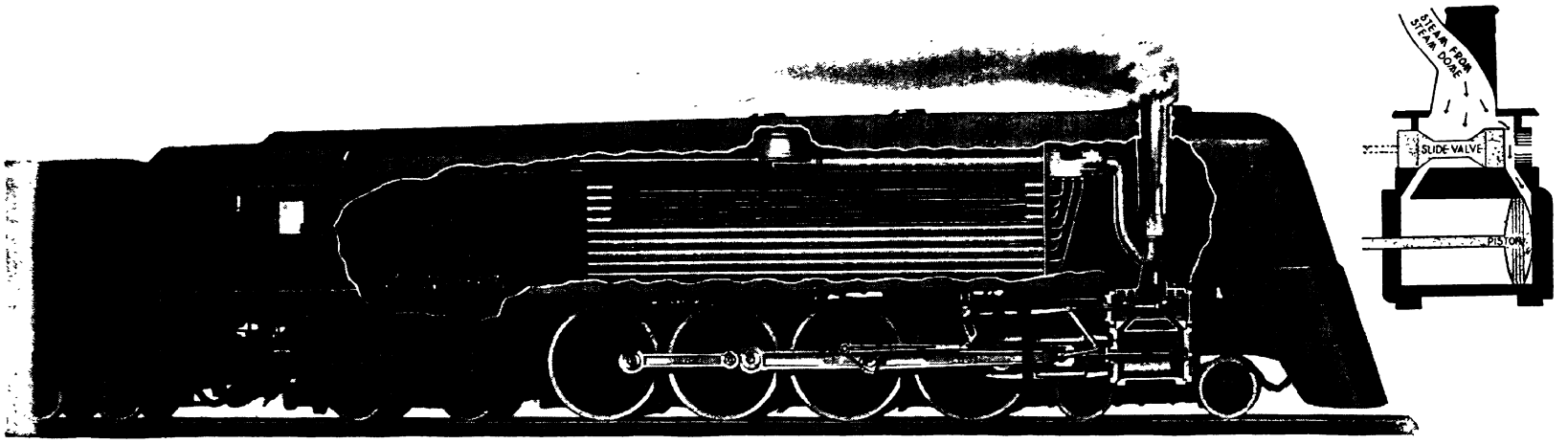
HOW FIRE AND WATER TURN THE WHEELS OF A LOCOMOTIVE



In this picture the steam coming from the steam-dome is about to pass into the rear end of the cylinder (see diagram at right); it will push the piston forward.



Here the piston is midway in its course. The rear inlet valve is now closed (see diagram at right), but the steam already in the cylinder pushes the piston forward.



In this picture the steam is about to pass into the front end of the cylinder (see diagram at right). This, of course, will cause the piston to move backward.

IF the outside of a locomotive could be removed and we could see the machinery and the parts inside, as the train went past, we would see what these pictures show us. The pictures give three views of one and the same locomotive; they show the boiler, furnace, smokebox and cylinders cut in half. You will note that this locomotive has four pairs of driving wheels, a four-wheel truck in front and two pairs of trailer wheels under the furnace and the cab.

The locomotive moves because water heated by the fire in the furnace is changed into steam, which expands or enlarges so fast that it can push aside anything that can be moved. Now this steam is let into each one of the two cylinders which are between the two pairs of front wheels. The steam pushes the rod called the piston forward, when the rear inlet valve is open, as in the first picture. It pushes the piston backward when the front inlet valve is open, as in the third picture. The inlet valves are opened and shut in turn by a slide valve (see the diagrams).

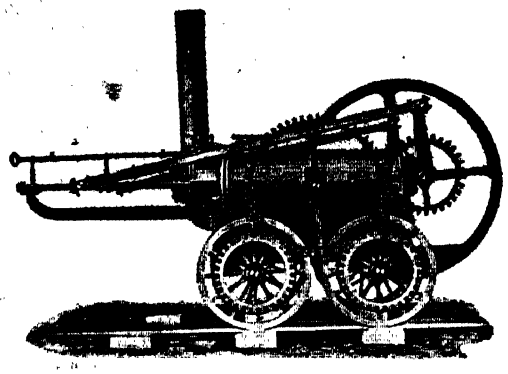
The boiler, filled with water, has a number of tubes or flues running from one end to the other. The heat and smoke from the furnace pass through these pipes to the smokebox in front and escape through the smokestack. The red color in these pictures indicates where there is fire and heat. When the heat passes through the tubes, the water in the boiler becomes hot and turns into steam. This first goes into the steam-dome on top of the boiler. In this dome is the throttle, which regulates the amount of steam that is to be sent to the cylinders.

The engineer opens the throttle by pulling a lever in his cab. The steam now passes from the dome through the thick pipe leading into the cylinders. In this way the steam can press on the piston and push it to one end of the cylinder or the other.

In the pictures we also see a device called the superheater. As the steam passes through the thick pipe leading from the dome, it is made to pass through tubes fitted inside the boiler tubes. Then it goes back again into the thick pipe and on to the cylinders. The steam, exposed to the heat in the boiler tubes, expands rapidly and exerts great power.

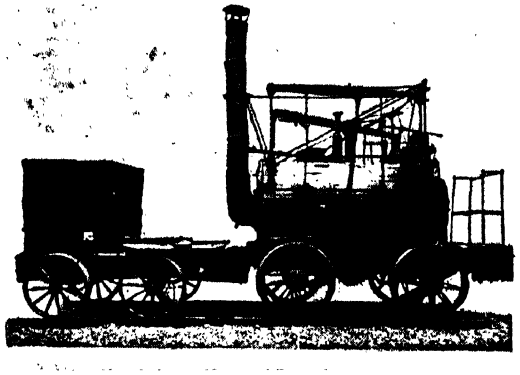
The steam enters the cylinder first through the rear inlet valve and pushes the piston away to make room for its expansion. The rear inlet valve is open in the first picture. When the piston is midway on its course to the other end of the cylinder, the inlet valve is closed, as shown in the second picture. The piston is pushed the rest of the way by the steam which is already in the cylinder and which expands still more. The third picture shows the front inlet valve open, with the steam about to drive the piston back again to the other end of the cylinder. As the piston goes to and fro, the piston rod slides forward and then backward and turns the wheels through the connecting and crank rods.

TREVITHICK'S ENGINE



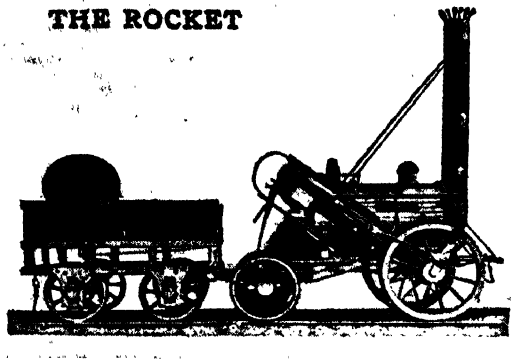
The first steam engine that ran along the road was made in 1801 by Richard Trevithick in Cornwall. It frightened people, who thought it an evil spirit.

PUFFING BILLY



The oldest locomotive in existence. It was built in 1813 and was used for more than 50 years. It can still be seen at the Science Museum in London.

THE ROCKET



The Rocket was one of the first engines that ran on a railway from one town to another. It was made by George Stephenson, and drew a thirteen-ton load.

dock (1754-1839) and Richard Trevithick (1771-1833) had been working on engines. Murdock was the man who discovered how to make gas from coal. In 1784 he made a little toy steam engine which ran on three wheels. Trevithick in 1801 made a steam engine that would travel along the road. In 1803 he made one that was capable of drawing a nine-ton load.

GEORGE STEPHENSON, THE FIRST RAILWAY-BUILDER, BEGAN WORK IN A COAL MINE

Stephenson went on working and studying and gradually getting better jobs, always with engines. In 1808 he went to the Killingworth mine where he showed such skill that he was placed in charge of all the machinery. Now he determined to build an engine to draw the loaded cars from where the coal was dug to the elevator shaft. This he did. Then he made an engine that drew a thirty-ton load of coal from the mine to the river port nine miles distant. He went on building engines for coal mines until 1822, when he started building a railway which would carry passengers as well as goods. The line, running from Stockton to Darlington, was opened on September 27, 1825. Stephenson himself drove the engine, which drew thirty-four small cars carrying coal and flour and a number of passengers.

A man on horseback rode in front of the train, waving a flag. He thought that he would be able to lead it all the way, that the train would never go fast enough to pass him. But presently George made a signal to him to get out of the way, and he set the train going at thirty miles an hour, although the weight which the little engine drew was nearly nine tons.

It was a happy moment for Stephenson when the train reached Darlington without accident. The train was unloaded, then started back, carrying only passengers. When Stockton was reached, it was found that about 600 people were riding in or hanging on to the trucks of the little train.

That was the first time in the history of the world that a steam engine had drawn a train carrying passengers over a railway.

STEPHENSON'S SECOND RAILWAY HAD A NEW AND BETTER ENGINE, THE ROCKET

The second railroad, also built by Stephenson, was between Liverpool and Manchester. Stephenson's son Robert helped to design the engine, which was called the Rocket, and which drew a load of thirteen to twenty tons, at ten to twenty-nine miles an hour. The Rocket was built on a new design. The

spent steam was directed into the smoke stack, thus increasing the draft and "stepping up" the amount of steam generated. The heating surface was also increased by the adoption of the multi-tubular boiler; that is, the use of many tubes through which the fire was forced, all being surrounded by water. The Rocket had only two cylinders and weighed but four and a half tons.

From that time, the engines of George and Robert Stephenson were purchased in many countries. The two became very prosperous. George died in 1848; and Robert, in 1859.

The United States was not far behind England in building railroads with locomotives. The need for them in America was greater because of the longer distances. Albert Gallatin, Secretary of the Treasury, did much to encourage the building of roads, canals and river-boats, especially to connect the seaboard cities with the new settlements farther inland.

Many Americans making trips to England rode on either the Stockton and Darlington or Liverpool and Manchester railroads. Upon returning home they urged the building of railroads between the seaboard cities and inland settlements. These men urged the construction of railroads on the grounds that (1) they were cheaper to build than canals; (2) they could run east and west following territorial expansion, whereas the main rivers flow north and south, and (3) finally, they would not be affected by seasonal changes which brought alternate floods and freezing to the rivers.

Proposed changes always meet with opposition from those whose interests might be interfered with and those who are "always agin" improvements. So it was but natural for those who had invested money in canals, turnpikes, taverns and stagecoaches to try to prevent the coming of the railroad.

Some charged that the Lord had never intended man to travel at the excessive speed of fifteen miles an hour, as claimed for the railroad—otherwise we would have been provided with legs capable of such speed! Others claimed that the new invention would kill people and livestock. Many farmers feared that barns and haystacks would be burned by the sparks from wood-burning engines. Others feared that through fright the hens would be prevented from laying eggs and the cows from giving milk.

However, progress prevailed. In the sum-

Photos of Trevithick's engine (p. 408) and James Watt by Brown Bros., New York

Young James Watt watches steam raise the lid of a kettle. Later in life he invented the modern steam engine.

Courtesy, Pennsylvania Railroad

Before locomotives became common, there were, in many places, horse-drawn cars running on tracks. This was an intermediate step between the old stagecoach and the engine-drawn train that we know today.

mer of 1829 a locomotive called the Lion was purchased from the Stourbridge Engine Works in England and operated on a coal road connecting Carbondale and Honesdale, Pennsylvania. It weighed only seven tons. It ran successfully, but made only one trip, since the light track was incapable of supporting its weight.

Shortly after 1830, four important railways were operating in the United States: the Baltimore and Ohio, the Carbondale and Honesdale, the Charleston and Hamburg, and the Mohawk and Hudson, connecting Albany with Schenectady, New York. On these roads, together with the two English lines, many inventions were tried which led to the great railroad systems which today crisscross the United States.

THE WOODEN RAILROAD TRACKS SOON WERE REPLACED WITH IRON

It was early discovered that the wooden railways could not long hold up under the wheels of the huge wagons carrying ten or fifteen tons of coal. To protect the splintering timbers, iron strips or plates three to four feet in length were placed upon them. This device proved satisfactory so long as horses were used as motive power. However, with the coming of the heavier and speedier locomotive, a new danger arose. Temperature caused the iron strips to expand and contract, which often broke or loosened them. As the train passed over these broken rails, the sharp ends frequently pierced the floor of the cars, endangering the lives of the passengers and even wrecking the train.

The solution to this problem was the all-cast-iron rail. In many instances these rails had a raised edge, or flange, on the inside in order to keep the wagon wheels on the track. Then came the "edge rail" with the flange down the center of the rail, providing a stronger running surface. This required a flange also on the wheels of the wagon or car. At first this flange was on the outside of the wheel, but later it was placed on the inside of the wheel, and that is where it is today. The flanged rail was no longer necessary.

About 1820 more speed and greater safety became possible with the new wrought-iron rail. In the 1840's the modern rail was invented by a great American genius, Robert L. Stevens, who designed the T-rail with the flat wide bottom which simplified its attachment to the ties with broad-headed spikes. Compared with the rails of today, Stevens' rails were exceedingly small, weighing but 36 pounds to the yard. Today rails weigh up to 150 pounds to the yard.

In 1863 the all-steel rail was invented. It brought great changes to the railroad industry. It is more durable than the wrought-iron rail, and much stronger and less liable to break.

As the loads carried over the early railroads increased in size and weight, better road beds became necessary. It became customary to slope the road bed up toward the center with a layer of broken stone at least six inches deep. On this foundation were sometimes placed solid stone or granite "ties" ranging from six to ten feet in length, laid parallel in trenches. Flat iron strips of rail were attached by means of wooden plugs sunk into the "ties." This method of track structure proved unsatisfactory, as the great weight of the trains caused the rails to spread. The regular wooden tie was then universally adopted. At first the rails were attached to these wooden ties by means of cast-iron "chairs" or sockets, but with the coming of the T-rail, as we said, large spikes were used, and the rail ends were held in place by plates screwed on both sides of each joint.

Until 1880 the space between the rails, or gauge, varied from road to road, ranging from three to six feet. By 1887 the standard gauge of 4 feet 8½ inches was in general use throughout the United States, and in

some other countries. It is now quite widely used over the world, though some countries were slow to adopt it.

The greatest improvements have been in the construction of locomotives. American inventors went to work soon after Stephenson's Rocket made its first run; and by 1830 a goodly number of American locomotives had been built, many of which made transportation history. We have space to mention only a few of the most important ones.

The Best Friend. One of these early successes was the Best Friend, built for the Charleston and Hamburg Railroad in 1830. It weighed 4½ tons, had two cylinders and a 54-inch drive wheel. At a speed of 21 miles it was able to haul 4 or 5 cars containing some 50 passengers. The Best Friend was the first locomotive to draw a train in America.

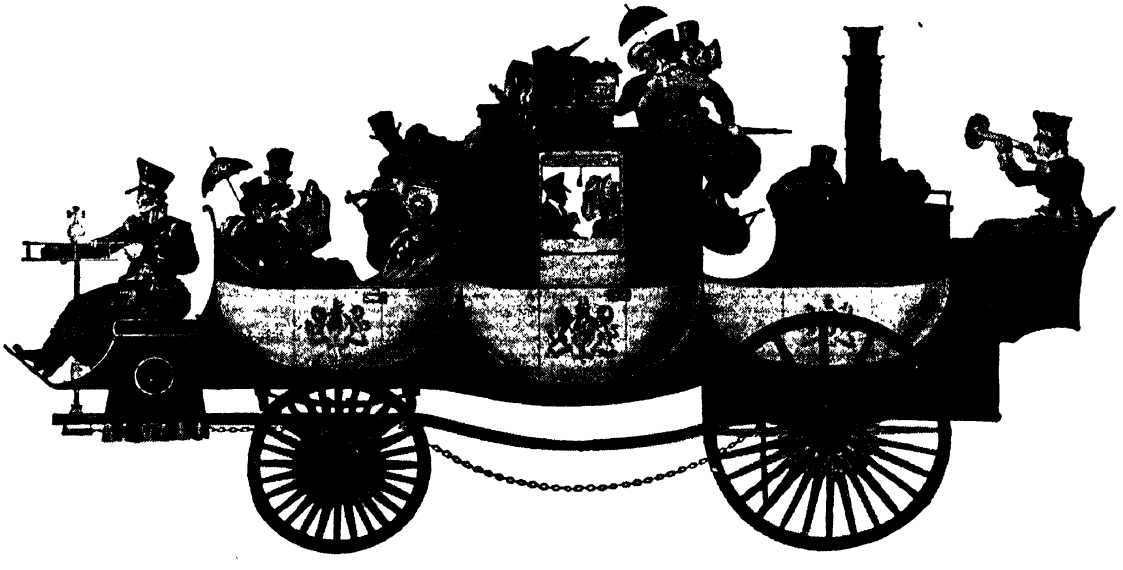
Tom Thumb. If you saw a locomotive that was no larger than the modern hand car, you would most certainly call it a toy. Yet that was the size of the famous Tom Thumb built by Peter Cooper for the Baltimore and Ohio Railroad. On August 28, 1830, it made a trial trip over a 13-mile stretch of track connecting the city of Baltimore with Ellicott Mills. Its success told the world that the steam locomotive had come to stay. This diminutive engine weighed but one ton. In its small boiler, musket (gun) barrels were used as tubes. Yet, in spite of its tiny size, it developed a pulling capacity of about one horse-power.

DeWitt Clinton. Probably the best known of the early locomotives, the DeWitt Clinton, was built for the Mohawk and Hudson Railroad, and made its trial trip on August 9, 1831. Running the 17 miles between Albany and Schenectady, New York, it hauled 3 coaches filled with passengers and made the trip in 1¾ hours. The return trip was even more successful. Hauling 5 coaches, it made the trip in even less time, 38 minutes. Looking not unlike a modern fire engine, the DeWitt Clinton had 5 cylinders connected with coupled wheels 4½ feet in diameter. It weighed 6 tons, and when operating without cars could attain a speed of 40 miles.

Equalizing lever. A defect common to all of the early engines was the great jar caused when passing over bumps and rough road beds. This was corrected by the invention, in 1837, of the equalizing lever. This is a heavy, flat bar which is fastened at its middle to the underside of the engine frame. Its ends are connected to the springs of the engine driving wheels in order to equalize shocks.

Locomotive accessories. The first locomotive equipped with a cab ran on what now is the Lehigh Valley Railroad in 1835-36. The cowcatcher, which at first was a small truck supporting two iron spears and fatal to cows, appeared in the early thirties on what now is a branch of the Pennsylvania Railroad.

Sometime during the first decade of rail-



The steam carriage shown above was the invention of a British civil engineer, W. H. James. It carried six passengers inside and twelve outside at a speed that varied from about eight to twelve miles an hour.

roading in the United States, Horatio Allen created the first headlight. He attached a small flat car in front of an engine on which he built a bonfire of pine knots. Candles, whale oil, kerosene and gas were successively used. Electric headlights first appeared in 1884.

Improved drive wheels. Because of the rugged country and steep grades over which American trains had to travel, heavier locomotives with greater traction power were necessary. To gain traction, more wheels were needed. The first improvement of this sort came in 1836, when an engine was built for the Philadelphia, Germantown, and Norristown Railroad, with a four-wheel truck in front and four driving wheels coupled together behind.

The success of this invention aroused engineers to new efforts in an attempt to build bigger and better locomotives. Fireboxes were greatly enlarged, and new discoveries made it possible to generate greater steam with more ease. The coming of the steel rail made possible the construction of heavier locomotives. These also were made of steel. Varying new wheel arrangements began to appear. In 1863 a new type of engine called the Mogul appeared. It had a single swinging axle, in front, followed by six coupled drivers. It was so successful that in 1867 it was further enlarged with an additional pair of drivers added. A few years later the Decapod, having ten wheels, went into operation. By 1890, ten-wheelers were common for freight locomotives, while passenger engines had as many as eight wheels and weighed around sixty tons.

In 1904 a new era in locomotive building began with the introduction of two new types: the Mikado, named for the Emperor of Japan, for whom the first one was built, and the Mallett, bearing the name of its French inventor. These were both powerful engines. Later Mallett models had as many as twenty driving wheels.

Following World War I even larger and more powerful engines were introduced, having very much larger fireboxes. These locomotives, using but 60 per cent as much coal as was required a generation earlier, were capable of generating much more power. Some of these newer locomotives weighed up to 144 tons, exclusive of tenders. It costs around $150,000 to build a modern locomotive.

Electric engines. Near Saratoga, New York, in 1885, experiments began leading to

Courtesy, Baltimore & Ohio Railroad

The "Tom Thumb" was an early locomotive about half as big as a modern automobile. During one of its early trial runs between Baltimore and Endicott Mills, about thirteen miles, a race was held with a horse-drawn car, as shown in the picture above. The engine proved better until it broke down, allowing the horse to win.

the construction of a practical electric engine. It was not until 1915, however, that an electric engine successfully made a long distance haul, when one was put on the 440-mile run across the Rocky Mountains by the Chicago, Milwaukee, St. Paul and Pacific Railway Company. Today electric engines are commonly used to replace steam locomotives as they approach the outskirts of some of our larger cities. Twenty-five railways in the United States now operate a total of 2,952 miles of electrified road.

Diesel electric engine. This is the most recent development in locomotives. Power is generated through the automatic spraying of oil into a cylinder of compressed air, the oil being immediately ignited by the heat resulting from the compression. Most of the streamlined trains are now drawn by Diesel engines.

Photograph by Modern Enterprises
This steam-driven train was one of the first used in New York State.

Passenger cars. In his POPULAR HISTORY OF AMERICAN INVENTIONS Waldemar Kaempffert includes a description by one who saw the first coach run on the Baltimore and Ohio Railroad. It was "a little clapboarded cabin on wheels, for all the world like one of those North Carolina mountain huts, with the driver perched on top of the front portico—driver, because the motive power then was one horse in a treadmill."

It was reported that the use of the treadmill as motive power was early abandoned because a bull, coming up the track one day, charged the coach-engine, sending both tread-mill and horse flying into the ditch.

The first passenger coaches were commonly nothing more than stagecoaches mounted on four iron wheels, with some of the passengers required to sit on the roof, where, unfortunately, they were forced to endure the dense smoke and flames which poured from the smokestack of the wood-and-pitch-burning engine. The first improvement was provided when three stagecoaches were joined end to end, forming a three-compartment car entered from the side, as is the custom on European trains today. Then came larger coaches, resembling big vans about the size of our early streetcars. These were lighted by tallow candles which frequently dripped on the already uncomfortable passengers seated on hard wooden seats. During the winter, wood-burning stoves placed at one end of each car provided a little uneven heat. Somewhat later, hot-water pipes running down the length of the car were attached to the stove. This was an improvement.

By 1850 travel was made much more pleasant through the placing of springs under the cars, and ventilators in the ceilings. In 1887 the electrically lighted coach and the closed-vestibule car came. Formerly, open platforms between cars had made a passage from coach to coach very dangerous.

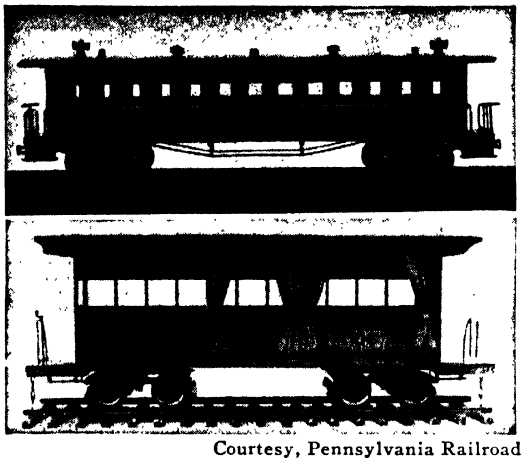
During the early years of the twentieth century the all-steel car was introduced, lessening the risks in case of collision or derailment. Formerly when such an accident occurred, the passengers were liable to be burned, maimed or killed as the cars burst into flame or splintered.

In 1929 the first air-conditioned train successfully made the trip between Chicago and Los Angeles.

Coaches have greatly increased in width,

height and length. The first coaches measured less than 40 feet in length; now they are 80 to 90 feet long, and weigh upward of 90 tons.

George Pullman. Travel on the first trains in America was slow and distances were relatively great. Because of such conditions, sleeping-cars of sorts were provided during 1836, appearing on the Cumberland Valley Railroad between Harrisburg and Chambersburg, Pennsylvania. They were merely coaches divided into four compartments with bunks ranged in two and even three tiers along the walls. Bedclothes were not provided, and toilet facilities were limited to a basin and a pail of water in the rear of each sleeping-car.



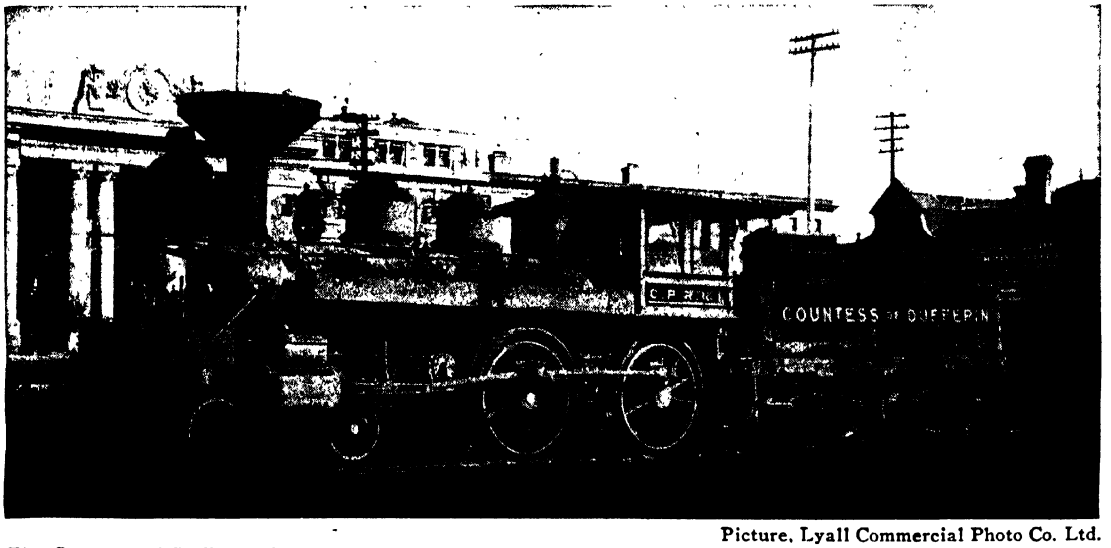
Courtesy, Pennsylvania Railroad

A passenger coach of the type in use about ninety years ago is shown at the top. The other picture shows one of the first American sleeping-cars.

It was not until 1858 that anything even remotely resembling a modern sleeper appeared. In that year a young engineer named George Pullman remodeled two old coaches, fitting them with ten sleeping sections finished in cherry wood with plush upholstered seats. Light was provided by oil lamps and heat by a box stove. This early experiment proved so successful that in 1864 Pullman built a new elegant car, the Pioneer, at a cost of $20,000. Its great size made it impossible to get it by many station platforms and under some underpasses. Upon the death of President Lincoln the following year, the Pioneer was chartered by the United States Government to carry his body from Chicago to Springfield. This compelled the railroad to alter certain station platforms; and within a comparatively short time railroads throughout the country began altering their equipment to make possible the use of cars similar to the Pioneer. By 1867 Pullman had built forty-seven sleepers.

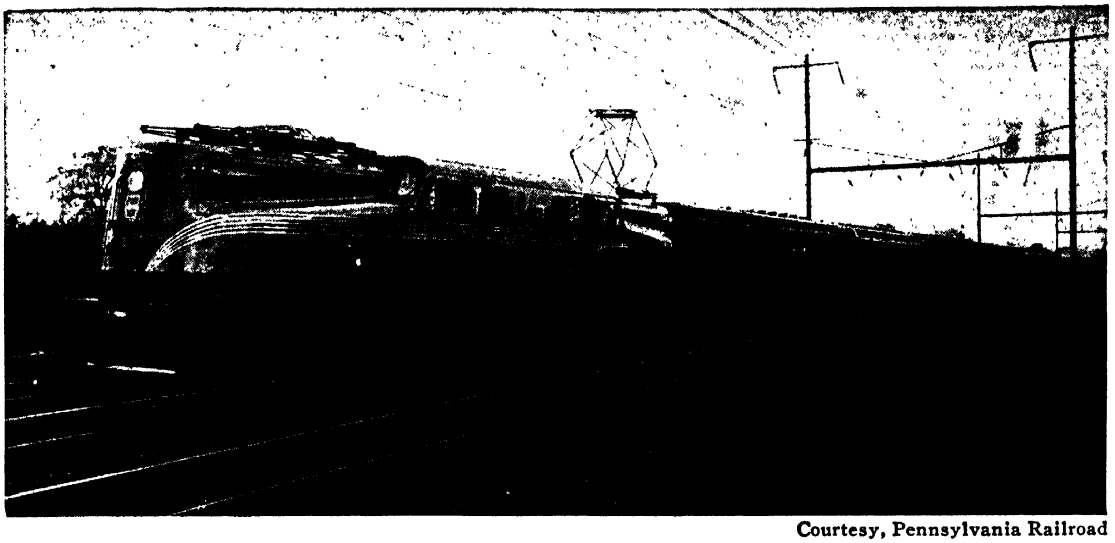
The next year the first modern dining car was introduced, serving meals at $1.00. It was called the Delmonico, after the famous New York restaurant of that name. Parlor and smoking cars soon followed. These new cars were beautifully furnished with thick carpets and cushioned seats. On the walls were large, expensive French mirrors.

Safety devices. No sooner was the task of providing steam locomotion for railroads solved than the problem arose as to how a moving train might be slowed and brought to a dead stop. Even at twenty miles con-



Picture, Lyall Commercial Photo Co. Ltd.

The Countess of Dufferin, first locomotive of the Canadian Pacific Railway. It is now on display in Winnipeg.



Courtesy, Pennsylvania Railroad

A modern streamlined electric locomotive. It is capable of pulling a fourteen-car train at a speed of more than 100 miles an hour. Electric engines frequently replace steam engines as trains approach our large cities.

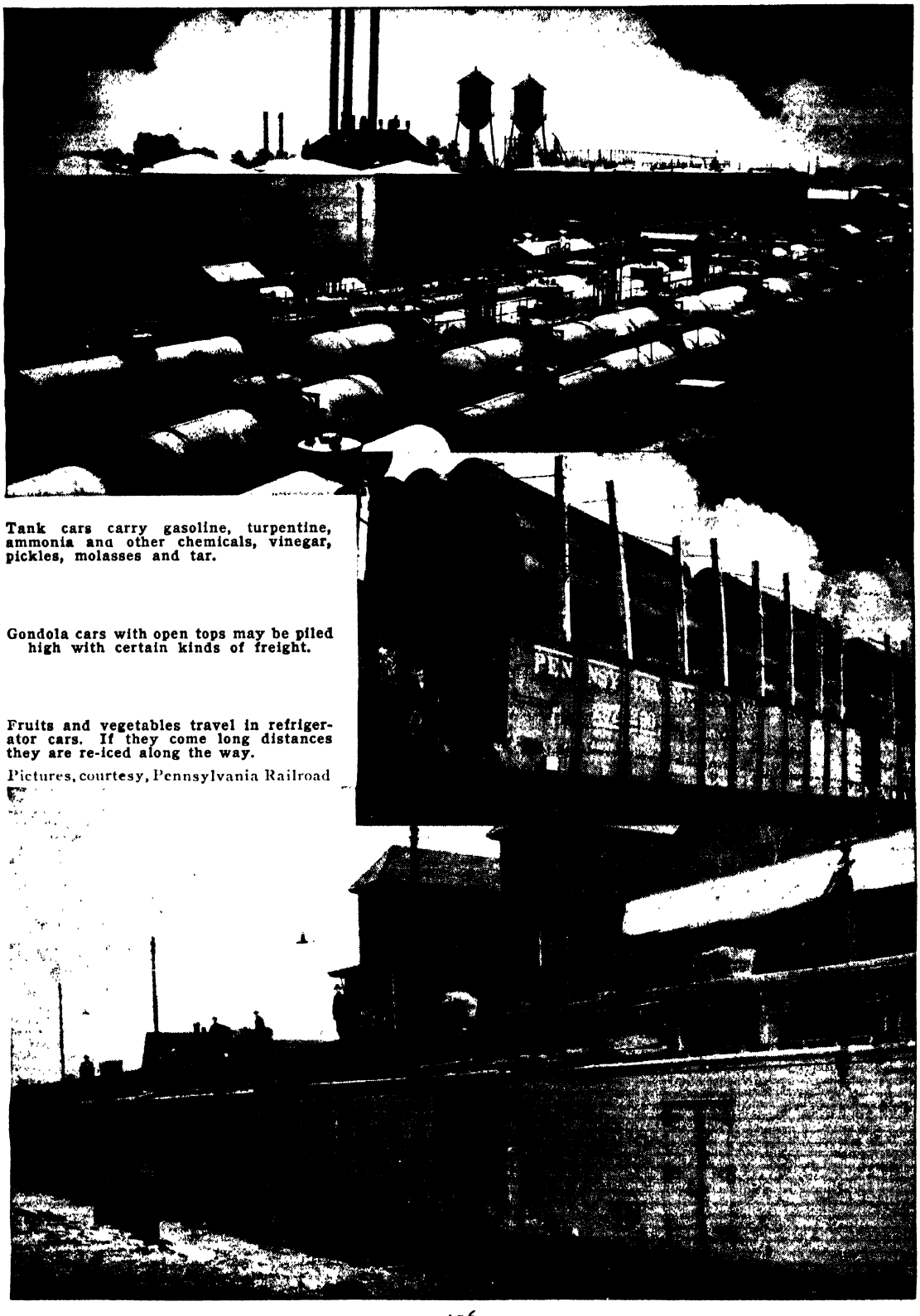
siderable momentum is attained. On some of the early trains it was customary for the engineer, upon approaching a station, to summon a labor crew by means of the hiss of escaping steam through the exhaust. By main force the laborers then would check the speed by catching hold of the train, while the station master thrust a heavy pole between the wheel spokes. Quite early, however, moderately successful hand brakes were invented. Real progress was made when in 1843 George Stephenson invented the steam brake.

In 1869 George Westinghouse commenced working on what turned out to be the highly successful modern air-brake system. He accomplished this by placing a steam-driven air pump on the engine, with a brake-pipe running under each coach connected with a brake cylinder and air chamber. To show the superiority of his invention over the old hand brake, he equipped a fifty-car train

Courtesy, Canadian National Railways

The International Limited of the Canadian National Railways. It has run in continuous daily service between Montreal and Chicago since 1900. The train's streamlined locomotive is one of the most modern engines in use.

HOW THE RAILROAD CARRIES FREIGHT



Tank cars carry gasoline, turpentine, ammonia and other chemicals, vinegar, pickles, molasses and tar.

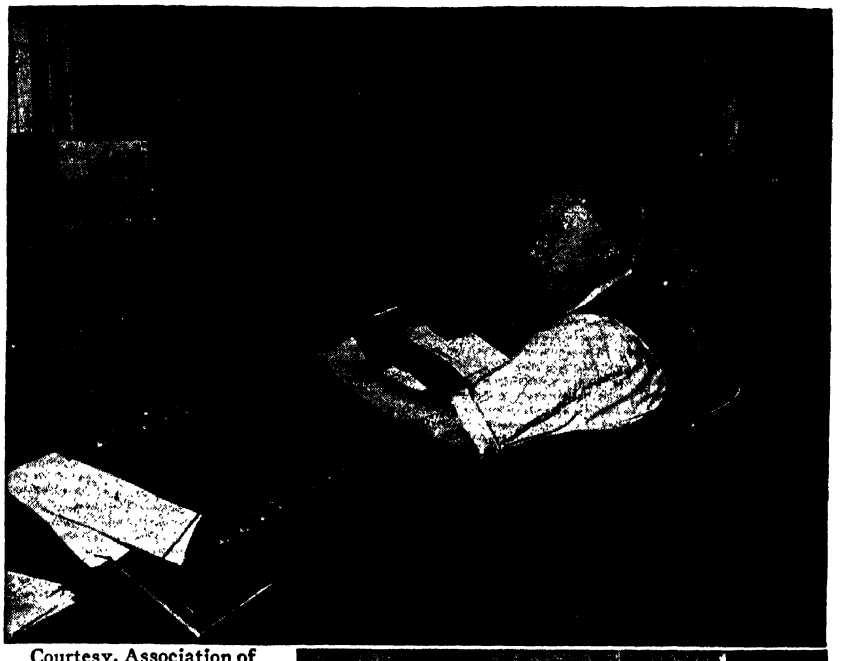
Gondola cars with open tops may be piled high with certain kinds of freight.

Fruits and vegetables travel in refrigerator cars. If they come long distances they are re-iced along the way.

Pictures, courtesy, Pennsylvania Railroad

with his new device, and amazed the onlookers by stopping it, after a twenty-mile speed had been attained, in 166 feet. The best that could be accomplished by applying the old hand brake was to attain a complete stop in 794 feet.

Signaling. Railroad companies soon realized the need of signaling devices. Without them costly collisions were bound to take place when trains were traveling in opposite directions on the same track at the same time. In the days of the single track the staff signal was adequate. There would be but one staff on a given stretch of road between two given stations. On that section no train could move unless the signal staffs had been placed in the hands of the engineer by that station master. At the end of the particular run the engineer would give the staff to the station master who in turn would intrust it to the engineer of a train ready to start in the opposite direction. This device proved no longer practical with the coming of double tracks and more frequent train schedules.



Courtesy, Association of American Railroads
The railroad dispatcher directs train movements and notes their progress.

Courtesy, Southern Pacific Company
Towerman switching cars and trains in a classification yard.

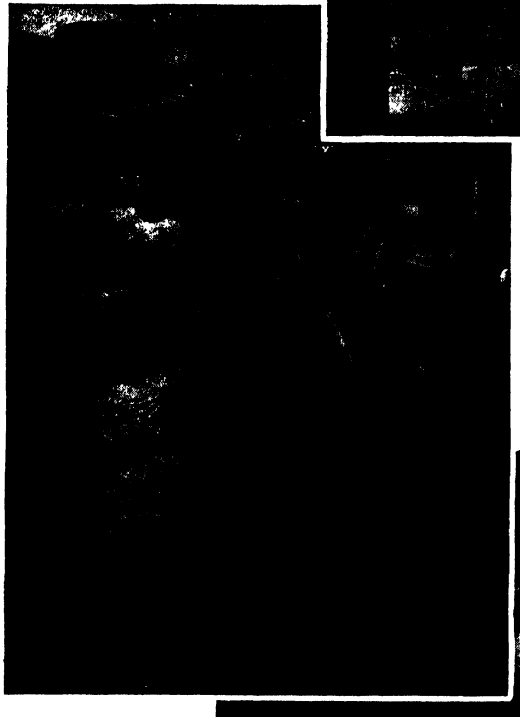
In 1834 the first system of fixed signals appeared in England. The invention was nothing more than a red and white disc placed upon a pole. By day the raising of the red disc indicated danger, while the white one by night told the engineer of an approaching train that the track was clear ahead.

The first semaphore signal was used in England in 1841; and in 1863 the modern block system was operated on the line between Philadelphia, Pennsylvania, and New Brunswick, New Jersey. The latest device is the automatic train stop. A rod extending down under the engine comes in contact with a raised rail as it approaches a danger signal. This contact completes an electric circuit which automatically locks all brakes, bringing the train to a complete stop.

People walking and riding likewise needed to be warned of an approaching train as they were about to cross the tracks on the highway. The first trains employed a man on horseback to ride ahead and give warning at each railroad crossing. As locomotives were able to attain greater speeds, stagecoach horns, whistles and bells

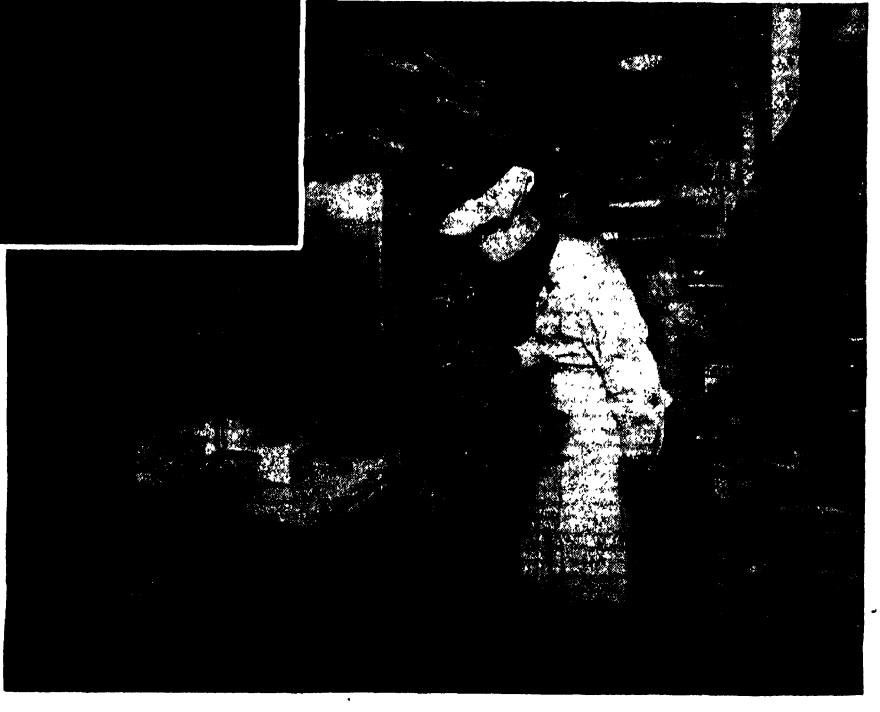
A TRAIN IS LIKE A HOTEL ON WHEELS

A modern dining car where it is possible for you to enjoy excellent meals at reasonable prices, while watching the countryside fly by the windows.



A little girl tunes in on her favorite radio program while traveling in one of the new lounge cars. This car also provides a lunch counter for passengers.

Constructed largely of stainless steel, this modern train kitchen makes use of every inch of space. Many scientific labor-saving devices are used.



Pictures by courtesy of New York Central System (top) and the Pennsylvania Railroad

took the place of the rider and his horse.

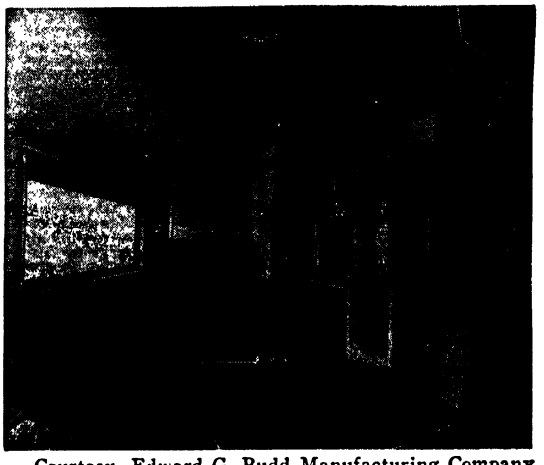
It was a long while before safety gates were invented. The first really practical ones came about 1880 and were operated by a crank. A few years later the pneumatic or air gate operated by means of a hand pump was successfully adopted.

In 1908 John J. Gard, of Harvey, Illinois, invented the first practical and easily operated electric gate. Today the electric gates are widely used, and a large number of them may be operated by one man in a signal tower. The electric gate is not interfered with by sleet, snow or cold. Electrical gates are now frequently so arranged as to operate automatically as an approaching train makes contact with an electric rail at a distance of several hundred feet from the crossing at which the gate is located. Among other crossing signals are the electrically operated waving arms, and the flashing red light, accompanied by the ringing of a crossing bell which signals the approach of a train.

Looking to the future, the railroads have their inventors busy devising new ways to increase the efficiency of freight and passenger trains. More streamlined trains will be in service. There will be improved sleeping facilities, and more provision for our amusement as we travel. We shall be able to dance, play games, see a motion picture or listen to the radio as we fly over the tracks at a speed George Stephenson, in his Rocket, could scarcely have imagined.

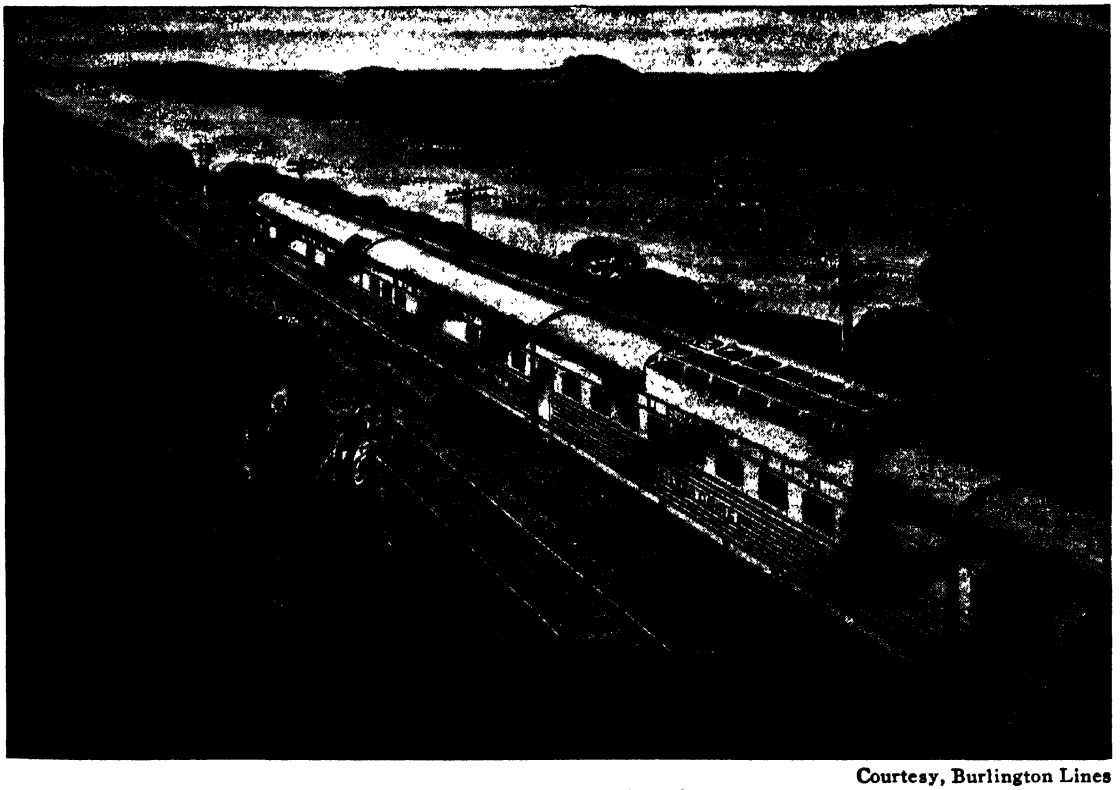
By GRAEME O'GERAN.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 441.



Courtesy, Edward G. Budd Manufacturing Company

This private sitting-room is turned into a bedroom by night with two berths, now concealed in the walls.



Courtesy, Burlington Lines

Through windows at the top of a car, the passengers are able to enjoy the scenery as the train speeds along.

THE MAP OF CHINA

Hagstrom Co.

China's boundaries are partly artificial, as shown by the heavy black line, which begins at the Gulf of Liao-tung, in the northeast, and ends at the Tonkin Gulf, in the southeast. Natural boundaries are formed by the Amur River (between Manchuria and the U.S.S.R.) and the mountain ranges in the far west.

James Sawders

Gateway to the new Peiping Library. This beautiful structure is a fine example of true Chinese architecture.

THE CHINESE REPUBLIC

THE Chinese land covers one quarter of Asia. It stretches from the Pamirs to the Pacific and from Siberia to India. The mysterious and wonderful mother-country, China proper, lies between the great region of Manchuria, Mongolia and Tibet, and the immense Pacific Ocean. China proper has an area of about 2,900,000 square miles. Its face is crossed by great mountain ranges running from the lofty heights of central Asia, and by immense rivers fed by the snows of Tibet and joined by a network of streams on their long journey to the ocean.

When we look at our map of China, we shall probably be dismayed and discouraged by the great number of difficult names. So perhaps it will help us, in our quest of a closer view of China and its people, to learn a few words of Chinese first. Then, at any rate, we shall understand what some of the names mean. That will give us a much better chance of remembering them, difficult as they are.

In this Land of Mighty Streams, *ho*, *kiang* and *kong* all mean river; *shan*, or *shan*, and *ling* stand for mountain; *pe*, *nan*, *tong* or *tung*, and *si* are the points of the compass, north, south, east and west; *hwang* is yellow, the old imperial color of China; *pei* is white; *fu*, or *foo*, and *king* mean town or court; *hai*, the sea; *chain*, heaven.

Knowing a few words like these, we can easily find the mountains of the east, Shantung, and the Peling (northern mountain) and Nanling (southern mountain) ranges. The last two shut in the basin of China's greatest and most important river, the Yangtze Kiang. Over three thousand miles lie between its sources in the heights of Tibet and its mouth in the Pacific Ocean. It makes a magnificent waterway into the heart of the country, wide and deep enough for steamers to ply for a thousand miles through the rich plains of central China. The river itself has done much to form these plains by bringing down fertile mud, as the Nile does along its

banks in Egypt, thus making its valley a sort of long oasis amid desert lands.

In its upper courses, separated from the lower by grand gorges, the Yangtze Kiang passes through a rich district of red earth as large as England and Wales together, and very thickly peopled. There are lakes in the basin of the Yangtze Kiang which act as reservoirs in time of heavy rains, so that its floods are not so disastrous as those on the Hwang Ho (Yellow River), which drains through northern China.

"China's Sorrow" is one of the names of the Yellow River, so dreadful are the floods when it bursts its banks and flows over the surrounding country and towns. Unlike the Yangtze, it is not navigable for long distances, but many of China's millions live along its banks. Floods are the bane of China. Tens of thousands of men, women and children may be swept away in a day; and livestock, growing crops and even the topsoil are lost, so that famine follows. However, the nations of the West have done much toward flood and famine control in China.

Water is not the only gift the inland provinces send to the mother-country: another is sand—yellow sand—that has been constantly blown by the strong winds from Mongolia over parts of northern China for centuries, till valleys have been filled up by deep beds of it and the low hills covered with it. The great desert called Gobi runs through Mongolia and into Sinkiang. Here dinosaurs once roamed and here civilizations flourished, later to be engulfed and preserved by the shifting sands, as Roy Chapman Andrews and other scientists have discovered and shown to the world.

A yellow land of yellow-skinned people—that is China—with a yellow river cutting its way through the soft soil, making deep cliffs on each side, and carrying its thick, yellow, sandy waters onward until they pour by ever changing mouths into a yellow sea. Small wonder that yellow is the color of China and that one of the titles of the emperor was "Lord of the Yellow Land."

Culver Service

A mandarin of the old Empire paying a ceremonious visit. The mandarin was an important public official.

The yellow basin of North China is even more fertile than the red basin of central China. Several valuable crops are raised in a year on the loess soil. (Loess is an especially fertile kind of soil which also occurs in other parts of Asia and in Europe and North America.)

The Si Kiang, or West River, drains southern China, rising in the eastern spurs

of the Tibetan heights and making its way through dense forests, past mountains with treasures of every sort of mineral and fields with crops that require a hot and moist climate.

China is the world's most populous country. It is estimated that more than 420,000,000 people live in the great cities, the fertile plains and along the waterways of China proper. The provinces of Mongolia and Tibet count some 6,000,000 inhabitants; there are about 29,000,000 in Manchuria, and most of these are Chinese.

Yet with all its millions much of China is not nearly so thickly populated as large sections of Europe. The coastal province of Kiangsu, however, which includes the great cities of Shanghai, Nanking and Soochow, contains over 36,000,000 people in less than 42,000 square miles. The state of Kentucky, about the same size, contains only about 2,900,000. This province is one of the most densely populated regions of the whole world. If we consider China proper as a whole, however, the density of population is far less than that of Belgium, Japan or even Italy. When the great outlying provinces are included in our calculations, the figure is even lower.

Probably you have seen curiosities brought back from the wonderland of the Far East, such as delicate embroideries on shining silks of gorgeous colors, dainty carvings in ivory and exquisite bowls and vases of the material named after the country — china. What is the far country like, whence come these treasures? Who are the clever workers that make them?

For thousands of years the people of China steadily worked, growing in numbers and changing rulers, suffering the horrors of war and enjoying the blessings of peace, but always busy in the same old ways, making the same things, cultivating the ground by the same methods for centuries, learning the same lessons in the same language.

The written history of China goes back four thousand years. Half that long ago, when the Chinese had already reached a high degree of culture, most of our ancestors in the wilds of Europe were still rough people indeed, barely making a beginning in civilized ways and thoughts. But China lost the advantage of the start by standing still, going to sleep and keeping to herself. Meanwhile, the young Western nations forged ahead.

There are many reasons that account for China's long sleep. The deserts and high mountains of central Asia formed a barrier

A silk farm in the days of the Empire. The production of silk has always been an important industry in China.

toward the West. Chinese life was based on a family or clan system. Reverence for parents and ancestors was the first duty of all Chinese. Children were intent upon carrying on the work of life in exactly the same way that their forefathers had handed down. Foreigners were not encouraged to visit China; indeed, they were long rigidly kept out. Thus, very little knowledge of the outside world and its discoveries penetrated into the heavenly or "celestial" kingdom which the Chinese believed to be supreme on the entire earth.

Some say that ages ago the ancestors of the Chinese came from the Tarim Basin and settled on the yellow loess-beds where it was so easy to grow food. Anyway, there they lived, advancing in civilization for long, long years, before they spread across the forest-covered mountain ranges which separate the basin of the Yellow River from that of the Yangtze Kiang. Here, too, the tribes flourished and grew and in time united under one ruler; the government became more settled, and many arts developed, such as the rearing of silkworms and the weaving of silk. This has ever been one of China's greatest and most profitable industries, though Japan has now surpassed China.

A SUCCESSION OF DYNASTIES RULED OVER CHINA FOR THREE THOUSAND YEARS

During most of her history China has been ruled by dynasties. A dynasty is a line of men from the same family, or from the same place, who rule, one after the other. You will find that ancient Egypt was also ruled by dynasties, and many European countries also, though they generally used the word line, or family, instead of dynasty.

The first dynasty in China about which we know very much is the Chow, so named because the emperors came from the province of Chow. It was the longest dynasty in China's history, lasting from about 1100 B.C. to about 250 B.C. During this dynasty, in 551 B.C., a great teacher and religious leader was born, Confucius. We tell you about this wise and noble man elsewhere. (See Index.)

The teachings of Confucius have been law to countless millions of his fellow-countrymen, there are shrines to him all over China and his books have been the foundation of all learning through the centuries in China; for Confucius collected and set in order the history of the empire, and inspired many books setting forth his teachings.

In 255 B.C. the Tsin (sometimes written Ch'in) dynasty, from the province of Tsin, or Ch'in. began to rule the country. The first Tsin emperor was Tsin-Shi Hwang-ti. He added the name of the province to his own name. It was from the dynasty of Tsin (or Ch'in), that the country began to be called China. Tsin was known as the first "universal emperor." He did much good for the country; he built roads and canals and set up many fine buildings. Yet he hated the works of Confucius and ordered all the philosopher's books to be burned. He was a first-class fighting man, and more than once defeated Tartar tribes in battle; but he had a different plan for treating the fierce Mongols who were raiding China from the North.

THE EMPEROR TSIN STARTS CONSTRUCTION ON THE GREAT WALL OF CHINA

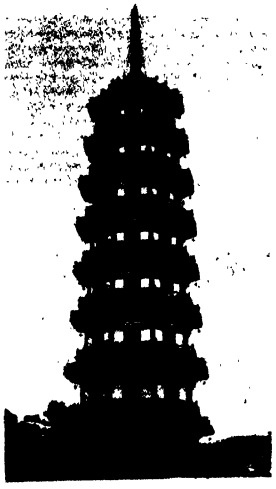
Tsin started a mighty wall that was to stretch all across the north of China. Twenty to thirty feet high, the wall was; and twelve to fifteen feet wide at the top, faced with granite or hard brick, and with many towers or small fortresses where watchmen could keep a sharp lookout for the raiders, and from which defenders could sally out to attack. This wonderful wall runs over hill and valley, across sand and river, up the face of the rocks, for more than 1,500 miles along the northern border of China proper. Much of it was built later, in the fourteenth century, and even as late as the sixteenth century. The wall still divides China from Mongolia; but it did not keep the Mongols out.

The Han dynasty ruled from 206 B.C. until 220 A.D. During this period Buddhism was brought to China, from India. The Han emperors extended the empire and improved the government. It was they who started the practice of appointing as government workers those who passed rigorous examinations in the classics, an early kind of civil service examination. This system lasted for two thousand years.

THE RULERS OF THE HAN DYNASTY FOSTER TRADE WITH THE COUNTRIES OF THE WEST

Trade was fostered by the Han rulers. Camel caravans made regular trips westward into central Asia, winding along the routes from one oasis to another across the deserts and through the mountain passes of Tibet and Turkestan. They carried Chinese silks, iron and other products which found their way (partly by sea) as far as Rome—and products of Greece and Rome were brought back to the Chinese princes and government officials and wealthy merchants.

PICTURES OF CHINA



THE GREAT PAGODA AT CANTON

A TYPICAL OLD PEASANT

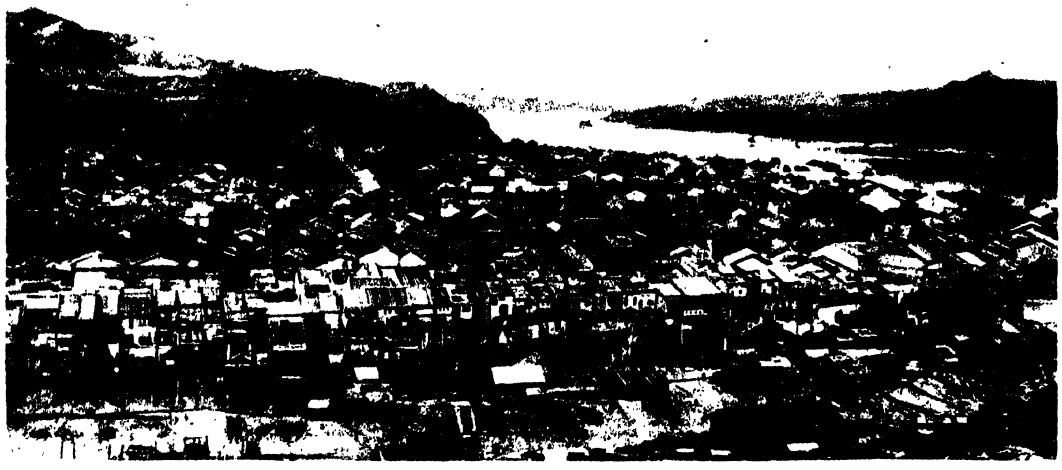
THE LUNG HUA PAGODA AT SHANGHAI

A SCENE ON THE GREAT PEARL RIVER AT CANTON

A STREET MARKET IN PEIPING

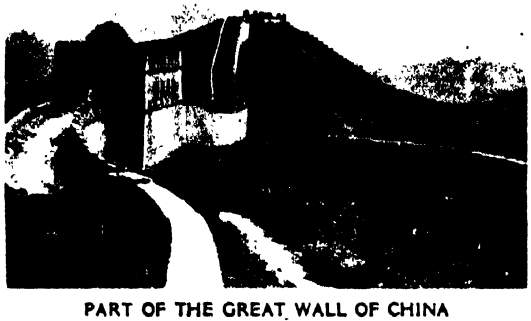
PORCELAIN TOWER AT THE OLD SUMMER PALACE, PEIPING

A STREET OF BOATS IN CANTON

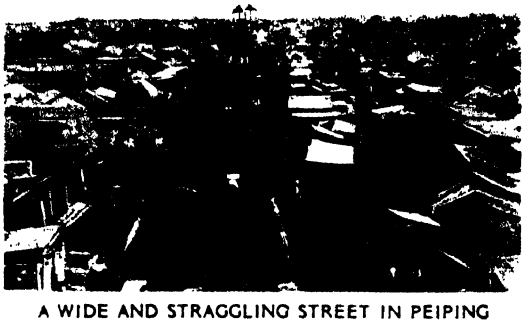


THE DENSE MASS OF HOUSES IN THE CITY OF CANTON

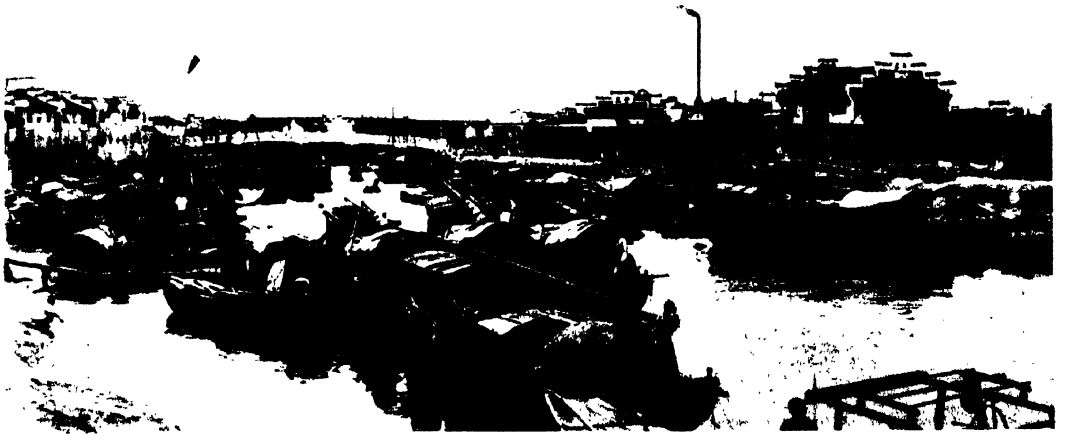
FAMILY ON A HOUSEBOAT AT CANTON BUSY WITH THEIR CHOPSTICKS



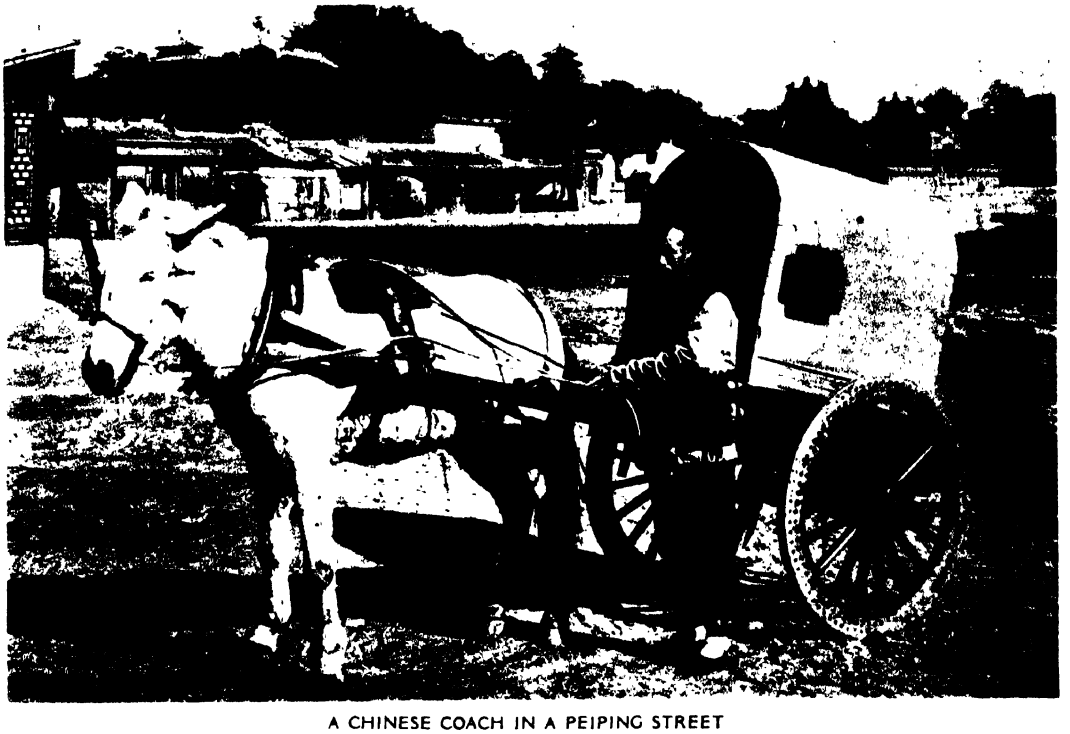
PART OF THE GREAT WALL OF CHINA



A WIDE AND STRAGGLING STREET IN PEIPING

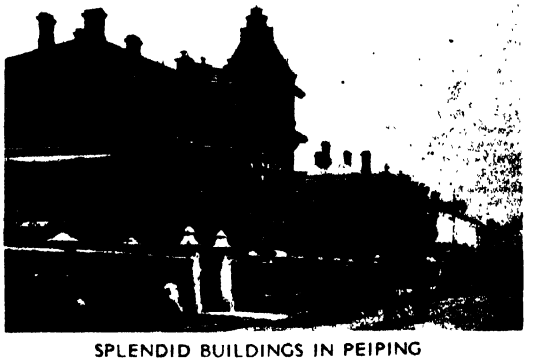


SAMPANS IN THE RIVER AT SHANGHAI, THE GREAT CHINESE SEAPORT

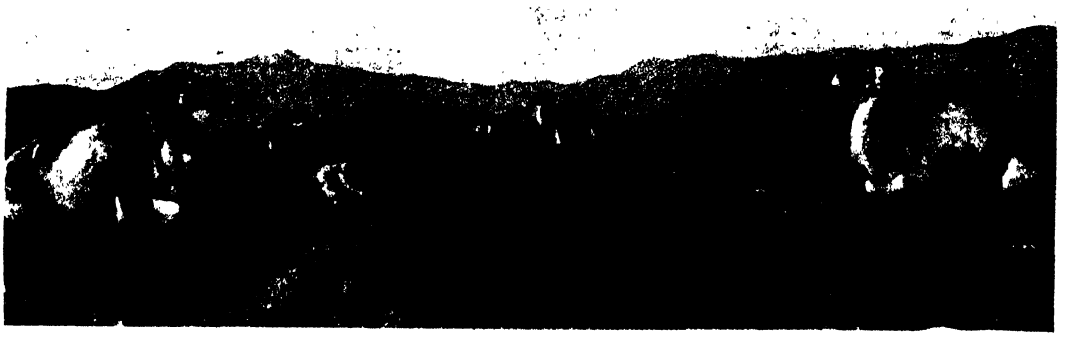


A CHINESE COACH IN A PEIPING STREET

A FINE STREET IN SHANGHAI



SPLENDID BUILDINGS IN PEIPING



THE GREAT STONE ANIMALS GUARDING THE APPROACH TO THE MING TOMBS

AN OLD MANDARIN READS HIS PAPER

A BRONZE LION AT THE OLD IMPERIAL PALACE, PEIPING

BOUND FEET—A PRACTICE THAT HAS BEEN DISCARDED.

SETTING OUT FOR A FISHING EXPEDITION WITH CORMORANTS TRAINED TO CATCH THE FISH

The pictures on these pages are by Ewing Galloway, Underwood & Underwood, the E. N. A. and others.

After the Han dynasty came to an end, there was a long period of disunion. Then came the Sui dynasty (589 to 618) and the great and wonderful T'ang dynasty (618 to 907). In the T'ang era, China became once more prosperous and powerful, the most progressive and the strongest country in the world. The borders of the realm were extended. The T'ang capital was the centre of thought and learning for half the earth. Literature flourished, and scholars were ordered to compile histories. Painting flowered into distinction, and to-day paintings from the T'ang dynasty are cherished among the world's great treasures. Paper had been invented in the Han era. Now it became even more important, because books began to be printed from type. A great encyclopedia was written at this time.

LITERATURE AND ART FLOURISH IN CHINA UNDER THE RULERS OF THE SUNG DYNASTY

Following the T'ang, there was another period of restlessness, until 960, when the Sung, or T'sung, dynasty began. It lasted until 1280. In all those years there was much warfare; tribes along the borders raided and pillaged and in some cases demanded and got tribute. Yet in the Sung dynasty literature and art flourished, and education spread. Schools and colleges, books and authors occupied a great place in life, as they had in the T'ang era. Buddhism flowered amazingly.

The fame of this land, with its learning and riches and its gorgeous palaces was carried to Europe, chiefly by Arab traders, and the romance and mystery of far-away China captivated the imagination of the West.

THE MONGOL DYNASTY IS FOUNDED BY KUBLAI KHAN, A POWERFUL AND WISE RULER

Early in the thirteenth century the Mongols gradually gained more and more power on the borders of central Asia, and in the north of China. The Mongol general, Jenghiz Khan, the "Greatest of the Great," flashed over western Asia and into China's borders, and ruled over an empire stretching from the China Sea to Russia. The Sung empire was divided with the Mongols. Finally Jenghiz Khan's grandson, Kublai Khan, completed the conquest of China and became emperor of all China in 1280. Kublai's realm extended over a large part of Asia and a wide area in Europe. He was the first emperor in the Mongol dynasty (1280 to 1368), one of the most brilliant rulers the world has ever known.

His capital was at Khanbaliq, near where Peiping (Peking) now stands; and to the court of Kublai Khan at Khanbaliq came the boy from Venice, Marco Polo, about whom we tell you on page 80. Marco Polo was the first European to get a passing view of the wonders of China. Kublai kindly welcomed the Venetian boy and sent him on many important government missions.

ACHIEVEMENTS IN CHINA UNDER RULE OF THE MONGOLS

Kublai was a great soldier and ruler, but the Mongol dynasty declined after his death. During Mongol rule, however, China went forward in literature; the form of writing called the novel developed, and excellent dramas were produced. In this dynasty also, the Grand Canal was completed, one of the most magnificent water courses in the world. It is 1,000 miles long and connects the lower Yangtze with the Hwang Ho.

Rebellions, murder, misgovernment and other troubles caused discontent after Kublai Khan's death, and in 1368 the Mongol dynasty came to an end, and the Ming dynasty began. It lasted until 1644. This was a purely Chinese government. The foreign Mongols had been driven back across the Great Wall to the Altai Mountains and Mongolia became a province of China. Despite many troubles at home and abroad, with the Mongols and the Japanese, the Ming dynasty gave China three hundred years of prosperity and advancement. Beautiful porcelain, the envy of Europe, was made, and another large encyclopedia was brought out. Peking was built—that is, many of the handsome temples and palaces that make the city even to-day an architectural wonder, were erected by the Ming emperors.

The Europeans had by this time become great travelers. Portugal, France, Spain and England were sending explorers and traders over the waters of the world. Silks and spices and lacquer-ware and precious woods from China were much in demand in Europe, and you will remember that in 1492, during the Ming dynasty, Christopher Columbus set out for India and China, sailing west. He found, not Asia, but America.

The Portuguese arrived at China by sea, sailing around Africa. Later the Spaniards came. The Portuguese traders made but little impression on China, but the Jesuit missionaries managed to make their way inland to preach the Christian religion. Meanwhile, however, the Manchus, descendants of old Tartar enemies of China, had settled

in Manchuria about the river Amur and made increasingly successful attacks on the empire. The Manchus, like the old Tartars before them, were mighty warriors.

In 1644 the Ming dynasty came to an end and a Manchu line of rulers seated itself firmly on the dragon throne in Peking, inside the Great Wall built centuries before to keep out invaders. Manchu became the official language of the court. The Chinese men were ordered to wear their hair in a queue, or pigtail, as a sign of subjection to the Manchus. Later the pigtail was willingly worn in token of loyalty to the Manchu line. The Manchu dynasty lasted until 1912, when it was swept aside by revolution, as we shall see, and China became a republic, with a president.

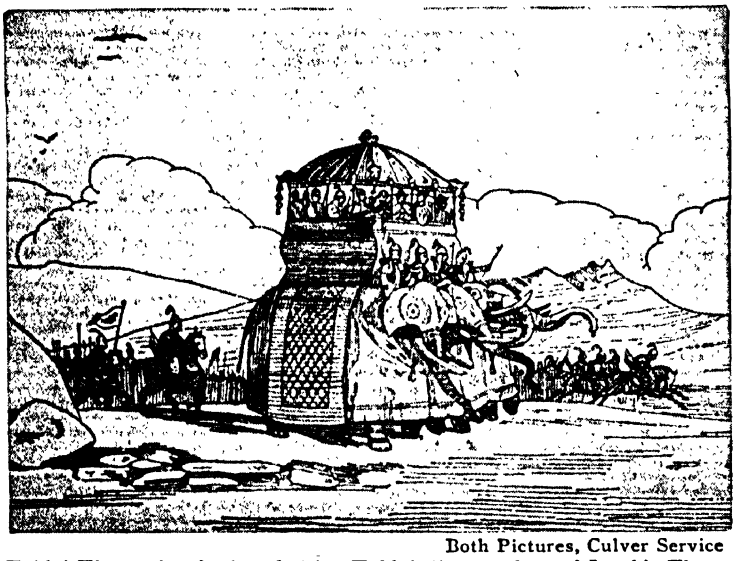
A great general—Jenghiz Khan.

From 1644 to 1912 is a long time for a single dynasty to remain in power. During those years China tried hard to live apart from the rest of the world, but in the end Europe forced her to open her doors.

For thousands of years the Chinese had been living in a world of their own. Their emperors had come to think of themselves as rulers of the earth. Consequently they utterly refused to receive the representatives of Western powers, unless they came as vassals bearing tribute. They refused to accept our idea of countries, large or small, dealing with one another on an equal footing.

Nor did closer contact with Europeans lessen the natural dislike of the Chinese for all foreigners. Many brave and unselfish missionaries came to China to spread the gospel among the Chinese, though China had a high moral culture of its own; but their good work was more than undone by the greedy and unscrupulous traders who stopped at nothing to win their ends. For the sake of gain they even helped to smuggle into the country in large quantities the evil drug opium, which the Chinese very properly had outlawed because of its most terrible effects. This evil practice was followed by the Japanese in China before and during World War II.

In truth the China trade was a prized source of wealth. Since 1557 the Portuguese had maintained a trading post on the island of Macao at the mouth of the Si Kiang. By the Treaty of Nanking in 1842, following a brief "Opium War" in which China for the first time felt the might of Western arms, the British obtained the nearby island of Hong Kong (which soon eclipsed Macao), a large war indemnity and, most important of all, the opening of certain "treaty ports" to foreign trading ships.



Both Pictures, Culver Service

Kublai Khan going forth to battle. Kublai, the grandson of Jenghiz Khan, was a most brilliant monarch. His court was described by Marco Polo.

Little by little China was forced to give way. Other nations—the Dutch, French, Germans—followed England's lead. There were campaigns and sieges and stormings and endless discussion of a more peaceful nature. Concessions and money were often exacted as a punishment for killing missionaries or other representatives and for burning their property. Little bits of territory were

nibbled away here and there and many more ports were opened. Large sums of money were invested or lent to the Chinese, and in return the customs, postal and other government services were organized under foreign administration. Foreigners in China lived under the laws of their own country—a state of affairs called by the tongue-twisting name of "extra-territoriality" and hateful to China.

Soon after the Treaty of Nanking a terrible rebellion devastated a large part of China for fifteen years. A young American soldier, Frederick Townsend Ward of Salem, Massachusetts, helped the Chinese government to put down this Taiping Rebellion, as it was called. He was killed in 1862, and the work was completed in 1864 by the British Captain Charles George Gordon, ever after known as "Chinese" Gordon.

Figure of musician, from a Chinese tomb of the T'ang Dynasty.

The chief reason China was not actually dismembered, as Poland had been a hundred years before, lay in the rivalries among the Western powers. The picture became even more complicated when Japan entered the field, having learned from the West rapidly and all too well. In 1894 Japan came to blows with China over Korea and quickly won, though China had begun at last to adopt Western military methods. The Western powers interfered and denied Japan the fruits of her victory. Russia, especially, had an interest in doing this, for in Russia's march toward the Pacific, she had obtained a strong foothold in Manchuria, whence came the Manchu emperors. As we tell you elsewhere, Japan ten years later completely defeated the great Russian Empire in war. Japanese influence in China grew. In all these struggles China was always the real loser—the helpless victim of aggression.

Both pictures, Metropolitan Museum of Art

Two theatrical costumes of the eighteenth century.

Meanwhile, in 1900, Chinese feeling against the "foreign devils" had broken out into open rebellion. A secret society arose, calling itself "The League of the Righteous Fists of Harmony," translated into English as "Boxers." At first it was only a small and weak organization but when the court at Peking gave secret support, the movement came out strongly against all foreigners, especially the missionaries. For two terrible months the European residents in China were in great danger. Many were killed and others suffered all the terrors of a siege. They were shut up in Peking, with a howling mob eager for their lives outside, until the allied forces, including the Japanese, brought relief.

Though China was an ancient and highly civilized country, and the Chinese themselves were honest and thrifty, the government was far from perfect. Chinese life was based on loyalty to the family and thus men in public office were inclined to favor family interests. This encouraged abuses, such as bribery and corruption. Chinese officials often demanded their graft or "squeeze."

At the same time local government in the provinces went on with little regard as to what took place in Peking. Provincial governors, village elders and family patriarchs did much as they pleased and carried on in their age-old ways. This is the reason for China's great stability, despite all disasters. This fact and the unwillingness of the court to entertain new ideas, however, made impossible a strong central government, able to fit the country into the modern age.

Yet to do this was a necessity. Railways and factories had begun to be built. The old ways of life were changing. Chinese students came back from foreign universities,

eager to make over their people. The Chinese system of education itself had been completely reformed during the early years of the present century.

During most of these troubled years the real power on the throne of China had been the Dowager Empress, a staunch foe of progress. At her death in 1908 a young child was placed on the throne. Dissatisfaction spread widely among the people. In 1911 a revolution took place and the Manchus were forced out. China declared itself a republic, with Yuan Shih-kai, a powerful general, as president. Great as had been the troubles that had gone before, they were as nothing against those now to come. Let us try to find our way through the recent events in China.

Yuan tried to rule with a firm hand. Indeed, he believed in a limited monarchy; but even before his death in 1916 serious civil war had broken out. Different provincial rulers, *tuchuns* or war lords, raised armies of their own. They fought among themselves, frequently changed sides, sold their support to the highest bidder and were not above playing the game of foreign interest, especially with the Japanese. Hundreds of thousands of men were constantly under arms in China, many of them little better than bandit gangs. They formed a useless burden on the country, a burden that fell chiefly on the impoverished peasantry.

Met. Mus. of Art
Porcelain vase of seventeenth century.

During the first World War China finally took the side of the Allies. Afterward the Western powers began to show more good will. In 1922 nine of the powers, including Japan, agreed to see to it that China should continue as a nation and that no one should take any of her land. Some concessions were actually returned. China also joined the League of Nations. During all this time, the Peking government, though it made treaties and undertook some constructive work, was very weak.

The real "Father of the Chinese Revolution" was Dr. Sun Yat-sen, a highly educated and intelligent man. He was, in fact, the first president of the young republic but gave way to Yuan Shih-kai for the sake of harmony. Dr. Sun (you will notice that most Chinese place their surname before their given name) formed a party called the Kuomintang—which literally means "Country-People Association." It was a patriotic party that wanted to restore China to the Chinese. We call such a movement nationalism.

The Chinese nationalists under Dr. Sun finally established a separate government in Canton, South China, which began to enlist considerable support. Dr. Sun himself died in 1925. His body now rests in a magnificent tomb on a hill near Nanking. He left his followers a simple, clear program and the year after his death the new nationalist forces started a spectacular advance under young Marshal Chiang Kai-shek. By the end of the year Chiang controlled most of China south of the Yangtze. A few months later Shanghai and Nanking were taken by his men, and Peking followed in June.

The seat of government moved to Nanking, the ancient southern capital, much to the distress of Peking, which was given the name of Peiping, meaning "City of Northern Peace." It is true that Chiang's newly established nationalist government was still far from controlling all China; but it earnestly set about the task of reconstructing the ravaged nation. A complicated new constitution was adopted and recognition was obtained from many Western powers. It seemed as if, even with Japan, a balance would be worked out.

Alas! It was not to be. Trouble continued with Japan, which steadily strengthened its hold on China. In 1931, the Japanese, who controlled the railroads, began to occupy rich Manchuria, where they had valuable interests, and into which millions of Chinese immigrants had been pouring The Japanese also landed troops in Shanghai and during the fighting much of the native city was burned. Despite China's show of resistance, despite the Nine-Power Treaty, despite protests from other nations, despite official condemnation by the League of Nations, the Japanese occupied Mukden in 1931. The three provinces of Manchuria, together with some other territory in Mongolia and northern China, were formed into a new state called Manchukuo. This state was ruled as a "puppet state," that is, the Japanese controlled it, though it was supposed to be inde-

pendent. China's last "boy emperor" of the Manchu dynasty, Henry Pu Yi, was lifted from obscurity and placed on the new throne of Manchukuo as Emperor Kang Teh.

Japan continued to extend her influence in northern China. In 1937 the Japanese suddenly launched an undeclared war on China. In the months that followed, the Chinese lost their seaports one by one; their capital, Nanking, was captured and sacked; other important districts were captured. The Japanese expected the Chinese to give up and surrender.

A UNITED CHINA RESISTS THE JAPANESE INVASION

Instead of crushing China, the invasion unified the people. The Chinese leader, Chiang Kai-shek, retreated, fighting, toward the west. The capital was removed to Chungking, in the province of Szechwan. The machinery from many factories in the east was set up in the west; and small co-operative industries began to supply the heroic Chinese army. Supplies continued to reach China from Russia and from Burma (along the famous Burma Road). The regular troops of the Chungking Government fought the Japanese to a standstill, while guerrilla troops harassed the Japanese in the occupied eastern regions.

CIVIL STRIFE FOLLOWS ON THE HEELS OF WAR

As you know, World War II ended with the defeat of Japan in 1945. But China was still a long way from peace. The unity which the struggle with Japan had brought about collapsed. Ever since the founding of the Republic, there had been conflict between the Nationalists and the Communists. Many of the Communists were driven toward the remote west of China; and during the early 1930's they established themselves in Shensi Province. As the war with Japan progressed, the Communists moved east; and by the time Japan was defeated, they were in control of most of northern China, including Manchuria. After the war, they began to inch south.

Efforts were made, especially by representatives of the United States, to end the fighting and settle the differences between the Nationalists and Communists. All the discussions came to nothing. Faith in Chiang Kai-shek and his government dimmed, and the Nationalist soldiers lost heart. Chiang resigned at the beginning of 1949; and by spring, the Communists were in control of practically all of China. The ancient land seemed destined to have a Communist government.

One of the most fascinating cities in China is Peiping—ancient Peking—just south of the Great Wall. There has been a city on this site for three thousand years. Peiping is like a Chinese puzzle box, with several towns fitted inside one another between walls. At the center, once called the Forbidden City, is the former residence of the emperors, its splendor vanished.

Culver Service
Dowager Empress Tzu Hsi, who died in 1908.

Shanghai, in the delta of the Yangtze, is a great commercial center in peacetime. The wide Bund along the water front, with its modern skyscrapers, is one of the famous streets of the Orient. Farther up the Yangtze is the capital city, Nanking; and still farther, Hankow, the "Pittsburgh" of China and a center of the tea trade. Canton, where thousands of Chinese live on houseboats in the Pearl River, is the most important city of the far south.

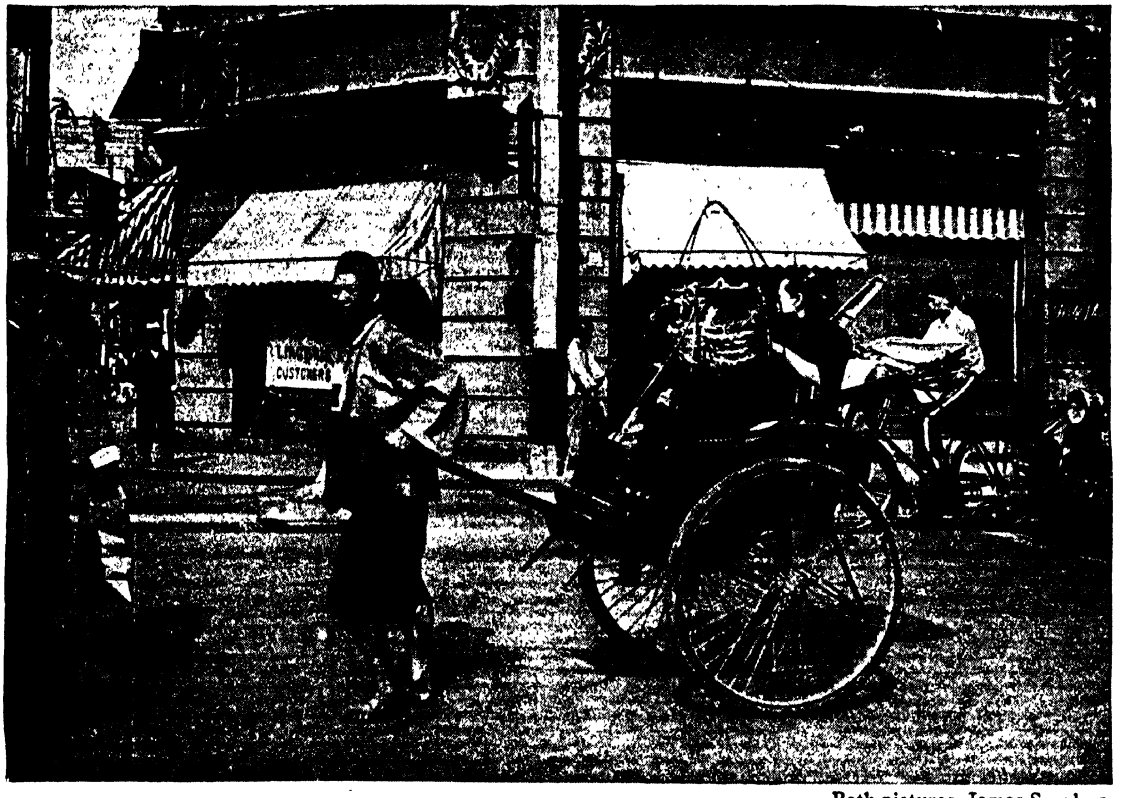
Among the leading agricultural products of China are cotton, tea, wheat, rice, barley, corn,

millet and other cereals. China's fibre crops, such as hemp, jute and flax, are also very important. Silk culture is one of the foremost industries. Pigs are raised everywhere and pig's bristles are a highly important article of export.

Nearly all the provinces of China have valuable coal deposits—one of the incredible tales Marco Polo told upon his return to Venice was about a "black stone that burns." In Shansi there are immensely rich iron as well as coal deposits, and the iron industry there is said to be the oldest in the world. In addition, China has great petroleum resources, largely undeveloped. Tin, tungsten, copper, antimony, gold and other metals and minerals are also produced. The chief tin mines are in the inland province of Yunnan. More than half of the world's antimony comes from China. We can see that China has great natural wealth which will undoubtedly play an important part in its future development.

A young Chinese and his quaint hair-do. China today is a striking combination of new ways and old ways.

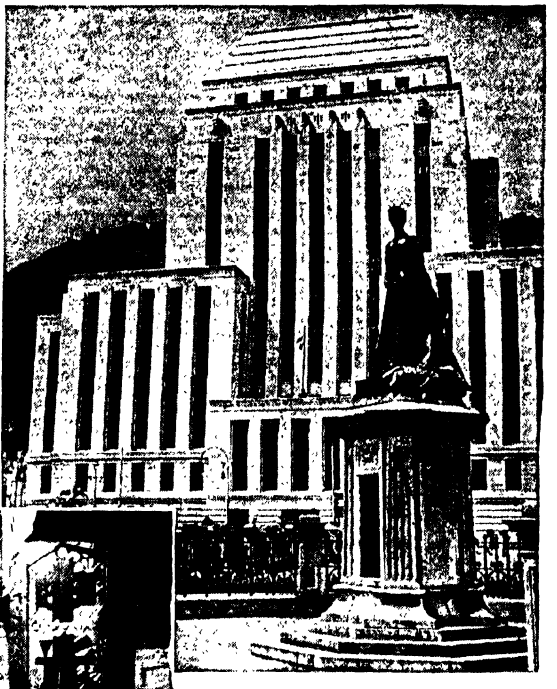
As we near the end of our story, we see what tremendous changes have taken place during the past hundred years in China, which for thousands of years had remained almost untouched. These changes are still going on. No longer are the feet of well-to-do women crushed into uselessness in infancy, as a badge of leisure and luxury. Gone is the queue, or pigtail, imposed by the Manchus as a mark of subjection. Rice, still the staple diet, is steadily giving way to wheat, and to-day the acreage planted to wheat is greater than that in rice. Millions of Chinese work in factories and offices, or attend the universities and schools. Many of these wear Western clothes and find their recreation by going to moving pictures or listening to the radio. They are alive to the demands of the new age.



Both pictures, James Sawders

A Chinese shopper brings her purchases home in the picturesque man-drawn "taxicab" known as the rickshaw.

Side by side with the modern influences there remain the traditions and usages of the past. In the vast back country provinces the peasants—and most Chinese are peasants—cling to their ancient ways of life. The basis of that life remains the family. Parents and the spirits of departed ancestors are held in deepest reverence. Chinese dislike moving away from the graves of their ancestors. When they do, they spare no effort to insure that after death their bodies go back to the land of their fathers. Customs in China are sometimes just the opposite of our own. Thus white, rather than black, is the color of mourning. Despite the influence of Western fashions, the standard Chinese dress remains the long blue cotton robe, often felt-padded.



The huge building of the Hong Kong-Shanghai Bank, in the British colony of Hong Kong.

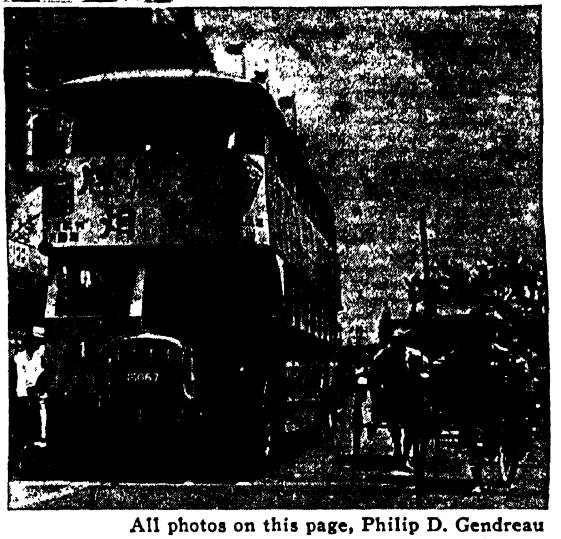
Native shopping quarter in Hong Kong. The Chinese population of Hong Kong is about a million.

The wealthier families, often with many members, live behind walls rigidly closed to the outside world. Several apartments generally open on connecting courtyards in which every detail is pleasing to the eye. The poor — most of them just above the starvation line—carefully till their tiny plots of land and tend their pigs and chickens, patiently bearing the fearful exactions of nature and of war.

Almost everyone in China drinks tea, and enormous quantities of pale tea (green tea) are consumed in China each year.

China has, indeed, awakened from her long sleep and is taking her place among the modern nations, but she has a long distance to go before she can catch up. In the world which men of good will hope to build, after the war, China will need considerable aid.

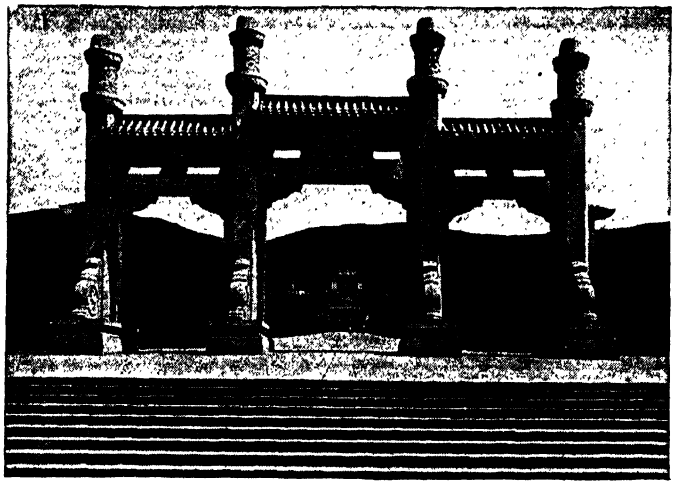
No nation, however, can become great by



All photos on this page, Philip D. Gendreau

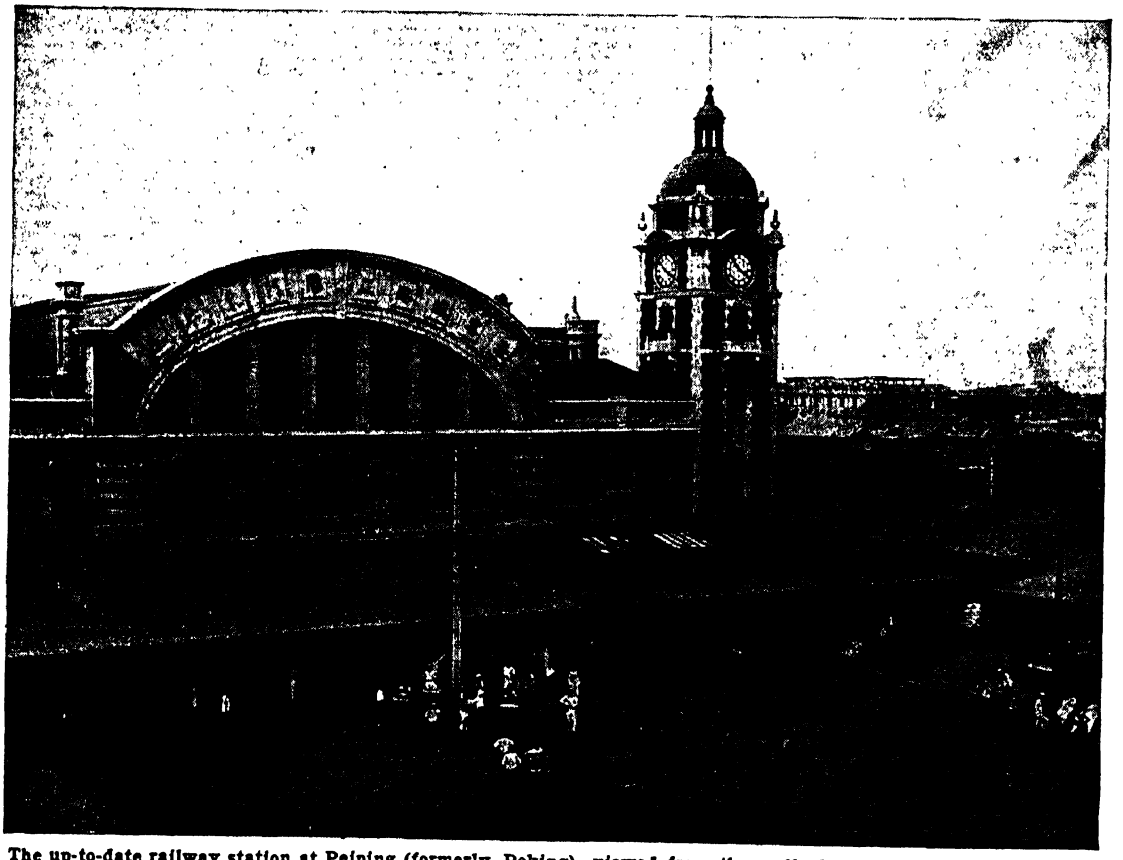
The old and new in transportation on the famous Bund, in Shanghai. The bus and the coolie-drawn rickshaws are competing for the passenger trade.

means of outside help. Greatness must grow from within, from the masses of the people, through wise leadership. One thing that has kept the masses from improving has been their lack of education. The classic written language of China has been far too difficult for the common people to learn. Our written language has twenty-six letters in its alphabet; theirs had thousands of characters to be memorized. Ordinary working people never had the time to learn to read and write. During the first World War, a gifted Chinese, Dr. Y. C. James Yen, found that a person could write so as to be understood if he knew about 1,000 characters. He began teaching this simplified Chinese. The idea spread, and many millions of children and grown people have since received the beginnings of an education, who could never have had it otherwise. The plan is called the Chinese Mass Education Movement.



Both pictures, James Sawders

The tomb of Sun Yat-sen, revolutionary leader, at Nanking.



The up-to-date railway station at Peiping (formerly Peking), viewed from the wall above the American Legation.

Books and newspapers are printed in the simplified vocabulary. For many years the Government has encouraged the movement. When all China's millions of people can read and write, we shall see a rising tide of progress, in field and factory, in shop and home.

THE PRODUCTS OF CHINA

Agricultural Products: Wheat, corn, barley, rice, millet, and other cereals; peas, soybeans, sweet potatoes, beans, and other vegetables; sugar; tobacco; peanuts; indigo; many fruits; hemp, jute, ramie, silk, flax, cotton; tea. Pigs, camels, cows, goats, sheep, buffaloes, horses, donkeys, mules and poultry.

Manufactures: Cotton, wool and silk materials, also rayon; flour (wheat and rice); iron; glass; electrical goods; tanning; cement; ships; railway equipment; lacquers and porcelains; embroideries.

Minerals: Coal, iron ores, petroleum, tin, antimony, manganese ores, molybdenum, bismuth, gold, mercury, silver, sulphur and many other minerals.

Other Products: Fish, vegetable oils (especially soybean and tung oils); dyes; pigs' bristles.

Both photos, courtesy, United China Relief

To protect themselves from destruction in air raids, publishing and printing companies, as well as newspapers, set up shop in caves dug out of solid rock, during the war. Above we see a typical printing shop, with the compositors' cases lining the cave walls.

Chiang Kai-shek visiting a boys' school, during the second World War. The Chinese educational system has undergone great changes within recent years; many up-to-date methods have been adopted.

FRENCH INDO-CHINA

SOUTH of China is an area on the map shaped like a thick letter S. Its long eastern coastline is washed by the Gulf of Tonkin, the South China Sea and the Gulf of Siam. Cutting into it on the west is Siam.

The name of this country is French Indo-China. It is a part of the French Union and both India and China have shared in its long history, so the name is very suitable.

This region, before World War II, was governed as five areas: these consisted of a colony, Cochinchina; and four protectorates, Annam, Cambodia, Tonkin and Laos. Since the war there have been changes in government, as you will see on the following page. However, the old divisions are still used in a geographical sense, and in our description of the country we shall refer to the sections by their time-honored names.

THE GREAT RIVERS THAT SERVE AS HIGHWAYS OF COMMERCE

In the north, at the top of the S, is Tonkin, with mountains rich in minerals and fertile plains. Running south from Tonkin is a mountain range that follows the curve of the coastline. Annam, along the coast, and Laos, inside, next to Siam, are long and narrow, following the middle curve of the S. In the south are the lowlands of Cochinchina, and to the west the ancient, storied kingdom of Cambodia with its mountains. Two wonderful rivers serve as great highways of commerce. The mighty Mekong, rising in Tibet, flows between Laos and Siam, then across the plains of Cochinchina into the South China Sea. The Red River rises not far from the source of the Mekong, but takes a quicker, more direct route to open water (the Gulf of Tonkin) across the top of the S. There are several other rivers. The Great Lake (called Tonle Sap by the natives) in Cambodia is connected with the Mekong River.

The land about the delta of the Mekong River and the river deltas in all parts of the country are extremely fertile. The principal crop is rice, the chief food of the natives. In fact, the southern part of the country is one of the world's great rice-growing areas. Other food crops include corn, yams, potatoes, coconuts, sugar-cane, tea and coffee. Cinnamon and pepper are grown for export. Another export is sticklac, a gummy substance found on trees, from which shellac is made.

Rubber is the most important of the industrial crops (those not used for food but in industry). The cotton plant is cultivated in all parts of French Indo-China and particularly in Cambodia. The forests yield teak and other valuable woods. Bamboos are found throughout the country. They are used in building houses and they make excellent paper pulp. Tobacco and kapok are raised.

Mineral deposits are found most abundantly in the mountainous regions of Tonkin, Annam and Laos. Important minerals include coal, zinc, wolframite, antimony, tin and salt, also graphite and lead. There are considerable oil deposits in Tonkin.

Among the most important industries are those connected with preparing rice for the market. There are a number of rice-cleaning plants in various parts of the country. Silk worms are raised in many different parts of French Indo-China and silk manufacturing is carried on on a large scale. Other manufactures include brick, pottery and glass.

THE LAKE THAT EMPTIES, LEAVING ITS FISH TO BE GATHERED UP

Livestock-raising and fishing are important. The fisheries of the Great Lake are particularly profitable. When the Mekong River overflows, its flood waters fill up the Great Lake. When the flood waters go down again, the lake empties. Instead of a lake, one sees a great number of small ponds. These are filled with huge quantities of fish, which are caught by the thousands and then salted or smoked. In some years exports of these fish to China amounted to 25,000 tons a year.

The area of French Indo-China is about 260,000 square miles; and a great mixture of races live there—many primitive tribes still living in remote places half hidden in the hills and jungles; Chams, who resemble the Malayans; Annamese, by far the dominant race; the Khmers of Cambodia; Chinese; French and other Europeans.

The capital, Hanoï, in Tonkin, has a population of 134,000. Other important cities include Cholon (population, 200,000), Saïgon (population, 110,000), Pnom-Penh (population, 102,000), Binh-Dinh (population, 75,000) and Hué (population 60,000).

Buddhism is now the principal religion; but long ago Cambodia must have been a shining centre of Brahminism (the Hindu religion). The old capital, Angkor Thom, is now only a heap of ruins in the jungle, near Great Lake. Enough remains, however, to show that it was a splendid, wealthy city

© Ewing Galloway, New York

The ruins of a long-forgotten temple, the Angkor Vat, in the jungle of Cambodia, seen from across the moat.

of palaces and temples built with towers dedicated to Siva, the Hindu god. South of Angkor Thom, and nearer to the Great Lake, are the ruins of a magnificent temple, the Angkor Vat. The mighty temple was built in the centre of a park surrounded by a moat. The Royal City, Angkor Thom, was deserted by its people centuries ago, probably because of attacks from the Siamese, and the temple, too, was left to fall into decay. The jungle grew up around the buildings and it was only by chance that all this splendor was discovered by Europeans less than one hundred years ago. The Angkor Vat seems, from its architecture, to have been a Hindu temple first, then re-dedicated to Buddha.

Now, with the seven-league boots of our imagination, let us take a long leap forward in time, and consider the recent history of French Indo-China.

The French first penetrated Indo-China toward the end of the seventeenth century, when they received several territories from the emperor of Annam as a reward for having helped him against the Chinese. The later history of Indo-China recalls that of many other European possessions in Asia. Native uprisings against the French led to expeditions against the natives, and in time these expeditions led to annexations. Cochinchina became a French colony in 1862. French protectorates were then established in Cambodia (1863), Tonkin (1884), Annam (1886) and Laos (1893).

After World War II, as you know, many regions in the world that had been ruled as colonies began to press for a bigger share in their own government. In Indo-China several changes were soon made. The whole area was declared no longer a colony but part of the French Union. Cambodia and Laos became independent kingdoms within the Union. Cochinchina and a newly formed state known as the Republic of Viet Nam, in northern Annam, were recognized by the French as republics within the Union, in 1946. This left some areas not accounted for; and in the two new republics all was not well.

Opposing elements succeeded in forming another government to include Tonkin, Annam and Cochinchina. This government was recognized by France in 1948; but it did not have the following of all the people in these areas. The Communists in Indo-China, particularly, were against it.

SIAM

THE ancient country of Siam, known as Thailand from 1939 to 1945, looks like a crouching animal on the map of Asia. Its head and forefeet are plunged in French Indo-China; its hunched back is set against Burma; its long tail forms part of the Malay Peninsula. There is a long range of mountains extending from north to south along the Burmese frontier to the Malay Peninsula. There are great forests in the northern part of the country. Wide plains, watered by the Menam River and its tributaries, stretch toward the south. Much of Lower Siam, which is a part of the Malay Peninsula, is covered with dense jungle.

Siam is one of the most fertile lands in all Asia. Rice is the principal crop and it is the chief food of the people. The country is celebrated for her fruits, which include the pineapple, the mango and the guava. The cultivation of rubber in the south has become an important industry; sugar-cane is also raised on a large scale. Excellent teakwood abounds in the forests of the north. This wood is used in Eastern countries to build temples and the boats called junks; and there is a large foreign demand for it as timber.

THE GREAT MINERAL WEALTH OF THE MALAY PENINSULA

There are large deposits of tin, particularly in that part of the country which is in the Malay Peninsula. Gold is found in many different places and copper, wolframite, zinc, manganese, precious stones and coal add to the mineral wealth. At one time Siam produced considerable quantities of iron. Very little is now mined, however; practically all the iron now used must be imported from abroad.

Siam has an area of some 200,000 square miles and a population of more than 15,000,000, made up of many different peoples. The chief stock, known as the Siamese or Thai (this word means free men), is of Mongolian stock; most of the other natives are also members of the great Mongolian family. Before World War II, Chinese estimated at half a million to a million and a handful of Europeans (less than 2,000) lived in Siam. The chief religion, as we might guess, is Buddhism; Mohammedanism and Christianity are also represented.

Bangkok (population, 681,000), the capital, is on the Menam River, some twenty miles from its mouth. This picturesque city contains the royal palace where the king dwells. The palace, on a bend of the river, is enclosed by a high wall. In a courtyard are kept several of the white elephants for which Siam is famous.

These elephants, which are really not white but pinkish gray, are held sacred by the Siamese; it is forbidden to harm them. Formerly the kings of Siam used to present white elephants to courtiers who displeased them; these courtiers were ruined by the expense involved in caring for the great beasts. From this custom we get the phrase "white elephant," meaning a useless gift.

Bangkok is a flourishing commercial centre. Other important towns of Siam are Chiengmai (population, 544,000) and Ayuthia (population, 300,000).

SIAM HAS BEEN AT WAR DURING MUCH OF HER HISTORY

The history of Siam has been a troubled one. Until the last century the people were frequently at war with the Cambodians and the Peguans, to the east, and the Burmese, to the west. By the end of the nineteenth century, however, Siam's foes had been overcome by two powerful European nations. The French occupied the territory (called French Indo-China) to the east; the English were in possession of Burma, to the west. The independence of Siam was guaranteed by the French and English in 1896, and from that time the country enjoyed a period of peace and prosperity which lasted for many years.

Until the year 1932 Siam was an absolute monarchy; the king had the power of life and death over his subjects. In that year, however, the country became a constitutional monarchy. The supreme power now belongs to the nation instead of to the king. This power is shared by the king, by an assembly of the people's representatives and by a state council.

When France was defeated by Germany in 1940, the Siamese regained some of their former territories. After the Japanese invasion on December 8, 1941, Siam was completely under Japanese influence, although in theory her independence was respected by Japan. The people, however, always yearned for freedom. A strong underground movement persisted in Siam and awaited the opportunty to aid the Allied forces. In 1945 Japan lost the war, and so lost all control in Siam. At the end of 1946 Siam became a member of the United Nations.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 464.

Mohammedans at Prayer, a painting by Jean Léon Gérôme.

THE STORY OF ORIENTAL RUGS

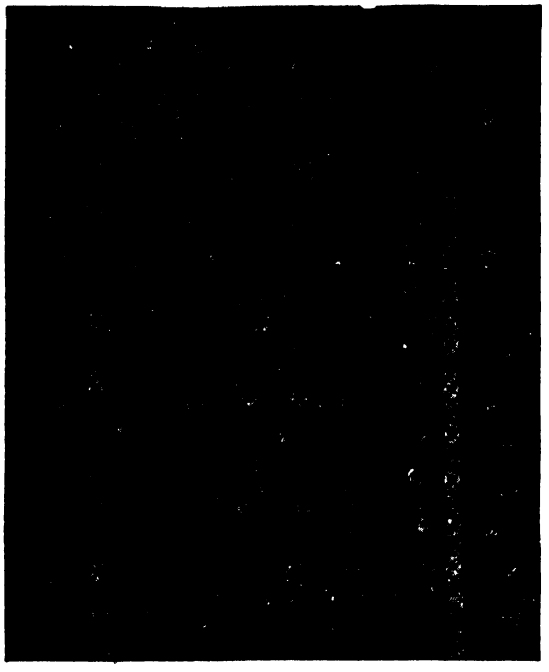
SOME winter morning when you throw back the covers before getting out of bed, think how different it would be if, instead of a soft rug beside the bed, there were only the cold, hard floor. A bedside rug adds great comfort to our daily lives and so do the rugs throughout the house. They are important also as decorations for our rooms, and for this reason great stress is laid on the patterns and coloring so that they will harmonize with the rest of the furnishings.

Most of the rugs seen to-day are made by machinery, and one may indeed wonder if rugs were used to any great extent before machines began turning them out by the thousands. While it is true that beautiful rugs have become available to almost everyone since the invention of the power loom, rugs of some sort were known even in the most ancient times. No doubt primitive man found protection from the damp earth by spreading skins or matted grass upon the ground.

Rug-weaving has been carried on since very early times; in fact, it is not known what peoples discovered the art. Carvings which adorned ancient Assyrian buildings several thousand years ago show us that rugs were known then. Enameled tiles from an Egyptian palace nearly as old tell us that their early culture included the weaving of floor coverings. Mention of rugs is made in the oldest books of the Bible and in Greek and Latin manuscripts. These early rugs were, no doubt, much like the homespun linen cloth we know and were, perhaps, embellished with needlework pleasing to the fancy. Most likely they served many purposes; in some Eastern countries to this day rugs are also used for curtains, hangings and other decorations.

We are most familiar with the pile rug or carpet. By running the hand over the surface of this type of rug, it is possible to feel the nap just as one does on plush or velvet. This kind of rug is called a knot-woven or knotted rug. When or where knotted rugs were first woven is not known, but what are thought to be the earliest examples of this type were discovered in central Asia, and they are believed to have been woven before the seventh century. Knot-weaving may have originated in this locality and then probably was carried westward by nomadic tribes into Persia and other western Asiatic countries, which became the permanent centre of the weaving of Oriental rugs.

Rugs from the East were brought to western Europe possibly by the Crusaders, certainly by Venetian traders. In the seven-



A Persian animal rug four hundred years old. It was found in a mosque where Persian shahs once worshiped.

teenth century knotted rugs were made both in England and France; but with the invention of the power loom, hand-weaving died out. Some of the machine-made rugs made in these countries and the United States are useful and beautiful, though they lack the charm of those from the East.

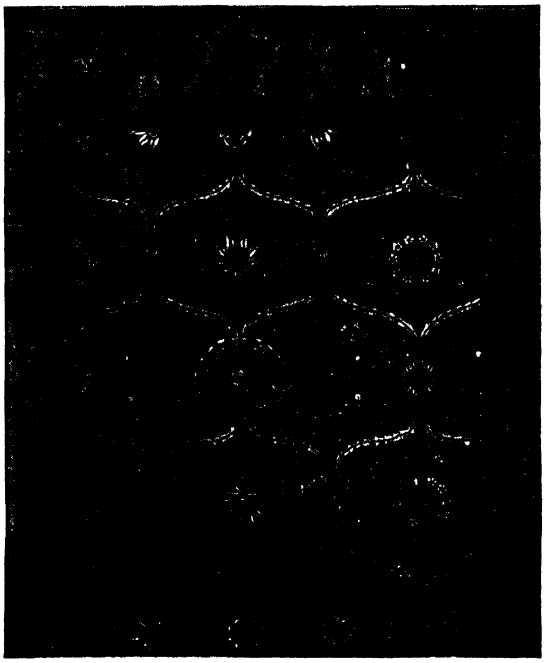
The weaving of rugs in Oriental countries, by which we mean Persia, India, Turkey, the Caucasus, Turkestan and China, is carried on to-day in much the same way as it was several hundred years ago. A primitive loom and a few simple tools are used. The beauty of the completed rug is due chiefly to the design and to the expertness of the weaver, though the quality of wool and dyes plays an important part.

Formerly, weaving was a household industry in some of these countries and the designs and colors were characteristic of the locality or tribe. In other countries, as we shall see, rugs were woven in royal factories where the most intricate and graceful designs were created by artists and the finest materials were employed.

While some rugs are still woven by nomadic tribes, the great popularity of Oriental rugs in America and Europe has brought about factory-weaving or weaving in private dwellings where the family is under contract. This does not mean that machinery is used but that the rug-weavers are under supervision. They must weave their rugs according to the designs and use the colors chosen by the Western buyers, and may or may not follow the traditional Oriental rugs.

Different conditions exist in each of the countries where Oriental rugs are woven, so let us examine the characteristics of each country separately.

Persia, the cultural centre of western Asia for so many centuries, was supreme in the art of rug-weaving. The rug artisans lived at the courts and did their work under the supervision of the kings or nobles. Thus weaving was not, as it is to-day, carried on in the humble dwellings of peasants or in commercial factories, and making a carpet was not a simple matter. There were many steps before the actual weaving. The design was worked out by an artist and most likely approved by the ruler. Wool was secured from the finest sheep and only the best of this was used. Plants and roots used in making vegetable dyes were gathered from all parts of the kingdom, and from other countries. Finally, weaving was begun and this consumed years, perhaps the greater part of the lifetime of the weavers. The finished product, however, was a thing of glorious perfection lasting until the nap had almost disappeared. Many an old rug, worn



Pictures, Metropolitan Museum of Art

This is one of India's beautiful rugs, woven in rich wine color, with flowers and trellis of light tan.

past usefulness, now hangs in some museum and is still dignified and beautiful.

Perhaps what is most characteristic of Persian rugs is the use of easy flowing lines in the design, with leaves and flowers.

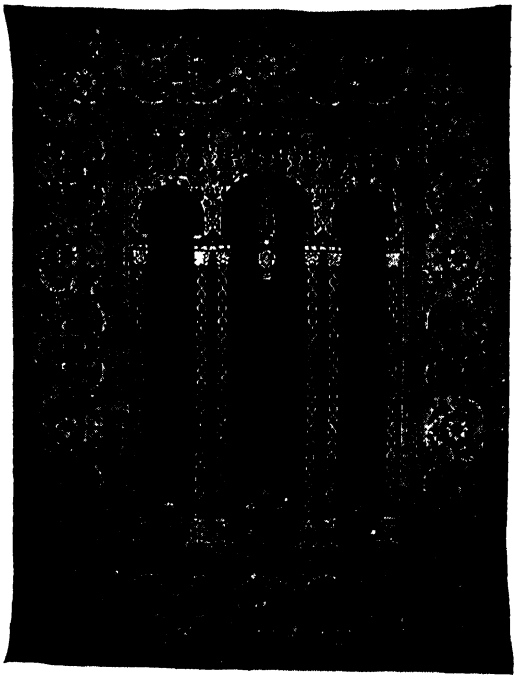
The masterpieces created from the fifteenth to the seventeenth centuries can be divided into four main groups—animal, medallion, garden and prayer rugs. In the first group are included hunting rugs depicting scenes from that favorite pastime of the kings and nobles, and also rugs showing many different animals. Those of the second group have a large oval or oblong design in the centre called a medallion. This medallion is surrounded by floral decorations.

In the third group are rugs having designs of formal gardens or groves of trees. However, most of the rugs in this group have designs of intertwining leafy stems and different flowers.

The prayer rugs were designed in imitation of the altar, or mihrab, at which the Mohammedan worships within the mosque. Prayer rugs are used by those fortunate enough to possess one, in their daily devotions. The true Mohammedan prays five times each day. When kneeling on one of these rugs, the believer points the top of the arch toward Mecca. However, those too poor to own a rug or who have not a rug with them may use any cloth or even a portion of their garments for the purpose. The Persians considered their prayer rugs sacred and did not sell them to unbelievers. Consequently, this type of rug is extremely rare outside of Persia. However, Turkish prayer rugs are fairly common and most of us are familiar with them.

The materials commonly used in the rugs were wool and silk. In some cases, gold and silver threads were employed in working out the design but this was not usual. The colors generally found in Persian rugs are red, blue, green and yellow.

The names given to Persian rugs of a century or so ago were derived from the locality of their origin. However, this is not always true to-day. The many different kinds of rugs produced are given names which are often descriptive of the type, but not the place in which they have been made. A few of the more familiar modern rugs are the Saruk, Kashan, Feraghan, Kirman, Hamadan, Meshed, Khorassan, Bijar, Tabriz, Herez and Lelihan.



Metropolitan Museum of Art

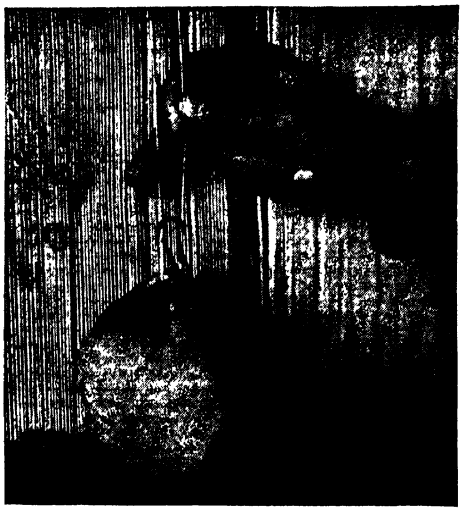
A Ghiordes prayer rug, woven in Turkey. The arches form the mihrab, or prayer niche, which the Mohammedan places toward Mecca before kneeling for prayer.

In India, little or nothing is known of early rug-weaving. In the sixteenth century, however, the great Mogul ruler, Akbar I, brought artists and weavers from Persia and established royal rug factories in India. These factories were continued by Jehangir and his successor, Shah Jehan, whom we remember as the builder of the Taj Mahal. The seventeenth century was the "golden age" of rugs in India. In some respects, the rugs produced during this time were even more beautiful than those of Persia.

Very close weaving and the use of fine wool gave them the appearance of silk velvet. A rich wine-red color that is impossible to duplicate to-day often formed a background for a design showing grace and beauty equalled only by the Persians. The types of design showed plainly Persian influence, though Indian artists did not copy Persian rugs but took the ideas and made designs that were distinctly their own. Animal rugs were woven, some showing hunting scenes and others animals of various kinds worked into the pattern. Flowers in the floral rugs were more natural in appearance than those of Persian rugs. The few prayer rugs that exist to-day contain floral designs also.

When the Mogul dynasty was overthrown in the seventeenth century, weaving of great rugs came to an end. British traders to India

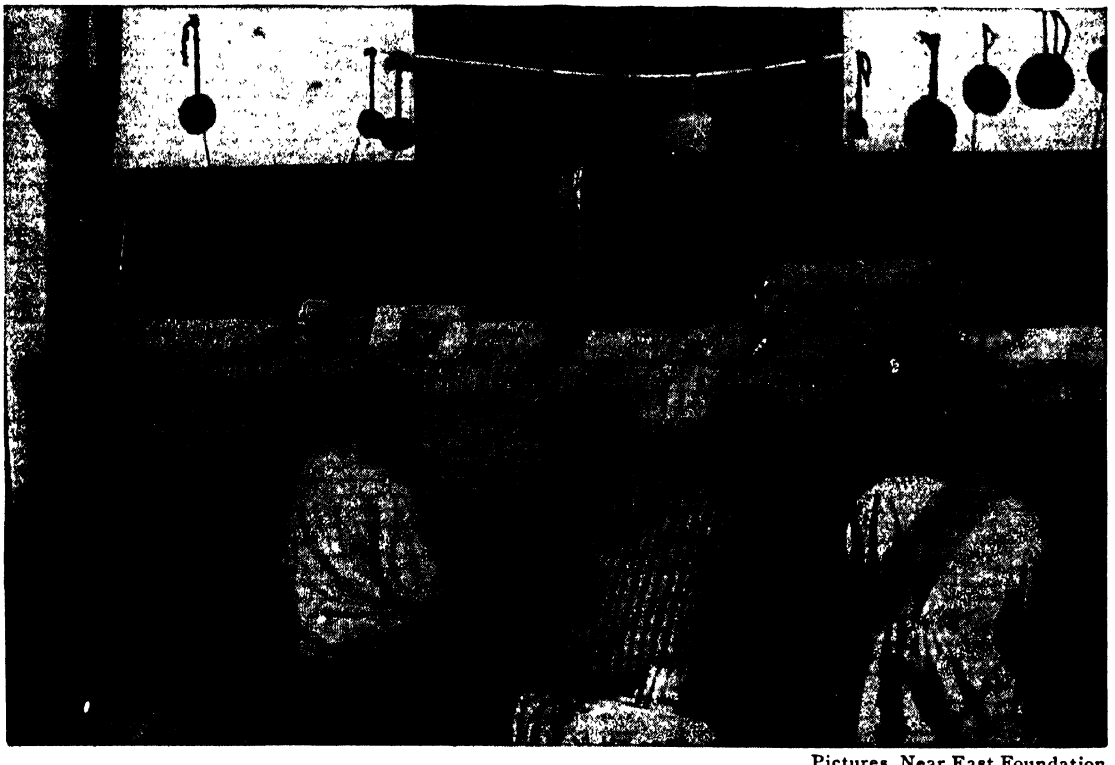
obtained some of them and sent them to England. Gradually an industry developed, and weaving is carried on in several large rug centres; but the weavers take more pride in copying Persian rugs than in carrying on the fine designs that originated in the great rug era of their own country.



The weaver is separating two warp threads with a hook. Around these he will wind colored wool, leaving the ends to form the pile.

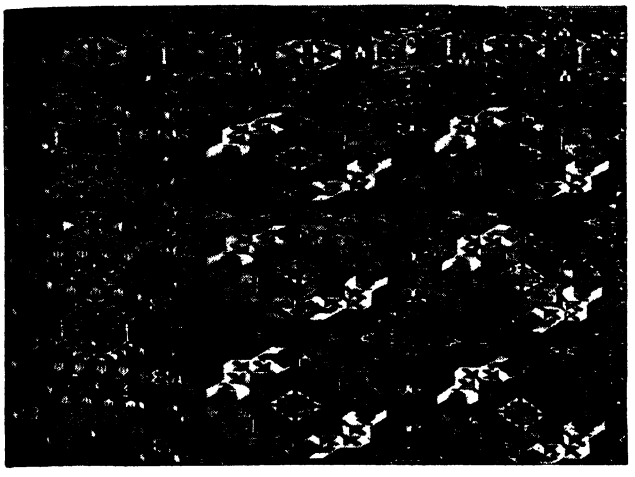
The oldest Turkish rugs now in existence are fragments thought to have been woven by the Seljuk tribe about seven hundred years ago. However, the real story of rug-weaving in Turkey began two centuries later, when rugs were exported to Europe. The design of these rugs was geometric and lacked entirely the graceful curves found in Persian rugs. About 1518 the Turkish sultan, Selim the Grim, captured the city of Tabriz, then the Persian capital. He slaughtered almost all the men but spared about a thousand talented rug-weavers whom he sent back to Turkey to work in a royal rug factory he wished to build. Then began an era of great rug-weaving in Turkey. Persian rugs, especially the medallion pattern, were copied, but the design had distinct Turkish characteristics. Silk as well as wool was used in these rugs; and red, deep blue, a rich dark green and yellow were the predominating colors.

Turks and Persians are both Mohammedan but belong to different sects. The beliefs of the Turkish Mohammedans do not allow them to picture a human being, or, in fact, any living creature. For this reason, animals or birds do not appear in Turkish rugs. However, their religious beliefs did not pre-



Pictures, Near East Foundation

Scene in a Persian rug factory. The weavers are following paper designs set up in front of them. The rug is woven from the bottom up. As each row of knots is made around warp threads, a weft thread is run across from side to side, to hold the knots in place. Next a comb is used to pack it down.



The Tekke tribe living in central Asia wove this rug with its geometric pattern. Some of the figures are not unlike the print of a camel's foot.

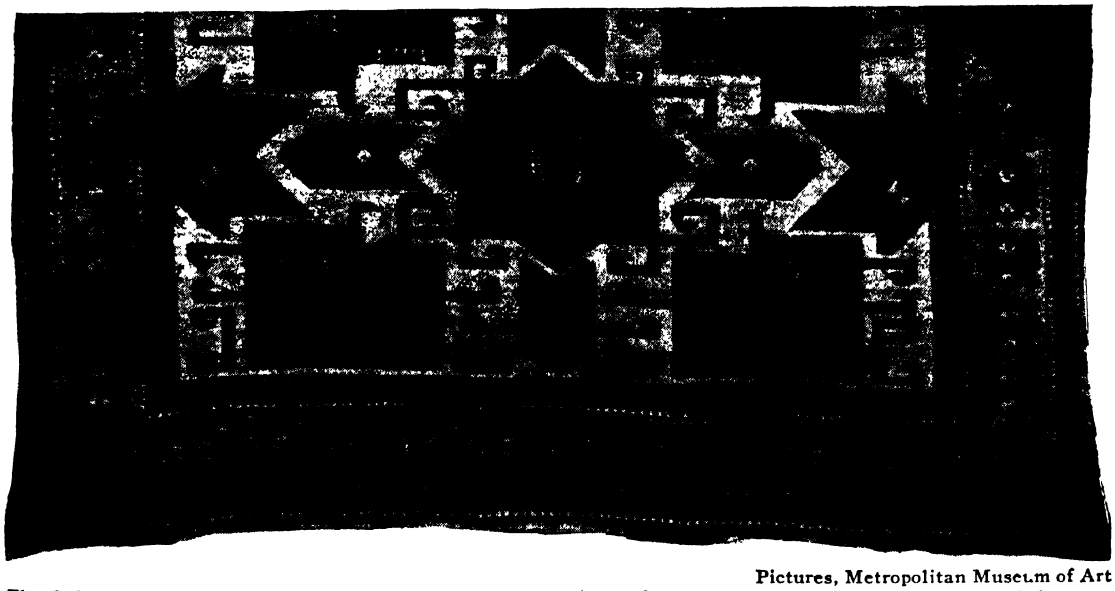
vent them from selling prayer rugs to the infidel, those not followers of Mohammed.

As a result, the making of prayer rugs grew into an industry. After the middle of the seventeenth century, the most outstanding rugs of Turkey were prayer rugs. The principal kinds were Bergamas, Ghiordes, Ladiks, Kulas, Melas and Mujurs.

Much of the modern rug-weaving in Turkey was done by Armenians and Greeks, who, during the first World War and shortly following, were deported to Greece and other countries. In consequence of these wholesale deportations, rug-weaving, one of Turkey's large industries, practically came to an end in Turkey but was continued in Greece and in the Balkans where the expert rug-weavers settled. Turkey is at present trying to reestablish rug-weaving and there are a few factories in former centres of this industry.

The Caucasus, a rug-weaving centre for many centuries, is the territory that lies between the Black and the Caspian Seas. It is now governed by Soviet Russia, but in times past it was often the battleground of Persian and Turkish armies. It is not strange that many rugs from this section show the result of contact with these two nations. Parts of the Caucasus are covered with huge mountains, where the people took refuge from invaders and resisted the introduction of new ideas. The rugs which these people weave are primitive in design and bold in color combinations. In the Caucasus, too, live many Armenians, who are highly skilled in the art of rug-weaving. In olden times they were sought for the royal rug factories of Persia, India and Turkey. They are an imitative people and the rugs woven by them show designs from many sources.

Thus it may be seen that Caucasian rugs are of great variety, but in general one may say that they are angular, or geometric, in design. Rug-weaving has always been a home industry carried on mostly by women



Pictures, Metropolitan Museum of Art

The bold, clearly defined geometric pattern of this Kazak rug from the Caucasus region reminds us of the rugs, blankets and other textiles woven by some of the American Indians. The colors are similar, too.

and girls, and it still is to a large extent, though much of the work is done under commercial supervision.

Some of the better known knot-woven Caucasian rugs of to-day are the Daghestan, Shirvan, Chichi, Kuba, Kabistan, Karabagh and Derbend. Two outstanding rugs, the Soumak and Kilim, are of tapestry weave. The former is often incorrectly called Cashmere because its smooth surface and the loose threads on the back give it the appearance of Cashmere shawls, which were made in India.

Western Turkestan, now a part of Soviet Russia, is a mountainous section of central Asia. It is chiefly inhabited by nomads, primitive in most respects, but highly artistic in the weaving of fine rugs. The outstanding design in most of their rugs is a geometric figure which is repeated throughout the pattern. These figures are known as "guls" and they might be called tribal seals or trade-marks, as they differ according to the different tribes which weave them.

Metropolitan Museum of Art

A Chinese rug of the Ch'ien Lung period (1736-1795 A. D.). The background is yellow, with blue, orange and tan design.

The rugs of the Turkomans are made of fine wool, and the principal color, usually forming the background, is a soft rich red, approaching the shade that we sometimes call "liver-color." However, this color varies, in the rugs made by the different tribes, from a brownish hue to the shade just described. Most of the rugs now on the market are of a much brighter red.

The weaving, which is done mostly by the women and girls, is not confined entirely to rugs. Bands or borders that adorn the entrance to their tents are sometimes so beautifully woven that they look like fine embroidery. Saddle bags, used when the Turkoman is on the march, and many other kinds of bags are similar to the rugs both in color and design. In some families special care goes into the weaving of bags and rugs for the trousseau of the daughter of the family.

Because the city of Bukhara has been for so many years the principal market for Turkoman rugs, the name Bukhara has become so associated with these carpets that their true names are almost unknown. They are, however, divided into the tribal names of Tekke, Salor, Saryk, Yomut, Ersari and Afghan, to name the more important ones. The rugs actually woven in and around Bukhara show Persian influence in design and are unlike those of the Turkoman tribes.

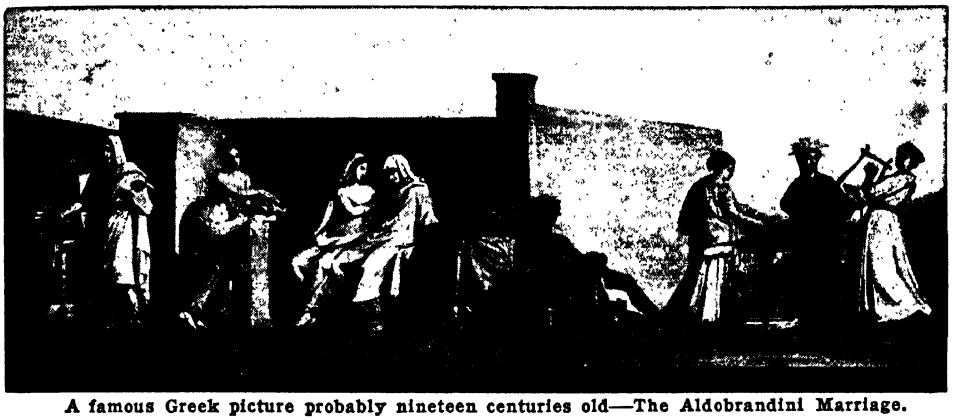
While it is not known exactly when the weaving of knotted rugs began in China, it is probable that the art was learned from the people of Turkestan. Rug-weaving in China never attained the importance of other forms of art, and there are comparatively few of their antique rugs in existence to-day.

The rugs were rather coarsely woven and of a poor quality of wool. Deep blue, a mustard yellow and peach or tan were the principal colors employed. In general the figures were used sparingly and this made the rugs simpler in appearance than those of Persia, India, and Turkey. Practically all the designs were symbolic, and it is said that only one who knows Chinese religion and philosophy can fully understand their meaning.

The best modern Chinese rugs, which command a high price on the American market, are made from a good grade of wool, most of which is imported from Australia. One unique feature is the embossed effect obtained by clipping the pile along the outline of the design. Chinese rugs, like the rugs from other Oriental countries, are influenced as to design and color by the markets of America and Europe. They are so well liked in America that the quantity imported ranks second only to that from Persia.

Rugs with Oriental designs are now made by machine in American factories. Some of these are beautiful and give long wear. They are less costly than hand-made Oriental rugs.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 529.



A famous Greek picture probably nineteen centuries old—The Aldobrandini Marriage.

ÆGEAN AND CLASSICAL PAINTING

DO you remember the story of Theseus, the Athenian prince who slew the cruel monster the Minotaur on the island of Crete? And do you remember how Ariadne, daughter of the king of Crete, gave the princely hero a clew of silk to unwind as he went into the Labyrinth so that he might find his way out again through its winding passages?

By a line of evidence as slender as a silken thread men of the nineteenth and twentieth centuries have traced their way back and forth over the Mediterranean until they have found the Labyrinth itself and taken the covering earth from buried cities, where a new story of an old, forgotten civilization can be read. This civilization and its art we shall call Ægean, and the tale of its discovery we shall tell briefly.

It all began in the mind of a little boy, Henry Schliemann, who loved to hear Homer's story of the siege of Troy, and believed with all his heart that the walls of Troy were still standing and might be seen if one could only find the place and dig deep enough. Schliemann worked hard and studied hard for years before he had a fortune great enough to give him a chance to open the earth upon the site of Troy and dig out city after city, buried one below the other. One of them was indeed Homer's Troy, where Hector fought against Achilles and died fighting. Next Schliemann turned to Mycenæ in Greece, the home of Agamemnon, leader of the Greeks against the Trojans. There he found tombs and treasuries that told of actual ancient life of ease and splendor, long lost and forgotten except in myth and song. Other places near Mycenæ were excavated and yielded more examples of the skill of those men of long-ago.

But where had been the beginnings of that ancient culture? This question was like a puzzle to be worked out. At last, about 1900, the archæologists had good reasons for believing that they had discovered the centre, perhaps the first home, of the earliest European culture, in the island of Crete. Sir Arthur Evans of Oxford, England, and others have had such success in unearthing these palaces and villas with their pottery and other furnishings that we feel as if we knew quite how the Cretans lived some four thousand years ago. And we can be sure how they looked, for the wall-paintings that are left show us men and women, alone or in groups, doing the things that were their custom.

And now, having found our way back to what seems to have been a starting-place, let us turn around and travel forward down the road of art in the old Ægean age.

We used to think that when Egypt

and Babylonia were enjoying their best days the northern Mediterranean had no life that could compare with theirs and that they acted as the teachers of southern Europe. Now we believe that the life of the Ægean world was moving along at an equal pace.

What do we know of the art of painting in Crete? From the decorations on the oldest pottery we learn that the early artists expressed themselves in symbols—made a sort of "shorthand." Wavy lines would represent the ripples on water when the wind was blowing over it. Spiral lines would stand for the twists of a shell or the coils of a tendril. It was not imitation but the record of an impression. The first pottery designs were in white on black—a kind of white chalk pressed into lines cut in the clay. Later, natural designs of grasses, reeds, flowers and sea-shapes were skillfully painted in dark colors on a light background. The crocus was a favorite motive, and so were the lily and the iris. Most characteristic of all were the sea-forms—shells and corals and fish, grouped into beautiful decorations. One jar shows two octopods with their long, reaching arms, set in the midst of other creatures of the sea—feather-stars, sea-anemones, corals and sea-urchins.

As for the paintings on the walls, they include a wide choice of subjects. In general, the outlines are fine and strong, the colors lively and interesting. In the great palace of Knossos fragments of wall-decorations give us beautiful portraits of youths bearing gold and silver cups, a procession of dancing girls, flower-gatherers, and splendid guardian griffins—far gentler scenes than the ones that pleased Assyrian and Babylonian monarchs. On one wall a blue boy is gathering crocuses and putting them into a vase. In a fragment from a villa in another place a cat is about to spring upon a pheasant.

But one theme that appears often, both in Crete and in Mycenæ and Tiryns in Greece, tells us that the favorite sport of those old sea peoples was the cruel one of bull-grappling. Young men and girls seem to have been trained to perform in the bull-ring; for the artists have painted them in the act of catching the bull's horns, or flying over the bull's back to be caught by another acrobat waiting with outstretched hands. The bull seems to have been almost a symbol: it is so often represented. In some cases it is only a head raised in relief and painted—such as the one at Knossos, extraordinarily life-like and vigorous, which is painted brownish red with a gray horn.

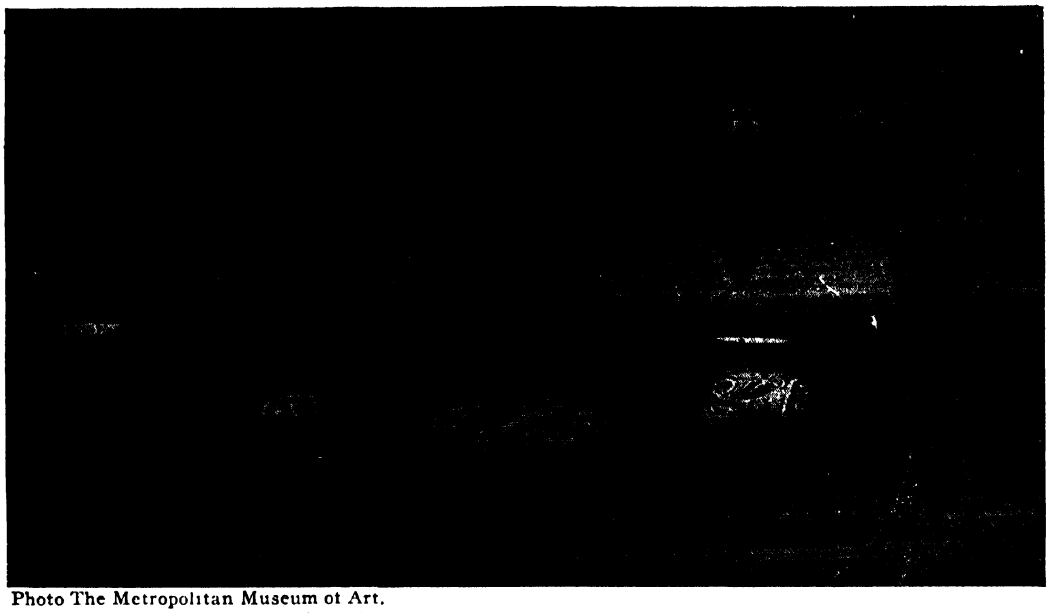


Photo The Metropolitan Museum of Art.

Cretan pottery, dating from about 1660 to 1500 B.C., which gives a variety of the favorite designs—the crocus, fishes in a net, starfish, nautilus, octopus and conventional patterns.

And now we may have gotten at the very secret of the Labyrinth and the tale of Athens' sending tribute of youths and maidens to Crete to be devoured by the Minotaur—half bull, half human. Minos,

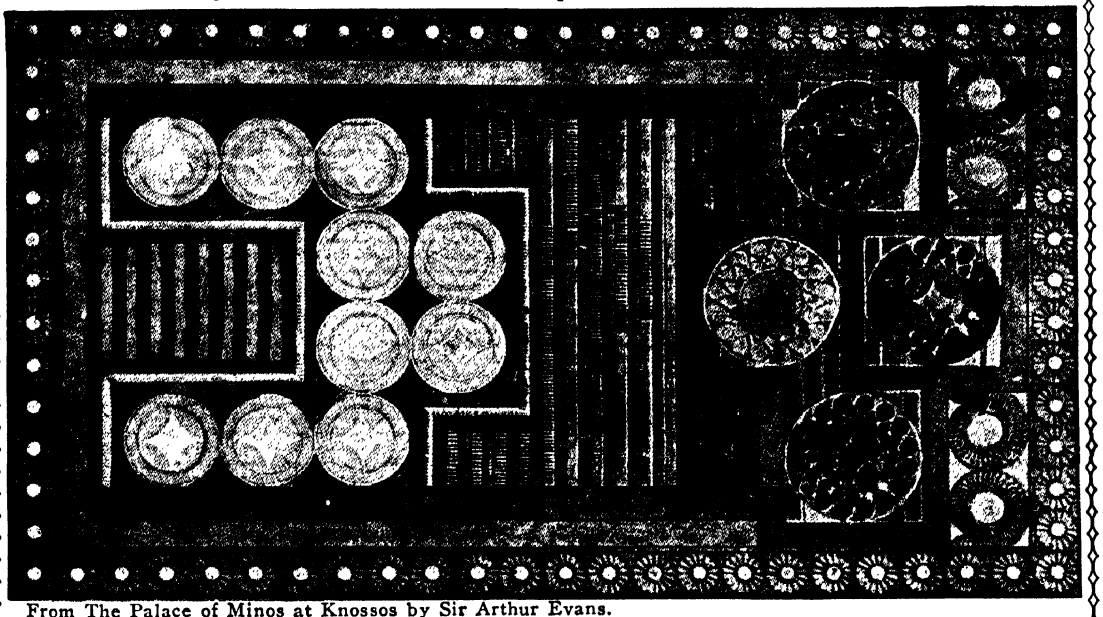
king of Crete, was a sea-king of great power. At Knossos was his palace, where Dædalus had built the Labyrinth, "the place of the double axes." *Labrys* was the name of the double ax, and the symbol is carved upon the walls of the palace in many places. It may be that Athens actually did send youths and maidens to the conqueror, not to be literally devoured by a monster, but to be trained for the dangerous sport of bull-grappling in the Labyrinth. When the inscriptions have been deciphered and can be read, we shall know more definitely.

In all the frescoes where men and women are represented the men are painted with brownish skins and the women white—the artist's convention to make a distinction. The women's clothes are amusingly modern-looking, with close-fitted bodices, flounced skirts and apron panniers. Both men and women have squeezed-in slender waists. A miniature painting of a balcony scene gives an animated group of the king's courtiers and ladies apparently looking on at some game or festival. One of the things we notice particularly in the art of the Ægean age is its abounding life, its indication of activity and movement—in striking contrast to the calm aspect of Egyptian expression.

Of the great carved stone jars, used for storing food—big enough and numerous enough to have held the Forty Thieves—of the metal cups and vases and the glazed porcelain figures we shall say more when we are talking about sculpture.

The development and decline of the art we have so quickly glanced over covered some fifteen or sixteen hundred years, with its Golden Age falling somewhere around 1500 B.C. For convenience archæologists have divided the progress into periods, and called them Early Minoan, Middle Minoan and Late Minoan, subdividing each of these periods again into three others.

Probably about 1400 B.C. the great sea-power was broken. The ruins of Knossos give many evidences of having been swept by fire in some vast overthrow. Ægean culture was doomed to become a dim memory in the minds of men, and later ages had to begin to build up for themselves new kinds of civilization and art.



From The Palace of Minos at Knossos by Sir Arthur Evans.

This sumptuous game-board found in the palace of Minos at Knossos is not so very unlike our parchesi board. Its decorations are in gold and silver, ivory and crystal, and blue enamel paste.

The invaders who flooded down across the Mediterranean coast into the peninsulas and then out upon the islands came from the north, bringing with them fresh vigor, different impulses and a new attitude toward the world. They were Indo-Europeans, and to them we owe very much; but their advance could not probably have been so rapid if they had not taken into their own lives something of the long and fruitful experience of the men they overcame. The art of Greece in the most

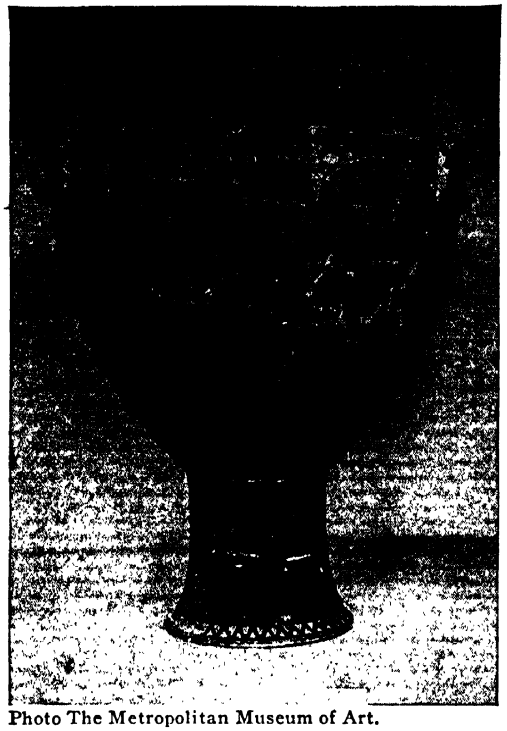


Photo The Metropolitan Museum of Art.
Large vase, Dipylon style, eighth century B.C.

brilliant days of its flowering may be traced in part to a living seed of the instinct to express beauty, which was planted far back in the time when Ægean splendor drooped and fell under the Northern sickle.

Therefore when we study the later life in Greece, in what we know as the Hellenic era, though we find a new and distinct development, we can see a trace of the old Ægean life. Hellenic art cannot be thought of as beginning earlier than 800 B.C., for from 1100 to 700 B.C. Greece was "in the making." Here, again, we examine the pottery to learn how the artists first thought and worked. The uses of the vases varied. Some are drinking-cups, some jugs, some bowls for mixing; others are jars to hold oil. And the shapes, altering as time went on, are as various as the uses. The finest are the simplest and have the severest handles.

The ornament, like the shape, varied with the passing centuries, and mirrors the rise and fall of Greek art. When the free, flowing decorations of Crete and Mycenæ had been lost sight of, there came into use a kind of stiff, geometric pattern with conventional figures in keeping with the designs. A famous set of vases belongs to this period—jars on which are painted naval battles and funeral processions. They are often called Dipylon vases, from the Dipylon (double-gate) cemetery at Athens, where many of them were found. The artists of those days were working out certain difficult problems for themselves and for all artists afterward. They had not learned perspective, so they painted all the legs of the horses in a team side by side, and both legs of a man even when he was shown in profile.

When the Greeks had traveled about the eastern Mediterranean and settled on some of the islands and the shores of Asia Minor, the influence of Oriental art began to be felt, but their native genius was strong enough to hold its own character, taking ideas and motives from the East and working them into its own creations. On the vases the severe geometric designs gave way to more interesting decorations. As the city of Corinth took the lead, the best vases of this period are called Corinthian. On them the paintings are done in dark paint on the light clay, and in this period fantastic animals and scenes from old Greek mythology began to be used.

During the sixth century B.C. there came another change in the style of vase-

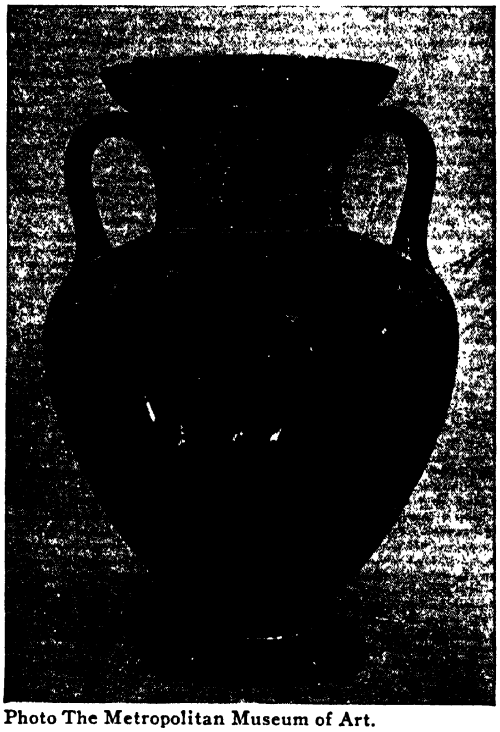


Photo The Metropolitan Museum of Art.
Amphora, with design of horsemen, 550-500 B.C.

painting. The figures were now black on a red, or sometimes on a creamy or white, background. In Athens they were developed to their best form: therefore the style is known as Athenian. Greater skill in representing figures is noticed as time brought more experience and knowledge; and artists began to claim credit for their work. Some of the Athenian vases of fine design are signed. "Nikosthenes made me," inscribed upon many a beautiful vase, tells the name of a painter who produced more pieces than any other we know. Others were Euphronios, Brygos and Douris.

Again there came a change of style when the decorators found that they could get better and more delicate results by leaving the figures in the red-clay color and outlining them with black, then painting in the background with black varnish. And now the painter, having learned full control of the lines, could make beautiful scenes with the charm of freedom and naturalness. The composition was more graceful, the figures were nobler and finer. The highest expression was reached about the middle of the fifth century B.C. After that began a gradual decline, indicated at first by more elaborate design and the introduction of more color.

Photo The Metropolitan Museum of Art.
Krater, with Dionysus and a Satyr, Athens, 500-480 B.C.

Unfortunately very few specimens of Greek wall-painting have been preserved for us, and that is one of the reasons why we treasure the vases which show the wonderful technique of brush drawing. It is very likely, too, that the vase-painters were closely influenced by the great artists of their time, whose fame is sung with eager enthusiasm in Greek writings. Some of the names we know well. There is Polygnotus, whose wall-paintings adorned public buildings at Athens and in other cities. Apelles and Zeuxis we place among the highest names upon the roll of art. But imagination must help us if we would try to feel the grace of line, the beauty of composition which we know their work possessed.

We can partly guess how great the pictorial art must have been from a famous painting called The Aldobrandini Marriage, which hangs in the Vatican Museum in Rome. There were innumerable frescoes painted by the Greek artists and their scholars, but all except those of a late period have perished. Some few were found in Egypt, and eleven of them are in the National Gallery in London. The rest we owe mainly to the excavation of the buried towns of Herculaneum and Pompeii, which were buried beneath a volcano eruption in A.D. 79 and discovered about the middle of the eighteenth century.

These two towns were by no means the home of what we should call Greek art of the high order, but they were freely and lavishly stored with art treasures executed under Greek influence. The paintings are chiefly compositions dealing with Greek mythology. There is an ancient Judgment of Paris, which has inspired many later pictures; another is Achilles Recognized by Ulysses. A great many of the frescoes were done by Roman scholars of the Greek masters.

Some of these paintings help us to realize what the work of the Greeks in their prime must have been. But the great fire of their genius had burned down, and here we see it going faintly by in thin flames.

The arrangement of the Classical collections in the Metropolitan Museum is well planned to illustrate these periods of art. In the Cretan and Mycenæan room the exhibits are, of necessity, mostly reproductions; but the Greek vases are represented by a number of fine originals, and there is an interesting example of wall-decorations in the frescoes from a villa near Pompeii, buried by the great eruption of the volcano Vesuvius.

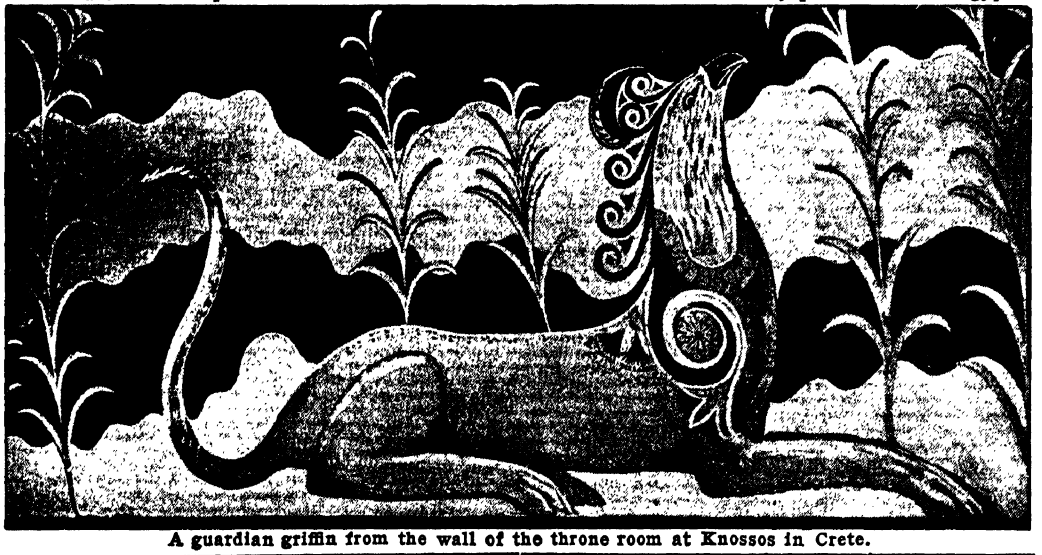
THE NEXT STORY OF THE FINE ARTS IS ON PAGE 575.

PICTURES THOUSANDS OF YEARS OLD

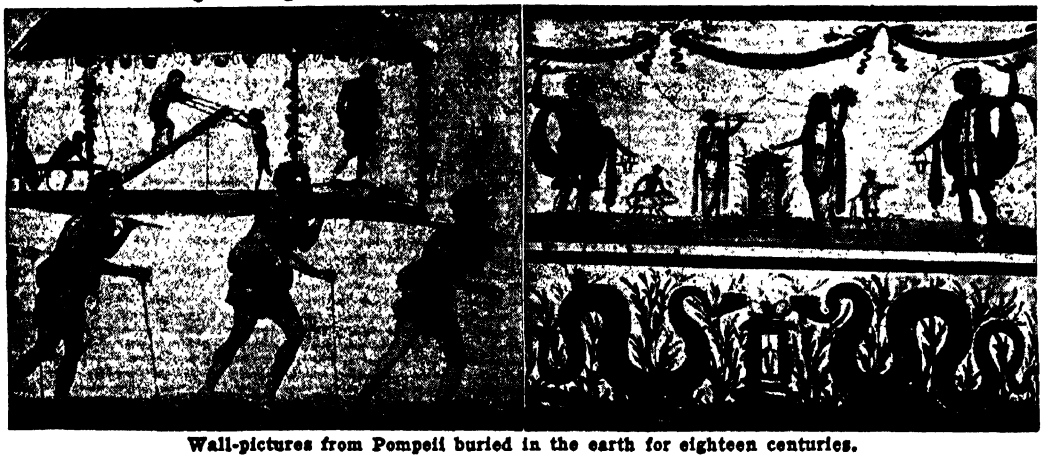
An old Roman portrait.

A Greek vase in the British Museum.

A mummy picture from old Egypt.



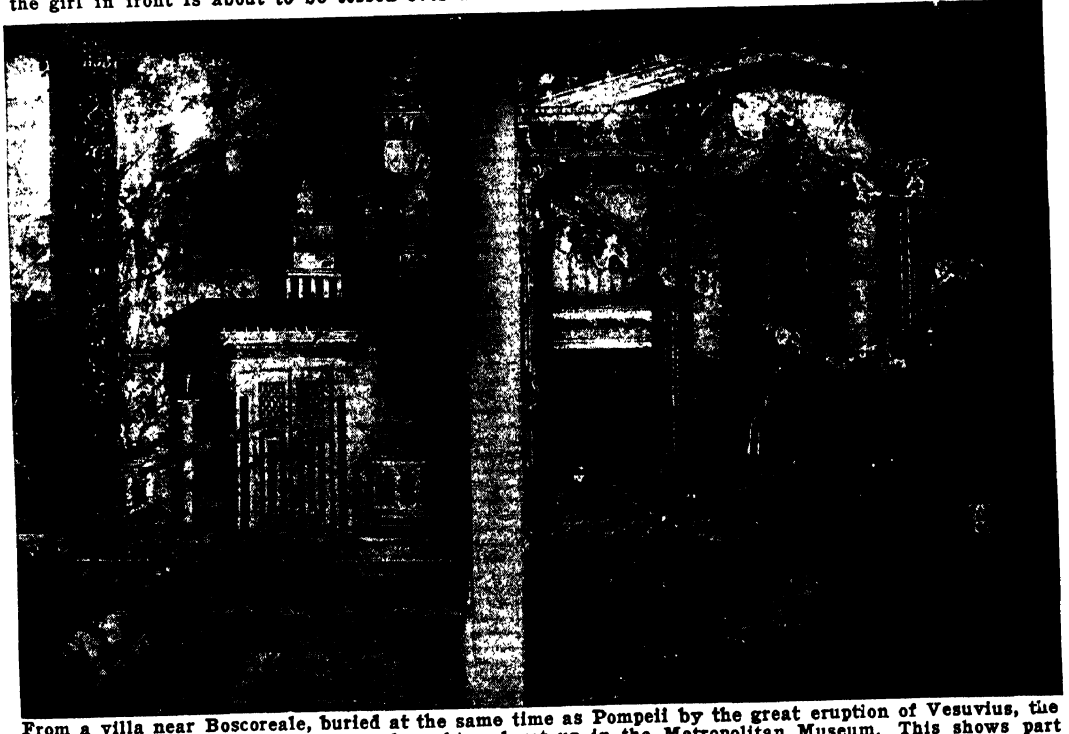
A guardian griffin from the wall of the throne room at Knossos in Crete.



Wall-pictures from Pompeii buried in the earth for eighteen centuries.

WALLS THAT TELL STORIES OF THE PAST

This fresco from the palace at Knossos, Crete, presents an exciting scene in a bull-grappling performance. A youth is in the midst of a somersault over the bull's back. One girl holds out her hands to him, while the girl in front is about to be tossed over after him. It is more thrilling than a modern circus act.

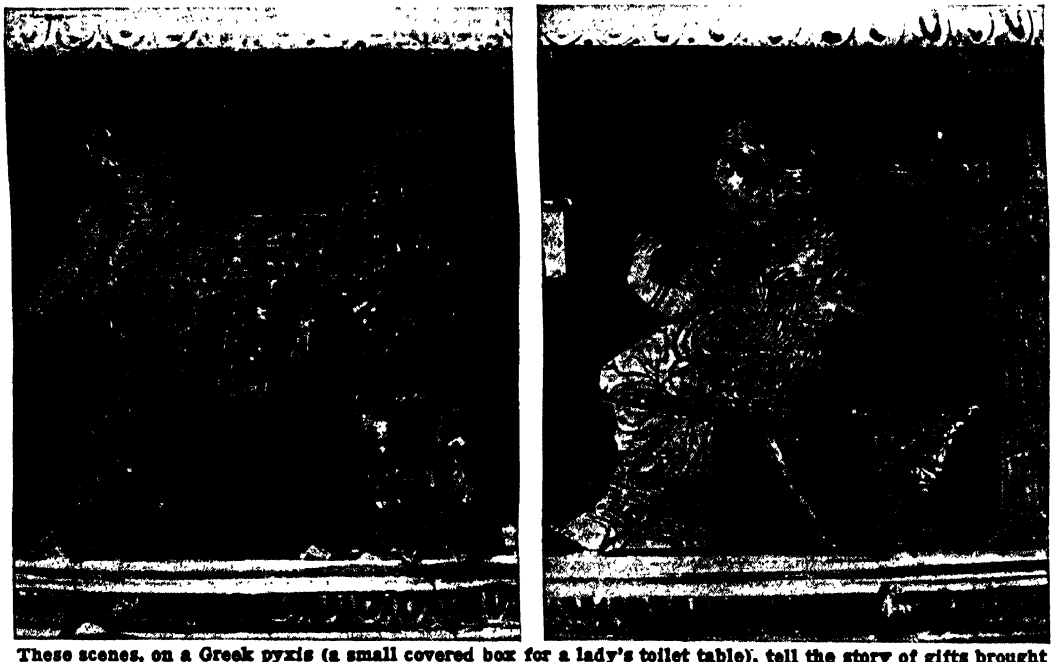


From a villa near Boscoreale, buried at the same time as Pompeii by the great eruption of Vesuvius, the frescoes of a whole room have been brought and set up in the Metropolitan Museum. This shows part of one wall, painted in an architectural design of doorways, colonnades, cornices and jutting balconies.

Photos The Metropolitan Museum of Art.

FUNERAL AND BRIDAL SCENES OF OLD

The painted panel on this sarcophagus, made of limestone and found at Hagia Triada, Crete, shows part of a funeral ceremony. We may suppose that the figure at the right represents the dead man in front of his tomb, and that the three approaching him are bearing gifts—the model of a ship and two calves. The women on the left are performing other rites. Notice the patterns of the fine decorative borders.



These scenes, on a Greek pyxis (a small covered box for a lady's toilet table), tell the story of gifts brought to a bride. The hand at the left belongs to a girl who is playfully balancing a stick on her other hand. The figure at the right holds a box on her left hand. The work is Athenian, of the period 450 to 420 B.C.

Photos, courtesy of the Metropolitan Museum of Art.

Does a Plumb Line Always Hang Straight?

A VERTICAL line at any point can generally be determined by suspending a plumb line, which is a weight attached to the end of a string, and allowing it to come to rest. The pull of the earth, or gravity, will stop the swinging of the plumb line. If we could see the line of the pull of the earth we should see that it passes through the motionless bob, the string and the support from which the string hangs. As the string is in the same line as the earth's pull, we say it hangs vertically.

At some places the plumb line does not hang quite vertically. Where this is so we know that it is caused by the action of some other force, such as the attraction of a great mass like a mountain, or by the gravitational pull of the moon, or by the centrifugal force of the earth's rotation. Dr. Nevil Maskelyne, a British astronomer, made several experiments in this subject. He found that when he suspended two plumb lines near a mountain, one on the north and the other on the south, the angle between their directions was greater than the angle between two vertical plumb lines should be. On measuring he found that each plumb line was pulled slightly toward the mountain.

In India a very strange thing happens. When a plumb line is suspended in the southern regions, it hangs quite vertically; but when taken north, it is pulled, not toward the Himalaya Mountains, but away from the massive mountains, toward the southern plain.

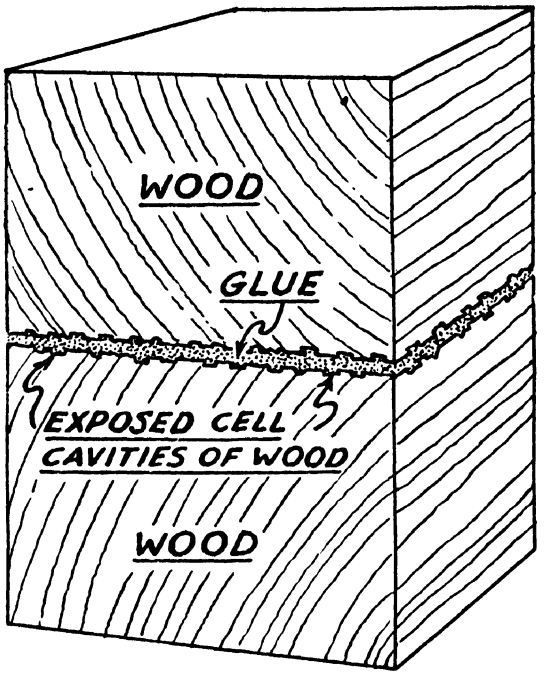
This behavior of the plumb line, so different from what we should expect, is due to the fact that the weight of the great tableland of southern India, and the material lying beneath it, is greater than the weight of the Himalaya Mountains and the material below them. The heavy plain attracts the bob of the plumb line away from the lighter mountains, massive though they appear to the eye. The unseen attraction is greater than the visible attraction.

IS THERE ANY FRESH WATER IN THE SEA?

Yes. Large quantities of fresh water are found at certain places in the sea. Most of these places are near the mouths of large rivers which continually pour enormous quantities of fresh water into the sea. This fresh water may spread out over the surface for many miles. The outflow of water from the Amazon is over a million cubic feet a second. So great is the flow that fresh water "rides" on the surface as far away as two hundred miles from shore. After a while its freshness disappears entirely as the mingling of fresh and salt water is completed. Ships short of fresh water have often obtained a supply from the sea near the mouth of the Amazon.

Off the mouth of this river many years ago a ship saw another vessel flying signals of distress. "Water, water! We are dying of thirst!" ran the message. From the friendly vessel went back the advice: "Cast down your buckets where you are." The distressed ship could not understand and signaled again and again, always with the same result. At last the captain let down his buckets and up they came, brimful of sparkling fresh water from the Amazon's mouth.

But fresh water can be obtained from the sea in a still more remarkable way. Much of the rain that falls in Australia sinks through



the soil till it reaches an impervious layer of rock. It runs along the top of this, perhaps hundreds of feet below the surface of the ground, and finally makes it way up through the sea as a submarine spring. Off the eastern coast of Australia fresh water from these springs is often dipped up in buckets by the crews of ships.

Off some of the South Sea islands the natives dive to the bottom of the sea and fetch up fresh water for drinking purposes in hollowed gourds. This is surely the most astonishing of all ways to obtain drinking water.

Ground ice has been seen rising to the surface of the sea off the Atlantic coast of America, coming, no doubt, from a submarine spring. When the fresh water reached the cold sea water, it rapidly froze into ice.

As you know, the fresh water would freeze at 32 degrees Fahrenheit, while the sea water still remained in the liquid state. This is because the freezing point of salt water is below the freezing point of fresh water. The ice, being lighter than the sea water, rose to the surface and floated.

WHY DOES GLUE HOLD WOOD TOGETHER?

Glue, when heated, changes its form gradually from the solid to the liquid state. It does not change with the speed of ice melting to water. It is what men of science call a viscous substance; that is to say, it is, for a time, only imperfectly fluid, and does not flow very quickly.

When we smear the surface of two pieces of wood with glue in the semi-liquid state, and press the two pieces of wood together, the glue is forced into the hollow air spaces of the wood. The glue does not penetrate the cell walls of the wood, but merely enters the exposed openings of the cell cavities. When the glue cools and hardens it is firmly anchored in each piece of wood, and the adhesion of the molecules of glue holds the whole structure together.

The more cavities in a piece of wood, and the larger the cavities are, the more easily it can be glued. Thus basswood, which has a coarse texture, can be glued more easily than oak, which has a fine texture.

As you read elsewhere in our book, the force that attracts like molecules is called cohesion. The force that attracts unlike molecules (molecules of different materials) is adhesion. Usually cohesion is a stronger force than adhesion. But in the case of glue when it is spread upon some other materials, such as wood, adhesion is stronger than cohesion. The glue adheres (sticks) to the wood. But cohesion of glue molecules with glue molecules is also needed to bind the two pieces of wood together. Thus the two forces enter into the process.

WHY IS SO MUCH OF NATURE GREEN?

The green coloring matter is a chemical substance found in the leaves and often in the stems of plants. Its name is chlorophyl, and it is one of the most important substances in the world. The plant cells that contain chlorophyl are busy factories. They take in water and minerals from the soil, and carbon dioxide from the air. Now they have the materials for their work. They need power to run their factory engines. They get this from sunlight. Now they set to work. They break down the carbon dioxide. The oxygen they set free, and it escapes into the air. The carbon, water and minerals are mixed and changed into starch and sugar and other materials which the plant needs for its growth. These manufactured foods then go from the factories (the green cells) to the other parts of the plant and build it up. The green cells go on making more foods as long as they have water and minerals, air, sunlight and enough heat. This process is called photosynthesis. "Photo" means light.

With very few exceptions the whole plant kingdom depends for its life on the green cells or chlorophyl. You will read more about this interesting factory work in the Department of Plant Life.

WHAT HAPPENS TO OUR SKIN WHEN WE BLUSH?

The flow of blood to the skin is regulated through thousands of very, very small blood vessels which join arteries bringing blood from the heart to veins which take it back again. Each of these blood vessels has its own nerve to open or close it. Thus the nerve system controls the flow of blood to the surface of the skin. When, therefore, the face becomes colored with a blush, it is because some of the nerves have turned on the tap controlling the blood supply. The nerves may be disturbed by anger, fright or shame, and turn on the tap involuntarily.

again came down in marching, or about 5 feet. Thus the Roman mile was considerably shorter than our mile—5,000 feet as compared with our 5,280 feet.

The discovery in modern times of the precise length of the Roman foot is not without interest. An Italian archæologist named Luigi Canina, who lived from 1795 to 1856, in the course of his researches into the subject measured very carefully the Antonine and Trajan columns in Rome, and found them—exclusive of their pedestals—exactly the same height. This height was known to be 100 Roman feet. Measuring chains of this precise length were then made, and with these the Roman miles were carefully measured off for twelve miles down the famous Appian Way. The correctness of the measuring chains was checked by the fact that the end of each mile, as measured off, corresponded with the sites of the old stones.

Here we see two Roman workmen, possibly slaves, setting up milestones along the Appian Way. Chains were used for measuring. A chain was 100 feet long. The Roman mile was 5,000 feet long, or 50 chains.

HOW DID THE ROMANS MEASURE DISTANCE?

A Roman mile consisted of 1,000 paces, or, in Latin words, *mille passuum*. Our word pace means the distance covered by each foot in succession—that is to say, from 30 inches, as laid down in drill-books for marching purposes, to 33 inches or even more. But the Latin word *passus* meant the distance between the point where the foot left the ground and the point where the same foot

DOES A FISH FEEL?

Certainly. Everything that lives, from a microbe up to a man, has some kind of feeling. The power to feel and to respond to what is felt is a mark of all living matter everywhere, and its disappearance without return is the mark of death. But the amount and the quality and the clearness of feeling differ widely in various living things. So it would be equally wrong to say that a fish

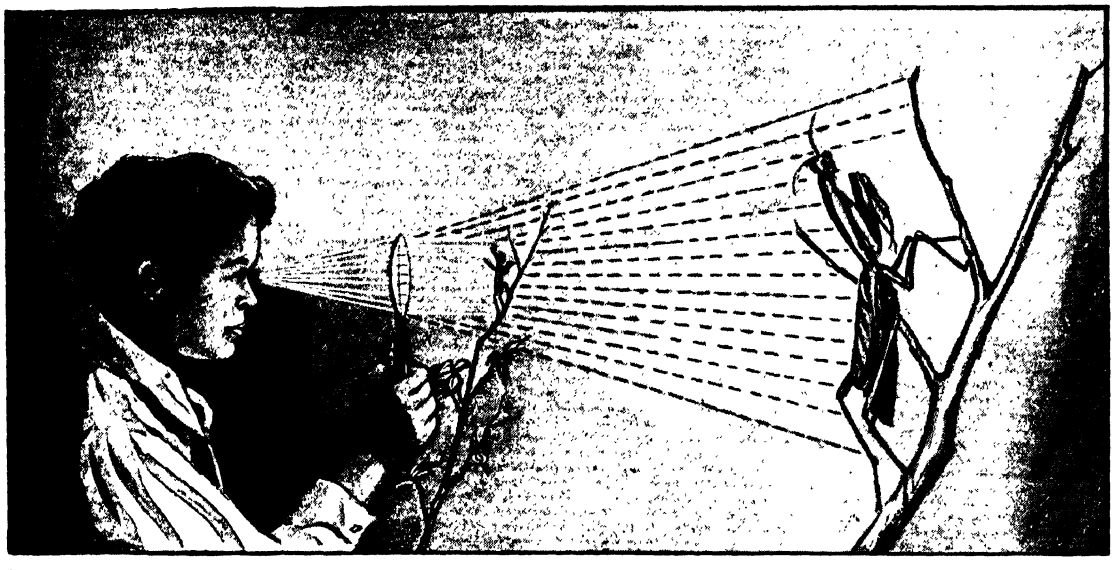
has no feeling and to say that it feels as we do. It does feel, but it does not feel as we do.

Seeing is a kind of feeling, and perhaps a fish sees quite as well as a young baby does. A fish hears, too, and smells and tastes. Also, a fish certainly has the sense of touch. It can suffer a kind of unpleasant feeling, too, and must do so, for instance, when it has a hook in its mouth.

A fish has only a very simple kind of brain, and can not feel sharp pain as we do, or even as some animals do.

In other words, what we see through a magnifying glass are rays of light reflected from the insect, bent by the glass and then brought together to the eye so as to appear to cover a much larger space, and the insect look larger.

A curious thing happens if the rays of light are allowed to continue beyond their meeting point, instead of being focused by the eye. We can do this with the aid of a mirror. Try this experiment for yourself. You will see the image turned upside down



Light-rays passing through a magnifying glass are bent, so as to come together and form a picture inside the eye. The eye imagines they came straight, not bent, so the enlarged view is really an imaginary picture.

HOW DOES A MAGNIFYING GLASS MAKE THINGS BIGGER?

This picture shows us how a magnifying glass makes things appear larger than they really are. What happens when we look at, say, an insect, is that rays of light are reflected by the insect and come together in our eyes.

If we look at the insect through a piece of window glass, the rays of light are slightly bent (see the chapter on Light, page 1988), but they are all bent equally. As a result, we see the insect much as we would see it if no glass were in the way.

A magnifying glass is so made that the rays are bent in a special manner. They are bent toward one another and come together and pass inside the eye. The eye imagines that they have come straight, as shown by the dotted lines in the picture. Thus the image appears to be bigger than the object really is.

(inverted). This is because the rays of light are brought to a point outside your eye; still outside your eye they cross, and continue on into the eye.

ARE MICROBES NECESSARY TO PRODUCE CREAM?

Strictly speaking, microbes do not help to make cream. Cream is in milk at the moment it leaves the cow. All that happens to it afterwards is simply a change of place. At first, its globules, as we call the drops of fat, are mixed through the milk; but as they are lighter than the rest of the milk, they rise to the surface by degrees, and form a separate layer.

But in the making of butter and cheeses, microbes are added to turn the milk and cream sour. The flavor of the butter or the cheese depends on the kind of microbe which has been added. Some dairies cultivate special microbes so as to obtain special flavors.

WHAT BECOMES OF THE SMOKE WE SEE?

Smoke is made up of a large number of different things, solid and gaseous. The solids are generally too heavy to stay in the air, and so, after a time they settle. There is a lot of oil made when coal is burned, and so the black particles of carbon found in smoke are oily, and that is what helps to make them so dirty. Some of the gases are already quite burned when they pass off in smoke, such as carbon dioxide, and we know what happens to carbon dioxide in the air —whether it has come from our lungs or from a furnace. It is used up by plants.

Other gases in smoke are not completely burned, and they get burned up in the air, forming more carbon dioxide. Water vapor, one of the things made by the burning of the hydrogen of coal is also formed.

WHY DOES A DOG GO ROUND AND ROUND BEFORE IT LIES DOWN?

This action represents a habit that has been handed down for countless generations. It goes back to the days when dogs were wild and lived in the jungle grass. If they wanted a comfortable bed, they had to turn round and round a few times so as to level the grass. Since that time many species of dogs have been domesticated, or tamed. These dogs now sleep on a mat or on the floor or even, if they are great favorites, upon a couch or bed. Yet, like their ancestors, they still go round and round before they lie down, even though there is no longer any need for the act. They are following the urging of instinct, which does not take into account the fact that circumstances have changed.

DOES THE SMOKE OF A TRAIN GO THE OPPOSITE WAY TO THE TRAIN?

No. The smoke is going in the same direction as the train, but so much more slowly that it seems to be going backward. When the smoke leaves the smokestack it is really poured into the ocean of air through which the train is pushing its way. The air resists the progress of the train, but it resists the smoke far more, since smoke is so light. If the train were going forward in a vacuum, the smoke would move forward with the train, and at the same speed.

A slow train seems to be going backward when seen from a fast train passing it. Just so the banner of smoke seen above a moving train seems to be going backward. This is a case where our eyes deceive us.

WHAT IS AN APTITUDE TEST?

An aptitude test is a test of a person's natural, untrained fitness to do some special thing, like learn foreign languages, play the violin or operate a complicated machine. Aptitude tests should not be confused with intelligence tests or with tests of skill given to people who have had training along the lines of the test. Aptitude tests aim to discover fitness along certain lines rather than to measure progress or intelligence.

Suppose you plan to study the violin but have no idea as to your fitness to do so. There is one aptitude test you can take which may warn you that you face a handicap. This is a test of musical pitch. It will discover your ability, or lack of ability, to tell when a given musical tone is higher or lower than some other given tone. If you do very badly with the test, it would hardly be wise for you to study the violin since your ear might never permit you to play in tune, no matter how much you practiced. Or suppose you wanted to prepare yourself for an occupation requiring a reliable sense of color. An aptitude test might show that you were color-blind, unable to distinguish red from brown and yellow from orange. The test would save you from a costly mistake. If it showed you to have a fine color sense, you would then have a solid basis of encouragement.

Most aptitude tests are not so simple as the two mentioned because a person's fitness to do some one thing often depends on more than one ability. This holds true even in the case of playing the violin. Violin playing does not depend on pitch sense alone. There is the question of the player's sense of melody, for which a test exists. Also there is his sense of harmony to be considered for which various different tests have been developed. Rhythmic sense is also very important to musical performance and it can be tested. Tests are frequently given in groups, called batteries, and in that way tell about a person's aptitudes somewhat more clearly than single tests could do.

There is a way to test the tests themselves. That is to compare the results of aptitude tests with the later success or failure of the people who took them. These comparisons, known as correlations, are not always favorable to the accuracy of the tests. People have done well at things for which the tests showed them unfitted and the other way around. The problem of discovering talents and predicting success is still far from solved.

WHY ARE THERE SOME ILLNESSES THAT WE CAN NOT GET TWICE?

When people have had smallpox or measles or scarlet fever once, they seldom suffer from them again, even if there should be an epidemic all around them. In some way or other the tissues of the body have become changed as the result of the first attack, and are better able to resist that particular kind of infection. We say then that the body is immune to that disease. Doctors make use of this immunizing power of the body, in a very wonderful way. They can give us a very mild form of a disease, or of a similar disease, by vaccination, and after that we are safe for years from any danger of getting the disease itself. On page 2487 you may read of the way in which vaccination protects us from smallpox. People are often vaccinated against typhoid and other illnesses; they are inoculated with the actual disease germs, which have been killed or weakened to the point where they are no longer dangerous. To inoculate simply means to introduce into the body disease germs or their products.

Sometimes, instead of actual disease germs, a person is inoculated with blood serum of an animal that has been given a disease and has created in its blood "antibodies" that fought and killed the disease bacteria, or anti-toxins that rendered harmless the poisons produced by the bacteria.

Diphtheria anti-toxin belongs to this class of medicine that prevents disease or, if given in the early stages, cures it.

CAN ANY ANIMAL LIVE FOR YEARS WITHOUT FOOD?

There is a very small creature known as the tardigrada, a distant relation of the spiders and popularly known as the water bear, which can dry up till apparently all life is extinct, and after remaining in that condition for years, can, with the aid of moisture, revive and live its normal life once more.

These creatures live naturally in a damp atmosphere, but if the atmosphere becomes dry they also dry up. All movement gradually ceases, the body shrinks until it looks like a battered grain of sand, and thus it will remain year after year, to all appearances dead. If placed in water, however, in a few minutes it will swell out, the wrinkles will disappear, the legs will stretch out, and gradually it will move. In an hour or so the creature is as active as ever, and crawls away.

Some snails, too, can remain apparently dead for years without food, and then revive and live as though nothing had happened to them. The most striking example of this was a desert snail from Egypt, supposed to be dead, which was fixed to a tablet in the British Museum, London, on March 25, 1846. On March 7, 1850, it was observed to have awakened from its long sleep and come out of its shell. It was removed from the case and lived for a considerable time.

WHAT IS THE BOOK CALLED THE NAUTICAL ALMANAC?

It is an almanac prepared specially for navigators and astronomers, with tables showing the daily positions of all the bodies of the solar system, the places of the fixed stars, predictions of forthcoming astronomical events, and other similar information. Nautical almanacs are issued by the governments of Great Britain, the United States and other nations.

WHAT IS DAYLIGHT-SAVING?

In all civilized countries for years past people have been gradually keeping later and later hours, with the result that for half the year at least they have missed much of the daylight. In the bright hours of the morning they have been in bed asleep, and for hours after darkness has fallen in the evening, they have been going about their business or pleasure in artificial light.

Benjamin Franklin in 1784 seems to have been the first to write about this strange habit of civilized man. He published a humorous article on the subject in a Paris paper. It was not until 1907 that the idea of putting the clocks back was seriously suggested. In that year an Englishman, William Willett, brought forward a plan to change the clocks during the summer months and make the people get up an hour earlier.

The question was much discussed for years, and in 1916, during World War I, Daylight Saving was adopted in England. One day in spring, by Act of Parliament, all the clocks were overnight put forward one hour. This saved electricity and soon Germany, Canada, Australia and some other countries passed Daylight Saving laws. After the United States entered the war that country, too, adopted Daylight Saving. All clocks were put ahead an hour in the spring, and put back an hour in the fall. After the war some of the countries repealed their Daylight Saving laws.

In the fall of 1940 Great Britain, France, Germany and several other countries did not put their clocks back on the usual date. They continued daylight saving throughout the year, though not so much daylight could be saved in winter. Nevertheless a considerable amount of electricity was saved even in winter. When the following spring came, Great Britain and Unoccupied France put their clocks one more hour ahead for the summer months.

The United States and Canada also put their clocks ahead for one hour for the duration of the war. The term Daylight Saving Time was changed to War Time.

WHAT ARE OUR EYEBROWS FOR?

Our eyebrows serve a good and useful purpose. If we had no eyebrows, the drops of sweat that form on our foreheads when we get warm would run into our eyes. This would be bad, not only because it would blur our vision, but also because sweat contains impurities which the body is getting rid of. Our eyebrows act as shields, catching the drops of sweat and turning them aside.

The eyebrows are beautiful in themselves, and they call attention to the eyes, just as we draw attention to a specially important word in a letter by underlining it. The eyes are the most interesting part of our faces, not only from their form, but also because they and the eyelids move so quickly, and so give the idea of life. That is why a face looks so different when the eyes are shut.

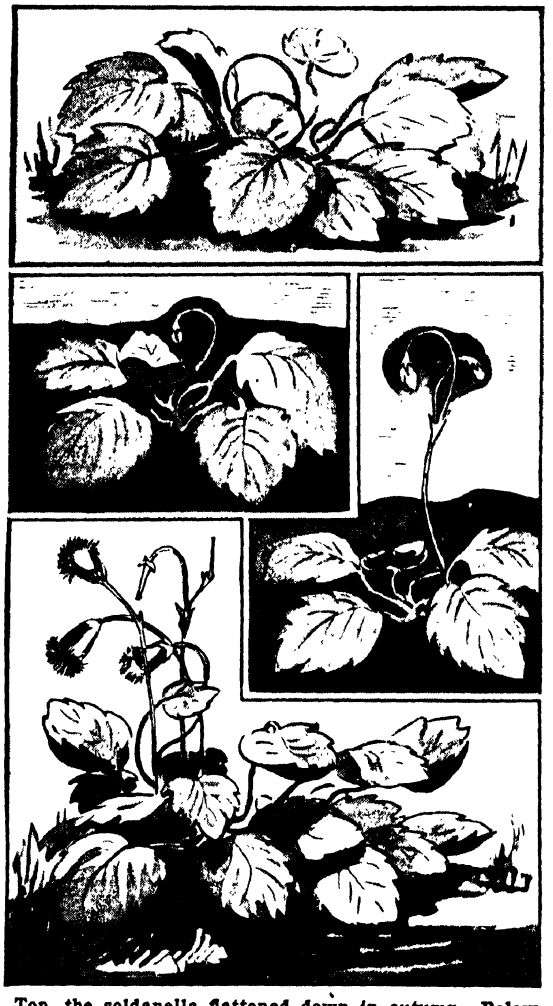
CAN ANY PLANT GROW UNDER ICE?

This is very often done by an interesting little Alpine plant called the soldanella. During the summer the flat leaves are exposed to the sun and the plant stores up fuel in the leaves until these become quite fat. Then, as time passes, they flatten to the ground, and when the snow falls the hard, leathery covering of the leaves protects them from damage.

The plant sleeps through the winter, but in early spring the water trickling through cracks in the frozen snow above gets round the root and causes the plant to germinate. A little bud begins to open and, using the fuel stored up in the leaves, melts a place for itself in the frozen snow or ice.

As it grows up toward the light it continues to melt the snow, until at last it emerges into the fresh air, but down below the snow again freezes together round the stem. The flowers open, and when the snow disappears the little soldanella is practically a full-grown plant with its blossoms open inviting the bees to enter and fertilize them. The bees accept the invitation, and fruits form, yielding seeds. The plant then flattens again to the ground and stores up fuel for the following year.

If the soldanella were to wait for the snow to disappear before it began to grow it would have little chance of surviving, for there are crowds of other plants all round that would overtop it, shut out the sunshine, and prevent its blossoms from opening properly. By melting its way through the ice and blossoming before the other plants have grown, the soldanella preserves its life and produces seeds which grow and carry on the race.



Top, the soldanella flattened down in autumn. Below, the plant under ice; next, the bud pushing up through the ice; bottom, the full-grown plant in summer.

How Does a Fly Walk on the Ceiling?

If you saw the foot of a fly under a microscope, you would notice on the bottom a sort of cushion, or pad, between two claws. The pad is fringed with tiny hairs. These hairs are hollow, and a sticky liquid oozes out through them from a little pouch where it is produced. Its stickiness helps the fly to hold on to a steep wall or to the ceiling, as it climbs or walks upside down.

The pads on the feet probably play a part also. Though scientists are not certain, it is thought that when the fly is walking on a ceiling or on a slippery surface, it presses the pads flat so that they act like six little vacuum discs, or suckers, and thus help to prevent falling. The fly is held to the walking surface by air pressure. The insect's six feet give better balance than four feet, or two, would do.

The eyes of the fly enable the insect to see in all directions at once. This ability must be another big advantage to the insect when it is walking upside down.

There are other insects which have the same type of hairy pads on the bottom of the feet; and these insects, too, can walk upside down.

HOW DOES OIL MAKE A ROUGH SEA CALM?

If we shake a bottle of oil, we notice how slow its movements are. Oil is what we call a viscous liquid. Water moves much more easily, and we call it a mobile — that is, movable—liquid. Oil will not sink in water, so oil poured on waves forms a layer of viscous liquid on top which lessens the splashing of the waves. It is difficult to understand what makes a liquid viscous. Partly it has something to do with the size of molecules. In the case of oil of any kind, the molecules are very large.

HOW IS IT THAT A WORM LIVES WHEN CUT IN TWO?

All animals except the very lowest depend on what we call a nervous system, which controls the power of movement, and so forth. Now, when this nervous system is all heaped together in the form of the brain, as it is in man and the higher animals, the life of a creature depends upon that brain being uninjured. But in lower creatures, like the worm, the arrangement of the nervous system is different. It is more scattered over the body, and so, when a worm is cut in two, there is enough nerve matter in each half to enable it to keep on living.

WHAT CAUSES CRAMP?

Cramp is really a spasm or contraction of one or more muscles in a limb or in some other part of the body. It may be felt by pain or by numbness. It comes sometimes when a person is swimming. It may be caused by overexertion and severe cold, and is probably due to some complicated change occurring in the muscle itself.

A sharp rubbing over the surface of the muscle will usually put it right. However, to be seized with cramp while swimming can be very dangerous, as you can easily understand. We must get to land before the cramp can be treated, and the fact that we have been seized with cramp might prevent us from doing so.

HOW MANY BOOKS ARE THERE IN THE WORLD?

Basing his conclusions on the most reliable data available in library catalogs, a librarian has estimated that the total number of titles of books published since printing was first invented is 18,000,000. Of some books, of course, only a few are printed, but of others hundreds of thousands, and, as in the case of such books as the BIBLE, PILGRIM'S PROGRESS, ROBINSON CRUSOE, millions have been printed.

It is impossible to say how many actual copies of the eighteen million titles have been issued, but, supposing the average edition to be only 3,000, the number of books issued from the printing presses of the world has been something like fifty-four billions.

Perhaps the most astonishing fact about these statistics is that about 6,000,000 of the titles have been issued in the present century, since 1900. That is to say, in the four and a half centuries following Gutenberg's invention of printing, only two times as many books were written and sent to the press as in the years since 1900. The librarian who has compiled these interesting figures believes that only about 20,000 of all the works are of real and lasting value.

WHY DOES HAIR GROW GRAY WHEN PEOPLE ARE OLD?

Some of the cells of the hair contain a pigment (coloring matter). As human bodies grow old, most of them lose the power to make new pigment, so that the hairs are colorless, or white. Some people lose the power to make the pigment when they are still quite young; others do not grow gray until they have reached a very advanced age.

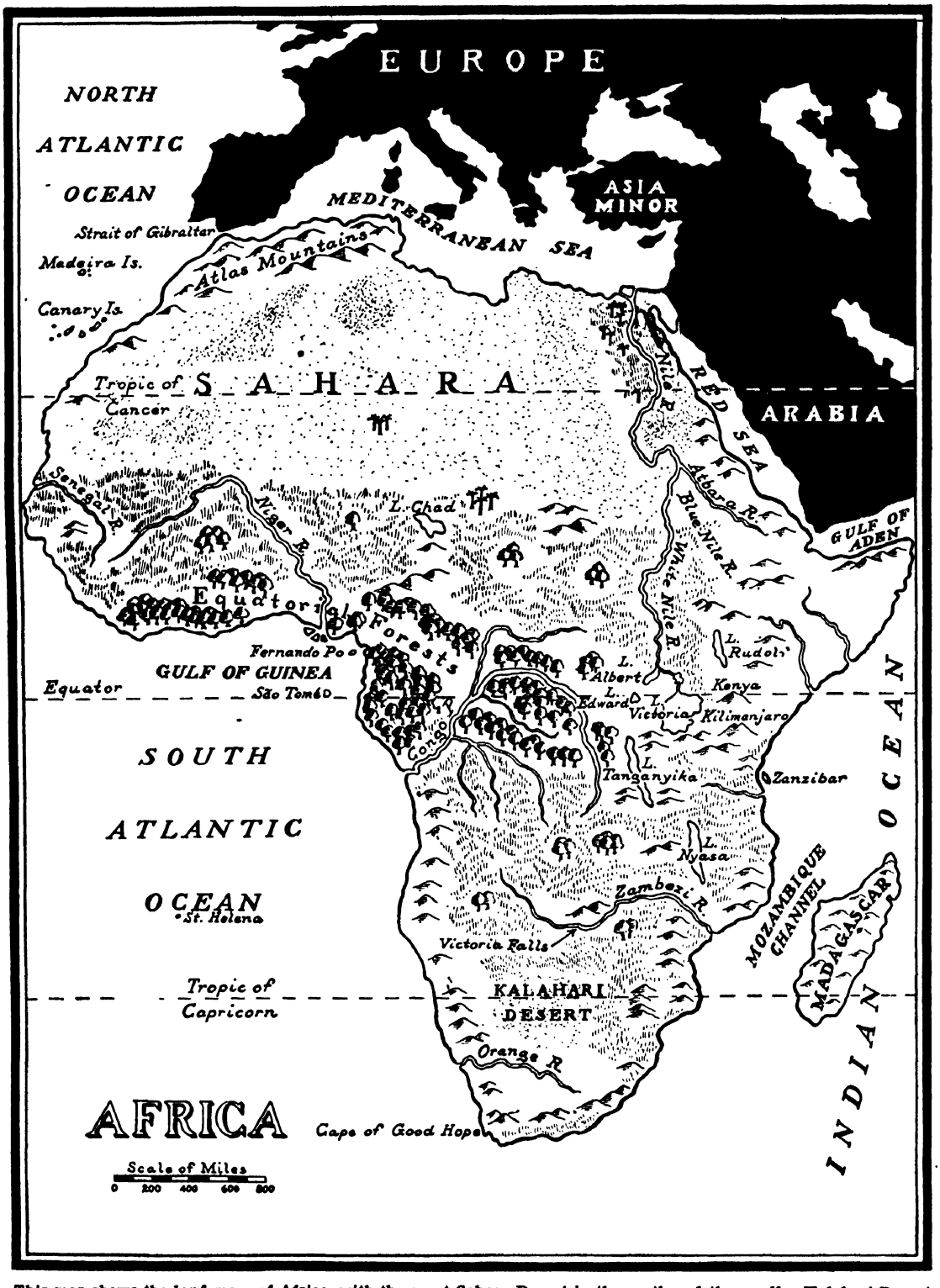
General health and good care of the hair may aid in keeping the color. However, loss of hair pigment runs in families, and many physicians believe that it is a hereditary trait. (See page 5613.) The condition of the nervous system has an effect upon the hair. Persons under a serious nervous strain have been known to grow gray quickly. We hear stories of people who turned white in a single night, because of shock, or fright or fear. Probably these stories are exaggerations; yet it is true that men and women under stress have become white-haired in a few months.

Scientists have studied for years, trying to find out what happens in the body that stops production of the color cells. In some cases, the mysterious little vitamins play a part. If the body lacks certain vitamins of the B family, the hair may grow gray. When these vitamins are supplied, the hair may regain its color.

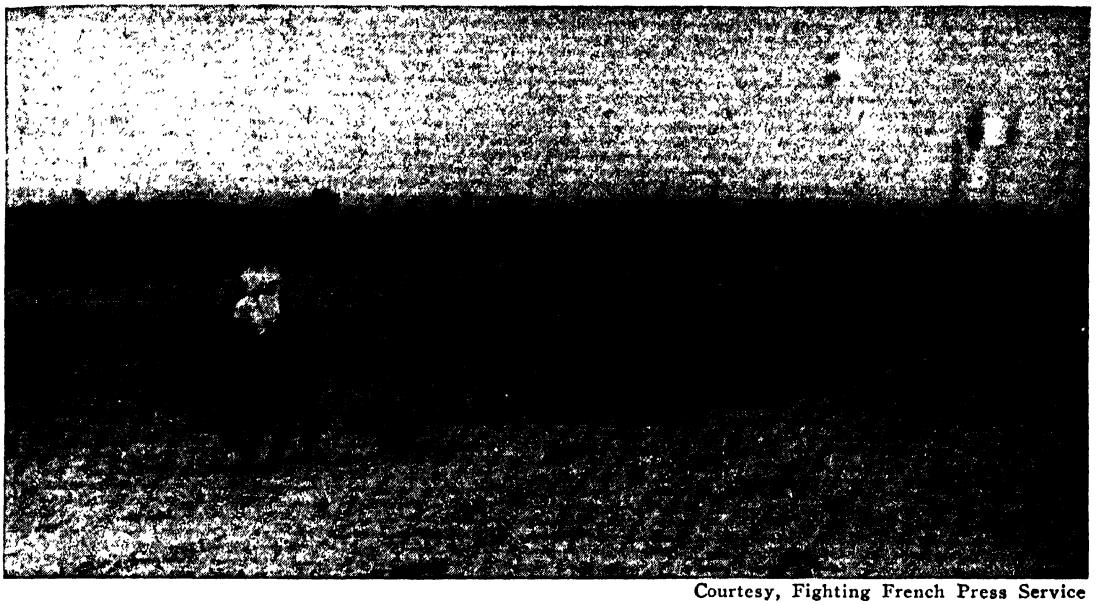
Many animals also grow gray with the years. You have noticed this, of course, among cats and dogs. It is true of mice and rats and they are often chosen by scientists for experimental specimens.

THE NEXT WONDER QUESTIONS ARE ON PAGE 519.

THE CONTINENT OF AFRICA



This map shows the land-mass of Africa, with the great Sahara Desert in the north and the smaller Kalahari Desert in the south, the equatorial forests on the west, near the Equator, the mountains and the mighty rivers.



Courtesy, Fighting French Press Service

A camel corps of Fighting French Africans, patrolling the desert near Lake Chad.

THE CONTINENT OF AFRICA

TWO hundred years ago, this chapter could not have been written. At that time Africa was known as the Dark Continent and the Mysterious Continent. It was a rather legendary place, from which came gleaming gold and ivory and—alas!—cargoes of wretched black slaves. To be sure, some parts of the continent were quite well known—certain areas along the northern coast; the Nile Valley, in the northeast; some of the fringe along the east and west coasts; a few scattered regions elsewhere. Most of the interior, however, was an utter mystery. Schoolboys of that time found the map of Africa easy to draw and to learn—there were so few names in it!

We of the twentieth century know a great deal more about the continent. We have explored its vast northern desert and the wide plains and forests. We have charted the winding river courses and the lakes; we have climbed the lofty mountains. We have learned a good deal about the peoples of Africa and about the animals and birds and insects of the continent. Already we know as much about it as about our neighbor, South America.

Africa is the second largest continent (Asia is larger); Africa has an area of about 11,500,000 square miles (this includes the islands that lie off the continent). It extends 5,000 miles from north to south and 4,600 miles from east to west—that is, from the easternmost point to the westernmost.

The average width of northern Africa is nearly double that of the southern part of the continent. If you look at the map on page 464, you will see that the western coastline makes a sudden turn to the east when it reaches Liberia. It continues for almost a thousand miles in that direction; then it dips suddenly almost directly south again. The great Gulf of Guinea lies in the bend that is thus formed.

Northwestern Africa almost touches Europe at the narrow Strait of Gibraltar. East of Gibraltar, the Mediterranean Sea separates Africa from Europe and from the Asiatic lands of Anatolia (Asia Minor) and Syria. Africa is connected with Asia by the Isthmus of Suez, across which runs the Suez Canal. South of the canal, the two continents face each other across the Red Sea. They almost meet again at Bab el Mandeb, a strait at the southern end of that sea.

The coastline of Africa then extends due east for 400 miles or so; it is separated from southern Arabia by the Gulf of Aden. Then, as the coastline swings sharply to the southwest, Africa takes leave of Asia and the other

Picture, Ewing Galloway

The town of Bouira in Algeria, North Africa. It is in a region of striking contrasts. Near by is desert, where the sun blazes hotly by day. Behind the town are cold, snow-capped mountains. The town is a railway centre, though the rolling stock (passenger cars and freight cars) do not look very modern.

continents. To the east, there is the Indian Ocean; to the south, there is the Antarctic; to the west, the broad Atlantic.

The coast of Africa is almost unbroken on every side, with few peninsulas and promontories and gulfs and bays. The coastline is only 16,000 miles long. This is really an amazingly low figure, when we realize that the coastline of Europe is about three times as long, though Europe is only a third as large as Africa.

There are comparatively few islands off the African coast. The only large one is Madagascar, which has an area of about 241,000 square miles. This huge island lies off the eastern coast; it is separated from the mainland by the broad Mozambique Channel. Of the other islands, the best known are the Canaries, the Madeira Islands and the Cape Verde Islands, in the North Atlantic; Fernando Po and São Tomé (St. Thomas), in the Gulf of Guinea; St. Helena (famous as the place of exile of the great Napoleon), in the South Atlantic; Zanzibar, Seychelles, Mauritius and Réunion, in the Indian Ocean.

Much of Africa is a vast plateau or tableland, which generally rises not far from the ocean. This plateau rises very abruptly indeed along the northwestern coast of the continent, in the Mediterranean lands of Morocco, Algeria and Tunisia. Here the tableland is quite irregular. Now it heaves itself upward to form the lofty range of the Atlas Mountains; now it sinks and gives way to fertile valleys.

South of the coastal strip lies the mighty Sahara Desert, which extends from the Atlantic, in the west, to the valley of the Nile, in the east. The Sahara is the greatest desert in the world, with a total area of over 3,000,000 square miles. It is not a monotonously even sandy waste. It has hills and even mountains, with habitable valleys watered by streams that lose themselves in the endless reaches of sand. Elsewhere the desert is furrowed with *wadis* (dry river beds), that extend in all directions. In some places, water collects in layers of rock under the sands; in these favored places, fertile oases often flourish. It is terribly hot in the Sahara when the sun beats down fiercely; at night, it often becomes uncomfortably cold.

As we have seen, the Sahara finds its way

barred, to the east, by the basin of the mighty Nile River. East of the Nile, the desert reappears. It is known as the Arabian Desert to the north; farther south, where the Nile River makes a great bend, as the Nubian Desert.

South of the Sahara, there is a broad belt of country known as the savanna (or savannah), where the grass is high and trees grow in scattered groups rather than in forests. The savanna covers much of the continent. It extends from the Atlantic, north of the Gulf of Guinea, eastward to the headwaters of the Nile; it takes in the region that is known as the Sudan.

The savanna forms the northern boundary of a belt of great forests that lie to the north and east of the Gulf of Guinea. They are known as the equatorial forests, since they lie close to the Equator. In this region the African plateau dips noticeably; however, it rises here and there to form a series of highlands and mountain ranges.

From the headwaters of the Nile, the savanna swings south and then turns westward again, thus hemming in the equatorial for-

The Sahara Desert is not a flat, sandy plain, but a vast rolling land, with hills and valleys, as you can see by this picture.

Pictures, Ewing Galloway

In the midst of the dry desert where nothing will grow, there are spots called oases, where there is water and where lush plants thrive. Here is such an oasis in Algeria.

ests on three sides. A branch of the savanna runs still farther south to what is now known as British South Africa. Here the savanna is called the veld (or veldt). It gives way, in the southwest corner of the continent, to the desert area known as the Kalahari.

A series of great lakes runs along the eastern part of the savanna, from the headwaters of the Nile clear down to Mozambique, in the southeastern part of the African continent. The largest of these lakes is Lake Victoria, also known as Victoria Nyanza (*nyanza* means lake in the native Bantu language). This vast body of water, about 27,000 square miles in area, is the second largest fresh water lake in the world (the largest is Lake Superior, in North America). Lake Victoria, which lies almost 4,000 feet above sea level, serves as a vast reservoir, from which the Nile River draws much of its waters.

To the northeast of Victoria lies Lake Rudolf; to the northwest, Lake Albert. Swinging southward from Lake Albert in a graceful curve, we find small Lake Edward and two very long and comparatively narrow lakes, Tanganyika and Nyasa. Lake Tanganyika (area, 13,000 square miles) is over 400 miles long—the longest lake in the world—but its average width is only about 30 miles. Lake Nyasa (area, 10,000 square miles) is about as narrow but not quite so long as Tanganyika.

The inland seas that we have just mentioned include almost all the important lakes on the African continent. The only other one of considerable size is Chad (or Tchad), in the Sudan, about 1,000 miles northwest of Lake Albert. Its area, during certain rainy seasons, has been estimated at nearly 30,000 square miles. In the dry seasons, however, it often shrinks to less than 7,000 square miles. It is then very shallow, and is surrounded on all sides by vast swamps. Some learned men think that the lake will dry up altogether some day.

The mightiest peaks of Africa are to be found in the mountainous country that runs parallel to the eastern coast, from rugged Ethiopia, in the north, to the extreme south of the continent. The two highest mountains of all, Kilimanjaro and Kenya, lie between Lake Victoria and the Indian Ocean. Kilimanjaro, with its picturesque twin peaks, towers to a height of 19,710 feet; snow-clad Kenya, 200 miles to the north, is over 17,000

Picture, Ewing Galloway

Watering a garden on the banks of the Nile, with a primitive device. There are great dams now, which irrigate large areas; but simple, home-made wheels are still used to lift the water. In Egypt the river itself, by overflowing its banks, irrigates the land and spreads a rich blanket of topsoil over the fields.

feet above the level of the sea.

To the south of Lake Albert (about 200 miles west of Lake Victoria) is the chain of mountains known as the Ruwenzori. These heights are supposed to be the wonderful Mountains of the Moon, mentioned by a number of ancient writers. The Nile was said to rise in mysterious underground channels leading from these mountains. Mount Stanley, the loftiest peak of the Ruwenzori, is almost 17,000 feet high.

AFRICA'S LONGEST RIVER—THE NILE—AND ITS MAJESTIC COURSE

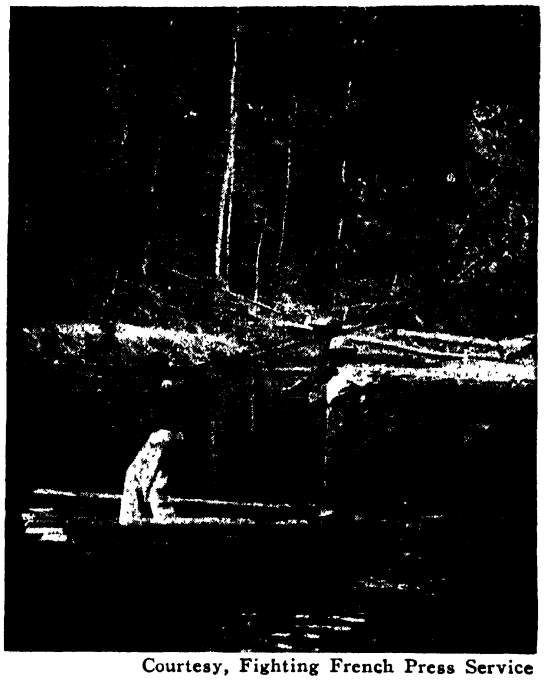
The Nile, the longest river of Africa (4,000 miles), is the only large stream that flows into the Mediterranean. As we have seen, it draws much of its water from Lake Victoria. The waters of that lake flow into Lake Albert, by way of a rather short connecting stream, and then from Lake Albert into the White Nile, a tributary of the Nile. At Khartoum, the White Nile is joined by the Blue Nile, which arises in the Ethiopian highlands. Two hundred miles beyond, the Nile receives the waters of another tributary, the Atbara.

From this point, the Nile flows in a majestic stream through the Anglo-Egyptian Sudan and Egypt without receiving a single tributary. Nine miles beyond Cairo, at a distance of ninety miles from the Mediterranean, the waters of the Nile divide. They enter the Mediterranean by a delta with two main channels, the Rosetta and the Damietta.

FERTILE EGYPT HAS BEEN CALLED THE GIFT OF THE NILE

In all, the Nile River drains an area of more than a million square miles. When the river is swollen by the spring rains and also by the melting snows of the mountains that lie near its headwaters, the Nile overflows all along its lower course. Some of this overflow is directed to irrigation channels or is stored up in dams. The rest spreads over the fields. When the river withdraws at last, the fields are covered with a layer of rich silt (fine earth) and are almost unbelievably fertile. Egypt is truly the "gift of the Nile," for if it were not for that great river, the country would be given over to the surrounding desert.

Most of the rivers that flow into the Indian Ocean arise in the highlands and mountains that run parallel to the eastern coast. The only great river flowing from the interior and breaking through the mountain barrier is the Zambezi, which is some 1,600 miles long—the fourth longest river of the continent. It drains an area of about 550,000 square miles.



Courtesy, Fighting French Press Service

Crossing a river on a crude raft which is pulled along by a rope strung from shore to shore.

Near the source of the Zambezi River, its waters tumble down in four cascades over a cliff almost 350 feet high, forming the magnificent Victoria Falls, almost twice as high as our own Niagara. The thundering roar of the falls can be heard twenty-five miles away; the clouds of spray rise to a height of 3,000 feet and more.

The Orange River (1,300 miles), flows westward nearly across the southern end of Africa through a barren region. Farther north, we come to the mighty Congo (2,900 miles), the second longest of Africa's rivers. It is fed by many tributaries; it is estimated that it pours into the sea a larger volume of water than the Mississippi. The Congo drains a vast area of 1,450,000 square miles.

The Niger River, arising near the Atlantic coast, beyond the Gulf of Guinea, first flows northeast to the picturesque city of Timbuktu, then east and finally southeast. It empties into the Gulf of Guinea through a number of mouths. The Niger, which is 2,600 miles long, drains an area of about 800,000 square miles. The Senegal River (1,000 miles) rises not far from the Niger. However, it soon parts company with its sister river; flowing toward the northwest, it

finally empties into the North Atlantic.

Geologists (men who study the history of the earth) tell us that Africa, like all the other continents, acquired its present form only after a series of vast changes extending over hundreds of thousands of years. A very long time ago, Africa was part of a great southern continent that included India, Australia and South America. This land mass was separated from another great land mass to the north by the Tethys Sea, a body of water that extended from Central America through the Mediterranean and across southern Asia.

Later, a part of the southern continent sank beneath the seas and thus the Atlantic and Indian Oceans were formed. Still later, a great crack or rift appeared in what is now eastern Africa. This crack exists to the present day; it is called the Great Rift Valley. This extends from the Jordan Valley, in the Asiatic land of Palestine, to the southern part of Lake Nyasa, in southeastern Africa. The Red Sea now fills part of the Great Rift Valley. Within the African continent itself, waters have gathered in the deeper places of the rift and have formed the chain of eastern lakes, about which we have told you.

All the violent changes described above took place many, many years ago. Africa has now settled down and is considered by geologists to be among the best behaved of continents. Earthquakes take place occasionally in the Atlas mountain region; but these earthquakes are not severe. Volcanic eruptions are largely confined to the eastern mountain belt that extends from Kilimanjaro to the Red Sea, although they also occur in certain mountainous areas near the Gulf of Guinea.

The greater part of Africa lies within the tropics and, as we would expect, the average annual temperature is high. In the burning Sahara, as we have said, the thermometer sometimes registers over 150 degrees. It is hottest of all in the Nubian Desert, where, according to the Arabs, the soil is like a fire and the wind like a flame.

The temperature is much lower on the highlands swept by the winds from the Indian Ocean and in the temperate regions of South Africa. The coldest places in Africa are the mountain regions. Extremely low temperatures, like those of the northern areas of Europe, Asia and North America, are quite unknown in the African continent.

Rainfall is particularly abundant in the lands lying north and east of the Gulf of Guinea, where rainfall of over 400 inches a year has been recorded (50 inches of rain a year is considered a moderate amount). In these regions, the rainfall is distributed fairly evenly throughout the year. In the

Courtesy, Belgian Information Center

A village in the Belgian Congo. The country is so hot and moist few white men can live there. Leopold II, King of the Belgians, once owned the area. In 1908 he turned it over to the Belgian nation.

desert regions of Africa, there is hardly any rain at all. Elsewhere, rainy seasons generally alternate with dry.

The African continent has vast mineral wealth. Over four-fifths of the world's diamonds and almost one-half of the world's gold are produced here. The Belgian Congo is the leading producer of diamonds; the richest gold mines are in the Union of South Africa. In the latter region, silver is mined in great quantities; it is found in many other parts of Africa, including Morocco. Africa also has great deposits of coal, iron, oil, mica, lead, bauxite, radium ores, manganese and other minerals.

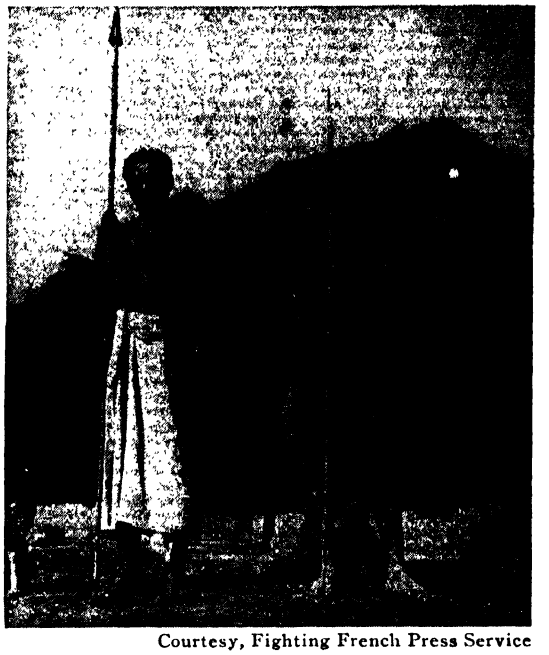
THE WIDE VARIETY OF PLANTS IN DIFFERENT PARTS OF AFRICA

The plant life of Africa shows astonishing variety. In the northwestern coastal regions, there are many plants also found in Southern Europe, such as the common oak, the cork oak, the pine and our little spring blossom, the arbutus. Date-palms and dwarf palms also abound. Wheat, corn, oranges and olives are cultivated in great quantities. In the fertile valley of the Nile, there are fine crops of cotton, corn, flax, sugar and hemp.

The date-palm flourishes in the oases of the Sahara; in other parts of the desert there are stubby growths of low, thorny bushes. As we enter the savanna region south of the desert, the low-lying bushes are replaced by scattered trees and shrubs, with an undergrowth of grasses and flowering plants. Here we find the baobab tree, the butter tree and the fan-palm. Agricultural products of the great savanna include cotton, beans, millet, coffee and tobacco. In southern Africa, where the savanna becomes the veld, the plants that grow upon the great heaths sometimes reach eighteen feet in height and form real forests.

In the equatorial areas watered by the Niger and the Congo, we find dense jungles that recall those of the Amazon Basin, in South America. Here an almost impassable barrier is formed in many places by giant trees matted together with lianas. (A liana is a tropical plant with a rope-like stem; it sometimes runs along the ground and sometimes twines its way up the trunks of trees.)

This equatorial forest is rich in rubber-producing trees, also acacias, African oaks, euphorbias, mahogany, kapok trees, teakwood and ebony. The swampy marshes abound in reeds. In some sections the coffee plant forms thick woods, as it does in southern Ethiopia. In the clearings that have been won from the jungle, the natives cultivate gourds, melons, bananas, beans, tobacco and many other plants.



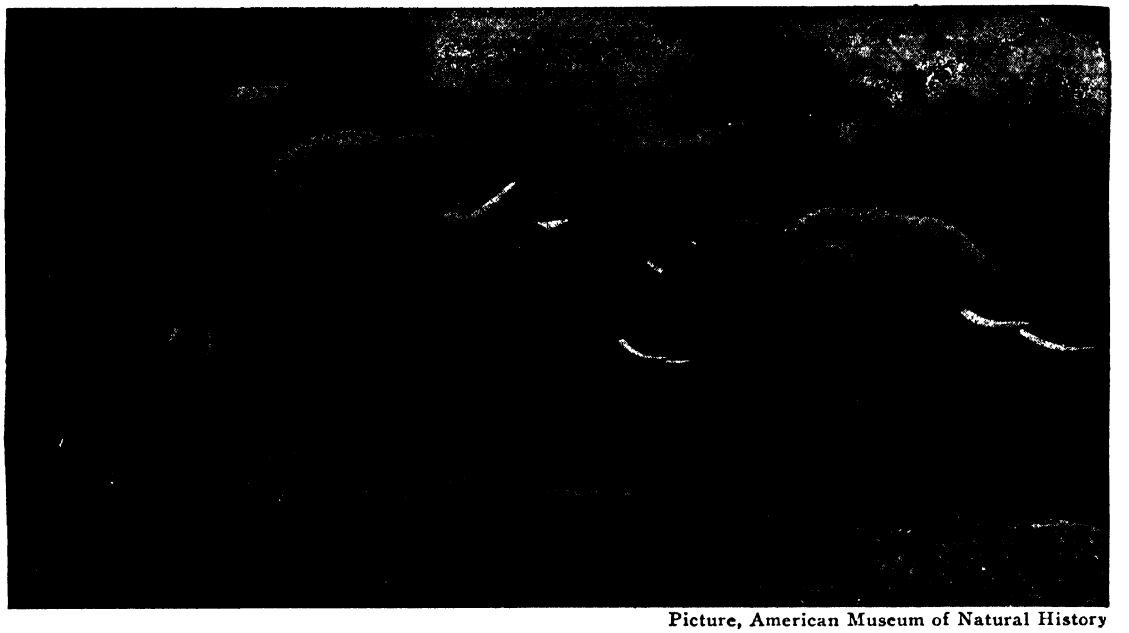
Courtesy, Fighting French Press Service

French African hunters, with the nets and hardwood spears they use to trap and kill wild animals.

The forests of Madagascar include many species of hardwood trees and palms. The most striking tree of all is the traveler's tree, which resembles a palm. It owes its name to the fact that the traveler may obtain water to quench his thirst by breaking the lower ends of the leaf stalks.

Animal life upon the African continent is as varied as its vegetation. The most important carnivore (flesh-eating animal) is the lion, which roams over the great savanna from the Sudan to Rhodesia. In the savanna, too, we find the fierce leopard and the skulking hyena and jackal. Here the giraffe, the tallest of animals, gallops awkwardly across the grassy plains. Here we see antelopes galore, from the twin-horned hartebeest to the graceful gazelle. We also find the striped zebra, the ill-tempered rhinoceros, the no less ill-tempered wild boar and many other wild creatures besides.

In the vast equatorial forests, great herds of elephants crash through the dense jungle growths. The African elephant differs considerably from his Asiatic brother. He is quite a bit heavier; his funny, flapping ears are much larger; he is not easily domesticated. His ivory tusks have been an im-



Picture, American Museum of Natural History

A lifelike group of African elephants mounted in the American Museum of Natural History. They generally live in large herds, each herd led, and apparently governed, by a leader.

portant article of commerce since the very earliest times. Another bulky inhabitant of the forest regions is the hippopotamus, who takes his ease in the rivers of the jungle. He is also to be found in many rivers and lakes of the savanna.

The equatorial forests are the home of the largest of apes, the gorilla, and the most intelligent of all, the chimpanzee. The gorilla, which is to be found chiefly in the Gabon district of French Equatorial Africa, is not nearly so terrible as he looks. He is a vegetarian, and rarely bothers creatures that leave him alone. In the equatorial forests, too, we find countless members of the monkey tribe —monas, guenons, vervets, mangabeys and others.

The most useful, perhaps, of the African animals that man has domesticated is the camel—that homely and hard-working beast that carries men and goods over the endless sands of the desert. In Africa one finds the one-humped species of camel, originally imported to the continent from Arabia and known as the Arabian camel. Horses and donkeys are particularly plentiful in northern Africa. Cattle, sheep and goats are raised in many different African regions.

Bird life is wonderfully represented in the equatorial jungle; here we find the brilliantly colored parrots, kingfishers, sunbirds, bee eaters, rollers and plantain eaters. The ostrich, that remarkable bird with the beautiful tail plumes and the powerful legs, is found in different parts of Africa, as far north as Morocco and as far south as the Union of South Africa. There are many species of falcons and vultures and eagles upon the great savanna. Waterfowl are abundant on the lakes and rivers.

In South Africa, we find the strange secretary bird, which looks like a hawk mounted on stilts; it kills snakes with powerful thrusts of its feet. The guide bird or honey bird is another curious inhabitant of this region. Fluttering temptingly in front of men or beasts, it leads them to tree trunks and other places where bees have set up their colonies. When the honeycombs are robbed, the guide bird darts in and obtains its share of the booty.

The most deadly of Africa's insects is the tsetse-fly, which has driven men and beasts alike from many parts of the savanna. The bite of this creature, which looks like a horse-fly, often infects its victims with the germs of the terrible sleeping-sickness. This illness is caused by a parasite, which is carried from one victim to another by the tsetse-fly.

The equatorial jungle of Africa is a real paradise for insects. Most dangerous of all are the driver ants, which are the terror of all living things, large and small. The driver ants advance in long columns, made up of millions of individuals, and they attack with

the greatest ferocity any creature that crosses their path. The jungle is also the home of numberless spiders, scorpions, centipedes, ticks and many members of the insect family.

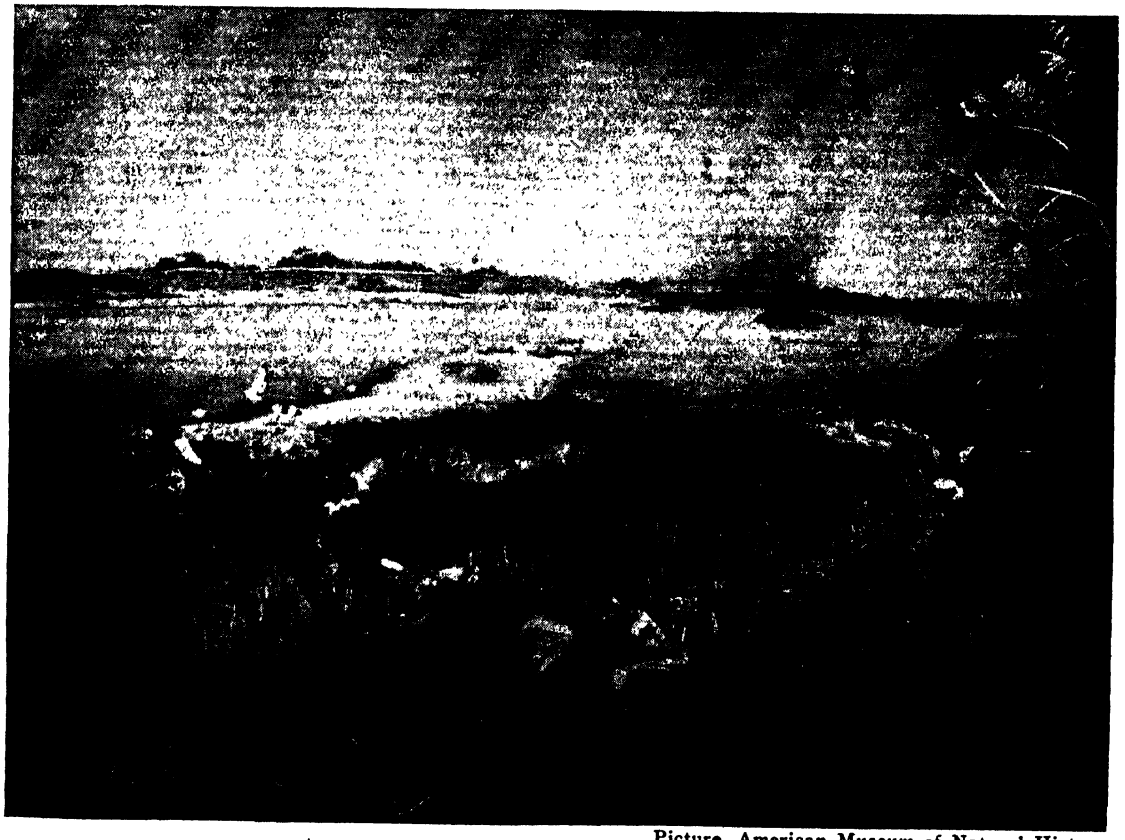
Perhaps the most terrible of Africa's snakes is the horned viper, which frequents the desert regions of northern Africa. Almost completely hidden under the sand, the horned viper suddenly strikes at its prey; its bite is fatal to men and animals. Among the other poisonous snakes of Africa are the deadly puff adder and the no less deadly African cobra. Although it is not poisonous, the great python of the equatorial forests is a constant menace, squeezing its prey to death in its mighty coils.

The reptile family is also represented by crocodiles and the Monitor lizards that dwell by many of Africa's rivers. The Monitor is the largest of all lizards; it sometimes reaches the length of eight feet. It leaves the adult crocodile severely alone, but often feasts on the eggs of the crocodile and also on its young.

In spite of its great area, Africa is not among the most populous of the continents—for one thing, few people live in the deserts that cover so much of it. The population is estimated at 150,000,000. This is a very rough estimate, however, since no census has ever been taken in many areas. The native peoples of the continent make up by far the largest part of the population.

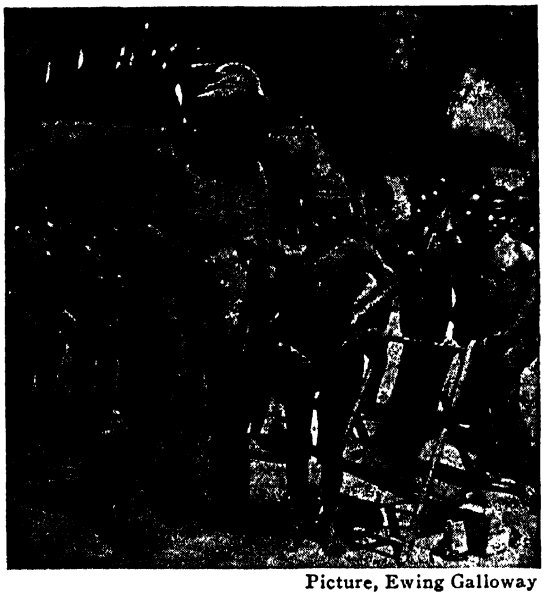
There is a great difference between the races to the north and east of the Sahara and those to the south. In the north and east, most of the natives belong either to the Semitic or Hamitic branches of mankind. Both Semites and Hamites were originally of pure Caucasian (white) stock; some of them, however, have inter-married with the Negroes to the south.

In general, one may say that the Semites include the Arabs and Jews of northern Africa and also many inhabitants of Ethiopia, where the mixture of Negro blood has been particularly great. The Hamites include many Egyptians, the Berbers of northwest Africa, the Tuaregs and Kabyles of the desert and certain peoples of eastern Africa,



Picture, American Museum of Natural History

A group in Akeley Memorial Hall, where the wild life of Africa is shown, in the American Museum of Natural History. This is a Nile River scene, with a male and female kob in the foreground, a hippopotamus behind, and a roan antelope at the right.



Picture, Ewing Galloway

In the forests of central Africa there are a number of tribes of pigmies—little people with brown skins, and hairy bodies. Very few of them ever grow to be more than four and a half feet tall. They live chiefly by hunting and trapping.

such as the Somalians and the Masai.

To the south of the Sahara, we find the Negro races which make up the great majority of the continent's inhabitants. The Negroes who dwell to the north are called the Sudanese; they occupy a great territory extending from north of the Gulf of Guinea to Lake Victoria, in the east. The Sudanese are black-skinned, have flat or broad noses, thick lips, narrow heads, woolly hair, high cheek bones and prominent jaws. Farming is their principal occupation.

South of the Sudanese are the Bantu races, of which the Zulus, the Kaffirs and the Bechuanas are perhaps the most prominent. Some of the members of the Bantu family resemble the Sudanese; others have prominent noses and comparatively thin lips. The Bantus are good farmers; many of them raise cattle on a fairly large scale.

The Bushmen, who dwell chiefly in the lands south of the Zambezi River, are generally classed as Negroes, but they differ greatly from the pure Negro type. They are quite short; their skins are yellowish brown; their skulls are shaped differently. The Bushmen are nomadic (that is, wandering) hunters. Their neighbors, the Hottentots, resemble them; however, the Hottentots are a more peaceful race, quite content to tend their herds of cattle.

Scattered over the forest regions of Central Africa are a number of pigmy tribes, which are supposed to be descended from the earliest inhabitants of the continent. Herodotus, a Greek historian of the fifth century B.C., spoke of a pigmy race dwelling in the heart of Africa; and, sure enough, there they were found by European explorers 2,300 years later! The pigmies have brown skins, retreating foreheads and prominent jaws; their faces and bodies are unusually hairy. They are hardly ever more than four and a half feet tall. The pigmies are mighty little hunters. They use clever nets, traps and nooses to catch all sorts of game, large and small.

The native inhabitants of Madagascar, who are known as the Malagasy, belong to the Malay race. They differ considerably from their brothers of eastern Asia, because there has been considerable inter-marriage with Arabs and Negroes.

Since the nineteenth century, when Africa was colonized on a large scale by the nations of Europe, the number of white inhabitants has greatly increased. However, they still form a comparatively small part of the total population; they probably do not number much over 20,000,000.

THERE ARE HEATHENS, MOHAMMEDANS, CHRISTIANS, JEWS AND HINDUS

About one-half of the inhabitants of Africa are heathens and worship native gods. The Mohammedans are also very numerous, particularly in North Africa and in the Sudan. They greatly outnumber the Christians, who form only about a tenth of the population. Most of Africa's Jews are settled in the northwestern coastal regions. There are numbers of Hindus in some of the British colonies in the continent.

Christianity is the religion of the great majority of people of European stock who have settled in Africa. It also prevails in Ethiopia, in Madagascar and among the Egyptian Copts. The Copts are descended from the Egyptian Christians who remained true to their faith when Egypt was overrun by the Saracens in the seventh century A.D. Missionaries have been active in spreading the doctrines of Christianity among the Negroes of the continent.

There are three independent nations in Africa—Egypt, Ethiopia and Liberia. Elsewhere, the flags of half a dozen countries of Europe have been raised. We shall tell you how this came about in another chapter (page 6803), which deals with the fascinating history of the African continent.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 561.

From an old print

This quaint drawing of an angel writing is from a ninth century manuscript of the Gospel of St. John, copied and illustrated by a monk.

THE GREATEST BOOK IN ENGLISH

THE HOLY BIBLE AND SOME OF ITS TRANSLATIONS

THE Bible is the most famous of the world's books. It forms the basis of the religious faith of Christians and Jews; Mohammedans accept many of its teachings. The poor and wretched of many lands have found consolation in its message; learned scholars have meditated over its deep lessons. It has inspired many of the world's literary, musical and artistic masterpieces. Its language is firmly rooted in the everyday speech of men the world over.

The Bible is not a book written by a single author. It is a collection of writings, composed by many different men over a period of hundreds of years. The very name Bible shows that this is so. This word comes from the Greek word *biblia,* which means books. When we read the Bible, then, we are reading a collection of books.

The Bible is divided into two parts—the Old Testament and the New Testament. The Old Testament deals with the history and the religious writings of the Jews, a people who believed in a single just and merciful God. Most of the Old Testament was written in the Semitic language that we call Hebrew. Certain parts, however, were written in Aramaic, which is another Semitic language, rather closely related to Hebrew.

The Old Testament represents only a part of a great body of religious writings—the part selected by wise men, from the fifth century to the second B.C., to be read publicly in the synagogues (places of worship) of the Jews. The books selected for this purpose numbered thirty-nine in all. These books were accepted as written under the inspiration of God.

The religious writings that were not included in the Old Testament were called apocryphal (that is, hidden; pronounced *a-pock'-rifal*). They probably received this name because they were hidden away and not permitted to appear in the libraries of the synagogues. Fourteen of the apocryphal books were put in a separate group at the end of the Old Testament by the early Christians. These Apocrypha, as they are called, are considered by Catholics to be divinely inspired, but they are not accepted by Protestants and Jews.

In the New Testament, we have the story of the life and teachings of Jesus Christ as well as the acts and epistles (letters) of the followers of Christ known as the Apostles, and works by other followers. Originally, the Apostles proclaimed the teachings of Jesus by word of mouth. Later, these were set down in writing; so were various accounts of the life of Jesus as well as the activities and teachings of His Apostles. These writings were in the Greek language.

As time went on, works of this sort multiplied. Some of them were written by men who had known the Master; others, by men who had not known Him and who, in some

cases, did not understand His teachings. At last, the Fathers of the Church realized that it was necessary to choose carefully from among all these writings. In the fourth century A.D., it was decided to accept only twenty-seven books, out of well over a hundred, as divinely inspired.

Comparatively few people can read the Bible in the original Hebrew or Aramaic or Greek. Fortunately, it has been translated into more than 1,000 languages and dialects, so that all the peoples of the earth may read it and profit by it.

The first translation of the Old Testament into Greek was the Septuagint (from the Latin word *septuaginta,* meaning seventy). It is said that this translation was written in the third century B.C. by seventy learned Jews of Alexandria, Egypt, at the bidding of Ptolemy II, the Egyptian king. The Greek Orthodox Church still uses the Septuagint text in its services.

THE VULGATE—GREAT LATIN TRANSLATION, MADE BY THE SCHOLAR-MONK, ST. JEROME

The greatest of the Latin translations of the Bible was called in Latin the *editio vulgata* or common edition; it came to be known as the Vulgate. This translation was mainly the work of the learned monk St. Jerome, who wrote in the fourth century A.D. It has been revised many times. The Vulgate is the official Bible of the Roman Catholic Church.

The first complete English translation of the Bible was the work of a group of scholars directed by John Wyclif, a fourteenth century religious reformer (see the Index). An unfinished translation was made in the early part of the sixteenth century by William Tyndale, another reformer, who was burned to death as a heretic. In 1535, a complete translation was made by Miles Coverdale, who based his work partly on Tyndale's translation.

HOW THE KING JAMES VERSION CAME TO BE MADE

In the seventeenth century, the English king, James I, who was a Protestant, set a number of scholars to work on a new translation, which was completed in 1611. This King James Version or Authorized Version, as it was called, became the official Bible of the Church of England. This was, perhaps, the most famous translation ever made into the English language. Its beautiful simplicity and its vigor have made it a model for many great authors.

At about the same time as the Authorized Version, there appeared the Douai Version, which was first prepared by Catholic refugees from England at the University of Douai, in France. Most of the work on the New Testament was done at Reims. The Douai and Reims translation was scholarly but did not have the graceful style of the King James version. In the eighteenth century the Douai-Reims version was revised by Richard Challoner, and that is the version most used by English-speaking Catholics.

In 1941 a revision of the Reims-Challoner version of the New Testament was presented to Catholics; it was made by a group of professors of Sacred Scripture who used the Latin Vulgate and the original Greek writings as well as Bishop Challoner's work. This new version uses many modern words (girl, instead of damsel; brothers, instead of brethren, for example).

There have been numerous other English translations of the Bible. These have aimed to correct certain inaccuracies in the Authorized Version and also to make use of newly discovered manuscripts. The most famous modern translation is the Revised Version, published in 1885 by a committee of English scholars, working together with an American committee. This version is more accurate than the Authorized Version, but it lacks the grandeur of the latter.

THE BIBLE IS A BOOK OF HISTORY, PHILOSOPHY AND POETRY

Why is the Bible so popular? It is not only because so many people accept it as a holy work, inspired by God. It is also because all men can find endless profit and entertainment in its pages.

The Bible gives a fascinating account of the doings and customs of the Jews and other peoples of ancient times. It contains powerful sermons and great allegories. There are fables and parables, in which a delightful story serves to point out a lesson. There are books in which the deepest problems of human life are discussed.

The Bible is also a great work of literature. Its narrative style is simple, natural and dramatic. Who can ever forget its absorbing stories—about Noah's ark, Joseph and his brethren, Ruth, Jonah and the whale, the Crucifixion? Then, too, the Bible contains some of the most beautiful poetry ever written. There are wonderful nature poems, stirring war songs and beautiful love songs. There are magnificent hymns of thanksgiving, sorrow and faith.

THE NEXT STORY OF LITERATURE IS ON PAGE 720.

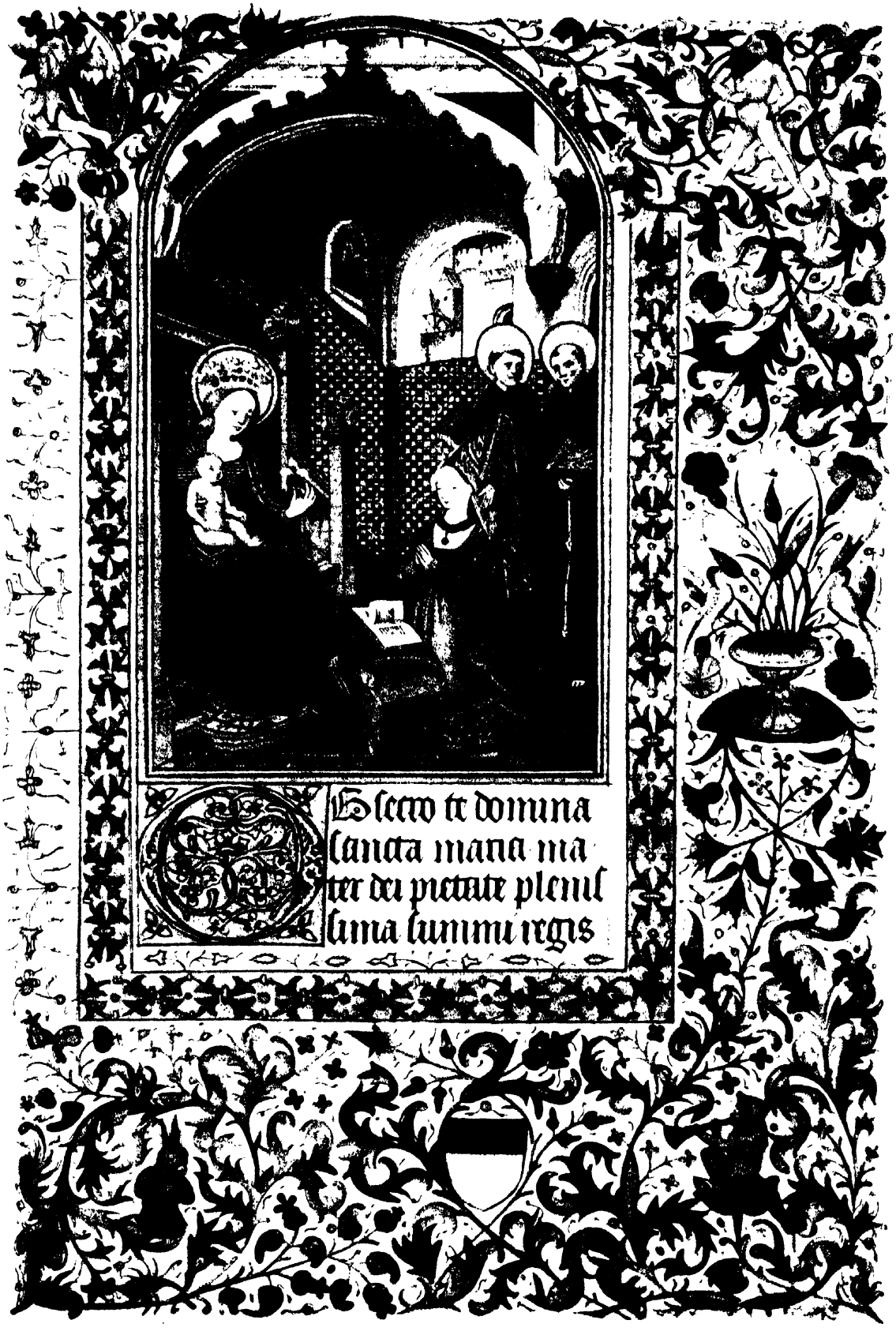
THE LOVELY BOOKS OF LONG AGO

The glorious books the old monks designed and copied by hand in the days before printing make us feel how poor our books are now. Here we give a few pages from old books that have come down to us through time, and are still to be seen in the British Museum.

A GLORIOUS PAGE FROM A BOOK MADE BY A MONK ABOUT 600 YEARS AGO

A RIDER ON A WHITE HORSE GOES FORTH CONQUERING AND TO CONQUER

FROM A BOOK MADE BY THREE ENGLISH ARTISTS 600 YEARS AGO



A page from a holy book belonging to a lady of the House of Saluces, in France, in the middle of the fifteenth century.

These pictures are from Bibles illustrated by English artists between the years 1250 and 1400.

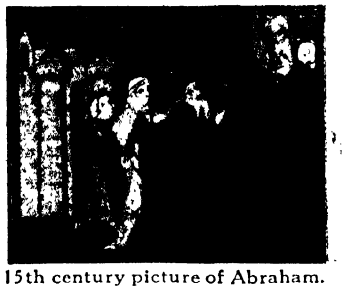
From a book 600 years old.

From a book made about the year 1300.

Six centuries old.

From a Book of Psalms made 600 years ago for an abbey of nuns.

From a Book of Psalms of about the year 1270.



15th century picture of Abraham.

Initials from an English-made Bible 650 years ago.

FAIRY SONGS AND FANTASY

Illustrated by Marie Lawson

Fairy Songs from Midsummer Night's Dream

By WILLIAM SHAKESPEARE (1564-1616)

I

OVER hill, over dale,
Through bush, through brier,
Over park, over pale,
Through flood, through fire.
I do wander everywhere,
Swifter than the moone's sphere;
And I serve the fairy queen,
To dew her orbs upon the green:
The cowslips tall her pensioners be;
In their gold coats spots you see;
Those be rubies, fairy favors,
In those freckles live their savors:
I must go seek some dew-drops here,
And hang a pearl in every cowslip's ear.

II

You spotted snakes with double tongue
Thorny hedgehogs, be not seen;
Newts and blind-worms, do no wrong;
Come not near our fairy queen.

Philomel, with melody,
Sing in our sweet lullaby;
Lulla, lulla, lullaby; lulla, lulla, lullaby!
Never harm,
Nor spell nor charm,
Come our lovely lady nigh;
So, good night, with lullaby.

Weaving spiders, come not here;
Hence, you long-legged spinners,
hence
Beetles black, approach not near;
Worm nor snail, do no offense.

Philomel, with melody,
Sing in our sweet lullaby;
Lulla, lulla, lullaby; lulla, lulla, lullaby!
Never harm
Nor spell nor charm,
Come our lovely lady nigh;
So, good-night, with lullaby.

III

We fairies, that do run
By the triple Hecate's team,
From the presence of the sun,
Following darkness like a dream,
Now are frolic: not a mouse
Shall disturb this hallow'd house:
Through the house give glimmering light,
By the dead and drowsy fire:
Every elf and fairy sprite
Hop as light as bird from brier;
And this ditty, after me,
Sing, and dance it trippingly.
First, rehearse your song by rote,
To each word a warbling note:
Hand in hand, with fairy grace,
Will we sing, and bless this place.

The Lepracaun; or, Fairy Shoemaker

By WILLIAM ALLINGHAM (1824-1889)

LITTLE Cowboy, what have you heard,
Up on the lonely rath's green mound?
Only the plaintive yellow bird
Sighing in sultry fields around,
Chary, chary, chary, chee-ee!—
Only the grasshopper and the bee?—
"Tip tap, rip-rap,
Tick-tack-too!
Scarlet leather, sewn together,
This will make a shoe.
Left, right, pull it tight;
Summer days are warm;
Underground in winter,
Laughing at the storm!"
Lay your ear close to the hill.
Do you not catch the tiny clamor,
Busy click of an elfin hammer,
Voice of the Lepracaun singing shrill
As he merrily plies his trade?
He's a span
And a quarter in height.
Get him in sight, hold him tight,
And you're a made
Man!

You watch your cattle the summer day,
Sup on potatoes, sleep in the hay;
How would you like to roll in your
carriage,
Look for a duchess's daughter in
marriage?
Seize the Shoemaker—then you may!
"Big boots a-hunting,
Sandals in the hall,
White for a wedding-feast,
Pink for a ball.
This way, that way,
So we make a shoe;

Getting rich every stitch,
Tick-tack-too!"
Nine-and-ninety treasure-crocks
This keen miser-fairy hath,
Hid in mountains, woods, and rocks,
Ruin and round-tow'r, cave and rath,
And where the cormorants build;
From times of old
Guarded by him;
Each of them filled
Full to the brim
With gold!

I caught him at work one day, myself,
In the castle-ditch, where foxglove
grows,—
A wrinkled, wizened, and bearded Elf,
Spectacles stuck on his pointed nose,
Silver buckles to his hose,
Leather apron—shoe in his lap—
"Rip-rap, tip-tap,
Tick-a-tack-too!
(A grasshopper on my cap!
Away the moth flew!)
Buskins for a fairy prince,
Brogues for his son,—
Pay me well, pay me well,
When the job is done!"
The rogue was mine, beyond a doubt.
I stared at him; he stared at me;
"Servant, Sir!" "Humph!" says he,
And pulled a snuff-box out.
He took a long pinch, looked better
pleased,
The queer little Lepracaun;
Offered the box with a whimsical grace,—
Pouf! he flung the dust in my face,
And, while I sneezed,
Was gone!

Thomas The Rimer

Thomas of Ercildoune lived in Scotland in the thirteenth century. He was a poet and a wise man, and many legends grew up about him. This ancient ballad tells how the Fairy Queen took him to Elfland, where he stayed for seven years.

TRUE Thomas lay on Huntlie bank;
A ferlie he spied wi' his e'e;
And there he saw a lady bright,
Come riding down by the Eildon Tree.

Her skirt was o' the grass-green silk,
Her mantle o' the velvet fine;
At ilka tett o' her horse's mane
Hung fifty silver bells and nine.

True Thomas he pu'd off his cap,
And louted low down on his knee:
"Hail to thee, Mary, Queen of Heaven!
For thy peer on earth could never be."

"O no, O no, Thomas!" she said,
"That name does not belong to me,
I'm but the Queen o' fair Elfland,
That am hither come to visit thee.

"Harp and carp, Thomas!" she said,
"Harp and carp along wi' me;
And if ye dare to kiss my lips,
Sure of your body I will be."

"Betide me weal, betide me woe,
That weird shall never daunten me."
Syne he has kissed her rosy lips,
All underneath the Eildon Tree.

"Now, ye maun go wi' me," she said;
"True Thomas, ye maun go wi' me;
And ye maun serve me seven years,
Through weal or woe as may chance be."

She's mounted on her milk-white steed;
She's ta'en true Thomas up behind;
And aye, whene'er her bridle rang,
The steed gaed swifter than the wind.

O they rade on, and farther on,
The steed gaed swifter than the wind;
Until they reached a desert wide,
And living land was left behind.

"Light down, light down now, true Thomas,
And lean your head upon my knee;
Abide ye there a little space,
And I will show you ferlies three.

"O see ye not yon narrow road,
So thick beset wi' thorns and briers?
That is the Path of Righteousness,
Though after it but few inquires.

"And see ye not yon braid, braid road,
That lies across the lily leven?
That is the Path of Wickedness,
Though some call it the Road to Heaven.

"And see ye not yon bonny road,
That winds about the fernie brae?
That is the Road to fair Elfland,
Where thou and I this night maun gae.

"But, Thomas, ye sall haud your tongue,
Whatever ye may hear or see;
For speak ye word in Elfyn-land,
Ye'll ne'er win back to your ain countrie."

O they rade on, and farther on,
And they waded rivers abune the knee;
And they saw neither sun nor moon,
But they heard the roaring of the sea.

It was mirk, mirk night, there was nae starlight,
They waded through red bluid to the knee;
For a' the bluid that's shed on earth
Rins through the springs o' that countrie.

Syne they came to a garden green,
And she pu'd an apple frae a tree:
"Take this for thy wages, true Thomas;
It will give thee tongue that can never lee."

"My tongue is mine ain," true Thomas he said;
"A gudely gift ye wad gie to me!
I neither dought to buy or sell,
At fair or tryst where I might be.

"I dought neither speak to prince or peer,
Nor ask of grace from fair lady!"
"Now haud thy peace!" the lady said,
"For as I say, so must it be."

He has gotten a coat of the even cloth,
And a pair o' shoon of the velvet green;
And till seven years were gane and past,
True Thomas on earth was never seen.

The Forsaken Merman

By MATTHEW ARNOLD (1822-1888)

COME, dear children, let us away;
Down and away below!
Now my brothers call from the bay,
Now the great winds shoreward blow,
Now the salt tides seaward flow;
Now the wild white horses play,
Champ and chafe and toss in the spray.
Children dear, let us away!
This way, this way!

Call her once before you go.—
Call once yet!
In a voice that she will know:
"Margaret! Margaret!"
Children's voices should be dear
(Call once more) to a mother's ear;
Children's voices, wild with pain,—
Surely she will come again!
Call her once and come away;
This way, this way!
"Mother dear, we cannot stay!
The wild white horses foam and fret."
Margaret! Margaret!

Come, dear children, come away down;
Call no more!
One last look at the white-walled town,
And the little gray church on the windy shore;
Then come down!
She will not come, though you call all day;
Come away, come away!

Children dear, was it yesterday
We heard the sweet bells over the bay?
In the caverns where we lay,
Through the surf and through the swell,
The far-off sound of a silver bell?
Sand-strewn caverns, cool and deep,
Where the winds are all asleep;
Where the spent lights quiver and gleam,
Where the salt weed sways in the stream,
Where the sea-beasts, ranged all round,
Feed in the ooze of their pasture-ground;
Where the sea-snakes coil and twine,
Dry their mail and bask in the brine;
Where great whales come sailing by,
Sail and sail, with unshut eye,
Round the world for ever and aye?
When did music come this way?
Children dear, was it yesterday?

Children dear, was it yesterday
(Call yet once) that she went away?
Once she sate with you and me,
On a red gold throne in the heart of the sea,
And the youngest sate on her knee.
She combed its bright hair, and she tended it well,
When down swung the sound of the far-off bell.
She sighed, she looked through the clear green sea;
She said: "I must go, for my kinsfolk pray
In the little gray church on the shore today.
'Twill be Easter-time in the world,—ah me!
And I lose my poor soul, Merman, here with thee."
I said: "Go up, dear heart, through the waves:
Say thy prayer, and come back to the kind sea-caves!"
She smiled, she went up through the surf in the bay.
Children dear, was it yesterday?

Children dear, were we long alone?
"The sea grows stormy, the little ones moan;
Long prayers," I said, "In the world they say;
Come!" I said, and we rose through the surf in the bay.
We went up the beach, by the sandy down

Where the sea-stocks bloom, to the white-walled town,
Through the narrow paved streets, where all was still,
To the little gray church on the windy hill.
From the church came a murmur of folk at their prayers,
But we stood without in the cold blowing airs.
We climbed on the graves, on the stones worn with rains,
And we gazed up the aisle through the small leaded panes.
She sate by the pillar; we saw her clear:
"Margaret, hist! come quick, we are here!
Dear heart," I said, "We are long alone;
The sea grows stormy, the little ones moan."
But, ah, she gave me never a look,
For her eyes were sealed to the holy book!
Loud prays the priest; shut stands the door.
Come away, children, call no more!
Come away, come down, call no more!

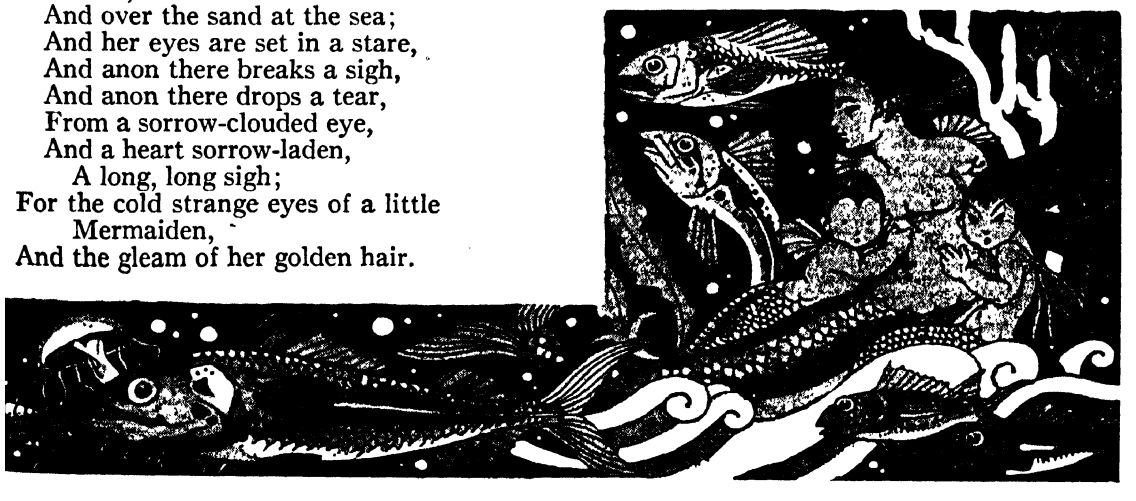
Down, down, down!
Down to the depths of the sea!
She sits at her wheel in the humming town,
Singing most joyfully.
Hark what she sings: "O joy, O joy,
From the humming street, and the child with its toy!
From the priest, and the bell, and the holy well;
From the wheel where I spun,
And the blessed light of the sun!"
And so she sings her fill,
Singing most joyfully,
Till the spindle drops from her hand,
And the whizzing wheel stands still.

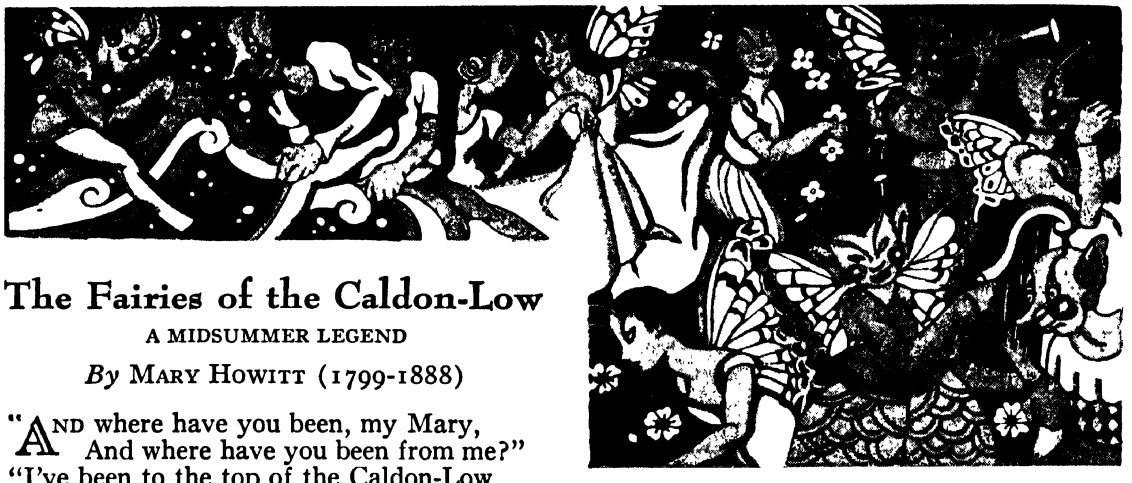
She steals to the window, and looks at the sand,
And over the sand at the sea;
And her eyes are set in a stare,
And anon there breaks a sigh,
And anon there drops a tear,
From a sorrow-clouded eye,
And a heart sorrow-laden,
A long, long sigh;
For the cold strange eyes of a little Mermaiden,
And the gleam of her golden hair.

Come away, away, children;
Come, children, come down!
The hoarse wind blows colder;
Lights shine in the town.
She will start from her slumber
When gusts shake the door;
She will hear the winds howling,
Will hear the waves roar.
We shall see, while above us
The waves roar and whirl,
A ceiling of amber,
A pavement of pearl.
Singing: "Here came a mortal,
But faithless was she!
And alone dwell for ever
The kings of the sea."

But, children, at midnight,
When soft the winds blow,
When clear falls the moonlight,
When spring-tides are low;
When sweet airs come seaward
From heaths starred with broom,
And high rocks throw mildly
On the blanched sands a gloom;
Up the still, glistening beaches,
Up the creeks we will hie;
Over banks of bright seaweed
The ebb-tide leaves dry.

We will gaze, from the sand-hills,
At the white, sleeping town;
At the church on the hillside—
And then come back down.
Singing: "There dwells a loved one,
But cruel is she!
She left lonely for ever
The kings of the sea."





The Fairies of the Caldon-Low

A MIDSUMMER LEGEND

By MARY HOWITT (1799-1888)

"AND where have you been, my Mary,
And where have you been from me?"
"I've been to the top of the Caldon-Low,
The midsummer night to see!"

"And what did you see, my Mary,
All up on the Caldon-Low?"
"I saw the glad sunshine come down,
And I saw the merry winds blow."

"And what did you hear, my Mary,
All up on the Caldon-Hill?"
"I heard the drops of the water made,
And the ears of the green corn fill."

"Oh, tell me all, my Mary—
All—all that ever you know;
For you must have seen the fairies
Last night on the Caldon-Low!"

"Then take me on your knee, mother,
And listen, mother of mine:
A hundred fairies danced last night,
And the harpers they were nine.

"And their harp-strings rang so merrily
To their dancing feet so small;
But, oh! the words of their talking
Were merrier far than all!"

"And what were the words, my Mary,
That you did hear them say?"
"I'll tell you all, my mother,
But let me have my way.

"Some of them played with the water,
And rolled it down the hill;
'And this,' they said, 'shall speedily turn
The poor old miller's mill.

" 'For there has been no water
Ever since the first of May;
And a busy man will the miller be
At the dawning of the day!

" 'Oh! the miller, how he will laugh,
When he sees the mill-dam rise!
The jolly old miller, how he will laugh,
Till the tears fill both his eyes!'

"And some they seized the little winds,
That sounded over the hill,
And each put a horn into his mouth,
And blew both loud and shrill:

" 'And there,' said they, 'the merry winds go
Away from every horn;
And they shall clear the mildew dank
From the blind old widow's corn:

" 'Oh, the poor blind widow—
Though she has been blind so long,
She'll be merry enough when the mildew's gone,
And the corn stands tall and strong!'

"And some they brought the brown linseed
And flung it down the Low:
'And this,' said they, 'by the sunrise
In the weaver's croft shall grow!

" 'Oh, the poor lame weaver!
How will he laugh outright
When he sees his dwindling flax-field
All full of flowers by night!'

"And then outspoke a brownie,
With a long beard on his chin:
'I have spun up all the tow,' said he,
'And I want some more to spin.

" 'I've spun a piece of hempen cloth
And I want to spin another—
A little sheet for Mary's bed,
And an apron for her mother!'

"With that I could not help but laugh,
And I laughed out loud and free;
And then on the top of the Caldon-Low
There was no one left but me.

"And all on the top of the Caldon-Low
The mists were cold and gray,
And nothing I saw but the mossy stones
That round about me lay.

"But, coming down from the hill-top,
I heard, afar below,
How busy the jolly miller was,
And how merry the wheel did go!

"And I peeped into the widow's field,
And, sure enough, was seen
The yellow ears of the mildewed corn
All standing stout and green.

"And down the weaver's croft I stole,
To see if the flax were sprung;
And I met the weaver at his gate
With the good news on his tongue!

"Now, this is all I heard, mother,
And all that I did see;
So, prithee, make my bed, mother,
For I'm tired as I can be!"

La Belle Dame sans Merci

By JOHN KEATS (1795-1821)

This perfect fairy ballad shows how truly Keats could enter into the spirit of an age long past. It tells much the same story as the medieval Thomas the Rimer.

O, WHAT can ail thee, knight at arms,
Alone and palely loitering;
The sedge has withered from the lake,
And no birds sing.

O, what can ail thee, knight at arms,
So haggard and so woe-begone?
The squirrel's granary is full,
And the harvest's done.

I see a lilly on thy brow
With anguish moist and fever-dew,
And on thy cheeks a fading rose
Fast withereth too.

I met a lady in the meads,
Full beautiful—a faery's child,
Her hair was long, her foot was light,
And her eyes were wild.

I made a garland for her head,
And bracelets too, and fragrant zone,
She looked at me as she did love,
And made sweet moan.

I set her on my pacing steed
And nothing else saw all day long;
For sideways would she lean, and sing
A faery's song.

She found me roots of relish sweet,
And honey wild and manna dew;
And sure in language strange she said—
I love thee true.

She took me to her elfin grot,
And there she gazed and sighed full sore:
And there I shut her wild wild eyes
With kisses four.

And there she lullèd me asleep,
And there I dreamed, ah woe betide,
The latest dream I ever dreamed
On the cold hill side.

I saw pale kings and princes too,
Pale warriors, death-pale were they all:
They cry'd—"La Belle Dame sans Merci
Hath thee in thrall!"

I saw their starved lips in the gloam
With horrid warning gapèd wide,
And I awoke, and found me here
On the cold hill side.

And this is why I sojourn here
Alone and palely loitering,
Though the sedge is withered from the lake,
And no birds sing.

Little Orphant Annie*

By JAMES WHITCOMB RILEY (1849-1916)

LITTLE Orphant Annie's come to our house to stay,
An' wash the cups an' saucers up, an' brush the crumbs away,
An' shoo the chickens off the porch, an' dust the hearth an' sweep,
An' make the fire, an' bake the bread, an' earn her board-an'-keep;
An' all us other children, when the supper things is done,
We set around the kitchen fire an' has the mostest fun
A-listenin' to the witch-tales 'at Annie tells about,
An' the Gobble-uns 'at gits you
Ef you
Don't
Watch
Out!

Onc't they was a little boy wouldn't say his prayers—
An' when he went to bed at night, away up stairs,
His Mammy heered him holler, an' his Daddy heered him bawl,
An' when they turn't the kivvers down, he wasn't there at all!
An' they seeked him in the rafter-room, an' cubby-hole, an' press,
An' seeked him up the chimbly-flue, an' ever'wheres, I guess;
But all they ever found was thist his pants an' roundabout:
An' the Gobble-uns 'll git you
Ef you
Don't
Watch
Out!

An' one time a little girl 'ud allus laugh an' grin,
An' make fun of ever' one, an' all her blood-an'-kin;
An' onc't when they was "company," an' ole folks was there,
She mocked 'em an' shocked 'em, an' said she didn't care!
An' thist as she kicked her heels, an' turn't to run an' hide,
They was two great big Black Things a-standin' by her side,
An' they snatched her through the ceilin' 'fore she knowed what she's about!
An' the Gobble-uns 'll git you
Ef you
Don't
Watch
Out!

An' little Orphant Annie says, when the blaze is blue,
An' the lamp-wick sputters, an' the wind goes *woo-oo!*
An' you hear the crickets quit, an' the moon is gray,
An' the lightnin'-bugs in dew is all squenched away,—
You better mind yer parents, an' yer teachers fond and dear,
An' churish them 'at loves you, an' dry the orphant's tear,
An' he'p the pore an' needy ones 'at clusters all about,
Er the Gobble-uns 'll git you
Ef you
Don't
Watch
Out!

*From Rhymes of Childhood, copyright 1890. Used by special permission of the publishers, The Bobbs-Merrill Company.

The Fairies

By WILLIAM ALLINGHAM
(1824-1889)

This poem is about Irish fairies. No other modern country has such vivid and varied fairy lore as Ireland.

Up the airy mountain,
Down the rushy glen,
We daren't go a-hunting
For fear of little men;
Wee folk, good folk,
Trooping all together;
Green jacket, red cap,
And white owl's feather!

Down along the rocky shore
Some make their home,
They live on crispy pancakes
Of yellow tide-foam;
Some in the reeds
Of the black mountain lake,
With frogs for their watch-dogs,
All night awake.

High on the hill-top
The old King sits;
He is now so old and gray
He's nigh lost his wits.
With a bridge of white mist
Columbkill he crosses,
On his stately journeys
From Slieveleague to Rosses;
Or going up with music
On cold starry nights
To sup with the Queen
Of the gay Northern Lights.

They stole little Bridget
For seven years long;
When she came down again
Her friends were all gone.
They took her lightly back,
Between the night and morrow,
They thought that she was fast asleep,
But she was dead with sorrow.
They have kept her ever since
Deep within the lake,
On a bed of flag-leaves,
Watching till she wake.

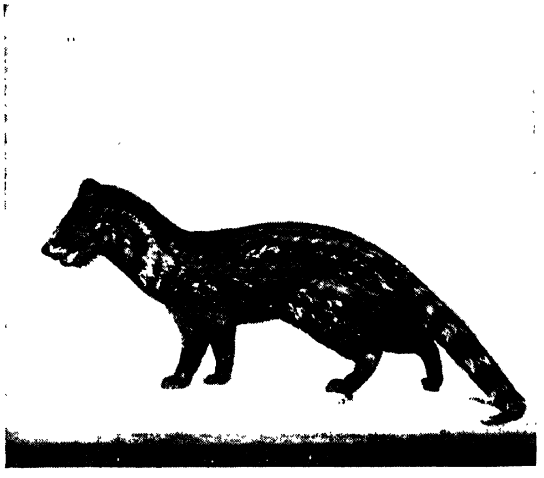
By the craggy hill-side,
Through the mosses bare,
They have planted thorn-trees
For pleasure here and there.
If any man so daring
As dig them up in spite,
He shall find their sharpest thorns
In his bed at night.

Up the airy mountain,
Down the rushy glen,
We daren't go a-hunting
For fear of little men;
Wee folk, good folk,
Trooping all together;
Green jacket, red cap,
And white owl's feather!

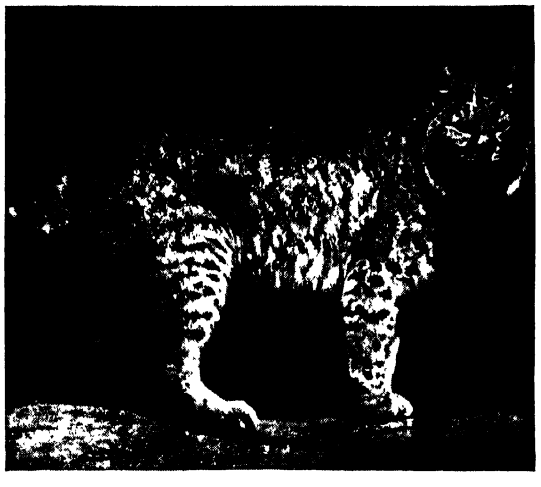
THE NEXT POEMS ARE ON PAGE 605.

SOME WILD MEMBERS OF THE CAT FAMILY

The fishing cat.

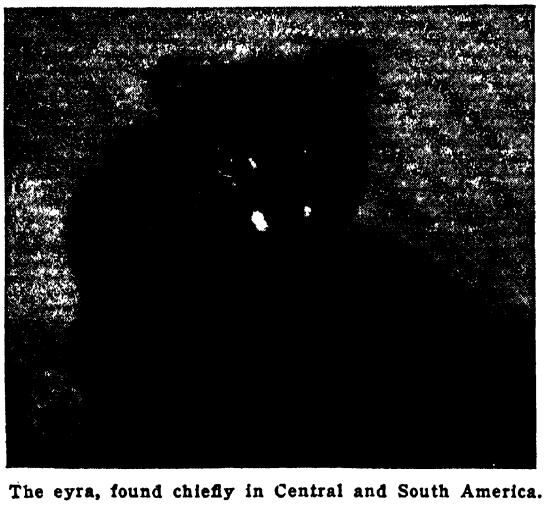


Large spotted genet.

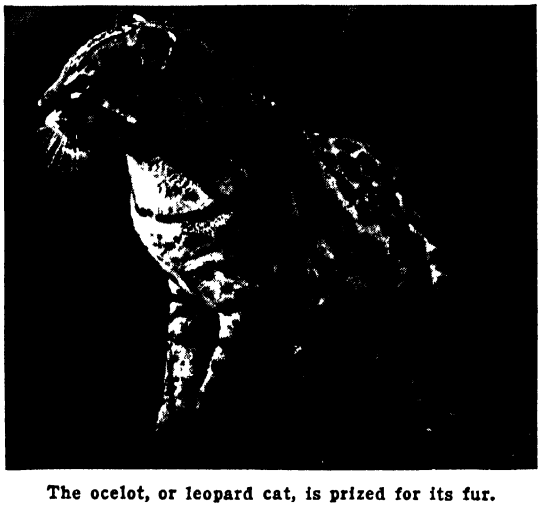


Wild cat, bob cat, or common lynx.

The handsome Siberian lynx, with long pointed ears.

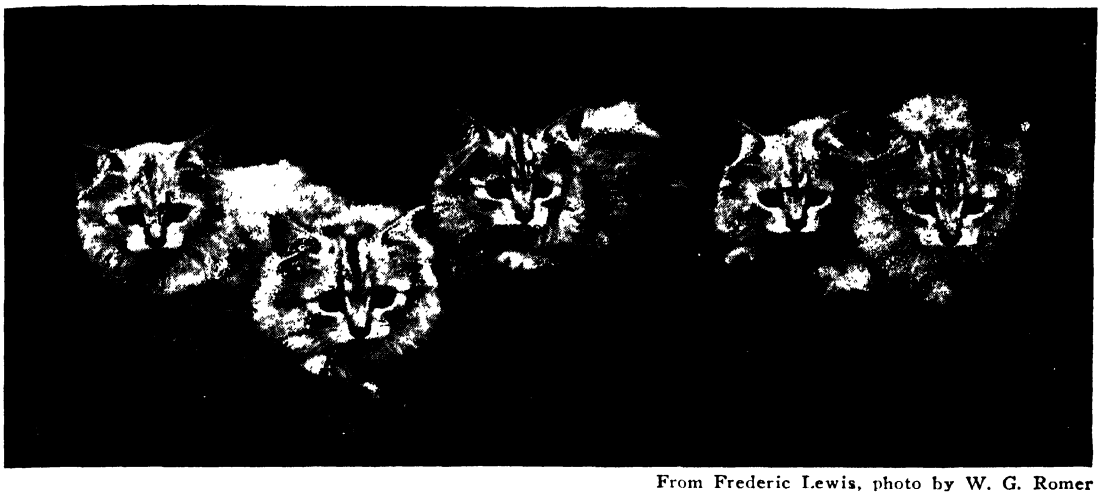


The eyra, found chiefly in Central and South America.



The ocelot, or leopard cat, is prized for its fur.

Pictures, N.Y. Zoological Society



From Frederic Lewis, photo by W. G. Romer

BIG CATS AND LITTLE CATS CIVETS AND HYENAS

THE cat family belongs to the order of animals called Carnivora. That word means flesh-eaters. This is one of the most magnificent orders in the scale of nature. For fierce and insolent beauty, for grace, strength, speed and audacity, there is no living thing to excel the animals that feed on flesh.

A long process in the refining of wits, of the sharpening of natural weapons, has brought these carnivores—so they are called —to the highest pitch of efficiency in the capture and killing of other animals. But we must remember that they kill only for food. Some of the carnivores also eat plant life.

There are two main divisions of Carnivora: those living in the water (including seals and walruses), and those living on land (including cats, dogs, bears and others). It is the large and important family of cats that we shall tell about in the following pages. The cat family has many members. They are at home on every continent except Australia; and though they differ widely, all have certain characteristics that mark them as cats. Like other Carnivora, they have hooked claws, not nails, and teeth which tear and chop or shear like scissors, but do not masticate (chew). The claws of most cats can be retracted, or drawn back, at the will of the animal. You have, perhaps, seen your house cat retract its sharp claws, and you have seen the claws suddenly dart forward from their furry sheaths. The cats choose to hunt their prey by night and the eyes of the animals are specially adapted to this habit. Their tongues have a special interest, for they are covered with small curved prickles which help to clean the flesh of their animal-food from the bones. Most of the cats climb with grace and strength. The lion, the tiger and the cheetah can not climb, nor can the serval, and perhaps some other cats. Most have tails which serve as a balance when the animal makes a sudden spring. Their bodies are flexible, with powerful muscles, especially the muscles of the jaws and limbs.

At the head of the family of cats is the lion, king of beasts. It is at home in Africa and in some parts of Asia. The majestic appearance of the male lion is crowned by a great mane, sometimes black, but always darker than the tawny skin. Not all male lions have manes, however. Added to that it has the most stupendous voice in nature; its ground-shaking roars unnerve animals so that they are often incapable of fleeing.

This is the lion's armament: teeth which can crush at one bite the bones of a small buffalo's, an eland's or a zebra's neck; claws like grapnels of yellow horn, which can hold a horse from its gallop and strip the flesh from its flanks; a gape which admits a man's

head into its mouth; strength which enables it to leap a fence when hauling a dead goat in its mouth; speed which makes it, for a short distance, a kind of flesh-and-bone thunderbolt.

The horny prickles on the lion's tongue are strong, and there is often a horny spine at the tip of the tail which is concealed by a tuft of hair. The male lion usually measures from nine to ten feet from nose to end of tail. The lioness is generally about nine feet long.

Two to four young (cubs) at a birth are the rule. The babies are tenderly cared for by the mother, though she may leave them in a hidden place to go hunting for food. She has the entire care of the cubs, and, in fact, would fiercely resist if the father tried to go near them. The young have brown bands or other markings, but these usually disappear before the animal is fully grown. The mane of the male does not attain its glory until the animal is five to seven years old.

As a rule, the lion does not attack man; now and then there is a lion that eats only human flesh; sometimes it takes man or beast by turns. In general the lion gains its food by its stealth and power rather than by its agility. This huge cat sometimes goes abroad by day but it is chiefly active at night. At that time it goes to some favorite lurking place near a spring or by the side of a river. Concealed among the brushwood, it lies in wait for the animals coming to drink. A single powerful leap generally lands it upon its prey, and the weight of the first blow crushes the animal's neck. The lion sinks its teeth into the neck of the prey at the same time pulling the head around with its strong paw. It may make a meal on the spot, or may drag the "catch" to some quiet place where it can feast in quiet peace. Lions may hunt singly, in pairs or in parties.

The two most notorious lions in all African history began their public career by raiding the sheep and goats collected for the workers who were building the Uganda Railway. Then they invaded the camp of men at Tsavo, and for nine months caused a reign of terror there. Night after night they crept from the jungle into the little city of tents; night after night each carried off a man. As darkness fell the beasts would be heard roaring in the forest. Silence would follow, then a cry of anguish would ring out, "Beware, brothers; Satan is here," and all knew that another poor native had gone to make a ravening lion's supper, prey of a dread beast.

The resources of the British Empire were behind the building of that railway, but the slaughter by these two lions became so terrible that at last panic paralyzed the undertaking, and all work ceased for about a month. Finally Colonel Patterson shot the two brutes, and the railway again marched forward.

Conditions such as these are often brought about by tigers in India, where one animal may kill over a hundred people in a year as the people go at night to draw water from a well. That tiger may in time be slain by the natives, but another creature of the same species sometimes appears in the old beat, and the remnants of a village's population, terrorized beyond endurance, flee at last.

Some giants of the tiger tribe live in Manchukuo, monsters, huge of bone and muscle, long of fur, at home in the snow and rigors of a bitter climate; but there have been specimens of the Indian tiger as large or larger. Probably the average Manchukuon tiger is, however, larger than the average Indian tiger which is about ten feet long and up to 550 pounds in weight. With its ability to live in swamps, in reeds, grasses, in caves or rocks, in old buildings and deserted cities, it has a wider range than the lion.

The tiger is a beautiful beast, bright tawny

THE CARNIVORA OR ANIMALS THAT LIVE ON FLESH

FISSIPEDIA—toe-footed

1. Felidæ—cat family
2. Viverridæ*—civets, ichneumons, and others
3. Hyenidæ—hyenas
4. Canidæ—dog family
5. Mustelidæ—martens, otters, weasels, skunks and others
6. Ursidæ*—the bear family

*Some of these eat plant life as well as flesh.

PINNIPEDIA—fin-footed. Seals, walruses and their relatives

yellow in color with dark stripes around the body. Chest and undersides verge toward white. All-white (albino) and all-black tigers are not unknown, but these are very rare.

The tiger is even more agile than the lion, and shows more cunning. It does not seek to terrify its prey by roaring, as the lion does, but stealthily prowls through underbrush, keeping well out of sight until the moment it is ready to spring. The striped coat blends with the background and helps to conceal the animal. Both lions and tigers thrive in captivity and many of those animals which we see in the zoos were born there.

A very rare and interesting animal is the tiglon, which is a cross between the tiger and the lion. The tiglon has the tawny color of the lion, but like the tiger it is striped, though the stripes are faint.

Next in our discussion come the leopards, the second animal scourge of India. Some 5,000 leopards are every year disposed of there, but the animals kill on an average 350 Indians in the same time. In a sense, leopards are more to be feared than lions and tigers, for, while these two can not climb trees, leopards climb superbly, either to catch a fugitive or to lurk in hiding ready to pounce down on one. In Africa the leopard is viewed with special abhorrence for this reason.

All these great cats are extremely difficult to kill, for they charge an enemy fiercely even when severely wounded. It seems as if they do not experience pain. The prey of cats, strangely, seem also not to feel fear or pain, as you may have observed for yourself if you have ever seen a house cat play with a mouse. The mouse seems to be in a sort of stupor, or state of dreaminess in which no sense of terror or pain is felt.

THE OUNCE, OR SNOW LEOPARD, THAT LIVES AT THE TOP OF THE WORLD

Lion, tiger, leopard we have named, but a special type of leopard must be added—the ounce, or snow-leopard, which haunts the towering Himalayas. In summer it ranges up to 18,000 feet. It is formidable at a height where a man is so exhausted that he thinks twice before undergoing the exertion of turning over in bed. There this great cat lives, never coming lower than 6,000 feet.

So far we have kept to the Old World, but now we must cross to the New, where we find no lions or tigers, but interesting parallels. The American jaguar is a big spotted cat with huge, powerful limbs. Its coat is decorated with rosettes, somewhat like the

N.Y. Zoological Society

The margay, or tiger cat, a South American wild cat.

leopard's coat; but you can easily tell them apart. In the centre of some of the jaguar's rosettes you will see a clearly marked spot, which the leopard does not have. The American jaguar is an accomplished swimmer and climber, a deadly foe to cattle and horses, and it is ready to kill an unarmed man if it is hungry.

America's lion is the puma, which, if men were not there to dispute its path to progress, might become plentiful, and for this reason, that the more varied an animal's diet the greater that animal's chance for survival. The puma eats anything, from a pig to a porcupine, from a horse to a snail, from a sheep to a bullock. It is a terrible scourge to ranches, and in olden days exterminated the half-wild horses which roamed free in Patagonia.

The one thing in its favor is that in no circumstances will it attack man unless it has to fight him to save its own life. It ranges from Canada to Patagonia, and bears different names, as cougar, panther and mountain lion, in different sections.

There are dozens of other cats. There is one beast, called the clouded leopard, which is as much a tree-dweller as a sloth. The lynx of both the Old and the New Worlds and the caracal are also cats. Then we launch into a world of lesser cats; the golden cat of the Indo-Malay area, which has a

Courtesy, Jayne Disbrow

Hajji Baba, a fine blue Persian pet.

gray Chinese cousin; the fishing-cat, which not only catches fish but small animals as well; the leopard cat, the serval, the tiger cat, the eyra, a weasel-like type; the Egyptian or Kaffir cat, from which our own puss is believed to descend; the various wild cats of America and the wild cat that is still found in northwestern Europe—all belong to the cat family. Each one is Destiny to some order of grass-feeders.

There are others, and we must note the cheetah, more cat than dog, yet not quite cat either, a leopard-like beast with claws resembling a dog's, and therefore not capable of freely working in and out of their sheaths. This animal is remarkable as the one which is caught young and trained to hunt like a dog, its quarry usually being the black buck of India. A cheetah runs down the fleetest of grass-feeders, and is regarded as the fastest of all runners for any distance up to about 400 yards. It is a fine sprinter but tires on long runs.

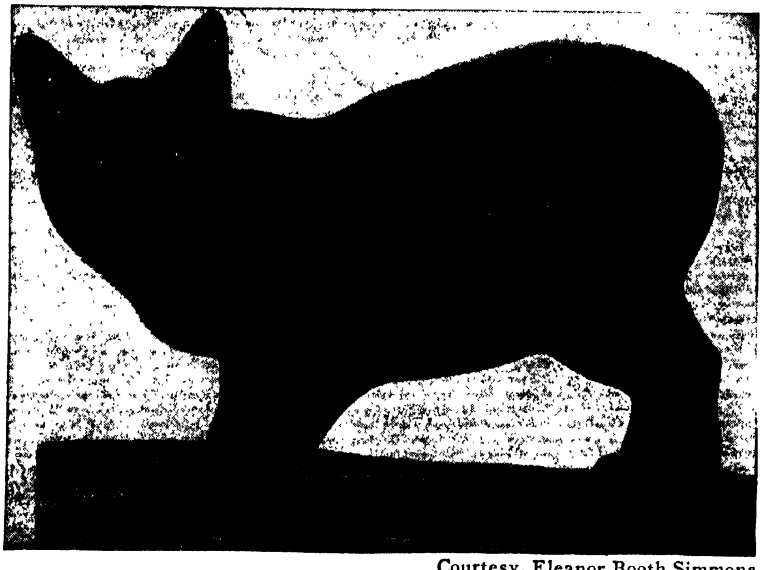
The cheetah and the domestic cat are the only animals from the feline group that we have brought home with us from the wilds, but our puss shows what man's selective care can do.

It is strange to think that the pet cat purring around your feet is a cousin of the lions and the tigers in the jungle, but so it is. Big cats and little cats, their kinship is shown by the lithe, agile bodies, the sharp teeth so well adapted to tearing meat, the sharp curved claws, and the muzzle framed in spreading whiskers, which are characteristic of carnivores or flesh-eating animals. But long association with human beings has modified our cats. They have learned to love us when we are good to them, and to eat many things besides meat.

Domestic cats are very numerous, and they are found everywhere that people are. They are the pets of great men and of little children. They patrol storehouses, shops, homes and public buildings, killing the mice and rats that would destroy our property. They give a touch of home to army camps; and though they hate water they are great seagoers; there is seldom a ship without its cat or cats.

Breeding pedigreed cats is quite a business, and fanciers have taken great pains to develop the fine points of the Persians or long-haired cats, the Manx or tailless cats, and the Siamese cats. As a matter of fact, however, the common short-haired cats that we call alley cats are as beautiful, in their way, as any breed. And they have a most distinguished ancestry. They are descended from the sacred cats of Egypt.

The first cats known in history were those the ancient Egyptians obtained by catching



Courtesy, Eleanor Booth Simmons

A Manx cat. This species has high hind quarters, and a very short tail, or none at all. Manx cats come from the Isle of Man, in the Irish Sea.

and taming Kaffir (or caffre) cats, small wild cats found in Africa and Asia. There is always something mysterious in cats, in their luminous eyes and aloof manner, and perhaps that is what led the Egyptians to worship them. Thousands of cat mummies in beautiful cases have been discovered in Egyptian grottos, attesting to the honor in which these people held cats. But perhaps these cats grew tired of being worshiped, for many of them made their way through Gibraltar into England and Scotland, where they mated with native wild cats and produced the breed of short-hairs now so common in Europe and America.

Persians, also called Angoras, originated in Turkey, and were first brought to America by sailors as presents for their sweethearts and wives. Maine coon cats are just Persians whose coats, in that cold climate, have grown exceptionally thick and coarse. Sailors, too, brought the first tailless cats from the Isle of Man. There are many legends to account for the tailless cat. One has it that warriors took the tails to adorn their helmets. Another says that cats loitered on their way into the Ark, and Noah, growing impatient, slammed the door on their tails. The truth probably is that these cats are "sports," animals or plants that by a quirk of nature have been given a different character from others

Courtesy, Eleanor Booth Simmons

A Siamese. These cats have blue eyes and pale fawn fur, dark brown face, ears, legs and tail.

Courtesy, George Clewell

A short-haired cat with beautiful "tiger" markings.

of the species, continued in the offspring.

The coloring of the cat's coat is one of its points of beauty. Siamese cats, which for a long time were the exclusive property of the kings and priests of that country, and only in recent years were brought to England and America, have their special colors, dark brown face, ears, legs and tail, on a pale fawn body, with deep blue eyes. There are also brown Siamese cats.

The Persians and the alley cats have many colors. There are white cats, black cats, yellow cats, maltese (blue or slate-colored) cats, and many others.

There are tortoise-shells, or three-colored cats, sometimes called calico cats. The pure tortoise-shell coat, marked with well defined patches of black, orange and cream, is a characteristic of the female; the male of this type is a red, or sandy, cat. Sir George Mivart, English authority on cats, records one instance of a male with the tortoise-shell coat, and others have been known, but they are extremely rare. Barnum, the circus man, offered to pay $1,000 for a tortoise-shell male cat but no one ever brought him one.

There are Tabby cats with curious intricate markings. The name "tabby" has nothing to do with the sex of a cat. Tabby comes from Atab, a street in old Bagdad, where moiré silk was made, what we sometimes call water silk. The silk was called *atabi* (or taffeti, later, taffeta), and the markings on these cats were said to resemble the *atabi* silk.

Cats have extraordinarily keen senses, which are of great service in saving them from danger. Their acute sense of smell warns them when an enemy is near, and often keeps them from eating doubtful food which a dog, more impulsive, would probably gobble up. As to hearing, experiments by the American Otological Society have proved that many cats hear more than twice as well as a normal human being, responding to sounds too faint for listening humans to catch.

HOW THE CAT'S WHISKERS HELP IT TO PROWL THROUGH THE DARK

It is the eyes of cats that are most wonderful. You have seen Puss dozing in the sunshine, the pupils of her eyes mere slits against the light. And you have seen the pupils dilate (open) at some sudden fright, or at the approach of darkness, until they covered almost the entire iris. It is this power of dilating the pupil that enables the cat to see farther in the dark than any other animal. A cat's whiskers, too, are of considerable help in a night prowl. The whiskers, technically termed *vibrissæ,* are equipped with special nerves, making them delicate organs of perception. The saying that a cat will not venture through a hole whose sides brush its whiskers is not without some truth.

The number of uses to which a cat puts its paws, besides walking on them and washing its face with them, is astonishing. They are better weapons in a fight than a dog's paws, for cats keep their claws from wear by retracting them when walking, while the dog's claws are blunted by their contact with the ground. Cats keep their claws effective by sharpening them on the trunk of a tree, or perhaps on your mother's favorite upholstered chair. In times of peace they conceal their claws and walk softly on the pads of their feet.

A CAT PERSPIRES THROUGH THE PADS OF THE FEET

Normal cats have five toes on each forefoot and four on each hindfoot, each with its pad, and a large pad in the centre of each foot. It is not uncommon, however, to see a cat with six toes on each forefoot. Cats, by the way, perspire through the pads of the feet, and not through the skin of the body as humans do.

Cats who are fond of cream have been known to leave their saucer of milk standing till the cream rose, then to skim the cream with a paw and lick it off the paw. A New York restaurant cat amuses guests by extracting malted milk tablets from their bottle and conveying them to his mouth with his paw. A more striking evidence of thought is the act of a cat who, liking to sit in the kitchen window and watch the birds outside, uses his paw to wipe a peep hole on the glass when the steam of the cooking mists it over.

THE CLEVER CAT THAT LEARNED TO TURN A KNOB AND OPEN THE DOOR

Instances of cats which open doors are many. When the door is the old-fashioned latched type it is not hard; the cat has simply to jump up or stand on his hindlegs, and press the latch down. But a cat in an Ohio town evolved a plan for opening a door that had a knob. He would hang by his forepaws, one placed on the knob and one curled around its stem, and work the knob back and forth till the latch loosened and the door swung open, and he rode triumphantly into the house.

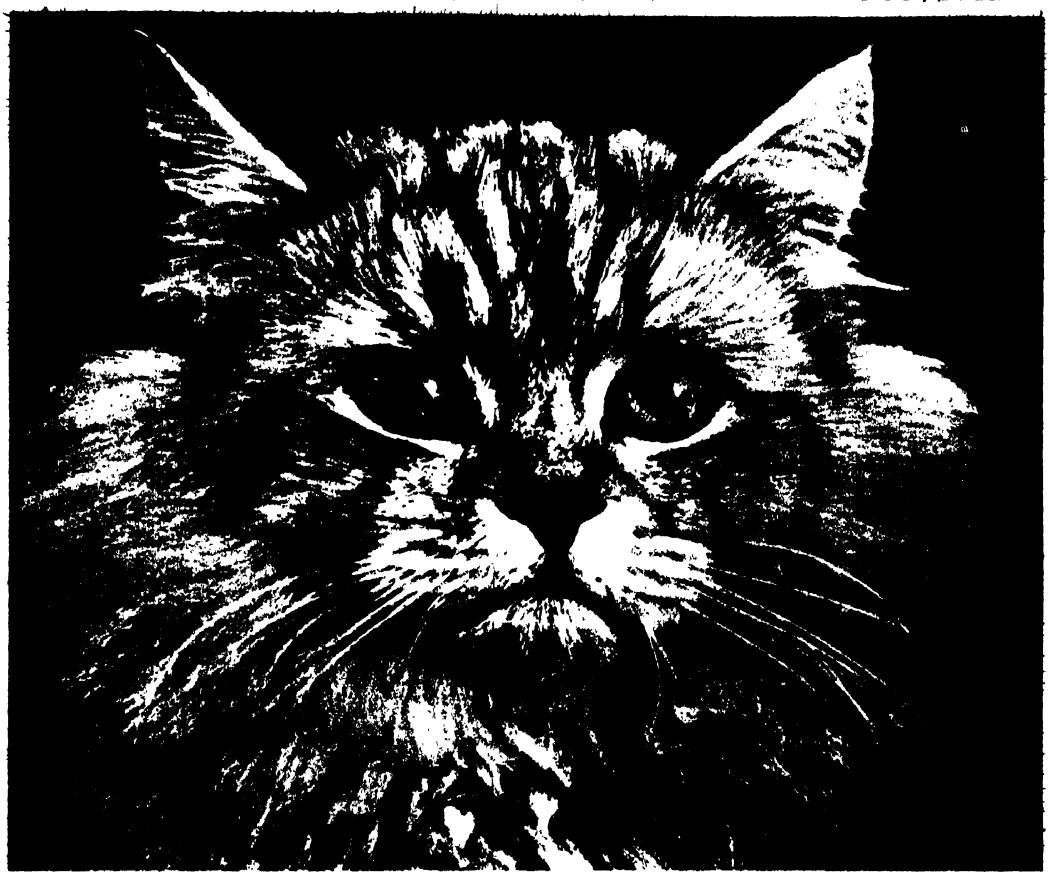
It is strange that despite the many proofs of cat wisdom, and of their capacity for affection, one is always hearing people say, "Dogs are so much more intelligent than cats," and, "Dogs love us, cats love only themselves." It must be because we like to be flattered, and dogs are constantly telling us how wonderful they think us, while cats are independent and refuse to flatter. But to the right people cats can show great devotion.

TOMMY, THE TIGER CAT THAT REPAID A FAVOR TO A FRIEND

They can feel gratitude, too. Tommy, a large tiger cat in a New Jersey town, was badly wounded by a gunshot, and a neighbor of his owners took him to her house and tended him. After he recovered and returned home he paid many a visit to his friend and her Airedale dog. One day, dozing at home, he heard sounds of battle; a strange dog had attacked the Airedale in its own yard. Instantly Tommy raced across the intervening lawn and flung himself on the intruder, biting and scratching until he drove the enemy off, chasing him far down the street.

It is said that cats love places better than people. It is true that sometimes a cat will desert its owners when they take it with them to a new home, and will return to the old abode, perhaps finding its way over long distances, as did a cat who disappeared from Salinas, California, and turned up weeks later in its former home, four hundred and fifty miles away. But well-treated cats usually stick to their friends wherever those friends go, and cases are numerous of cats

MEMBERS OF THE GREAT CAT FAMILY



PUSSY ON THE HEARTH

THE FIERCE TIGER OF INDIA

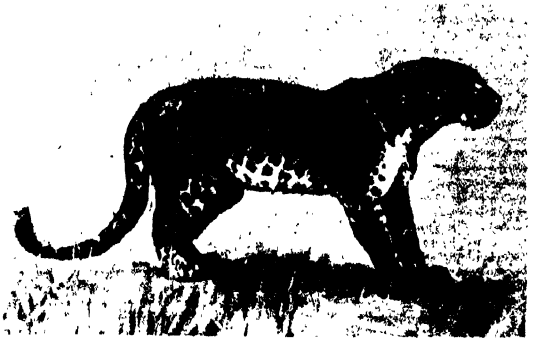
THE MAJESTIC LION OF AFRICA

THE FINE HEAD OF THE SNOW LEOPARD

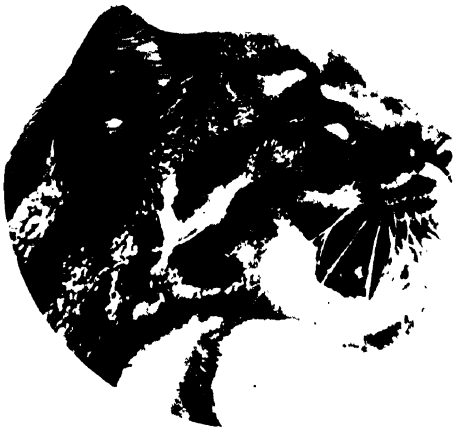
THE HANDSOME JAGUAR

FIERCE-LOOKING WILD CATS OF SCOTLAND

THE STRIPED HYENA

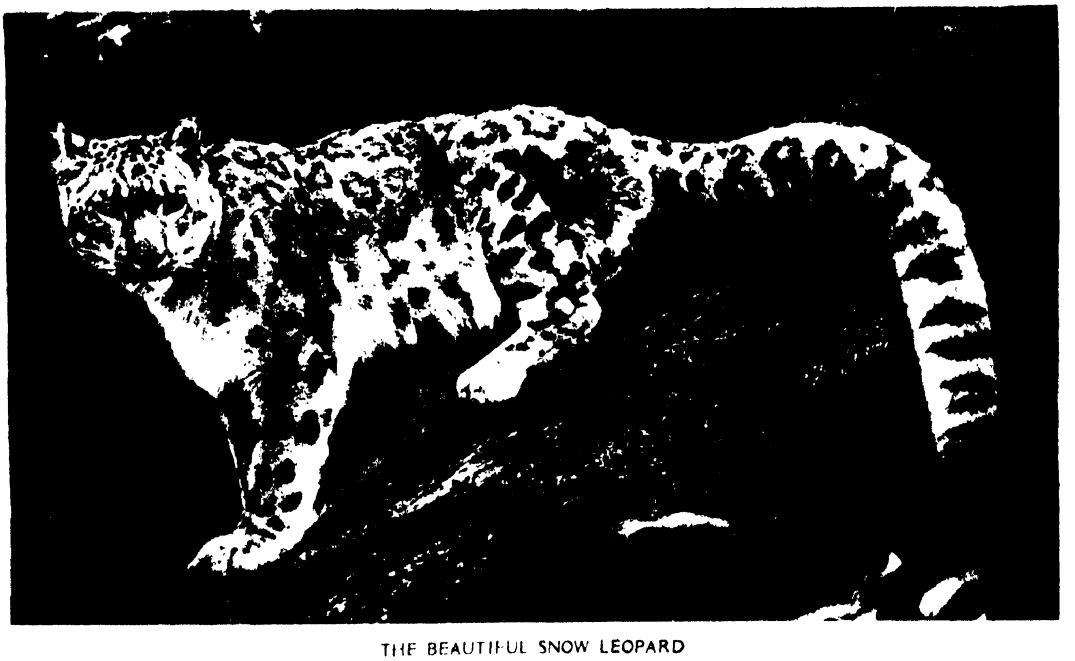


THE LEOPARD

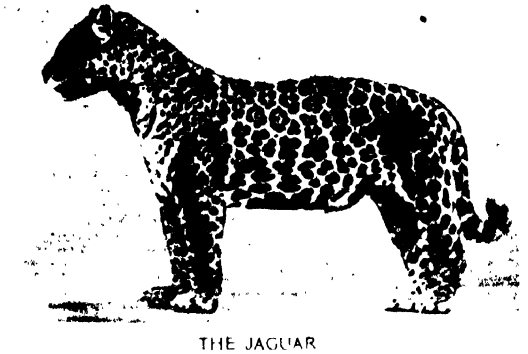


THE CLOUDED LEOPARD

A LIONESS LOOKS OUT



THE BEAUTIFUL SNOW LEOPARD



THE JAGUAR

THE BINTURONG

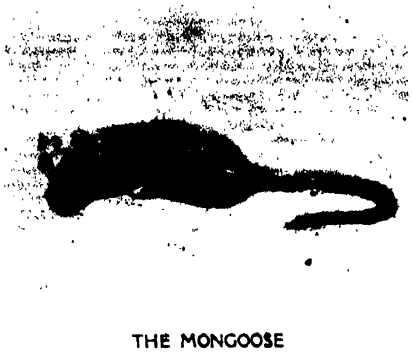
THE PUMA OF AMERICA

THE KING OF BEASTS

THE WEST AFRICAN SERVAL

THE TIGER AT HIS EASE

THE LEOPARD CAT



THE MONGOOSE

THE CARACAL

THE AFRICAN CIVET

THE CHEETAH

who have traveled widely with their owners, minding it no more than well-trained dogs.

Cats are devoted mothers. Literally they will go through fire and water for their young. At the height of a great waterfront fire in New York, some years ago, firemen and spectators were amazed to see a draggled cat emerge from the burning building with a kitten in her mouth, and carry it through streaming water and tangled hose to a place of safety outside the fire lines, where she dropped it to return for the others. She brought out five kittens in this way.

THE TRIBE OF CATS PAYS ITS WAY BY KILLING MICE AND RATS

Unlike dogs, which are bred for many purposes, cats are important to human society in just two ways, as pets and as ratters. In their practical capacity they are nature's check on a most dangerous form of vermin. But for the incessant war cats wage on rats and mice we would be hard put to save our food, libraries and other possessions from the rodents. Most governments recognize this and have cats on their pay-rolls. The dean of government-employed cats in the United States was Champion Tom, who for many years was the official mouser in the Post Office building in Washington.

There has always been a cat in the English Treasury. For a long time Treasury Bill, a fine red cat, kept the prime minister's residence at No. 10 Downing Street, London, free from rats. Bill had a grant from Parliament for food. Early in World War II Admiral Nelson, a big black cat, assumed charge. Prime Minister Winston Churchill greatly admired Nelson. This fine black cat died in 1943.

THOUGHTLESS HUMAN BEINGS KILL MORE BIRDS THAN CATS DO

Some people would exterminate cats because they catch birds. It is the nature of cats to hunt, but they are not the birds' worst enemies. According to the American Humane Society, boys with sling shots and hunters with guns and snares kill more birds than cats do. The number of cats who do kill birds would be reduced if people who abandon unwanted cats and kittens in city alleys and country roads would take them instead to humane shelters to be disposed of.

Cats inspire strong feelings. One likes them very much, or not at all. Many writers like cats for companions, perhaps because they are quieter than dogs. Mark Twain once doubted that a house without a cat could be a home. Sir Walter Scott had a valued cat named Hinse; and Samuel Johnson would leave his dictionary-making to go out and buy oysters for Hodge, his cat.

The average life of a cat is about twelve years, but many live longer. Perhaps the most notable old cat was one that died in Sydney, Australia, in 1938, at the age of twenty-eight years. There have been instances of cats living thirty years.

A famous old American cat was Tommy Clark, of Seneca Falls, New York, who died in 1938, shortly after his lifelong friend, William L. Clark, celebrated Tommy's twenty-fourth birthday with a party at which many people gathered to do the wise old cat honor. A cat named Nathaniel Winkle, loved companion for more than twenty years of a New Jersey woman, Mrs. Jennie Correll Bartleman, went about in his later days on a peg leg, the result of an accident to his right forepaw. He managed his artificial leg with great skill.

THE LONG-BODIED, SHORT-LEGGED KINDRED OF THE CATS

Farewell, then, to lion and family, and now to their near kindred. These are found in the civets, a tribe which has a great number of species, all in the Old World. Without dealing with fine points we may note that they are all long-bodied and short-legged.

The group includes the remarkable true civets, which develop a well-known perfume. Africa, India, Malay, Java, Malabar, all give their name to civets; there are civets that rob the Java coffee trees of their ripe berries, that frequent the palm trees of Africa and Asia, and civets in the East which are otter-shaped and supremely adapted to life in the water—though sleeping, of course, on land.

THE ICHNEUMONS, INCLUDING THE MONGOOSES WHICH FIGHT AND KILL POISONOUS SNAKES

In the same family we come next to the ichneumons, as varied a group as the civets, distinguished into genera and species by color, teeth toes, thick tails, thin tails, short tails, white tails, red tails. The ichneumons which chiefly interest us, however are the mongooses.

These little animals, sacred in Egypt, are natural guardians of Indian and Egyptian homes. They are great snake-fighters. Long ago there was an unspoken bargain between man and mongoose, that man should furnish the home and mongoose should fight and eat all the snakes that appeared. The mongoose has redeemed his bond. He in incorrectly believed to be unhurt by cobra-poison, but he fights with such agility as rarely to be bitten.

Pictures, N.Y. Zoological Society

The meerkat, or suricate, a South African civet, barks like a dog. It has only four toes on each foot.

Master mongoose is not so pretty a pet as the jolly South African meerkat, but he is a fearless little ally when snakes come. Have you read Kipling's story about a mongoose, Rikki-Tikki-Tavi?

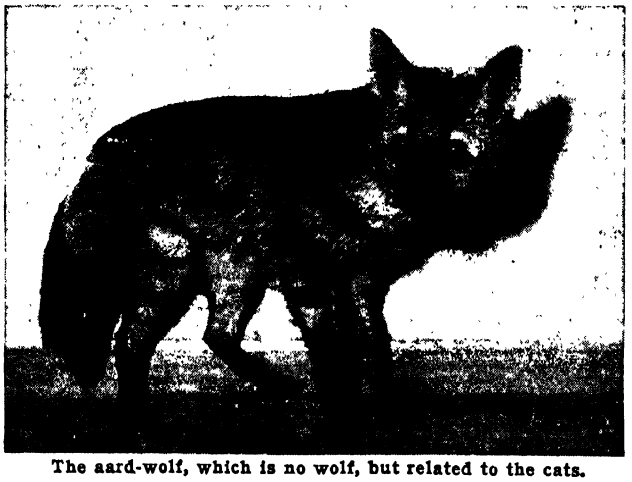
From the cats to the civets, from the civets to the hyenas, with that strange animal, the aard-wolf, to act as connecting link. Built like a long-legged fox, and resembling a starveling striped hyena in appearance, this creature, living in burrows, seldom seen by day, and eating carrion and termites, seems an isolated freak; but the aard-wolf shows us how civets may have developed along one line and hyenas along another, from a far-away common ancestry.

The hyenas themselves are creatures with a past. They were once common in England, and cracked bones that the sabre-toothed tiger had stripped of flesh. Now restricted to three species and to the warmer parts of the Old World, they continue to crack the bones left by stronger animals, though they will attack a donkey or an ox if it be tied and helpless.

The striped, the brown and the spotted hyena make up the family today, the most repulsive of all mammals; powerful, ungainly, ferocious, but cowardly beasts. They will not face a waking man, but they will attack if he is sleeping, or too ill to defend himself. In Syria and Palestine the striped hyena haunts rock-cut tombs; in India it is at home in rocky crevasses. Everywhere it despoils the couch of the dead.

Its chief wonder is the might of its jaws. This feature is most pronounced in the ignoble king of the tribe, the spotted hyena of Africa. Here is a pair of jaws which can crack the thigh-bone of an ox as easily as we should crack a walnut. This is the fiercest of the three species, and will raid camps and kill small cattle and ponies. The brown species, which is the least common, is restricted to South Africa.

They are members of nature's order of scavengers. They come after the gigantic feast of the warrior animals. A lion has a kill and dines on fifteen or more pounds of flesh. The jackal and vulture follow. But the hyena performs the last rite. He rids the scene of its pitiful evidences of tragedy. He is the living charnel-house, the receptacle of the bones. So even this repulsive animal has its niche in the world.



The aard-wolf, which is no wolf, but related to the cats.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 597.

BIRTH, LIFE AND DEATH OF A PLANT

THERE is a rhythm to life. There is a time of saving and a time of spending. A period of storing up energy—the power of doing work—is followed by a period of work, or activity. In ordinary green plants there is sunlight-capture during the day and manufacture of sugars and proteins; in the darkness this stops, but there may be other internal activities, such as cell division, fermentation and transport of material from one part of the resting plant to another.

The so-called sleep position of many leaves, such as the clover, is very different from their position during the day, when they are busy transforming the sun's rays into food. The life of the plant is naturally a seesaw between work and rest, but it is also in tune with the alternation of day and night.

But there is also a larger rhythm in the plant's life, and that is related to the march of the seasons. In temperate countries there is the sprouting, leafing, growing period of spring; the maximum industry and the flowering of summer; the fruiting and seed-scattering of autumn; and the entrenchment and rest of winter. Two ways of looking at this must be combined.

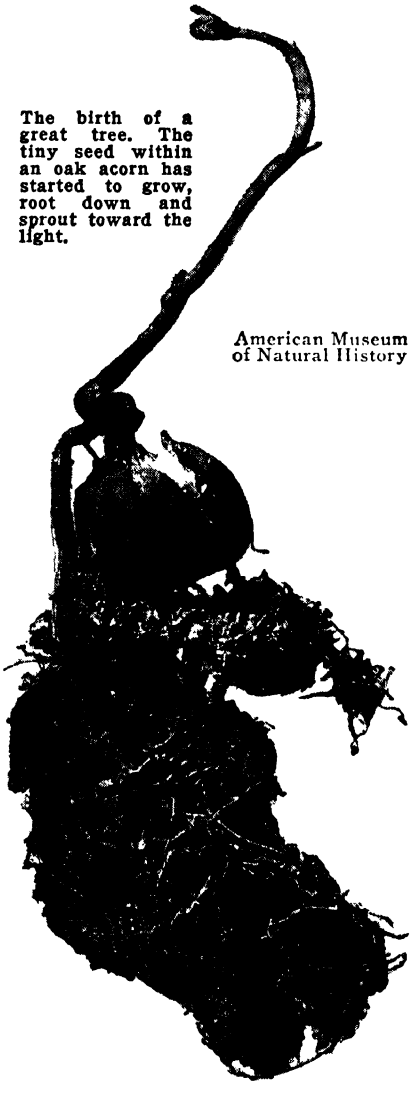
First, it is in the nature of every life to have a youthful growing time—the ascending part of the life curve; next comes a period of maturity and great activity; then a time

Harold Lambert, from Frederic Lewis

A vegetable garden for a little girl to keep. She has planted the seeds very carefully, on a balmy spring day, when the cycle of most plant life in northern climates is beginning. Soon, with plenty of water, and as the sun grows warmer day by day, tiny green seedlings will poke their way through the soil. By the time summer comes, there will be crisp radishes and cucumbers for the whole family to enjoy.

concerned with reproduction, or the continuance of the race; and finally there is the downward part of the curve during which activity wanes and age leads to death.

There are four great chapters in the life of man—youth, love, maturity and age; and there are four great chapters in the life of a plant—leafing, flowering, fruiting and withering away. These chapters depend on the nature of the organism; they are determined from within.



The birth of a great tree. The tiny seed within an oak acorn has started to grow, root down and sprout toward the light.

American Museum of Natural History

But the second point of view is that in temperate countries there are regular changes of the seasons; and to these the life of the creature must be adjusted. There are many annual animals, such as an ordinary queen bumblebee. A young queen lies in a sleep-like rest throughout the winter; she awakens in early spring and, after visiting early spring flowers and collecting pollen and nectar, she becomes the mother of a large family. She ceases to go out of doors at all, and her working daughters do everything but lay eggs. She usually dies in the autumn. But among her daughters there are young queens, some of them fertilized by drones; the daughter queens sleep through the winter and begin the story afresh next spring.

The point is that the chapters in the bee's life-history are adjusted to the variation of the seasons, and so it is with the plant—with its spring foliage, its summer flowers, its autumn fruits and seeds, and its winter rest, or death. In the case of an annual plant, the whole life-curve rises and falls with four seasons. In the case of plants that live for many years, the external ups and downs have to be faced many times, and they leave their mark on the great chapters of life, youth, maturity, maximum vigor and age. The annual plant has its single spring in its youth; the perennial plant has many springs, and enjoys a period of youth and renewal every year.

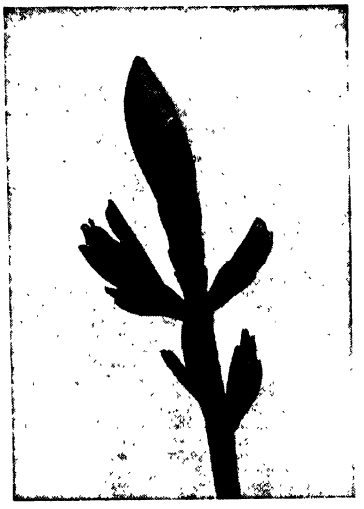
Spring is the season of young things, and we see this in the crowds of seedlings that rise from the ground. The seeds were formed in the sunshine of the previous season; they were scattered and sown in various ways when ripe. They have lain dormant in the ground through the cold and storms of winter. But the waiting has not been a mere marking time; there have been preparations within the seed itself.

Toward the end of winter, if we dig up some of the seeds in the ground, we find that their protective envelopes have been weakened by rotting. As the spring showers moisten the ground and the water soaks into the seeds, the living matter reawakens, and this is helped by the rise of temperature. The stores of starch and proteins in the seed are fermented and thus made available for the young plant, which develops rapidly and bursts out. The young stem grows upward toward the light. The young roots grow downward and they also move in the cavities in the soil. The first leaves are expanded in the light and air, and when the seeds are thickly sown there is often keen competition among neighboring seedlings.

Another feature we notice in spring is the opening of the leaf buds of trees and bushes. They, too, were formed in the previous season. They are young shoots with closely packed young leaves—well wrapped up in tough bud scales, often varnished with resin—which keep out the moisture during the cold weather. The spiral arrangement of the young leaves inside these protective coats allows many leaves to be economically packed away in a small space. The new shoot is due to the lengthening-out of the tiny axis in the core of the bud. The two

THE LEAF OF THE SYCAMORE OPENS

April 30.



May 1.

May 2.

May 3.

May 4.

May 5.

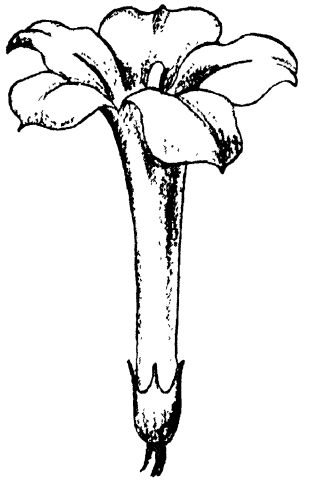
May 6.

May 15.

May 22.

How a leaf bud of the sycamore tree develops, from day to day, under the warm sun of May.

The bell-flower is well named from the shape of its corolla.



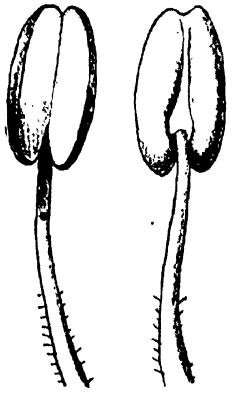
The fragrant jasmine has a corolla in the shape of a trumpet.

The petals of the potato flower join to form a wheel-shaped corolla.

main triggers that set off the activity of growth within the bud are the rise of temperature in the spring and the ascent of sap from the stem. Living matter contains 70 or more per cent of water, and increase of living matter in the plant can not take place without plenty of watery sap.

If we look in spring at a cut surface on a birch tree, where a branch has been lopped off, we see that it is very wet. This is an overflow of the sap which is ascending from the roots. It is possible, by inserting a very thin tube into the young wood of a tree like the maple, to show that the sap rises with considerable pressure, and this pressure has often been measured. This ascending sap, which comes up from the roots through tiny tubes in the young wood, consists of soil-water and dissolved salts. It is necessary for the reawakening and growth of the buds, and for the manufacture of carbon compounds in the sunlit leaves. The materials from the soil become a part of living plant tissue.

The filaments of the stamens in the mallow appear to form one tube.



Front and back of a stamen; filament joins anther at the back.

We can not give a short answer to the question What causes the ascent of sap? but the two most important factors are root pressure and the giving-off of water vapor from the leaves. The soil-water passes by diffusion through the surface of the rootlets into the concentrated sugary fluid of the living cells. As a cell receives fresh supplies it passes on its surplus water to another cell, thus enabling itself to absorb more water from the soil.

Thus the water passes with considerable pressure up the stem from cell to cell; perhaps it brings to mind the way firemen used to pass buckets of water from hand to hand. But then there is another process, working from the leaves backward and downward. The using-up of water in the leaves, and the loss of water vapor into the air must make one cell more dense than another, so that it is able to draw on its neighbor. Thin fluids tend to flow toward thicker or more dense fluids. Thus the sap is pushed upward from below, and pulled upward from above.

As we have seen, summer is the time of the plant's greatest activity. Then foliage is at its best, there is the richest supply of sunshine, and the process of splitting up carbon compounds is at its height. There is an enormous chemical industry going on, though all is so quiet!

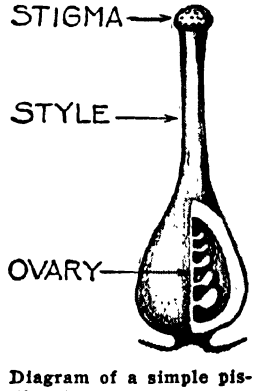
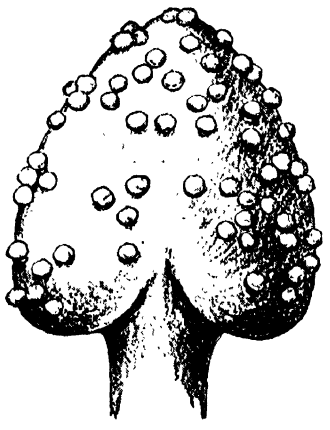


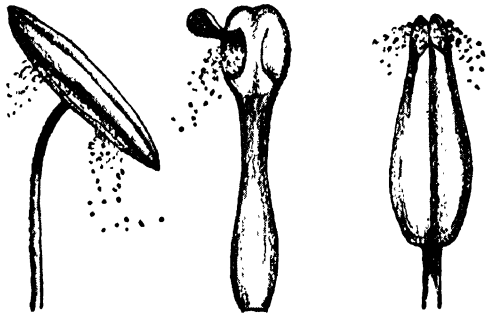
Diagram of a simple pistil, with the ovary open to show the tiny ovules in rows.



The stigma of a pistil with pollen deposited on it.

No one can fail to associate summer with flowers, although there are also many spring flowers. Spring flowers are usually, though not always, of paler colors. White and yellow flowers are common in spring; bright hues of red, blue and purple are more common in summer.

The flower consists of the organs of reproduction. Flowers differ greatly. Many flowers are made up of four or five whorls, or circles, of transformed leaves, named (starting from the outside) sepals, petals, stamens and pistils. There are often two whorls of stamens. Now let us examine these parts more closely.



Anthers discharge pollen in various ways. In the first figure, the pollen comes out of slits; in the second, little flaps lift up to release it; in the third, it comes out of tiny pores.

The outside circle consists of sturdy little green leaf-like forms, called sepals, often joined in a sort of cup, or shell. In fact, the circle of sepals is called the calyx, which means shell. It enfolds the bud, and later holds the flower firm, steadying it against the wind. In many cases the calyx, or part of it, is carried on into the fruit. You see it on strawberries, before they have been hulled, and on apples and pears.

Inside the calyx is the corolla, a circle of glorified leaves called petals. Flowers vary enormously in the size and shape and number of their petals. Their colors range over the whole color band, from deep purple to red, and with every hue and tint in between.

By the brilliance of the petals, or their sweet nectar or their scent, the flowers attract visitors, usually insects, but in some cases even small birds. The visitors help the plant to carry on its race, as we shall see.

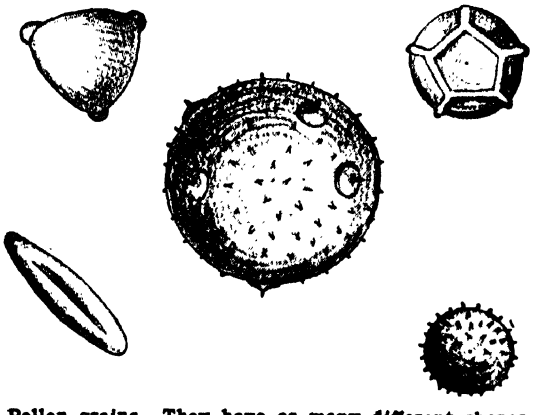
Inside the circle of petals is a circle (or two circles) of stamens. This is usually called the male part of the flower. Stamens are of many forms. A common type has a stalk called a filament, ending in a knob or sac at the top, called an anther. The anther contains a fine powdery dust, called pollen, usually golden in color.

Inside the circle of stamens, at the very heart of the blossom, is the female part, the pistil. This often looks something like a vase with a long neck. The long hollow neck is the style; the enlarged base is the ovary. Inside the ovary are undeveloped seeds, called ovules. The top of the vase is a knob, the stigma, generally ridged and sticky on the outside.

Every part of the flower has a task to perform in carrying on the race of the plant. The sepals add strength, the petals attract visitors. The visitors come to collect nectar or pollen. Bees, for instance, collect both pollen and nectar for food.

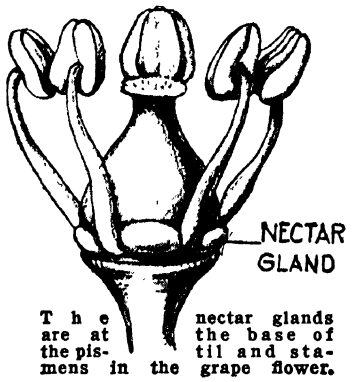
Now, the ovule, the egg, from which the daughter plant will grow, can not start to develop until one of its cells has been united with a cell from one of the pollen grains. This is called fertilization. However, most plants need to have the pollen from one flower fertilize the ovules on another flower, for best development. Such a union is named cross-fertilization.

This is how cross-fertilization usually happens. The pollen ripens inside an anther. The anther then splits open and the pollen grains (which are rigid and rough) stick to

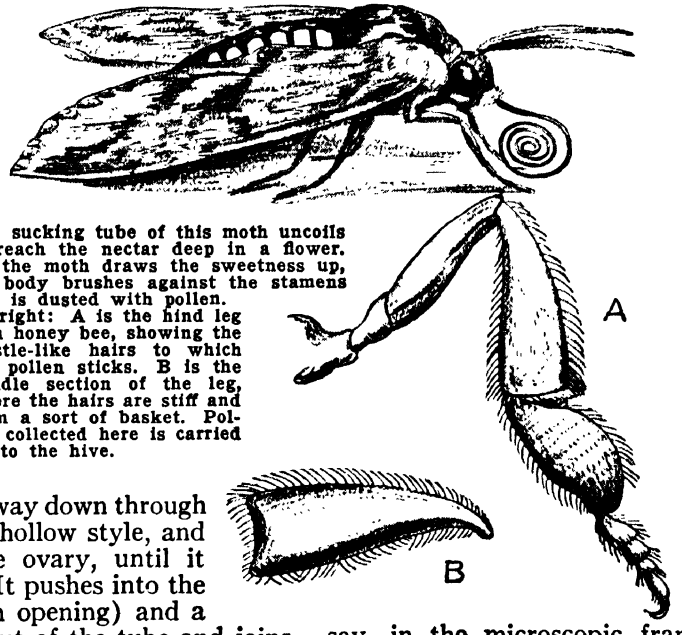


Pollen grains. They have as many different shapes as the flowers themselves.

the outside of the anther. Along comes an insect, say a bee, seeking pollen and nectar. The bee's hind legs have pockets for storing pollen to take back to the hive; but almost its whole body is hairy, so a good deal of pollen adheres to its body. The bee, now covered with pollen, flies to another flower of the same species. The sticky stigma usually is taller than the anthers; the bee brushes against the stigma and some pollen grains from the first flower come off upon the stigma of the second flower.



The nectar glands are at the base of the pistil and stamens in the grape flower.



The sucking tube of this moth uncoils to reach the nectar deep in a flower. As the moth draws the sweetness up, its body brushes against the stamens and is dusted with pollen. At right: A is the hind leg of a honey bee, showing the bristle-like hairs to which the pollen sticks. B is the middle section of the leg, where the hairs are stiff and form a sort of basket. Pollen collected here is carried off to the hive.

Presently, from a pollen grain, a tiny thread, or tube, sprouts. Longer and longer it grows; it pushes its way down through the stigma into the hollow style, and then down into the ovary, until it comes to an ovule. It pushes into the ovule (which has an opening) and a cell works its way out of the tube and joins with a cell in the ovule. The two cells merge, then divide into two; the two divide into four; the four become eight, and so forth, and a seed, treasury of a new plant, is on the way.

Not all flowers are complete, or perfect, like those we have described. Some seem to have no use for petals. A number of plants have pistils on some of their flowers and stamens on others. Corn is such a plant. An entire plant may have nothing but pistillate flowers, while another of the same species has nothing but staminate flowers. Many trees are in this group.

Where stamens and pistils are in the same flower, there are several ways of reducing the chances of pollination within the flower (pollen falling on the stigma of its own flower). For instance, anthers and ovaries may ripen at different times.

Summer is the time when the earth gets its largest supply of energy from the sun. Much of it warms the land and the sea and the air, and so quickens life. But much of the energy is in the form of light. This is health-giving in many ways, quickening the pulse of life, and in some cases *energizing* animals. However, its chief importance is that it is a source of energy to green plants. These trap the light so successfully that they accumulate more of it than they need. They thrive and grow, they multiply and spread.

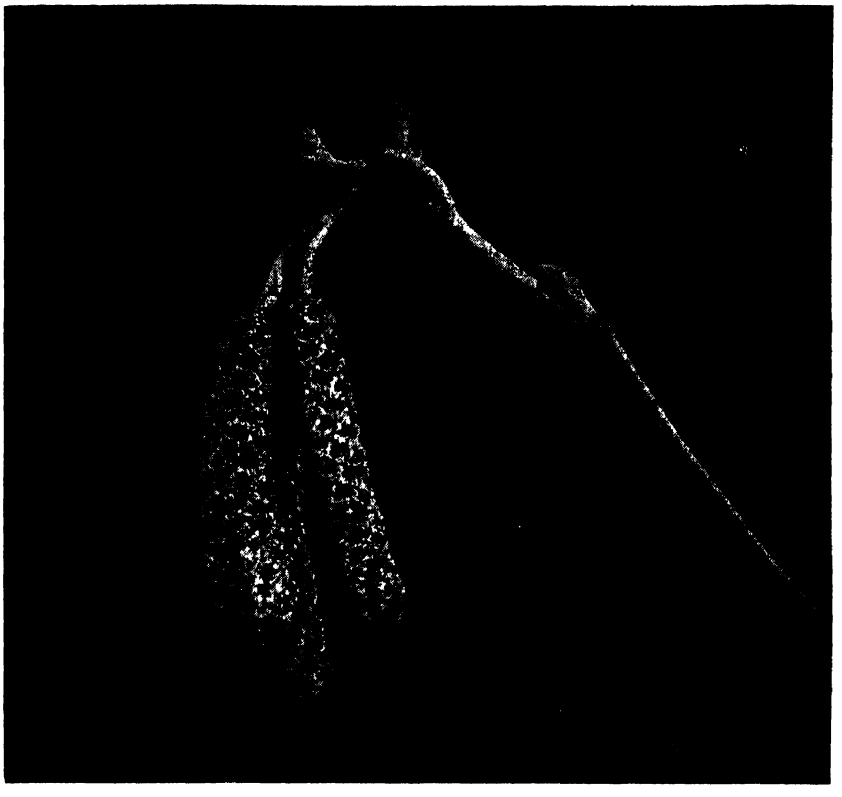
All higher plants, especially the ordinary flowering plants, are very complicated organisms. Consider, for instance, the architecture of a green leaf. Each cell is like a laboratory, working hard in sunlight. When there is much work being done in transforming matter and energy from one form to another, there is bound to be wear and tear in the furnishings of the laboratory —that is to say, in the microscopic framework of the living cells. In other words, *growing old is inevitable*. As Shakespeare said:

> And so, from hour to hour, we ripe and ripe,
> And then, from hour to hour, we rot and rot,
> And thereby hangs a tale.

To a long-lived plant every spring and summer bring opportunities of becoming more or less young again. Age is staved off, but in the end it wins. In many cases there is a sacrifice of hard-worked parts in the autumn, and the plant sheds what has become a source of weakness. We see this in the falling of the dead and exhausted leaves of trees. But there are limits to this saving of life by losing it. In the end age must win,

and what we see so plainly in autumn is the waning of life, either for the year or forever, as far as the individual plant is concerned.

The fall of the leaves is a sign of autumn. They have worked hard; the furnishings of the laboratory show wear and tear; the leaves are growing old. Moreover, with lowered temperature and frozen ground they could not continue the use they make of water. The supply can not be kept up, and even if water were available, it would be liable to freeze in the leaf and burst the cells. Thus the leaves *have to fall,* and it is well for the plant that this should be so.



The alder has two kinds of flowers. The catkins, hanging down, are the male flowers, having stamens. The smaller female flowers, with pistils, stand erect. Sometimes male and female flowers are on different plants, as in the willow; and then wind or insects are absolutely necessary to carry the pollen for fertilization.

A very interesting point to remember is that before leaves are shed there is a movement of most of the useful material into the stem of the plant. The remnants of the green coloring matter (chlorophyl) account for the color of the leaf when it is ready to fall.

And along with the withering and the fall of the leaves we must take the dying-down of the stems of many plants, so that nothing is left exposed to the cold of winter. If a sudden frost comes, the parts above ground may be killed in a night while there is still much life in them, and that means great loss to the plant. When cold sets in gradually, there is a retreat of almost all matter that is valuable into the root. Thus, what withers and is swept away as rubbish is often as empty as a fallen leaf.

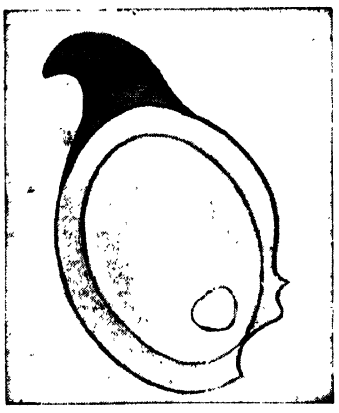
But there is another very distinctive note in the life of the plants in autumn. Just as we associate sprouting and leafing with spring, and flowering and intense growth with summer, so we must recognize autumn as the season of fruiting and seed scattering. The fruit is what we may call a ripened ovary, as some plants do not produce seeds. Stamens and petals fall away; the sepals often wither; the supplies which may still be coming up the floral axis are taken by the fruit, which often becomes quite large, or into the seeds, which receive a useful legacy of proteins and fats.

As the flower withers the nectaries close, and sugary material which overflowed in these glands may be taken by the fruit. Besides juicy fruits, there are multitudes of dry pods and capsules, which liberate the seeds by breaking up; though changed in appearance, they are really modified foliage leaves.

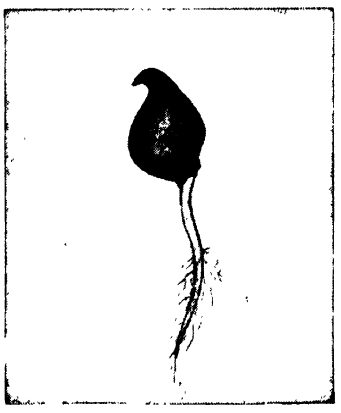
In the temperate countries of the Northern Hemisphere most plants pass into a state of rest. The leaves have fallen; the buds are well wrapped up; it may be that there are no parts left above ground; there are stores in underground parts; the seeds are sleeping. This is partly because a rest is needed after great activity, and partly because of the cold of the winter.

Evergreens, like the holly and the pine,

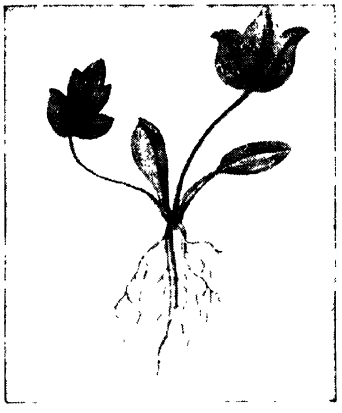
THE LIFE-STORY OF A BUTTERCUP



1. The seed of a plant is like the egg of an animal, the product of two parents. Here is the seed of a buttercup inside the seed vessel, or ovary, of the flower, with the young plant, or embryo.



2. The seed, which we call an ovule, absorbs water, and chemical changes also take place inside which cause it to sprout, or germinate, throwing out a tiny white thread which is the root.



3. The seed-coat now bursts open and a stem begins to grow upward, which we can see is a continuation of the root. Presently tiny leaves that were folded up tightly inside the seed begin to open out.

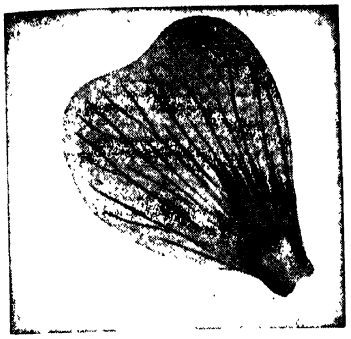
5. The plant now grows rapidly, until at last we have a perfect buttercup with stem, leaves, flowers and roots—a wonderful work of art containing within itself all the power of carrying on the race. We would appreciate the beautiful flower more if it were rare and costly instead of common.

4. The flower is not only beautiful to look upon, but is also a very wonderful and complicated piece of work, as we can see if we cut a buttercup down the center.

6. Still more wonderful is a horizontal section of the flower, showing the arrangement of the parts. In order are the five green leaves, or sepals, then the five yellow petals, pollen-bearers and carpels.

These pictures show the wonderful life-story of a flower, the flower chosen by our artist being the common meadow buttercup. We see it from the seed to the flower and from the flower to the seed again.

HOW THE RACE OF FLOWERS IS CARRIED ON

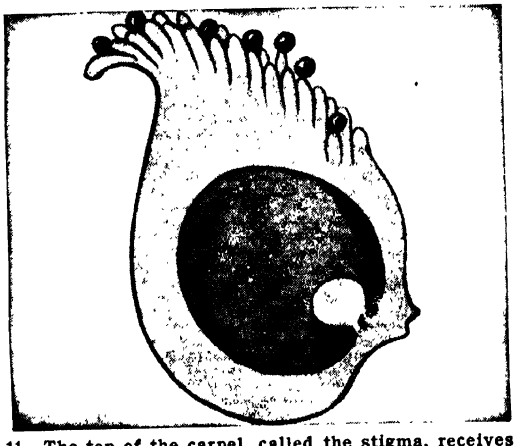


7. If we take one of the yellow petals, we shall find at its base a tiny pocket, or gland, called a nectary, containing a honey-like fluid which attracts insects.

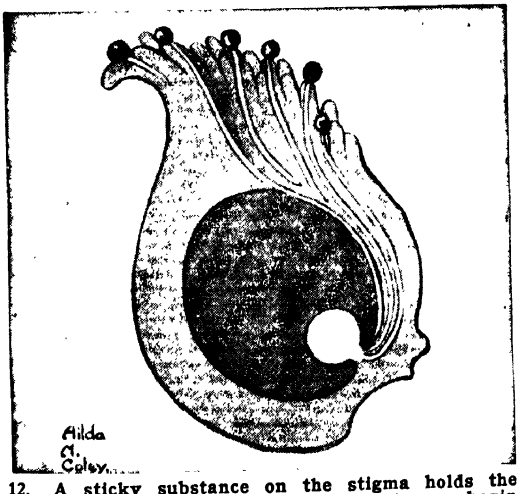
8. These are the stamens of a buttercup. Both a back and a front view of one are shown. The stamen is divided into pockets called anthers, containing pollen.

9. Here is another view of a stamen, showing the anther open and shedding its pollen in the form of a fine powder consisting of tiny grains.

10. The seed organ, or pistil, of the buttercup is made up of a number of modified leaves called carpels, clustered round the top of the flower stalk; this shows such a cluster of carpels, with one magnified.



11. The top of the carpel, called the stigma, receives the grains of pollen from the stamen, and here is the pollen resting on the stigma, while inside the seed vessel, or ovary, a seed is waiting to be fertilized.



12. A sticky substance on the stigma holds the grains of pollen prisoner, and these at once begin to form little tubes which make their way down into the ovary and penetrate the seed, so promoting fertilization. The seed is in this way made capable of producing another plant.

13. Here is a cluster of carpels after being fertilized, one detached showing the seed developing. This brings us to the stage of our first picture, and now we have to imagine the whole process going on again. A buttercup will fertilize itself, but the plant is stronger if the pollen is from another plant.

Everywhere the principle is the same in all cases, but the buttercup has been taken for the purpose of these illustrations. In the buttercup, as in many other flowers, both parents appear on the one plant.

have leaves especially suited, by their tough skins, to stand the cold and to go on slowly capturing winter sunshine; but we have only to walk under these trees to see that their leaves also have a very limited life. They fall off piecemeal, as it were, not all at once.

Then there are woolly plants, as the mullein, which are so well wrapped up that they do not need to die down. Besides evergreens and woolly plants, there are many exceptional cases, but these do not affect the general truth that winter is a time when the fires of life burn low.

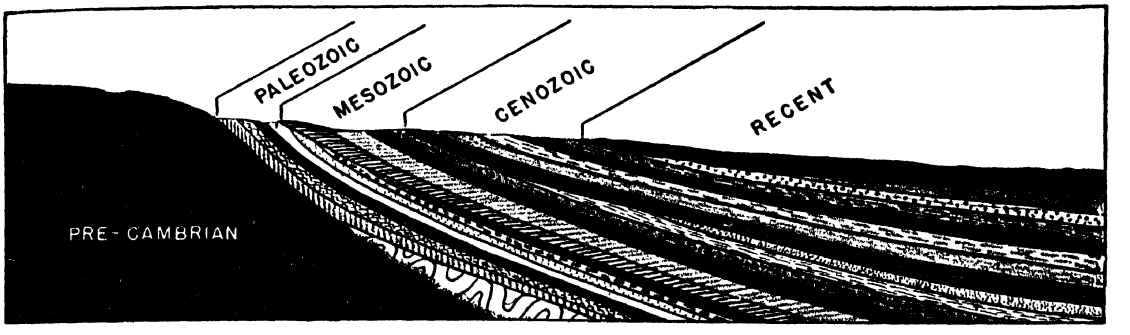
THE NEXT STORY OF PLANT LIFE IS ON PAGE 744.

New York Botanical Garden
In northern climes, spring is the herald of a new year.

Canadian Travel and Publicity Bureau
Flowers ripen into fruit in summer's warm sun.

By late autumn, the woods are bare and hushed.

Frederic Lewis
Plants and seeds slumber under winter snows.



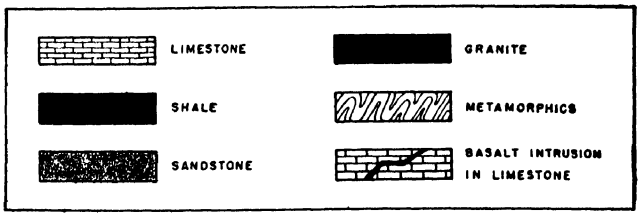
The earth's crust is in uneven rocky layers which formed at different times through long ages. Pre-Cambrian rocks are the oldest, then come those of the Paleozoic (Ancient Times); the Mesozoic (Middle Times); the Cenozoic (Later Times), and the Recent layers. The diagram shows an imaginary slice through the crust.

THE ROCKY FOUNDATIONS OF THE CONTINENTS

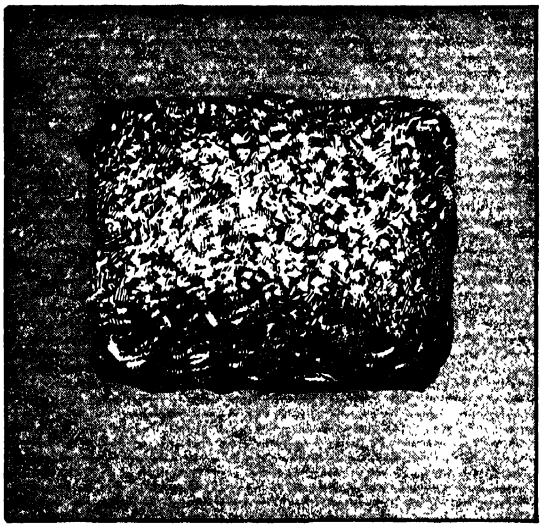
IN an earlier chapter we told you something of the original rocks of the earth. With additions from the air and the sea, these are the source of everything man has, grows or makes. However, during the long ages which have passed since the molten stuff of the earth cooled down, atmospheric agents have been working on those primeval rocks, and some of them have been arranged and rearranged many times.

The first rocks, those which crystallized (hardened) from molten magma, or liquid rock, are known as igneous, or fire-formed, rocks. The molten magma contained a number of elements. All of our chemicals and their compounds come from the earth; and the molten magma may be considered a vast doughy mass of many ingredients. As the magma cooled, various elements began to join together in compounds; and the compounds cooled in crystal form. First, perhaps, iron and oxygen combined. These two elements form a close union very hard to break apart; and to this day, there are in the earth's crust masses of iron ore believed to have formed when the magma was cooling. Then some of the iron and the silicon and the oxygen combined; still later, some of the iron and magnesium and silicon and oxygen combined. All of these compounds, or minerals, were somewhat heavier than the still liquid rock of the surface and probably tended to sink, if time permitted. The lighter compounds probably floated on the heavier ones, and the rocks became solid in layers or zones. Mineral after mineral crystallized; and the composition of the remaining magma was changed as each substance in turn was subtracted from it in the form of a solid. Eventually all the liquid rock solidified and a solid crust was formed. Near the surface, the crust contained a little of the early crystallizing compounds, but mostly the later minerals. The early compounds had sunk to a lower level.

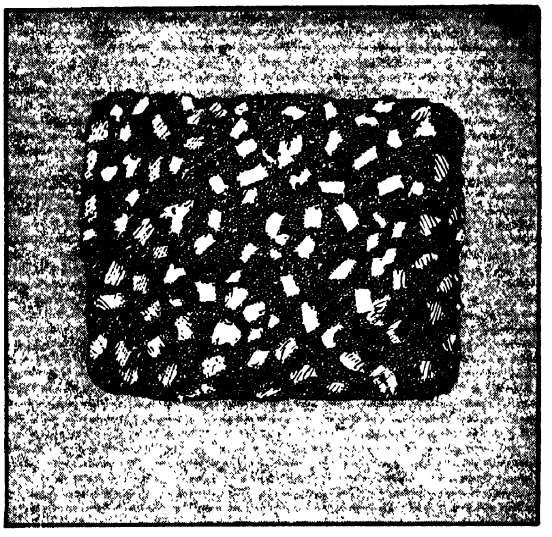
In this way, as you can see, many different kinds of mineral assemblages, or rocks, were formed from the magma. The rate of cooling must also be considered in studying the igneous rocks. Lava, or molten rock from a volcano, which pours out upon the surface, cools quite rapidly and becomes solid in a period of days or even hours. Magma which is squeezed into warm or hot rocks deep beneath the actual surface of the earth cools slowly; and the mineral crystals have a long time to form, and so they grow larger. A magma of a certain composition, quickly crystallizing as lava does, might give a porous, fine-grained rock, while the same magma crystallizing slowly might result in a coarse, compact granite, with large pink splotches of feldspar, gray blobs of quartz and black specks of



This chart shows the geologists' "shorthand" for the chief kinds of rocks. By consulting the chart you should be able to name the rocks shown in geologists' diagrams. See, for instance, the picture at the bottom of page 515.



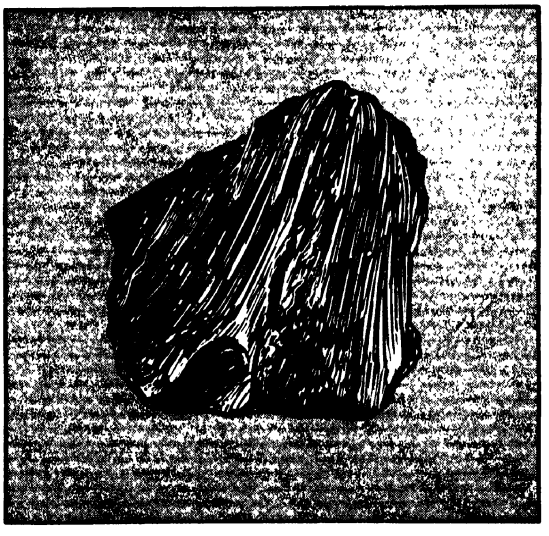
A block of granite. It is a coarse-grained rock.



Porphyry has coarse crystals set in a finer mass.

mica. Thus we see that as the magma cooled, various kinds of rock were formed, depending on: 1) composition of the magma; 2) partial separation and settling of some compounds; 3) the rate of hardening. All the rocks that hardened from the hot magma are called igneous, or fire-formed, rocks.

Igneous rocks are named according to their mineral composition and texture. Take, for instance, a series of coarse-grained rocks —granite, diorite, peridotite. These range in color from light gray or pink to black. Granite, the lightest in color, is made chiefly of quartz (silicon and oxygen) and orthoclase feldspar (potassium, aluminum and silicon) with a little mica and hornblende. More hornblende and no quartz makes the rock a diorite; and here the feldspar is composed of sodium, calcium and silicon and may be darker in color. When we find a rock composed entirely of the dark iron and magnesium and silicon we call it a peridotite. The rock in which African diamonds are found is such a heavy black material. These coarse-grained rocks, as we have said, formed slowly, beneath the surface of the earth's crust.



Volcanic rock, which has very, very fine crystals.

If, on the other hand, the magma reaches the surface and escapes through a volcanic eruption, it must solidify very quickly, and it forms a series of volcanic rock. In these the crystals have had no time to grow; they are so small they are not visible to the naked eye. Under a microscope we can see that they are composed of the same minerals as the coarse-grained series. A volcanic rock from a granite magma is light white or pink in color and is called rhyolite. The fine-grained equivalent of a diorite is a gray andesite. The equivalent of the peridotite is a black basalt. Sometimes a magma starts to crystallize slowly, deep down in the earth, and then escapes to the surface, or near it, and finishes its hardening quickly. This gives relatively large crystals firmly set in a mass of finer-grained minerals. The surrounding mass is called a matrix. Such a rock, with coarse and fine grains, is known as a porphyry. The name refers only to this mixed

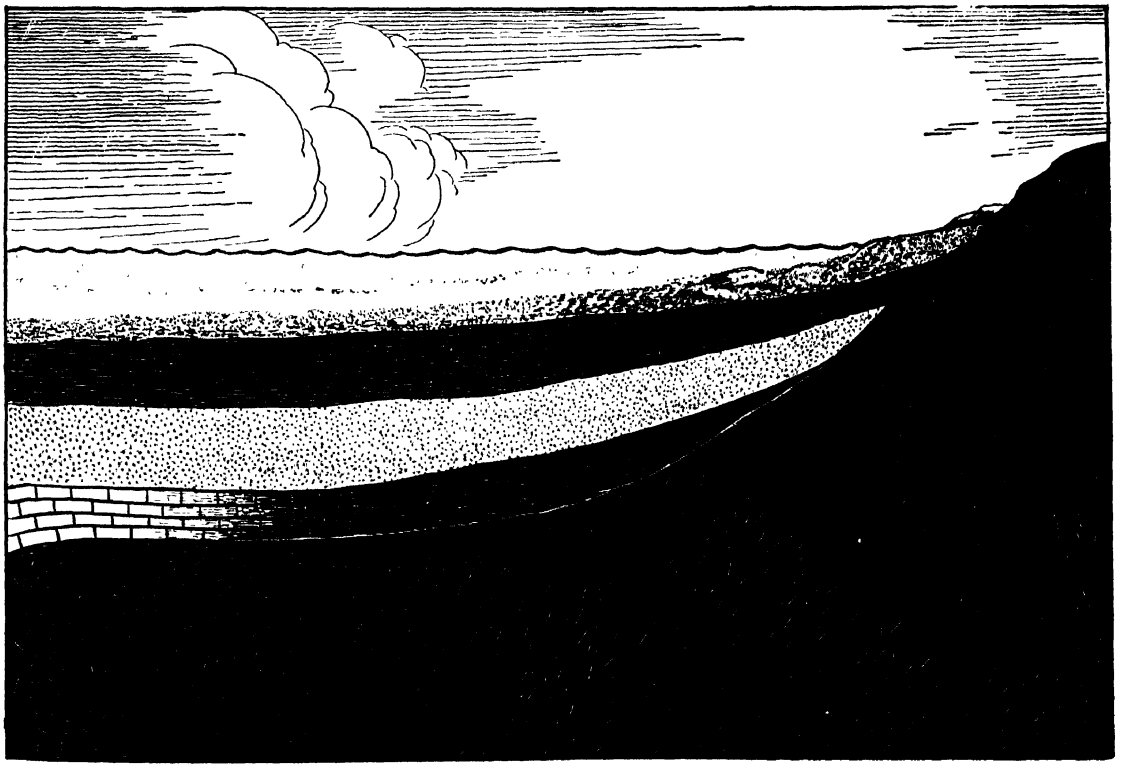
texture, not to the mineral nature of the rock. We may have rhyolite porphyries, basalt porphyries and granite porphyries.

In a previous chapter we learned how rocks can break down upon exposure to the agents of the atmosphere. This is known as weathering; and eventually all rocks succumb to weathering. We have seen that the earth's first rocks were igneous, and that igneous rocks are composed of several different minerals. Feldspar is far softer than quartz. It is easily attacked by the elements of the weather and crumbles away to clay. Hornblende also crumbles easily; but quartz is very resistant to the attacks of oxygen and water, and will stay unaltered even after it is freed from surrounding matter by the decay of its neighbors.

In this way, we get several products as a rock decomposes—clay, substances which actually dissolve and go into liquid, quartz fragments or sand and pieces of rock which may be rounded into pebbles or boulders when other rocks rub against them. All these products may be carried away by the wind or by running water. The water dissolves some, and carries others as grains that will not dissolve; some bounce along and some roll along, pushed when the streams are strong, stationary when the water level goes down.

Sooner or later, the current of a river slows down as it draws near a lake or the sea, and passengers begin to alight. First, the boulders and pebbles cease their advance, then the sand is left behind, and finally the clay settles down upon the floor of the stream and the water becomes clear. But the dissolved material remains in the water and adds to the salt of the sea. The salt stays behind when the water is lifted again in the air by evaporation and carried away to fall on land as rain or snow, and then to start once more its journey to the sea, bringing along a new load of sediment and salts. That is why the sea is salty. The rivers are all the time bringing more salt to it.

Now let us go back to the boulders and pebbles and sand and clay that are brought along by the swift-rushing streams and "dumped" here and there along the way. When these "dumps" reach some size they form a second class of rocks, known as the sedimentary rocks. They are very different



The ocean-bed is made up of a number of layers of rock, just like the rest of the earth. The lowest layer shown here is granite (see the chart on page 513). Above the granite, there is a layer of limestone and shale. Then come layers of sandstone and shale. The sediment shown above the shale is gradually hardening into rock.

from the primary, or igneous, rocks. Sedimentary rocks are sorted, quartz here, and clay there, and so on, while our igneous rocks were varied in composition. Sedimentary rocks are found in bands, or ribbons, for minor variations in the river's flow will mean slightly coarser particles one day and finer ones the next; masses of igneous rocks in one place are more or less homogeneous mixtures. (All granite or all basalt, for instance.) Plant and animal remains are often buried in the sedimentary rocks and are preserved as fossils (see the picture on page 92). We do not find anything like that in the igneous rocks.

HOW SEDIMENT, CARRIED BY RIVERS, IS PRESSED INTO SOLID ROCK

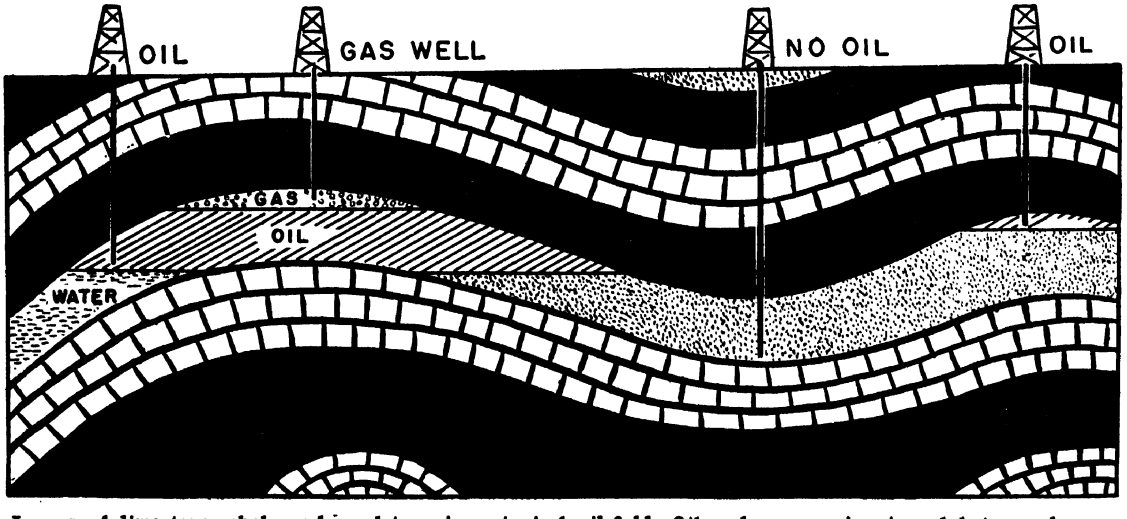
You will remember that we spoke of the dips and folds in the earth's crust in which sediments were sometimes deposited; and we said that these low places might be lifted later into mountain ranges. Such low places have served since the very beginning of the earth's history as dumping grounds for the sediments transported by the rivers; and in the course of years, tremendous deposits have been built up. As a trough sank beneath the load and became deeper, and as the crust continued to buckle, thousands of feet, even miles, of sediments were loaded in the wrinkles. The weight of all this matter squeezed out the water and caused the matter to be pressed into solid rocks. Circulating solutions cemented sand grains together; a bank of loose sand became a sandstone, a bed of clay became a shale. Lime in sea water crystallized and layers piled up on the ocean floor to make a limestone.

Sometimes the deposits in a region were of one nature, sometimes of another. The sedimentary rock was thus formed in series, or layers, with beds of limestone on top of sandstone, and shales on top of the limestone. In certain places, many plant remains were deposited, beds of rock were deposited on top, pressing down the plant matter. Through long ages it underwent chemical changes and became peat and coal; and probably petroleum was formed in some such way. A layer of salt formed when a little uplift and evaporation dried up an arm of the sea. Masses of pebbles and boulders were often cemented to make a conglomerate (rock mixture).

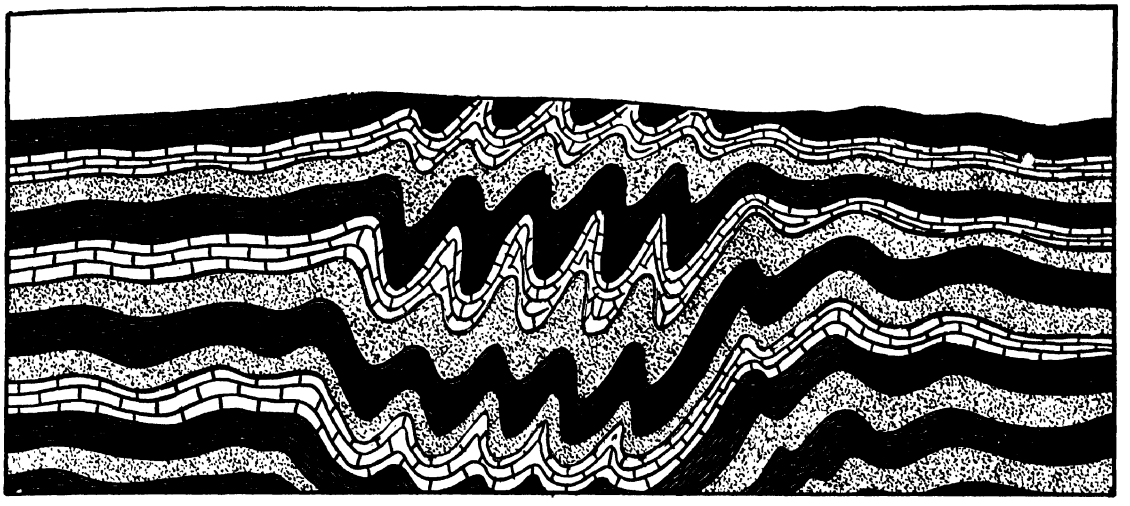
A NORTH-AMERICAN BASIN IN WHICH SEDIMENTS WERE DEPOSITED FOR AGES

All of these formations are sedimentary rocks and today much of the world is underlain by sedimentary rocks that once formed under shallow seas and were later thrust up. In America we find sedimentary rocks almost exclusively from the Appalachians to the Rockies. This region was one vast basin in which sediments were deposited for many, many years.

Sedimentary beds several miles deep, however, can build up a tremendous load; and conditions near the bottom may be very different from those at the earth's surface. Sometimes the beds lower down may get so deep that they are baked by the heat within the earth, and any water that is there may



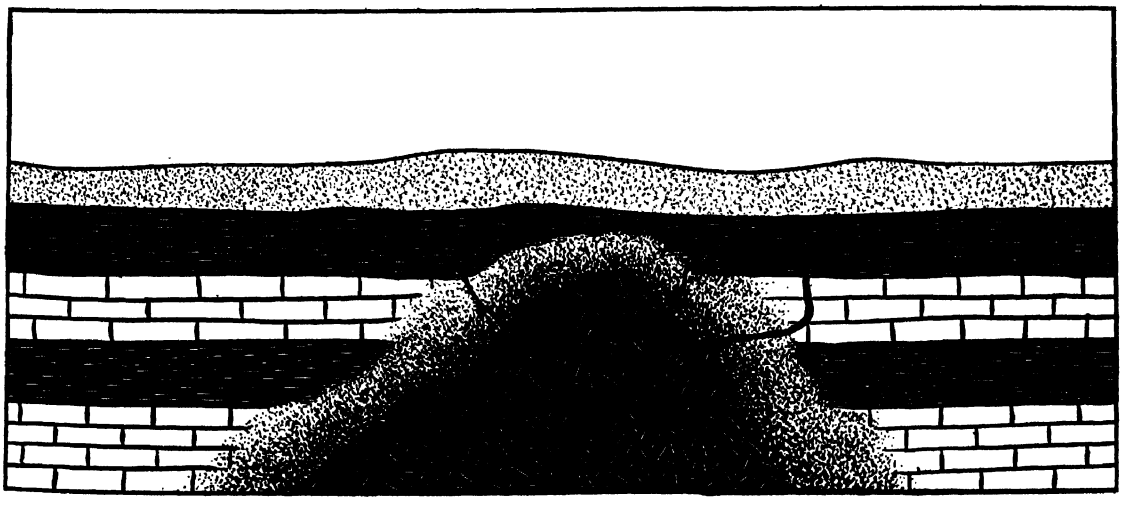
Layers of limestone, shale and sandstone in a typical oil-field. Oil and gas are imprisoned between layers, in a kind of pocket with a dome-shaped roof. In former days a company might drill into a rich oil-field and yet fail to "strike" oil. Modern devices help to prevent this. See the article on Petroleum, in Volume 13.



The sedimentary rock layers of a region do not always lie in neat ribbons. They may be heaved and pushed and folded, due to weak places which give way after a while. Heat and pressure from such folding changes (metamorphoses) the structure of the rocks. Such changes are called regional metamorphism.

be driven out and heat and pressure may cause chemical changes. The clays may revert to feldspars or micas or hornblendes of the original igneous rocks. Mountain making, those compressional thrusts of the earth's crust, will also make tremendous pressure and heat. More heat and gases are added by igneous rocks pressing their way—intruding—into the sedimentary beds, and soon we find that all the minerals of the sedimentary rocks have gone back to the igneous state again. But there is one great difference—the original igneous rocks were mixed and varied in their composition, or make-up. Here, on the contrary, we have beds of a uniform nature.

So, instead of a rock composed of several minerals like quartz and feldspar and mica, we may get one of mica alone. Since these new rocks, our third great class, have been changed by heat and pressure we call them metamorphic (changed) rocks. We know them by the igneous minerals they contain, plus the banded sequence of sedimentary rocks, plus the effects of the great stress which caused them to change back to the original minerals. A banded rock with about the composition of a granite is called a gneiss (pronounced "nice"). A rock almost entirely made of mica is called a schist. Quartz is a stable mineral—it is not easily changed.



Hot liquid rock, or magma, may leak upward, or intrude, into layers of sedimentary rock. The magma's heat and gases, by chemical action, change (metamorphose) the rocks around the intruding bulge. Such a change is called contact metamorphism, to distinguish it from regional metamorphism described at the top of the page.

As a sediment it formed only sandstone. When sandstone is metamorphized (changed), it is still more firmly cemented together; the grains break through the sand instead of around them as in the sedimentary sandstone. We call this new rock a quartzite. Limestone simply recrystallizes when it is pure and it becomes a marble.

Metamorphic rocks, since they are caused by the great compressional stresses of mountain making, will naturally be found in mountain areas. However, since they were formed deep in the earth, they are not to be expected where the mountains are young, but mostly in ancient regions where erosion has removed miles of covering rocks and exposed the roots of the mountains. The old mountain ridges of the Appalachians are among the best-known metamorphic regions. Manhattan Island, on which New York City lies, is largely composed of schist.

Sometimes igneous matter leaks up into sedimentary rocks without great pressure, bringing along heat and gas, and changes the surrounding rocks by simple chemical action alone. This causes another type of change called contact metamorphism. There you will not find the familiar banded, or ribboned, effect of most metamorphic rocks. Instead there may be new and often uncommon silicates. (Silicates are minerals composed of oxygen, silicon and other elements.) Mineral ores may be found in such deposits.

Eventually the heat and pressure at a place in the crust may be great enough to remelt the deeply buried rocks and to form a new magma. This ends our cycle, for with the new magma we start over again. Igneous rocks form, and then erosion starts its history again. A new cycle may start over at any point and stop anywhere, giving us the fascinating variations which make the earth's foundations and geology a problem and a pleasure to those who study nature's ways.

By FREDERICK POUGH.
Illustrated by Thomas W. Voter.

SOME WORDS WE USE IN SPEAKING OF THE ROCKS

Igneous rocks—the earliest rocks, formed out of hot magma. Sometimes called fire-formed rocks.

Granite—a coarse-grained igneous rock.

Porphyry—rocks having coarse-grained crystals set in fine-grained mass.

Basalt—a fine-grained igneous rock.

Sedimentary rocks—rocks formed by the weathering and breaking down of older rocks into sediment (mud, sand, clay, etc.), transported by water or wind to a new area, and hardened by pressure as fresh layers of sediment and circulating solutions were added on top.

Limestone—a kind of sedimentary rock chiefly made of lime, formed under the ocean. The lime in some cases has been chemically precipitated, in others comes from tiny sea animals whose shells were made of lime, that is—calcium carbonate ($CaCO_3$). In such cases the skeletons are still to be found in the limestone.

Chalk—a soft limestone.

Coal—a rock formed from trees and other plants buried between layers of sedimentary rocks, and changed by pressure and chemical action.

Peat—half-formed coal.

Petroleum—oily fluid formed in pockets of sedimentary rock; probably from remains of both plant and animal life.

Sandstone—a kind of sedimentary rock formed of sand grains cemented together.

Conglomerate—a mixture of pebbles of varying sizes and cemented into a rock.

Intruding magma—hot liquid rock leaking up into a series of later rocks.

Metamorphic rocks—rocks which, through heat and pressure and intruding magma, have been changed from their original forms.

Gneiss—banded metamorphic rock with about the composition of granite.

Schist—banded metamorphic rock largely made of a single mineral-like mica.

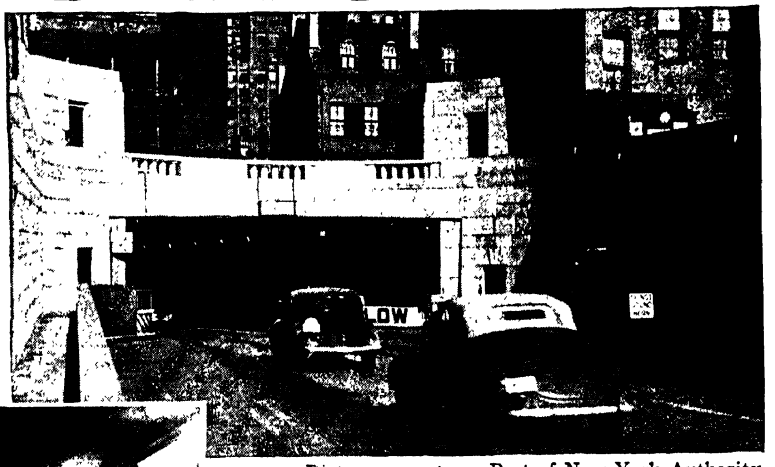
Marble—metamorphosed limestone.

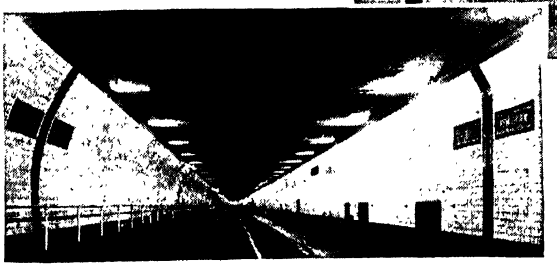
Orthoclase feldspar—common or potash feldspar; orthoclase refers to the way the crystals of such feldspar break.

Rhyolite—a very acid volcanic rock which has the same chemical composition as granite. Rhyolite is really granite in lava form. It consists mostly of silicates.

THE NEXT STORY OF THE EARTH IS ON PAGE 629.

Where Is the Holland Tunnel?





Pictures, courtesy, Port of New York Authority

Entrance to Holland Tunnel. Left, inside the tunnel.

THE most interesting of the world's great tunnels are those which go under rivers. One of the largest of these is the Hudson River Vehicular Tunnel, popularly known as the Holland Tunnel. It is one of the most remarkable engineering feats of our day. It consists of twin tubes 9,250 feet long, each having a roadway 20 feet wide. Traffic, running one way in each tube, is divided into two lanes, one for slow travel and one for fast. Trucks and commercial vehicles are usually sent on the slow lane so that passenger traffic need not be held to their rate of speed.

Before the tunnel was built, the only way in which a motorist could cross from New York to New Jersey, or vice versa, was by driving the car on a ferry and being ferried across the river. This was very slow both because a boat does not travel fast and because a ferry can carry only a few cars at a time. Traffic would collect at the dock and have to wait in line for the next boat, and on popular driving days, such as Sundays and holidays, it would sometimes be necessary to wait for hours to be taken across. It can easily be seen what a great help the tunnel is, as an automobile can go through in a few minutes.

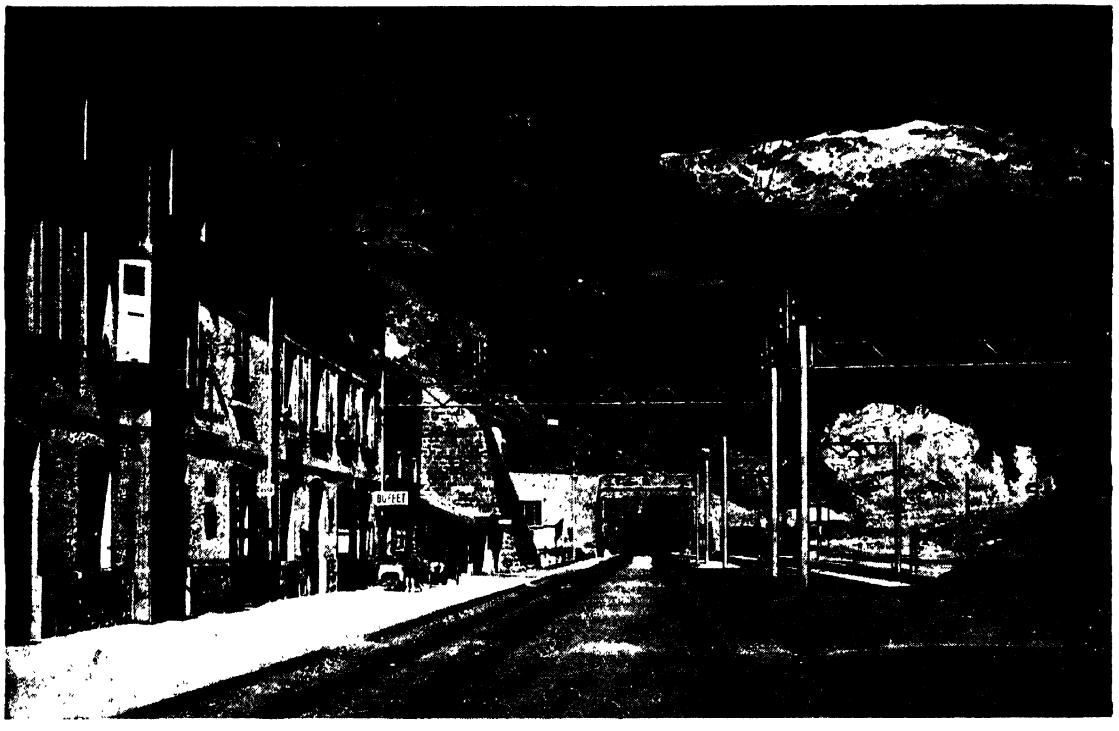
The construction of such a long underwater tunnel involved many engineering problems, chief of which was the difficulty of keeping the tunnel free of the poisonous gases discharged from the motors. After many experiments, this was accomplished by building four ventilating stations, one at each end of the tunnel, one in the river near the New York side, and the other in the river near the New Jersey side. Fresh air is forced, by means of ventilating fans at each of these stations, into the tunnel through a lower air duct, from which it passes into chambers on each side of the roadway and then into the roadway itself. The fresh air causes the exhaust gases to rise and by suction they are carried off through the openings at the top.

Lined with white glazed tiles, kept beautifully clean, the interior presents a very pleasing appearance. Along one side is a narrow railed walk where watchmen are on duty at all times of the day and night to direct traffic and to help any motorist who is forced to stop.

The tunnel was named in honor of Clifford M. Holland, the chief engineer who successfully planned and directed the work until his death, when the tunnel was nearing completion. It was first opened November 13, 1927. Over 52,000 automobiles passed through it on that day.

It was not long before traffic between New York and New Jersey grew too heavy for the Holland Tunnel to serve all of it. On October 25, 1931, the great George Washington Bridge was opened (see page 30), and in December, 1937, another tunnel, the Lincoln, began to take some of the stream of cars. On the pages that follow we show you pictures of various kinds of tunnels.

TUNNELS THROUGH THE ALPS



The southern end of the nine-mile Lötschberg Tunnel, in Switzerland. Other famous tunnels under the Alps are the Mont Cenis, about 8 miles long; St. Gotthard, 9¼ miles; Simplon, 12¼ miles; and Arlberg, 6⅛ miles.

Pictures, courtesy, Swiss Federal Railroads, upper photo, E. Gyger

An electric train coming from the northern end of the St. Gotthard Tunnel at Göschenen, Switzerland. The southern end is near Airolo, Italy. This tunnel is more than 3,600 feet above sea level.

STEPS IN MAKING A TUNNEL

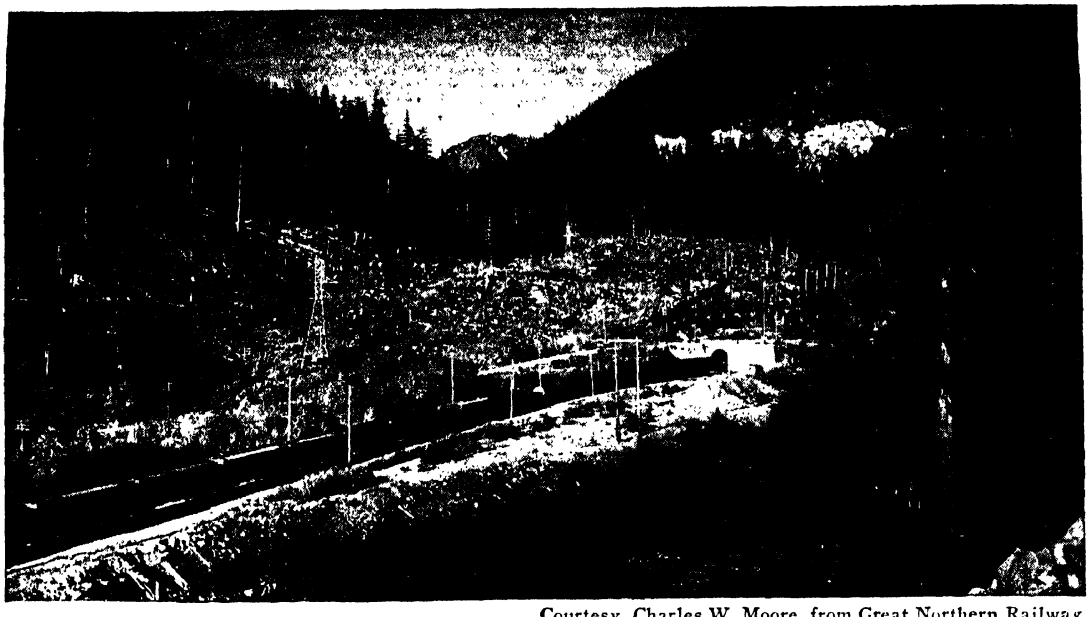
Courtesy, Chesapeake and Ohio Railway Company

New and old Blue Ridge Tunnels of the Chesapeake and Ohio Railroad near Afton, Virginia. At the left you can see cars loaded with muck coming out of the new tunnel, which is being dug.

Courtesy, U.S. Department of the Interior

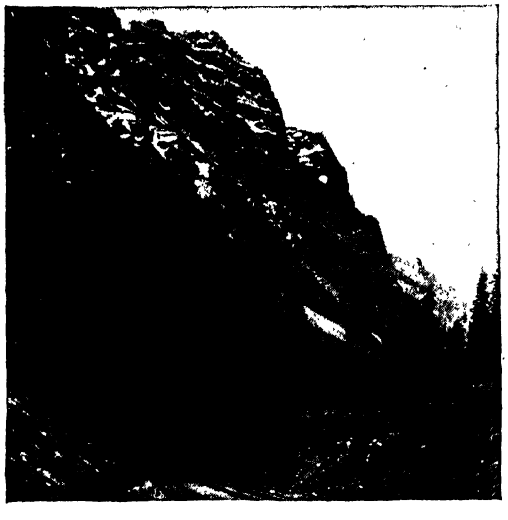
Gunnison Tunnel under the Rocky Mountains, in Colorado. Concrete is being placed along the side walls. The platform on which the men are working is 8 feet above the tunnel floor. This is a 6-mile tube for carrying water.

TUNNELS IN WESTERN NORTH AMERICA



Courtesy, Charles W. Moore, from Great Northern Railway

The longest tunnel in America is the Cascade, in Washington, which bores through the Cascade range of the Rockies for 7.8 miles.



Courtesy, Paul Standard and Canadian Pacific Railway

Connaught Tunnel under Rogers Pass, in the Selkirk Range, British Columbia, is 5.02 miles long. This tunnel was completed in 1916.

Courtesy, Denver and Rio Grande Western Railroad

Moffat Tunnel, 6.11 miles long, is under *James Peak, in Colorado. Shown here is* the East Portal (entrance).

TUNNELS BORED BENEATH RIVERS

Courtesy, Detroit Convention and Tourist Bureau

Most famous tunnels under mountains are for railway trains. Another kind of modern tube is the vehicular tunnel, by which motor cars, trucks and busses run under rivers. Above is the Detroit-Windsor Tunnel, showing where the boundary line between Canada and the United States passes under the Detroit River.

Courtesy, New York City Tunnel Authority

Right, the two tubes of the Queens Midtown Tunnel which runs under the East River between the boroughs of Queens and Manhattan, New York City.

Courtesy, British Information Services

The great Mersey Vehicular Tunnel connecting Liverpool and Birkenhead, England. It is more than two miles long.

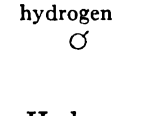
HOW ATOMS COMBINE TO FORM MOLECULES

AND MOLECULES GROUP TO FORM SUBSTANCES

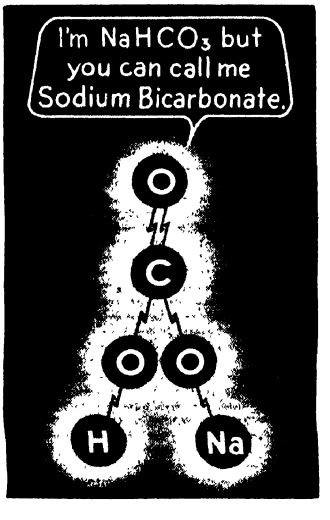
THE buildings in a city are usually made of brick or wood or steel or stone. Yet it is not these materials that give a city its character, but rather the way in which the materials are put together to form the buildings. In much the same way in science, the nature of a material—bicarbonate of soda, for example—is not determined so much by the kinds of atoms it contains, but rather by the groups into which these atoms are arranged. These groups are called molecules.

The atoms correspond to the wood and brick of a building, the molecules to the buildings themselves.

A molecule of bicarbonate of soda contains six atoms—one of sodium, one of hydrogen, one of carbon, three of oxygen. Once these six have joined together (combined) they stay together as a unit, unless some violent disturbance, such as great heat, causes them to separate. In combining, atoms obey laws called rules of valence. An atom's valence can be thought of as the number of hooks it has, by means of which it holds on to other atoms. Look at the atomic ingredients for a molecule of sodium bicarbonate:



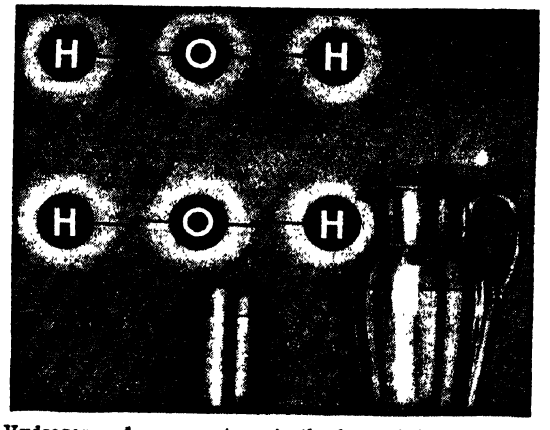
Hydrogen and sodium have a valence of 1—one hook for each atom; oxygen has a valence of 2—two hooks; carbon has a valence of 4—four hooks.



When two or more different kinds of atoms join together (combine) to make a molecule, we call the new substance a compound. Some molecules contain only a few atoms; others, particularly those built around carbon, may contain thousands of atoms. But even the biggest molecule is much too small to be seen, except indirectly with that powerful instrument, the electron microscope. It is hard to imagine how small molecules are.

It is also hard to imagine how many molecules there are in the world—even how many

molecules of just one substance. Take water, for example. A water molecule, H_2O, consists of two atoms of hydrogen joined to one atom of oxygen. This is true whether the water molecule is in the form of ice or of liquid or of vapor. The following story, which is attributed to the English physical chemist Aston, may give you some idea of how numerous water molecules are. Suppose you were able to take every molecule separately from a glass of water, and tie a tag on each. Then put them all back into the glass. Now pour the glass of water down the drain. It will mix with other water in the sewers and rivers, and eventually find its way to the sea. Some of the original water molecules will evaporate and be carried by the wind all over the world. They will fall as rain. After a very long time the molecules from your glass of water will be thoroughly mixed with water all over the world; every ocean, every river, every lake, will have some. Then go to the nearest faucet and draw a glass of water, and if you count the number with tags you will find several hundred.



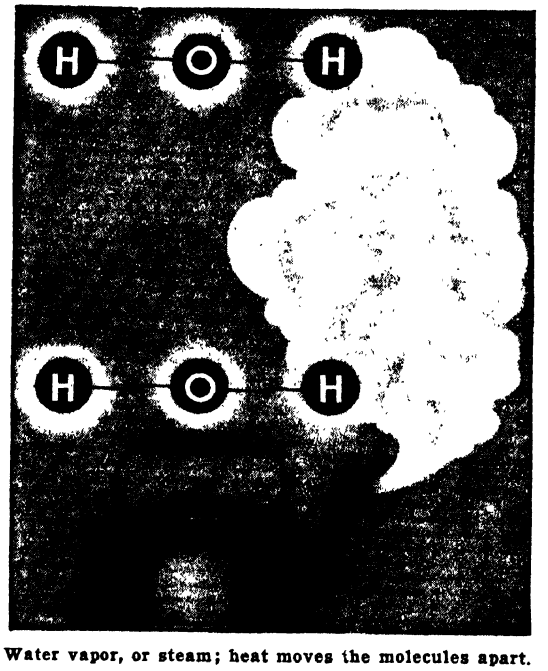
Hydrogen and oxygen atoms in the form of liquid water.

BOTH ATOMS AND MOLECULES ARE HELD TOGETHER BY THE FORCE OF ELECTRICITY

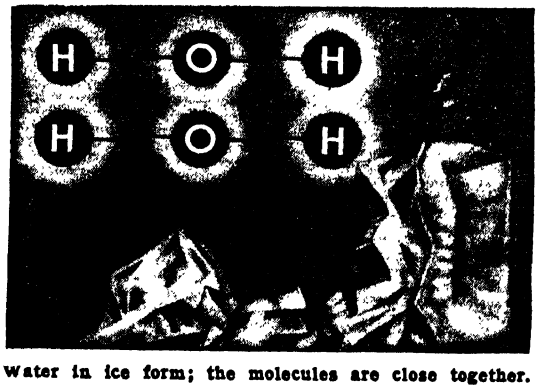
Molecules are not so permanent as atoms. In other words, it is much easier to break up a molecule into its atoms than it is to break up an atom into its particles. The nucleus of the atom resists smashing. In fact, smashing the nucleus of an atom requires an enormous output of energy. We may therefore regard atoms as almost permanent, while molecules continually break up and their atoms combine again.

What is the force that makes atoms combine into molecules? It is the same force as that which holds the particles of atoms in their places—the power of electricity. A hydrogen atom, as you know, has one electron and one proton. Every electron is charged with negative electricity, every proton is charged with positive electricity. The hydrogen atom, having one positive particle and one negative particle, is therefore electrically balanced, or neutral, which is the normal condition of every atom.

However, atoms seem to strive also for another kind of harmony in their relations with atoms of other elements. If the shells are not full of electrons, the harmony is not complete. The "odd" electrons (electrons in a shell that is not full) will either attract electrons from other atoms, or will themselves jump over into other atoms. This



Water vapor, or steam; heat moves the molecules apart.

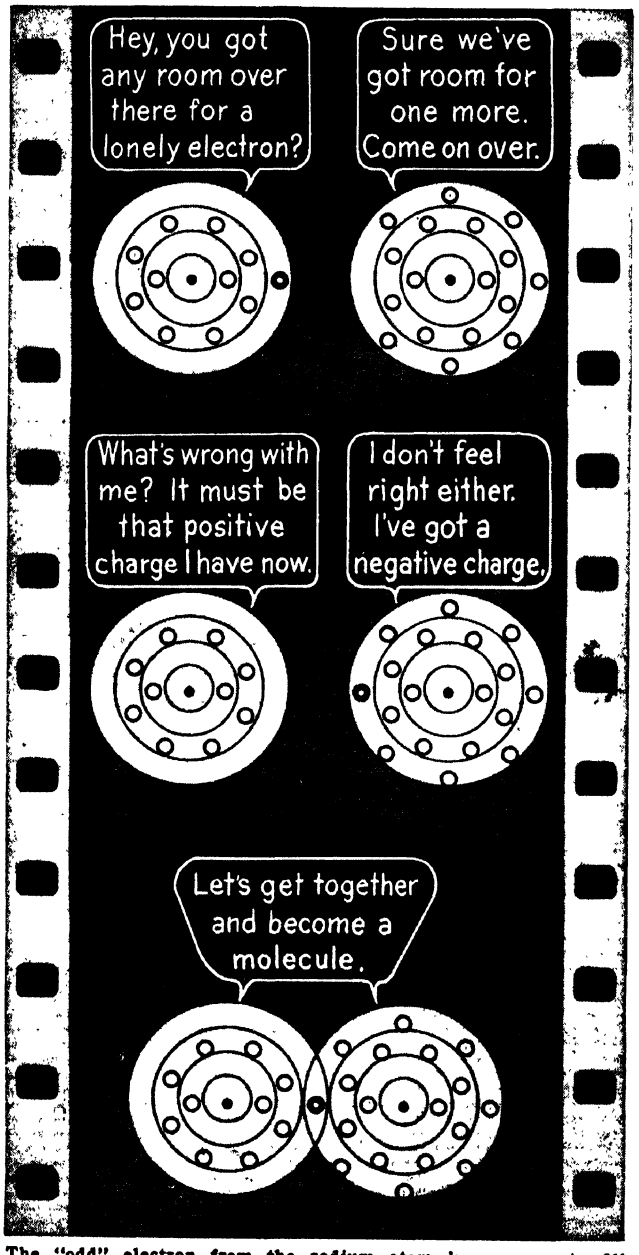


Water in ice form; the molecules are close together.

is what valence is. The "odd" electrons are called valence electrons.

Now let us go back to the hydrogen atom. The inner shell—K shell—of every atom has room for two electrons; yet the hydrogen atom contains only one electron. Therefore when a hydrogen atom gets near enough to another atom with an incomplete shell, it may attract an electron from that other atom. This will mean that the hydrogen atom has a larger negative electron charge than the positive charge in its nucleus; and the other atom, which has lost an electron, will have a larger positive charge than its negative electrons can now balance. So those two atoms will be held close by simple electrical attraction, and the two together will be electrically balanced or neutral. That combination is a molecule.

Salt is a simple example of such a molecule. It is made up of sodium and chlorine, each of which has valence 1. Sodium has 11 electrons—2 in the K shell, 8 in the L shell and 1 in the M shell (which could hold 8). Chlorine has 2 electrons in the K shell, 8 in the L shell, and 7 in the M shell (which could hold 8). Therefore the one odd electron from sodium jumps across to fill the incomplete shell of the chlorine.



The "odd" electron from the sodium atom jumps over to fill the outer ring of the chlorine atom. This makes the chlorine negative and the sodium positive. Electrical attraction moves the two together to form a molecule of salt, NaCl.

Now you can understand why helium, neon, and argon are noble gases, and will not combine. Let us refer to the table of elements on page 148. Helium has 2 electrons. Its K shell is full and it has no other shells. It has no odd electrons. Neon has a full K shell (2 electrons) and a full L shell (8 electrons). Argon has a full K shell, a full L shell and a full M shell—18 electrons in all.

Now look at carbon, in the table of elements. It has 6 electrons—2 in the K shell and 4 in the L shell. The L shell could hold 4 more electrons, and so we say carbon has valence 4. The molecules of which living things are composed—trees and flowers, men and animals—are extraordinarily varied and complex. But they are all alike in one respect. They all contain carbon atoms. *The study of carbon compounds* (molecules containing carbon) *is called organic chemistry. That part of chemistry which deals with metals and other elements that do not occur in large proportions in growing things is called inorganic chemistry.*

One reason for the importance of carbon lies in the fact that it has a high valence—it can combine with atoms having valence 1 or 2 or 3 or 4. It can make combinations in any num-

ber of different ways. We shall explain these things more fully in the later chapters of our work when we come to chemistry. The purpose of this article is to show you how atoms of the ninety-odd different elements combine to form molecules of other substances, in somewhat the same manner as bricks and wood and stone are combined in buildings.

Now we must say a little about molecules coming together. They are not held tightly by electrical power, but herded together, attached more closely in solids, less closely in liquids and not attached to one another at all when matter is in the freely moving state we call a gas.

Wax from a burning candle will stick to a glass candlestick. This demonstrates the force of adhesion—dissimilar molecules sticking together.

It is fun to climb a tree, except when someone shakes it violently. Then you are likely to lose your hold. Stating this in a scientific way, we say that both you and the tree have so much energy of motion that your arms are too weak to hold you in position. It is the same way with molecules. When they have too much energy, they tend to stay apart, as in a gas. When they have very little energy, they stay together, as in a solid. *Increase of heat means increased energy of motion.* That is why ice or sugar can be melted merely by application of gentle heat. The heat causes the molecules to break away from other nearby molecules.

Although the forces which hold molecules together are not very strong, nevertheless if a lot of them have to be pulled apart at once, quite a large force may be needed. When a piece of ice is to be broken without being melted, the molecules on one side of the break have to be pulled away from the molecules on the other. Some substances break easily, others with difficulty, so the forces holding molecules together must vary in strength with different kinds of molecules. The amount of pressure which a soap bubble will stand depends on what kind of soap and how much is used in the soap solution.

Some molecules stick very tightly to other molecules of different kinds. When a drop of paraffin wax, such as is used for covering the top of jelly, is put on a piece of clean glass, it sticks very tightly and you have a difficult task to scrape it off. On the other hand, a drop of water on a block of paraffin does not stick at all. It will roll off if the paraffin is tilted a little—because water molecules will not adhere to molecules of wax. *The force which causes similar molecules to stay together is called cohesion; the force which causes dissimilar molecules to stick together is called adhesion.* In glue, adhesion is stronger than cohesion. In mercury, cohesion is very strong, and there seems to be no property of adhesion at all.

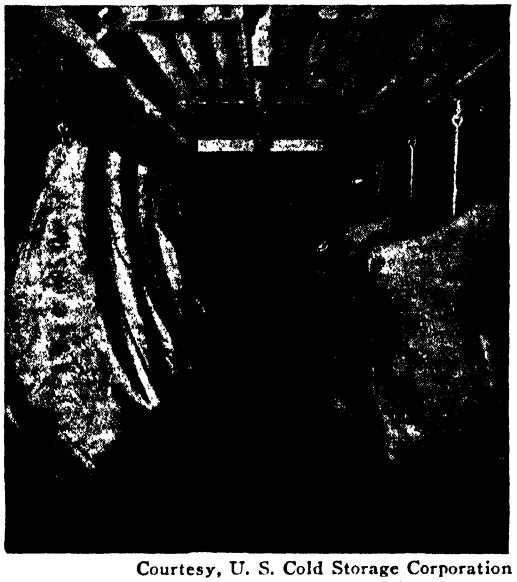
Particles of mercury—the silvery liquid in a fever thermometer—stick to each other closely, but not to the container. This is cohesion.

By THOMAS H. OSGOOD.

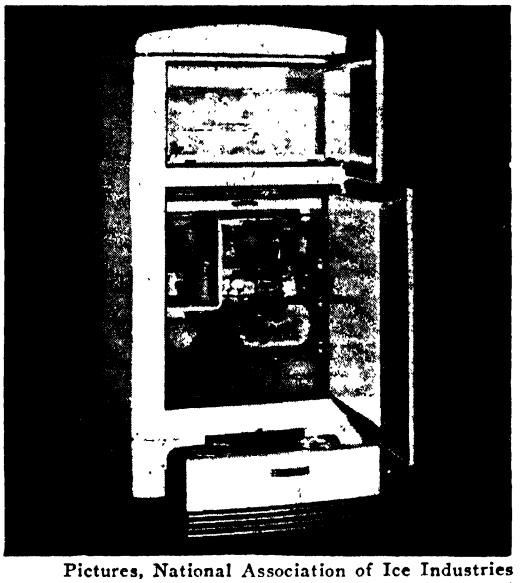
THE NEXT STORY OF SCIENCE IS ON PAGE 609.

HOW FOOD IS PRESERVED BY COLD

Meat in a show counter is kept fresh by ice chopped into small pieces by means of a machine.



Courtesy, U. S. Cold Storage Corporation



Pictures, National Association of Ice Industries

The picture on the left shows how meat is kept in a cold-storage room, where it is 15 degrees below zero! In the right-hand picture we see the arrangement of the food compartments in a modern domestic refrigerator.

Courtesy, Locker Publications Company

A locker room in a community frozen food centre. Each patron has his own locker. After food has been put through the quick-freezing process at the centre, it is kept in these lockers until it is to be used.

ICE
AND MACHINES THAT MAKE COLD

Courtesy, Houdaille-Hershey Corporation

Cutting ice by hand in the good old days. The sled in the background is carrying off the cut blocks of ice.

HAVE you ever stopped to think what a difference ice makes in our comfort and in our health? In the icebox the butter is hard, the milk sweet and cool, the lettuce crisp and tender, the dessert firm, and the meat for the next dinner does not spoil. Then too, there are ice cream, soda water and lemonade, and perhaps some of you are allowed to have iced tea. When you go to the market with your mother, you see the butcher bring out the meat from an icebox as large as a room, perhaps, and you see the fish lying on ice, or you may select quick-frozen foods from a special refrigerated cabinet kept very cold, at about zero degrees F. You have read that the meat and the fish are brought to market in cars or ships which are themselves iceboxes.

Furs and woolens may be kept free from moths in the summer if they are stored in specially made cold rooms. Many of our theatres, stores and other public buildings, and a few private homes and also some trains are cooled in summer by what we call air conditioning. Air conditioning is also used in many factories to get a better finished product or to speed up the process of manufacture. In this article we read about the way in which we get ice, and about the machines that make cold.

If you live in the country or in a little town in Canada or the northern part of the United States, perhaps you have seen men cutting ice and storing it in small icehouses during the winter for use during the summer; but the ice for a great city can seldom be gathered so easily, for there is not always near by a body of pure water large enough to furnish a sufficient quantity of ice.

In former years most of the ice used even in large cities was natural ice that came from near-by rivers and ponds. A large natural-ice industry existed which cut and stored the ice during the winter and brought it to the city when it was needed. New York City, for example, got much of its ice from the shallow upper reaches of the Hudson River. Hundreds of men and horses, dozens of large icehouses and scores of boats were needed to handle the crop. Only in the northern winters, however, does natural ice get thick enough to be cut for use.

Ice used to be a very rare luxury in the tropics. Once in a great while a few precious shiploads were sent to India and other parts of Asia, and Rudyard Kipling tells us how it was doled out in pieces no larger than a walnut. Formerly large cargoes of natural ice were also shipped from the North to Southern ports in the United States, but the waste through melting was so great that ice was very expensive in Southern towns.

To-day all that has changed. Ice is made wherever it is used, no matter how hot the climate may be. We can hardly imagine what housekeeping would be like without ice. Our whole system of supplying large cities with fresh foods depends on the use of cold-storage rooms and of railroad cars and ships which are great traveling cold-storage rooms. We tell you more about cold storage in the story, Ways of Preserving Food, which begins on page 2169. Now let us see how the miracle of abundant ice has come to pass. There are several methods of making ice. One of them, which we shall describe in this chapter, is based upon evaporation.

First of all, let us understand what a cold-making machine must do. It has a hard

Courtesy, National Association of Ice Industries

A modern ice-cutting machine. A certain amount of ice is still cut from frozen ponds and lakes and the upper courses of rivers in winter.

job, for heat is found in nature oftener than cold; it is more difficult and more expensive to get a cold temperature than to get heat. Cold is the absence of heat. So our machine simply takes heat away from a box or a room, or a vessel of water. If it takes enough heat from the water, the water becomes ice. Then the ice takes heat from its surroundings and in doing so, of course, melts. In fact, when a substance changes from solid to liquid, or from liquid to gas, it absorbs much heat. If you have ever spilled alcohol on your hand, or have had your mother bathe your aching forehead with camphor (which is simply solid camphor dissolved in alcohol), you will understand this. As the alcohol evaporates—that is, changes to gas—it takes the heat from your skin and makes your skin feel cooler.

There are a number of substances which, while they are liquids under pressure, will change to gases at low temperature if the pressure is removed. One of the cheapest of these is called anhydrous ammonia, which will evaporate—that is, change to a gas—at a very low temperature, if placed in an open vessel. Under heavy pressure it becomes a liquid but struggles to resume its gaseous form. Anhydrous means without water.

Here is the secret of one of the most common methods of ice-making. Anhydrous ammonia is allowed to flow slowly into pipes where it has room to expand into a gas. These pipes pass through a great tank of brine. In changing to a gas the ammonia absorbs the heat from the brine and makes it very cold. As salt water freezes at a lower temperature than fresh, the brine does not freeze. But if cans of fresh water are placed in the brine, the heat will be taken from them, and in about forty-eight hours water in a can 50 inches long, 22 inches wide and 11 inches thick become solid ice. Air is blown through ice during freezing to make it transparent and free from taste.

The pictures on page 532 show this method of ice manufacture. The cans of water are frozen solid in cold brine; then they are drawn from the brine and are dipped into warm water to loosen the ice blocks. The loose blocks slide out and the cans are ready to freeze other blocks.

The ammonia gas, after it has passed through the pipes in the tank of brine, is again compressed, and it becomes hot in the process. The pipes full of the compressed ammonia are arranged so that cool water runs over them, and the ammonia, cooling, becomes a liquid and is used again as before. So the process goes on day and night.

All city water supplies contain dissolved minerals. Ice frozen from this water would be white and have an objectionable flavor if steps were not taken to remove the minerals as the ice freezes. Because of this fact ice was made with distilled water for many years. Then it was discovered that a stream of air bubbling up through the can would prevent the minerals in the water from freezing into the ice. The rising bubbles keep the water in rapid motion and hold the dissolved minerals in the unfrozen water. The ice remains clear as it freezes, from the sides of the can inward. When nearly all the water is frozen the remaining one or two gallons in the core of the block are drawn off with the minerals they contain and fresh water is put in to complete the freezing.

After the ice blocks are removed from the cans they are stored in a room at a temperature below freezing (thirty-two degrees F.) where the walls, floor and ceiling are well insulated to keep heat out.

ICE AND MACHINES THAT MAKE COLD

You have heard of cold-storage warehouses, and perhaps know that fruits, vegetables, meat, fish, eggs and other foods are kept in them, sometimes for months. The plan is very simple. A warehouse is built with walls so made that they are poor conductors of heat; the heavy doors fit very tightly. The walls of warehouses, like those of a refrigerator, are built of poor conductors called insulation; cork is the commonest material used for this purpose, but redwood bark, steel metal sheets, fibre glass and other materials are also used. The rooms may be cooled in different ways. Sometimes brine is cooled in the way you have been told, and it is then pumped through pipes which pass through the storage rooms. The brine takes up the heat from the air, and after it has finished its journey, comes back to a tank, where it gives up its heat, and so makes the journey over and over again.

Sometimes the brine-pipes do not pass through the rooms, but are arranged in coils outside, and fans drive air, which has been cooled by passing over the brine-pipes, into the storage rooms. In a few cases the ammonia-pipes pass through the rooms.

To keep the food in good condition the cold-storage rooms have special means to control the moisture in the air and the air circulation as well as the temperature. Many of the products are stored in a frozen state, while others are held at just above their freezing points. Since we have been using frozen foods in larger quantities, cold-storage warehouses have had to install new machinery to keep some rooms as low as zero degrees F. for this purpose.

Ice refrigerators have been in use in homes for almost a century. During the past few years their design and construction have been greatly improved. Most of them are equipped with modern devices which can produce ice cubes in a short time and make smooth frozen desserts easily and quickly.

Since about 1925 home refrigerators containing small machines have become very popular. (See the diagram on page 535.) Most of them work on the very same principle as large refrigeration plants. A small electric motor compresses the refrigerating gas (ammonia, sulphur dioxide, methyl chloride, or other especially developed compounds such as the Freon group of refrigerants). The compressed gas passes to the condenser where it is cooled by water or air and becomes a liquid. Then it is conducted in pipes to the freezer coil inside the refrigerator. There it changes back into a gas, taking up much heat in the process. In fact, it sucks up heat much as a sponge sucks up water. This heat is taken by the gas as it

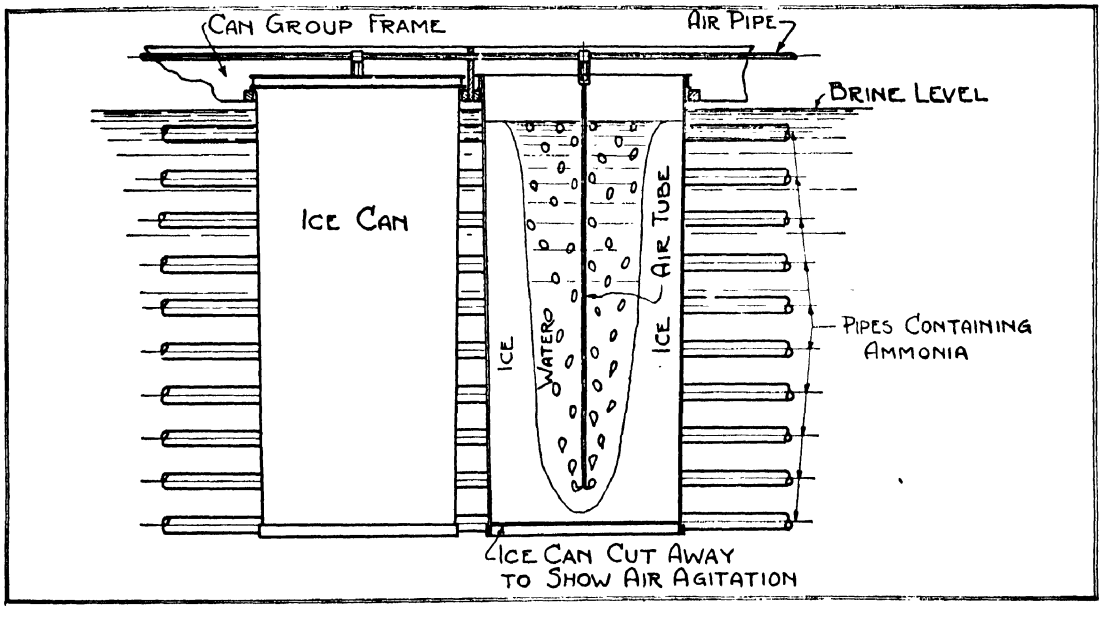
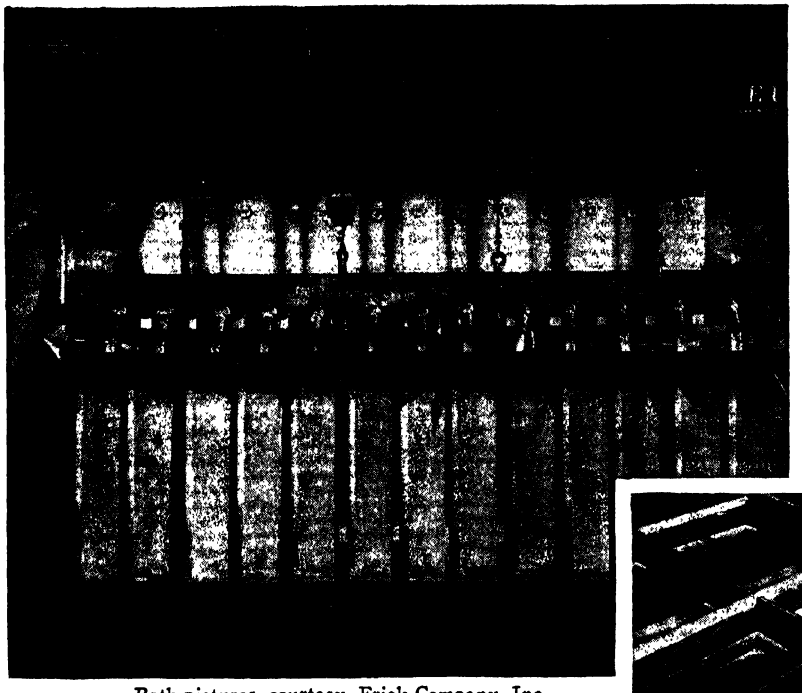
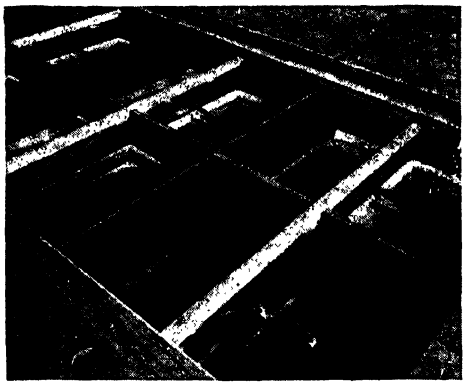


Diagram showing how cans of water are frozen in a brine tank. The liquid ammonia passing through the pipes shown here expands and becomes a gas. In so doing it absorbs heat from the brine and makes it very cold. The water in the can, therefore, is frozen solid, as the can is completely surrounded by brine. The air pipe in each can blows air into the water while it is freezing. This produces transparent ice (ice that one can see through).

HOW ICE BLOCKS ARE MADE





Both pictures, courtesy, Frick Company, Inc.

The above picture shows water flowing from pipes into cans. The cans, each containing 300 pounds of water, are then lowered into the ice-freezing tank, filled with brine. Here the water is frozen solid. At the right we see some cans of water in the ice-freezing tank. The small tubes in each can blow air into the water while it is freezing. This produces clear or transparent ice.

Courtesy, National Association of Ice Industries

At the left of the illustration we see the cans full of ice blocks that have been recently frozen in the tank filled with brine. These cans are about to be dipped in hot water, so that the blocks of ice may be removed easily from the cans. After being dipped in the hot water, the cans are lifted by the traveling crane shown at the extreme left of the picture; they are turned over and the ice blocks come sliding out. The blocks then go down the incline shown in the picture and out into the ice-storage room shown elsewhere in this article.

goes back to the compressor to begin the cycle all over again, and it is this heat which is carried away in the condenser.

Most of these refrigerators are beautifully finished in white porcelain and require only a small amount of electric current and very little attention. They help to make housekeeping more pleasant and efficient. Inside the freezing compartment are several trays in which the familiar little ice cubes can be frozen, or where frozen desserts may be prepared. Refrigeration engineers are continually working on designs for more convenient refrigerators. The newest ones are now being built with special compartments for freezing foods and storing frozen foods, and with other improvements.

Another principle of refrigeration is the absorption process which actually freezes by means of heat. A tiny gas flame in the generator heats a mixture of ammonia and water. The ammonia is driven off as a gas and turns into liquid ammonia in a water-cooled or air-cooled condenser. The liquid ammonia is allowed to turn back into gas inside the evaporator, which is located inside the icebox. In doing so the ammonia takes up heat, just as in the other machines. To keep the pressure constant the ammonia gas is mixed with hydrogen gas and then separated again and taken up by the weak ammonia solution from the bottom of the generator.

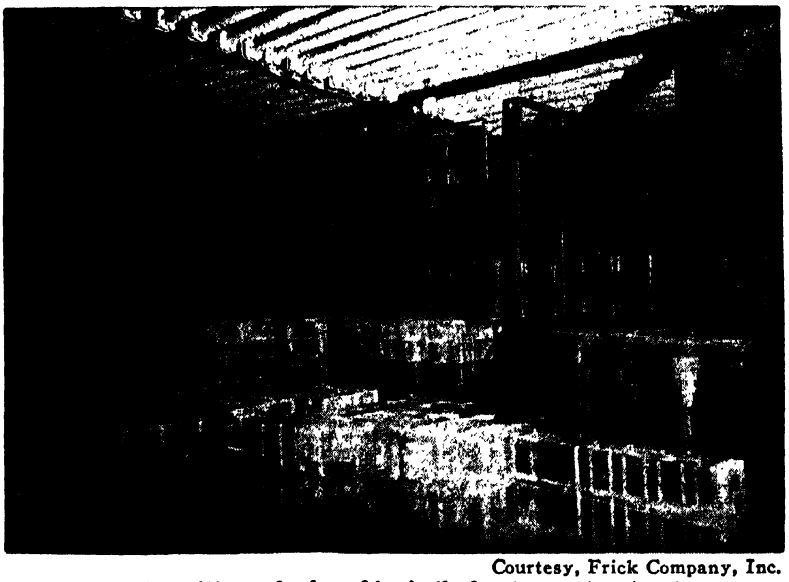
This is done in the absorber. The tiny gas flame which drives off the ammonia from the generator likewise "bubbles" the ammonia solution, which is now very strong, to the top of the generator again. In this manner a single gas flame—a very tiny one, too—will keep the refrigerating device operating for an indefinite period of time. Kerosene or electricity may be used, instead of gas, in order to furnish the heat that is required to run the refrigerator. The absorption process that we have just described was originally developed in Sweden by two brilliant young students of science—Baltzar von Platen and Carl G. Munters. It operates without a sound. It should be added, however, that the mechanical refrigerators which use electric motors are almost noiseless now.

Perhaps your mother sometimes has ice cream delivered to your home in a neat parcel, with a mysterious small frosty pellet which keeps it cold for many hours. This frosty pellet has several trade names; dry ice is the most descriptive. It is the solid form of carbon dioxide gas.

When ice made from water comes in contact with warm air, it melts into water again. When dry ice comes into contact with warm air, it thaws into its original gaseous state. But the process is very gradual, for dry ice is much colder than water ice. It has a temperature of about 110 degrees F. below zero. In thawing, it absorbs twice as much heat as an equal amount of melting water ice. Moreover, as it thaws into gas it expands and forms a thick protecting cloud about the article near which it has been packed, so that the air, which is lighter, can not get through. The refrigerating capacity of dry ice is, for these two reasons, said to be about ten times that of water ice.

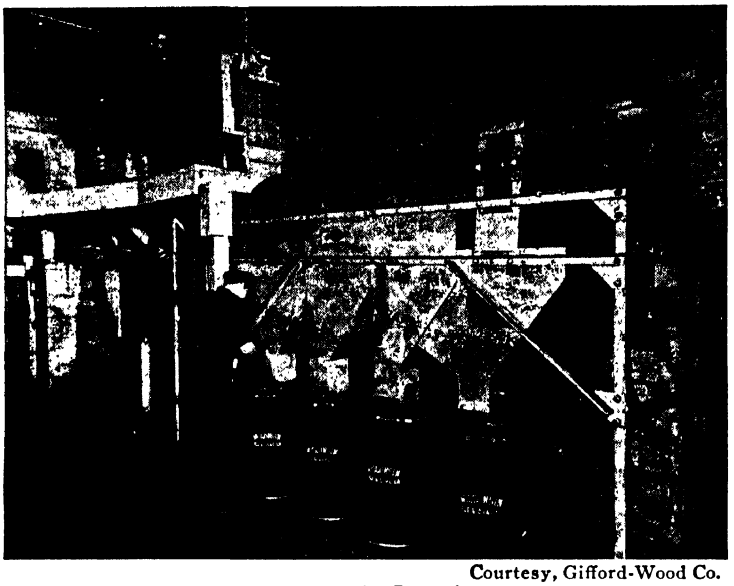
Dry ice really is completely dry, and therefore can be used for packing foods that are going on long distances by parcel post. Its use in shipping perishables and its value in hot countries can not be overestimated.

Early man living in temperate climates certainly knew that food did not spoil so



Courtesy, Frick Company, Inc.

This picture shows 300-pound cakes of ice in the low temperature ice-storage room of a modern refrigerator plant. These big ice blocks have been frozen in the brine-filled tanks described elsewhere in this article.



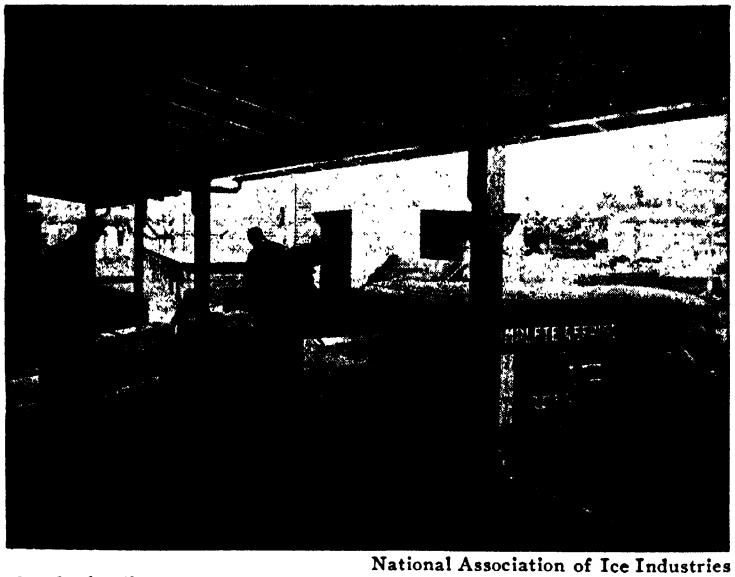
Courtesy, Gifford-Wood Co.

Making sized ice (ice in small sizes). Ice cakes are fed into a machine where the ice is crushed into small pieces of varying sizes. These are separated by means of a revolving screen, having meshes that range from fine to coarse. The pieces are fed into bags after being screened.

rapidly in winter as in summer. However, it was the famous English philosopher, Lord Francis Bacon (1561–1626), who may be said to have started the idea of cold storage. He stuffed a hen with snow to test the idea that cold would preserve food, but he died shortly after the experiment. It was more than 200 years before the world knew why cold will preserve food. The reason is that harmful bacteria can not thrive and multiply in temperatures less than 40 degrees or 50 degrees Fahrenheit. That is why our refrigerators should be kept at less than 50 degrees. At 32 degrees the food would be injured by freezing, therefore the refrigerator temperature should be above 32 degrees. As you know, there is today a method of freezing foods quickly which does not injure them, and which permits them to retain the vitamins which all of us need to keep healthy.

Air conditioning, properly speaking, includes heating buildings, trains and ships in cold weather, cooling them in warm weather, and supplying them with a constant circulation of fresh, clean air that is neither too moist nor too dry. Air conditioning is important not only in the buildings where we live and work; it is also used in industry, in textile mills, for instance, where a certain amount of moisture in the fibres is needed to give the yarn strength and the cloth high quality. Chocolates and some other candies need dry rooms. So do photographic films and other products such as airplane wings (after being "doped"). Air conditioning is also used in "stratosphere" chambers, where the temperature can be changed from 110 degrees F. to 50 degrees below zero in a few minutes, exactly as if the airplane had flown from the ground to a great height. Instruments, the reaction of pilots and the motors can thus be tested with the airplane never moving off the ground.

The history of heating is an old one beginning with a simple fire which primitive man built in the open. When houses were first built for shelter, there was a place for



National Association of Ice Industries

Ready for the consumer at last.—Loading ice delivery trucks with blocks of ice at the loading platform of a large-size refrigerating plant.

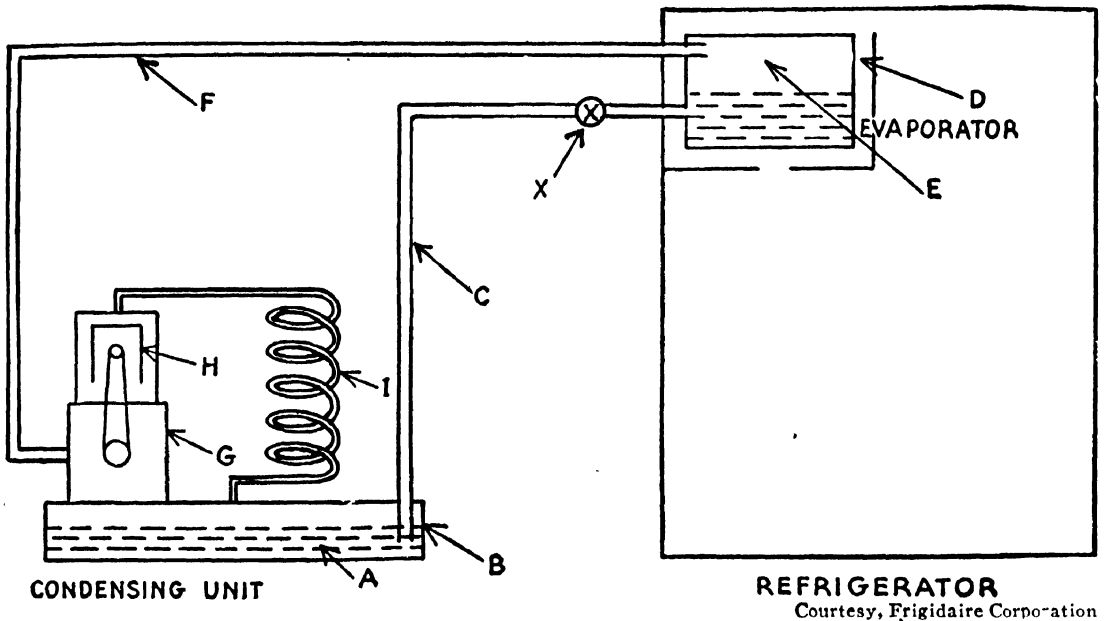
a fire in the centre, and the smoke escaped through a hole in the roof. Chimneys with fireplaces came next, and then stoves. One type of stove was invented by Benjamin Franklin, and it is in use to-day, although furnaces of various types are more common. In some places a central heating plant is used for several buildings. Hot air, steam, hot water, vapor or vacuum heating methods are in use to-day. Coal, petroleum and gas are the fuels most generally burned.

It is necessary with any system to have good ventilation for, otherwise, we should be poisoned by the foul air. In the house, it is nearly always possible to have a window open in the room where we are, or in an adjoining room, but good ventilation is not secured so easily in office buildings or in theatres or auditoriums where people gather in large numbers. Two systems have been used in such places—one, drawing out the impure air, known as the aspirating system; and the other, forcing fresh air in by means of blowers. This is called the plenary system.

Even though a room has the proper temperature and fresh air is coming in, sometimes our throats feel dry. This is because there is not enough moisture in the air. In most places to-day, the fresh air which is forced in by the plenary system, mentioned above, has been given a certain amount of moisture, too.

Air conditioning has been used in industry since about 1906; mechanical cooling systems in homes, theatres and trains have been known since 1922. Now it is possible to have your house cooled from a central plant or have a small cooling unit in one room. In the larger units a current of cool, clean air is sent through the building, absorbing heat as it travels; it comes back to the machine from which it started and is there washed, cooled and dehumidified (some of the moisture taken out). Then it is sent on its way once more through the house or theatre or train or ship. The air is actually washed by sending it through a spray of cold water. This also cools it. The water is cooled with ice or by a refrigerator built on the principle of a cold-storage machine.

In the smaller room units the heat is removed directly from the air in the room by the evaporation of Freon or some other substance in coolers that are set where the air will pass over them.



Courtesy, Frigidaire Corporation

This diagram explains the principle of mechanical refrigeration. The refrigeration medium (A), in liquid form and under pressure, travels from the tank (B) through the pipe (C) and the control device (X) to the evaporator (D). Here the pressure is released and the liquid becomes a gas. As it expands, it grows very cold and draws heat from the refrigerator. The gas (E) is drawn through the pipe (F) into the crankcase (G) of the compressor by the piston (H). This same piston compresses the gas into the condenser coil (I). As the gas is compressed, its temperature rises and this heat is carried away by water or air passing over the coil. At the same time the gas turns into a liquid again and flows back into the tank (B). The operations described above are then repeated, and the same process goes on indefinitely or, rather, as long as the compressor is working. This diagram shows direct refrigeration, generally used in household electric refrigerators.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 633.

A hare would often come jumping along, and spring right over the little Fir Tree.

The Discontented Fir Tree

By HANS CHRISTIAN ANDERSEN

OUT in the forest stood a pretty little Fir Tree. It had a good place; it could have sunlight; air there was in plenty; and all around grew many larger comrades—pines as well as firs. But the little Fir Tree wished ardently to become greater. It did not care for the warm sun and the fresh air; it took no notice of the pleasant children, who went about talking together, when they came out to look for strawberries and raspberries. Often they came with a whole pot-full, or had strung berries on a straw; then they would sit down by the little Fir Tree and say, "How pretty and small that one is!" But the Fir Tree did not like to hear that at all.

Next year he had grown a great joint, and the following year he was longer still, for in fir trees one can tell by the number of rings they have how many years they have been growing.

"Oh, if I were only as great a tree as the others!" sighed the little Fir, "then I would spread my branches far around, and look out from my crown into the wide world. The birds would then build nests in my boughs, and when the wind blew I could nod just as grandly as the others yonder."

It took no pleasure in the sunshine, in the birds and in the red clouds that went sailing over him morning and evening.

When it was winter, and the snow lay all around, white and sparkling, a hare would often come jumping along, and spring right over the little Fir Tree. Oh! this made him so angry. But two winters went by, and when the third came the little Tree had grown so tall that the hare was obliged to run round it.

"Oh! to grow, to grow, and become old; that's the only fine thing in the world," thought the Tree.

In the autumn woodcutters always came and felled a few of the largest trees; that was done this year too, and the little Fir Tree, that was now quite well grown, shuddered with fear, for the great stately trees fell to the ground with a crash, and their branches were cut off, so that the trees looked quite naked, long and slender—they could hardly be recognized. But then they were laid upon wagons, and horses dragged them away out of the wood. Where were they going? What destiny awaited them?

In the spring, when the Swallows and the Stork came, the Tree asked them, "Do you know where they were taken? Did you not meet them?"

The Swallows knew nothing about it, but the Stork looked thoughtful, nodded his head, and said:

"Yes, I think so. I met many new ships when I flew out of Egypt; on the ships were stately masts; I fancy these were the trees. They smelt like fir. I can assure you they're stately—very stately."

"Oh that I were only big enough to go over the sea! What kind of thing is this sea, and how does it look?"

"It would take too long to explain all that," said the Stork, and he went away.

"Rejoice in thy youth," said the Sunbeams; "rejoice in thy fresh growth, and in the young life that is within thee."

And the Wind kissed the Tree, and the Dew wept tears upon it; but the Fir Tree did not understand that.

When Christmas time approached, quite young trees were felled, sometimes trees which were neither so old nor so large as this Fir Tree, that never rested, but always wanted to go away. These young trees, which were always the most beautiful, kept all their branches; they were put upon wagons, and horses dragged them away out of the wood.

"Where are they all going?" asked the Fir Tree. "They are not greater than I—indeed, one of them was much smaller. Why do they keep all their branches? Whither are they taken?"

"We know that! We know that!" chirped the Sparrows. "Yonder in the town we looked in at the windows. We know where they go. Oh! They are dressed up in the greatest pomp and splendor that can be imagined. We have looked in at the windows, and have seen that they are planted in the middle of a warm room, and adorned with the most beautiful

things—gilt apples, honey-cakes, playthings and many hundred candles."

"And then?" asked the Fir Tree, and trembled through all its branches. "And then? What happens then?"

"Why, we have not seen anything more. But it was beyond compare."

"Perhaps I may be destined to tread this glorious path one day!" cried the Fir Tree, rejoicingly. "That is even better than traveling across the sea. How painfully I long for it! If it were only Christmas now! Now I am great and grown up, like the rest who were led away last year. Oh, if I were only on the carriage! If I were only in the warm room, among all the pomp and splendor! And then? Yes, then something even better will come, something far more charming, or else why should they adorn me so? There must be something grander, something greater still to come; but what? Oh! I'm suffering, I'm longing! I don't know myself what is the matter with me!"

"Rejoice in us," said Air and Sunshine. "Rejoice in thy fresh youth here in the woodland."

But the Fir Tree did not rejoice at all, but it grew and grew; winter and summer it stood there, green, dark green. The people who saw it said, "That's a handsome tree!" and at Christmas time it was felled before any one of the others. The ax cut deep into its marrow, and the tree fell to the ground with a sigh; it felt a pain, a sensation of faintness, and could not think at all of happiness, for it was sad at parting from its home, from the place where it had grown up; it knew that it should never again see the dear old companions, the little bushes and flowers all around—perhaps not even the birds. The parting was not at all agreeable.

The Tree only came to itself when it was unloaded in a yard, with other trees, and heard a man say:

"This one is famous; we want only this one!"

Now two servants came in gay liveries, and carried the Fir Tree into a large, beautiful living-room. All around the walls hung pictures, and by the great stove stood large Chinese vases with lions on the covers; there were rocking-chairs, silken sofas, great tables covered with picture books, and toys worth a hundred times a hundred dollars, at least the children said so. And the Fir Tree was put into a great tub filled with sand; but no one could see that it was a tub, for it was hung round with green cloth, and stood on a large, many-colored carpet. Oh, how the Tree trembled! What was to happen now? The servants, and the young ladies also, decked it out. On one branch they hung little nets, cut out of colored paper; every net was filled with candy; golden apples and walnuts hung down, as if they grew there; and more than a hundred little candles, red, white and blue, were fastened to the different boughs. Dolls that looked exactly like real people—the tree had never seen such before — swung among the foliage, and high on the summit of the Tree was fixed a tinsel star. It was splendid, particularly splendid.

"This evening," said all, "this evening it will shine."

"Oh," thought the Tree, "that it were evening already! Oh, that the lights may be soon lit up! When may that be done? I wonder if the trees will come out of the forest to look at me? Will the sparrows fly against the panes? Shall I grow fast here, and stand adorned in summer and winter?"

Yes, he did not guess badly. But he had

a complete backache from mere longing, and a backache is just as bad for a tree as a headache for a person.

At last the candles were lighted. What brilliance, what splendor! The Tree trembled so in all its branches that one of the candles set fire to a green twig, and it was scorched.

"Heaven preserve us!" cried the young ladies; and they hastily put the fire out.

Now the Tree might not even tremble. Oh, that was terrible! It was so afraid of setting fire to some of its ornaments, and it was quite bewildered with all the brilliance. And now the folding doors were thrown open, and a number of children rushed in as if they would overturn the whole Tree; the older people followed more deliberately. The little ones stood quite silent, but only for a minute; then they shouted till the room rang; they danced gleefully round the Tree, and one present after another was plucked from it.

"What are they about?" thought the Tree. "What's going to be done?"

And the candles burned down to the twigs, and as they burned down they were extinguished, and then the children received permission to plunder the Tree. Oh! they rushed upon it, so that every branch cracked again; if it had not been fastened by the top and by the golden star to the ceiling, it would have fallen down.

The children danced about with their pretty toys. No one looked at the Tree except one old man, who came up and peeped among the branches, but only to see if a fig or an apple had not been forgotten.

"A story! A story!" shouted the children; and they drew a little fat man toward the tree; and he sat down just beneath it—"for then we shall be in the green wood," said he, "and the tree may have the advantage of listening to my tale. But I can only tell one. Will you hear the story of Ivede-Avede, or of Klumpey-Dumpey, who fell downstairs, and still was raised up to honor and married the Princess?"

"Ivede-Avede! cried some, "Klumpey-Dumpey!" cried others, and there was a great crying and shouting. Only the Fir Tree was quite silent, and thought, "Shall I not be in it? Shall I have nothing to do in it?" But he had been in the evening's amusement, and had done what was required of him.

And the fat man told about Klumpey-Dumpey who fell downstairs, and yet was raised to honor and married the princess. And the children clapped their hands, and cried, "Tell another! Tell another!" for they wanted to hear about Ivede-Avede; but they only got the story of Klumpey-Dumpey. The Fir Tree stood quite silent and thoughtful; never had the birds in the wood told such a story as that. Klumpey-Dumpey fell downstairs, and yet came to honor and married the princess!

"Yes, so it happens in the world!" thought the Fir Tree, and believed it must be true, because that was such a nice man who told it. "Well, who can know? Perhaps I shall fall downstairs, too, and marry a princess!" And it looked forward with pleasure to being adorned again, the next evening, with candles and toys, gold and fruit. "To-morrow I shall not tremble," it thought.

"I will rejoice in all my splendor. To-morrow I shall hear the story of Klumpey-Dumpey again, and perhaps that of Ivede-Avede, too."

And the Tree stood all night quiet and thoughtful.

In the morning the servants and the chambermaid came in.

"Now my splendor will begin afresh," thought the Tree. But they dragged him out of the room, and upstairs to the garret, and here they put him in a dark corner where

no daylight shone. It was a dreary place.

"What's the meaning of this?" thought the Tree. "What am I to do here? What is to happen?"

And he leaned against the wall, and thought, and thought. And he had time enough, for days and nights went by, and nobody came up; and when at length someone came, it was only to put some great boxes in a corner. Now the Tree stood quite hidden away, and one can suppose that it was quite forgotten.

"Now it's winter outside," thought the Tree. "The earth is hard and covered with snow, and people can not plant me; therefore I suppose I'm to be sheltered here until spring comes. How considerate that is! How good people are! If it were only not so dark here, and so terribly lonely—not even a little hare. That was pretty out there in the wood, when the snow lay thick and the hare sprang past; yes, even when he jumped over me; but then I did not like it. It is terribly lonely up here!"

"Piep! piep!" said a little Mouse, and crept forward, and then came another little one. They smelt at the Fir Tree, and then slipped among the branches.

"It's horribly cold," said the two little Mice, "or else it would be comfortable here. Don't you think so, you old Fir Tree?"

"I'm not old at all," said the Fir Tree. "There are many much older than I."

"Where do you come from?" asked the Mice. "And what do you know?" They were dreadfully inquisitive. "Tell us about the most beautiful spot on earth. Have you been there? Have you been in the storeroom, where cheeses lie on the shelves, and hams hang from the ceiling, where one dances on tallow candles, and goes in thin and comes out fat?"

"I don't know that," replied the Tree; "but I know the wood, where the sun shines and the birds sing."

And then it told all about its youth.

And the little Mice had never heard anything of the kind; and they listened and said:

"What a number of things you have seen! How happy you must have been!"

"I?" replied the Fir Tree; and it thought about what it had told. "Yes, those were really quite happy times." But then he told of the Christmas Eve, when he had been hung with candy and candles.

"Oh!" said the little Mice, "how happy you have been, you old Fir Tree!"

"I'm not old at all," said the Tree. "I only came out of the wood this winter. I'm rather backward in my growth."

"What splendid stories you can tell!" said the little Mice.

And next night they came with four other little Mice, to hear what the Tree had to relate; and the more it said, the more clearly did it remember everything, and thought, "Those were quite merry days! But they may come again. Klumpey-Dumpey fell downstairs, and yet he married the princess. Perhaps I may marry a princess too!" And the Fir Tree thought of a pretty little Birch Tree that grew out in the forest; for the Fir Tree, that Birch was a real princess.

"Who's Klumpey-Dumpey?" asked the little Mice.

And then the Fir Tree told the whole story. It could remember every single word; and the little Mice were ready to leap to the very top of the tree with pleasure. Next night a great many more Mice came, and on Sunday two Rats even appeared; but these thought the story was not pretty, and the little Mice were sorry for that, for now they also did not like

it so much as before.

"Do you only know one story?" asked the Rats.

"Only that one," replied the Tree. "I heard that on the happiest evening of my life; I did not think then how happy I was."

"That's a very miserable story. Don't you know any about bacon and tallow candles—a storeroom story?"

"No," said the Tree.

"Then we'd rather not hear you," said the Rats.

And they went back to their own people. The little Mice at last stayed away also; and then the Tree sighed and said:

"It was very nice when they sat round me, the merry little Mice, and listened when I spoke to them. Now that's past too. But I shall remember to be pleased when they take me out."

But when did that happen? Why, it was one morning that people came and rummaged in the garret; the boxes were put away, and the Tree brought out; they certainly threw him rather roughly on the floor, but a servant dragged him away at once to the stairs, where the daylight shone.

"Now life is beginning again!" thought the Tree.

It felt the fresh air and the first sunbeams, and now it was out in the courtyard. Everything passed so quickly that the Tree quite forgot to look at itself, there was so much to look at all round. The courtyard was close to a garden, and here everything was blooming; the roses hung fresh and fragrant over the little fence, the linden trees were in blossom, and the swallows cried, "Quinze-wit! quinze-wit! my husband's come!" But it was not the Fir Tree they meant.

"Now I shall live!" said the Tree, rejoicingly, and spread its branches far out; but, alas! they were all withered and yellow; and it lay in the corner among nettles and weeds. The tinsel star was still upon it, and shone in the bright sunshine.

In the courtyard a couple of the merry children were playing who had danced round the tree at Christmas time, and had rejoiced over it. One of the youngest ran up and tore off the golden star.

"Look what is sticking to the ugly old fir tree!" said the child, and he trod upon the branches till they cracked again under his boots.

And the Tree looked at all the blooming flowers and the splendor of the garden, and then looked at itself, and wished it had remained in the dark corner of the garret; it thought of its fresh youth in the wood, of the merry Christmas Eve, and of the little Mice which had listened so pleasantly to the story of Klumpey-Dumpey.

"Past! past!" said the old Tree. "Had I but rejoiced when I could have done so! Past! past!"

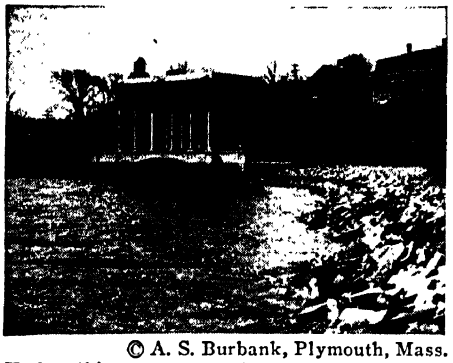
And the servant came and chopped the Tree into little pieces; a whole bundle lay there; it blazed brightly under the great copper kettle, and it sighed deeply, and each sigh was like a little shot; and the children who were at play there ran up and seated themselves at the fire, looked into it, and cried "Puff! puff!" But at each explosion, which was a deep sigh, the Tree thought of a summer day in the woods, or of a winter night there, when the stars beamed; he thought of Christmas Eve and of Klumpey-Dumpey, the only story he had ever heard or knew how to tell; and then the Tree was burned.

The boys played in the garden, and the youngest had on his breast a golden star, which the Tree had worn on its happiest evening. Now that was past, and the Tree's life was past, and the story is past too; past! past!—and that's the way with all stories.

THE NEXT STORIES ARE ON PAGE 1017.

Fate has mocked Hans Christian Andersen. The novels and poetry he considered his most important work are little read to-day; but children and grownups almost everywhere in the world have come to love and honor his name for the joy and delight of his fairy tales.

REMAINS OF THE EARLY SETTLEMENTS



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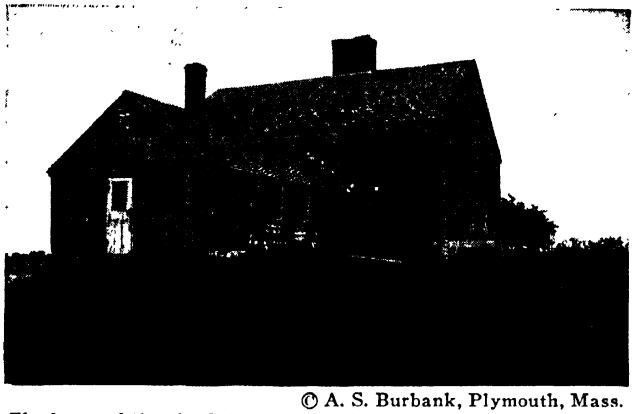
Under this canopy, at Plymouth, Massachusetts, is the famous rock on which the Pilgrims first set foot in the new land. The pavilion was erected in memory of the brave band, three hundred years later.



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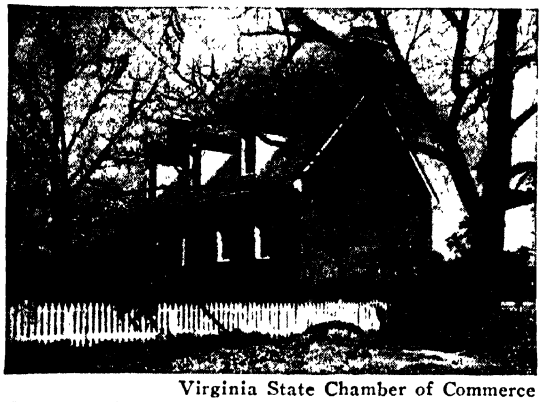
The home of the shy John Alden and his wife, Priscilla Mullens, as it looks to-day. The story of this Plymouth romance is told in Longfellow's Courtship of Miles Standish.



Virginia State Chamber of Commerce

This charming colonial dwelling, near Jamestown, was built on land given by Powhatan to John Rolfe when he married Pocahontas, Powhatan's daughter.

N. C. Dept. Conservation and Development

A lovely chapel made of logs, with a thatched roof, built on the site of the "Lost Colony of Roanoke." Whether all the settlers were slain or some were carried off by the Indians remains a mystery.

Photo, Ewing Galloway

The remains of the first Anglican church in North America, at Jamestown. The tower is the original structure.

Photo, courtesy Metropolitan Museum of Art

Great fireplaces, simple furniture, as in this room of about 1640, were common to most early American homes.

From an old print

Finding the evidence of the vanished Roanoke settlers. "Croatoan" was the name of an Indian tribe.

BUILDING HOMES IN THE NEW LAND

A HUNDRED years after John Cabot reached the coast of North America in 1497, there was only one permanent white settlement in what is now the United States. This lone settlement was the little fort of St. Augustine, Florida, founded in 1565 by the Spanish. North and west of Florida stretched hundreds of miles of forest and plain in which, so far as we know, not a single white man had made a home. It is possible that some of the members of Sir Walter Raleigh's lost colony of Roanoke were still alive among the Indians in the forests of Virginia or Carolina, or even farther west. (See page 6333.) Perhaps, too, an occasional white man, captured from one of the French or Spanish exploring expeditions, had been adopted into an Indian tribe. If so, such men were absorbed into the Indian way of life and lost all contact with white civilization.

America had been a great disappointment to all the exploring nations except Spain. In Mexico and Peru the Spanish had found gold and other treasures in immense quantities, but no such wealth was found by the men who explored the coasts of the northern continent. Later on the fur trade was to bring great wealth to the French and Dutch and English, but for many years these countries took little interest in the New World.

We have already told how the explorers kept on trying to find a passage through the continent to Asia. This search went on for a long time after settlements were established on the Atlantic seaboard; indeed, it continued almost up to the time of the American Revolution. It delayed the settlement of the country, but it was not really a waste of time, for the searchers naturally learned much about America, even though they failed to find a passage to Asia.

Before 1600 wise men in France and England began to see that these lands across the Atlantic would be more valuable if people went to live in them, to cultivate the soil and carry on trade with the mother-countries. One of these wise men was Sir Walter Raleigh, who was at that time a great favorite of Queen Elizabeth of England. Sir Walter sent several colonizing expeditions to Virginia, but all of them failed. At last Raleigh's money ran out and he was forced to give up. You may read all about Sir Walter Raleigh

in other parts of The Book of Knowledge if you look for his name in your Index volume.

About the year 1600, that is, at the beginning of the seventeenth century, certain people in England began to make serious plans for sending settlers to America. For a long time land had been expensive and hard to get in England. Well-to-do landowners were buying up the best farm land and using progressive methods of farming which the small farmers could not afford. Therefore many small farmers had to leave their acres. People were land-hungry, and the idea of owning and cultivating land in America appealed strongly to them.

Companies were formed to finance colonies, and shares in these companies were bought by members of the nobility and gentry, and by rich merchants. In 1606, King James I, who had succeeded Queen Elizabeth, gave land in America to two companies, the Virginia Company of London and the Virginia Company of Plymouth. The London Company was granted the land from Cape Fear to the Potomac River, and the Plymouth Company was given the land from about the top of Maine to about Long Island Sound. All of this territory was called Virginia in those days. Each company was governed by its own council in England, and both of these councils were under a royal council which represented the King.

THE FIRST ATTEMPT TO SETTLE WHAT IS NOW MAINE

Both companies sent out colonies in the same year, 1607. We shall tell about the Plymouth Company's colony first, although it was really the second of the two settlements. One hundred and twenty men sent out by the Plymouth Company settled at Sagadahoc, on the Kennebec River, in what is now Maine. They landed in August of 1607, built a fort, some houses and a thirty-ton ship which they called the Virginia. Unfortunately, the winter that followed was bitterly cold and there was not enough food. Some of the men returned to England. Many of those who stayed died, and all suffered great hardships. The next year those who were left alive sailed back to England. After that it was many years before another permanent settlement was attempted in Maine.

In December, 1606, the London Company sent more than one hundred men to Virginia in three little ships called the Susan Constant, the Goodspeed and the Discovery. They explored the coast, sailed up a river which they called the James, in honor of the King, and on May 24, 1607, settled on a low point of land which was almost an island in the river. They named the new settlement Jamestown.

JAMESTOWN STRUGGLES WITH DISEASE, HUNGER AND INDOLENCE

For fifteen years misfortunes followed the colony but never quite overcame it. To begin with, the settlers had picked the wrong sort of situation for their town. The place was low and swampy, and during the first summer fifty persons died of fever. The men themselves were unsuited to a pioneer life. Many of them were classed as "gentlemen," which meant that they knew nothing about working with their hands. Others were merchants, jewelers, perfumers and the like. Only a few were accustomed to hard physical labor. There were six carpenters, one blacksmith, one stonemason and a few unskilled laborers. It would, naturally, have been difficult to find any men in an old settled country like England who knew how to deal with the problems of life in the wilderness. Nevertheless a better choice could have been made.

Some of the men were lazy and quarrelsome. Many wasted their time hunting for gold instead of clearing land and planting crops. All of the colony's supplies went into one storehouse and all of the men shared equally, whether or not they worked to add to the stores. Such a system discouraged the men who were willing to work and made the others lazier than ever. The supplies that had been brought over from England soon gave out and the colonists were obliged to live by hunting or by what they could get from the Indians. By the end of 1607 there were only thirty-eight men left alive, but more were sent out from England.

The colony was really held together by a few strong, determined men, among them the famous explorer and soldier, Captain John Smith. Smith was a member of the council which had been appointed to govern the colony, and for a while he ruled it with a firm hand. He made the men build a church and some houses and strengthen the wooden palisade around the settlement. He also succeeded in keeping the settlement on fairly good terms with the neighboring Indian tribes.

More food and supplies were sent out to the colony from England, and for a time things improved. In 1609 about 800 people arrived in Jamestown, and John Smith went back to England to have a wound treated.

BUILDING HOMES IN THE NEW LAND

The ship carrying Sir Thomas Gates, the leader of this new expedition, had been separated from the rest of the fleet by a hurricane, and was wrecked on the coast of Bermuda. The colony was again without strong leadership, and since the new settlers were no more suited to be colonists than the first lot had been, another period of strife, disease and starvation soon set in. Supplies gave out, and the Indians, who were now thoroughly hostile to the settlers, watched in the forest outside, to kill anyone who left the fort to hunt for food. This was the Starving Time, long remembered in Virginia.

When Sir Thomas Gates, who had been shipwrecked in Bermuda, was at last able to get to Jamestown in May, 1610, he found that half the people were dead and the rest weak and despairing. Gates had not enough supplies with him to feed the colony for long. Therefore he determined to take the people on board his four small ships and carry them to Newfoundland, whence they might get back to England.

The people were set to work getting ready the ships, one of which was the Virginia, which, you remember, had been built in Maine by the members of the unfortunate Sagadahoc colony. When all was ready the boats dropped down the James River, leaving the empty fort to the forest and the Indians.

It was not intended, however, that the Jamestown colony should suffer the fate of Sagadahoc and the Roanoke colony. As the boats neared the mouth of the river they met a fleet coming in from the sea. It was the new lord governor of Virginia, Lord De la Warr, with several hundred colonists and food enough to last a thousand people for one year. The people who, a few hours before, had said good-bye to Virginia forever, turned back once more to Jamestown.

The Bettmann Archive

With the arrival of a group of courageous young women to marry the Jamestown colonists, in 1619, real homes were now established in Virginia and the permanent settlement of the colony was assured.

Lord De la Warr did not stay in Virginia very long, though he made great improvements in the settlement while he was there. When illness forced him to return to England in 1611, another governor was sent over, Sir Thomas Dale. This governor was a stern, harsh man but he seems to have been the sort of governor that the colony needed. He made peace with the Indians; he made the men work and obey the laws; and he allowed every man to have a piece of land for himself, and to keep whatever he made on it.

At first it was planned to produce many different kinds of things in Virginia, including iron and salt, glass, hemp, flax and cattle.

Silkworms were introduced and a silk industry was started. Two events kept these plans from being successfully carried out. In 1614 John Rolfe, who had been experimenting with the culture of tobacco, sent some of his crop to England on the ship Elizabeth. The success of his venture marked the beginning of the great tobacco-growing industry in Virginia, but it caused people to lose interest in other products. Then, in 1622, the Indians of the Powhatan Confederacy attacked the Jamestown settlement and killed more than 400 of its 1,240 people. Many of those killed were men who had been long in the colony, and were the most experienced and active in developing its resources.

The Bettmann Archive

In founding the first settlements, the colonists suffered great hardship. Illness and hunger haunted them. The meager food supplies were doled out, as the new land had to be cultivated before harvests could be reaped.

During the earlier years of the colony, few women came over, but in 1619 the company sent over about a hundred young women to marry colonists. Those who married tenants of the company's lands had their traveling expenses paid by the company, but husbands who owned their land had to repay the company in tobacco. Homes were now built outside the original settlement, and there were several little villages along the James River and the streams that flowed into it.

The year 1619 was an important one in the history of Virginia and of the United States. There were now eleven little settlements in Virginia, and each of them was given permission to elect two representatives to help make laws for the colony. They met in the little church at Jamestown on July 30, 1619, and thus took place the first meeting of the first legislature in America.

In this same year, it is said that a Dutch ship which touched at Jamestown sold the colonists twenty Negroes to work in the tobacco fields. This was the beginning of Negro slavery in the American colonies, but it was many years before Negro slaves were to be found in Virginia in any great number. Most of the servants and plantation laborers were white people, either prison convicts who were sent from England to the colonies to work out their terms, or poor people who bound themselves to work a number of years in order to pay for their passage to the new land. These were called "redemptioners," and some of them became successful farmers or businessmen after their period of work for others was over.

Now that we have taken the Jamestown colony through the hardships of its early years, let us turn to the first years of another colony. You remember that the Plymouth Company had tried to make a settlement on the coast of Maine, in North Virginia, as it was called, in 1607, the same year that Jamestown was founded, but failed. After Captain John Smith left Virginia the Plymouth Company employed him to explore and make a map of their territory. This he did in 1614, and called the country New England, the name by which it is known to-day.

At the time when all of these events were taking place, people's religious beliefs and political beliefs were very closely connected. Rulers did not think it safe for men to have independent ideas about religious worship. They thought that if people refused obedience to the particular church which was established by law, they would soon disobey the law in other matters. In England the established church was the Anglican, or English Church, but there were many people in the land who found things to object to in the forms or beliefs of this church. Some of these people formed a party within the church, calling themselves Puritans, because they thought that the Church of England needed to be purified. Others refused to belong to the Church of England at all, and were looked upon as rebels against Church and State. Sometimes they were persecuted severely, and at all times they suffered great

inconvenience because of their opinions.

These Separatists, as one group of rebels was called, were scattered in little congregations in certain parts of England, and during a period of persecution some of them fled to Holland, where they were allowed to believe as they pleased. In 1607, the year in which Jamestown was founded, a tiny congregation at Scrooby, in Nottinghamshire, moved, first to Amsterdam and then to Leyden, in the Netherlands, where they worked very hard to live. After ten years, however, the leaders began to talk of removing to America. Work in Holland was hard, some of their young people no longer believed as their fathers did, and were growing up Dutchmen instead of Englishmen. This distressed the little congregation. They did not approve of the religious views of the Dutch any more than they had approved of those of the Church of England. So they planned to find a new home where they could remain Englishmen and yet be free to follow their own religion and way of life.

MERCHANT ADVENTURERS JOIN THE PILGRIMS FOR THE VOYAGE TO AMERICA

The Leyden Pilgrims, as they came to be called, arranged to join a group of English merchant adventurers who had been promised land by the London Company. First the Pilgrims sailed from Holland to Southampton, in England, on a ship called the Speedwell. Here the group of merchants, many of whom were not Separatists, joined them in a ship called the Mayflower, and the two ships set sail for America. Before they were well started on their voyage, the Speedwell was found to be leaking. The two ships turned back; repairs were made, but the Speedwell was found to be not seaworthy, so the ships turned in again, at Plymouth Harbor. Some of the Speedwell's passengers were crowded into the Mayflower, which made the voyage alone.

THE LONG, DREARY VOYAGE OF A CROWDED SHIP, THE MAYFLOWER

There were now 101 persons on board the Mayflower, besides the crew. Of the 101 passengers, thirty-five were the Leyden Pilgrims. The rest were mainly of the merchant adventurer group, many of whom were not Separatists. So many people on such a small ship made the voyage an uncomfortable one. The lack of fresh food made some of the people ill, and a spell of stormy weather added to their discomfort, besides throwing the ship off her course. When they finally reached America it was found that they were off the shores of Cape Cod, instead of the coast of what is now New Jersey, where they had permission to land.

They decided to stay where they were, for they thought that they could get permission from the Plymouth Company. After exploring the coast, the Pilgrims and their associates landed, on December 21, 1620, at the place which Captain John Smith had already named Plymouth in his maps of the region. Later the colony did get permission to use the land from the New England Council, which had succeeded the old Plymouth Company. The colony never did receive a charter from the King, probably because James I disapproved of the Separatists.

SEVERE COLD ADDS TO THE HARDSHIPS OF THE PLYMOUTH COLONY

If the Virginia settlers found the summer hotter than anything they had known in England, the colonists in the north found the winters terrible. You must remember that they did not have well-built houses with furnaces and coal to give them heat. They lived in rude cabins with no floors, or, at best, with floors of logs split in half. The first winter was a very bad one, and more than half of the little company died, including the governor, Deacon John Carver.

Like the Jamestown Colony, the Plymouth settlers began by putting all of their goods into one community storehouse, for they had borrowed money to bring them over and had agreed to work together to pay off the debt. But here, too, it was found that men did not work so well when each man could not have the fruit of his own labor, and the system was soon changed. After Governor Carver died, William Bradford was elected governor. From then until his death in 1657, Governor Bradford was re-elected every year but five.

In the meantime, the Puritan party in England was having a difficult time. The bishops and the King were determined to break it up, and the main body of the Church of England was strongly opposed to it. All of these troubles caused some of the Puritans to think of migrating to America as the Pilgrims had. They did not want to go to Virginia, for it was under the Anglican Church, and Puritans did not fare any better there than in England itself, so they decided to go to New England.

In 1628 a body of Puritans bought the right to settle on the land between the Charles and the Merrimac rivers, and in the same year a man named John Endicott

brought over about forty people and founded Salem. There were already a few white people living near there, but they were not Puritans, and Endicott treated them with great severity. Indeed, Endicott, who became governor of the little colony, was a very harsh governor, and not a wise one. He made many curious laws. He compelled

© A. S. Burbank, Plymouth, Mass.
Icebound, the sturdy little Mayflower lies anchored in Plymouth harbor. In this imaginary picture there is also a glimpse of the desolate, forbidding shore.

the women to wear veils in church for fear that men might look at them and not listen to the sermon, which was often several hours long. He thought it was wrong to wear a wig, which was the fashion for men at that time, and he punished a man who dared to wear one.

The next year another party of Puritans came out to New England; and in 1630, a strong, able leader, John Winthrop, led nearly a thousand persons, with many cattle and horses, and made several settlements on Massachusetts Bay. You must remember the difference between the Puritans and the Pilgrims. The Pilgrims, who settled at Plymouth, had separated from the Church before they came to America. They were poor people, and most of them had had very little education.

The Puritans still belonged to the Church of England until after they had settled in America. They came from many different classes of English society. Some of them were wealthy, and almost all of them were well educated. Both the Pilgrims and the Puritans were deeply religious, and both disapproved of the forms and many of the beliefs of the English Church; but the religious ideas of the Puritans and Pilgrims were not exactly alike. This is one of the reasons why the two groups founded separate colonies, which were not united for many years.

The Puritans' Bay Colony grew very rapidly, and before 1634 nearly five thousand settlers had come. They did not suffer so much as the Pilgrims and the Jamestown colonists had. They had plenty of money with which to buy things in England, but most important of all, they had learned from

The Bettmann Archive
The landing of the Pilgrims at Plymouth, after a lithograph by Currier and Ives. The faces are stern but hopeful. One man is kneeling down to offer a prayer of thankfulness for their safe arrival after the perilous voyage.

the experience and the mistakes of the earlier colonizers. In 1636 they decided to start a college to train ministers for the churches. A young minister, John Harvard, died in 1638, and left his books and a sum of money to the college, which was then named for him.

Although these Puritans had come to the New World in order to have their own way in religion, they were not willing to give the same rights to others. They banished a

young minister named Roger Williams because he taught that it was not right to compel a man to support a church in which he did not believe, and that the judges had no right to punish a man because he broke the rules of the church. Williams also said that the King of England had no right to grant the land on which the colonies were planted, because it belonged to the Indians. Williams escaped before the authorities could send him back to England, and took refuge among the Indians. He bought some land from them and founded the town of Providence in 1636. Other persons who were driven out of the Massachusetts Bay Colony because of religion also moved southward; and their settlements, together with Providence, became the colony of Rhode Island, where every man was allowed to think, believe and teach what he pleased.

You remember that Henry Hudson, in 1609, sailed up the river that now bears his name, and claimed the country for the Dutch. He also found that the Indians had many furs which they were willing to exchange for a few beads or a hatchet. These furs seemed as good as gold to the Dutch, and soon they sent out traders to deal with the Indians. Some people say that there were a few houses on Manhattan Island as early as 1614. The same year, or early in 1615, Fort Nassau, near the present city of Albany, was founded, and settlements in New Jersey also were made. These early Dutch settlements were largely trading posts, and it was not until several years later that real colonists were brought over.

The Dutch claimed all of the country between the Delaware, or South River, and the Hudson, or North River, and they called this land New Netherland. In 1626 Peter Minuit, who had been appointed Governor of New Netherland by the Dutch West India Company, bought Manhattan Island from the Indians for about twenty-four dollars' worth of beads and trinkets. The little town that had begun to grow, down at the foot of the island, was called New Amsterdam.

Next, large tracts of land along the Hudson River were offered to any men who would bring over fifty settlers at their own expense. Soon there were many farms along the river, farmed by the tenants of the patroons, as the owners of the tracts were called. The patroons became very powerful and lived in great state, like the nobility of Europe.

In 1634 another English settlement was founded in the country around the Chesapeake Bay. George Calvert, whom King James I made Lord Baltimore, had been converted to the Roman Catholic faith, and he wished to found a colony where all Christians would have freedom of worship. At that time the Catholics were persecuted in England, and Lord Baltimore hoped that the colony

Culver Service

Pilgrims going to church, from the painting by George H. Boughton. The minister walks with thoughtful face, carrying his Bible. The other men are armed and alert, to guard against possible attacks by Indians or wild beasts. As you can see by the little girl who holds her mother's hand, children were dressed just like adults.

Courtesy of the Long Island Historical Society

The largest of these Dutch buildings along the water front of New Amsterdam, in 1679, is the "stadt huys" (state house). The peaked roofs are characteristic. In those days the East River bordered the street.

he planned would be a land of peace and prosperity for English Catholics. At first he tried to make a settlement in Newfoundland, but the climate was too severe. Then he persuaded King Charles I to make him Lord Proprietor of a large tract of land north of the Potomac River, where the states of Maryland and Delaware now are.

Lord Baltimore died just as the charter was to be granted, and it was given to his oldest son, Cecil, the second Lord Baltimore. The land was named Maryland, to compliment Queen Henrietta Maria, the wife of King Charles I. For all this great tract of land the only rent the lord proprietor was to pay to the King was two Indian arrows every year, and one-fifth of any gold and silver that might be found. Protestants as well as Catholics were welcomed.

The lord proprietor had great powers. He could coin money, grant titles of nobility, appoint judges and pardon criminals. If he decided to call a legislature, the laws which were made did not have to be submitted to the King. In fact, the lord proprietor was almost like a king. We shall see that some other colonies, which were founded later, were governed in the same way.

The second Lord Baltimore sent his brother, Leonard Calvert, in charge of a colonizing expedition that founded St. Mary's in 1634. From St. Mary's many new settlements were made along the rivers.

Almost from the beginning there was trouble with the Virginians over territory claimed by both Maryland and Virginia. Then there was a large Puritan element in the population of Maryland, and during the period when, in England, King and Parliament, Cavalier and Puritan were struggling for power, the Maryland Puritans made a great deal of trouble for their lord proprietor. At one time they joined some Virginians and captured the capital, forcing the governor, Leonard Calvert, to fly to Virginia for safety. When the Parliament triumphed in England, and Charles I was beheaded, efforts were made to take the proprietary away from Lord Baltimore; but Oliver Cromwell, the Lord Protector of England, ruled that Lord Baltimore and his family were still the owners.

This did not end Maryland's troubles. For a time the Puritans got complete control of the assembly, and would not allow Catholics to have any power. At last, the fourth Lord

Baltimore turned Protestant, and in 1715 his rights were restored and his family held control until the American Revolution.

Just about the time that Maryland was founded, Sweden was a more powerful country than it is to-day. The great King Gustavus Adolphus hoped to establish a colony in America, and gave permission to a group of men called the Swedish West India Company, to send out colonists. The King died, however, before anything had been accomplished. Under his daughter, Queen Christina, who succeeded him, a few men settled on the Delaware River in 1638, and called the colony New Sweden. The leader of these colonists was Peter Minuit, the same Peter Minuit who, a few years before, had been the first Dutch governor of New Netherland, and had bought Manhattan Island from the Indians. Minuit, who was from northern Germany, had left the service of the Dutch and gone to Sweden.

From an old print

George Calvert, Lord Baltimore, the founder and first proprietor of Maryland.

The Dutch would not agree that the Swedes had any right to this land, and Peter Stuyvesant, the one-legged governor of New Netherland, was able to make them yield to his power. This was the beginning of the colony of Delaware.

Governor Stuyvesant also had troubles. He was very hot-tempered and overbearing, and he did not believe in giving the people any voice in the government. Many people in New Amsterdam did not like his ways. The English had always claimed all of North America because of the discoveries of Cabot, and after King Charles II was restored to the throne and Englishmen were once more at peace with one another, they sent a fleet to New Amsterdam and ordered the town to surrender. The people, who did not like Governor Stuyvesant, would not fight, and so, in 1664, New Netherland became an English colony. Both the colony, New Netherland, and the town, New Amsterdam, were renamed New York, in honor of the King's brother, the Duke of York, who was later to be King James II of England. In 1673 the Dutch again got possession, but kept it only a few months, after which they lost their colony forever. It is interesting to know that stubborn old Peter Stuyvesant continued to live on his farm on Manhattan Island. When he died he was buried in the Church of St. Marks-in-the-Bouwerie in New York, where his grave may be seen to-day.

The Duke of York, in 1664, granted the southern part of his new province to two of his friends, Lord Berkeley and Sir George Carteret. They named their territory New Jersey, after the island of Jersey in the English Channel, of which Carteret had been governor. Settlers came from the other colonies, from the British Isles and from northern Europe. Among them were French Huguenots and many Quakers. Some Quakers bought Lord Berkeley's share, and after a time the province was divided into East Jersey and West Jersey. There were quarrels with the Governor of New York, who claimed the right to rule the Jerseys, but the disputes were settled at last in favor of the Jerseys. Then William Penn and other Quakers bought Carteret's share, East Jersey. Later they were joined.

Although it was not next in time, we shall here tell the story of the founding of Pennsylvania. William Penn was the son of a distinguished English admiral who was a friend of the royal family. Very much to the disgust of his family, young William became a Quaker, and sometimes wandered over the country preaching to all who would listen to him.

The Quakers at this time were very much despised. They believed that it was wrong to show special respect to a person because of his rank or position, and therefore they would not take off their hats before rulers, or address people by any title, not even Mister. Instead they addressed everyone as "friend." They believed it was wrong to wear jewelry or fine clothes, or to follow the fashions. They did not believe in bishops or priests, and they refused to swear in court. You can readily see that to most people the Quakers must have seemed very peculiar indeed. Some people even thought them dangerous.

King Charles II liked William Penn in spite of the fact that he was a Quaker. It

From an old print

When New Amsterdam surrendered to the English in 1644, the stubborn Dutch governor, Peter Stuyvesant, was led down from the ramparts without a gun being fired. He had lost a leg fighting in the West Indies years before.

is said that the King had owed Penn's father a large amount of money, and that he decided to pay the debt in land. However this may be, in 1681 the King gave Penn a large tract of land lying west of the Delaware River. He and his descendants were to own it, just as the Calvert family owned Maryland. It is said that the King himself chose the name Pennsylvania, which means Penn's Forest.

William Penn gave a great deal of thought to the sort of colonists he wanted. Many English Quakers came, as well as Scotch, Irish and Welsh, but Penn especially encouraged farmers and craftsmen from the Rhine Valley, Switzerland and Sweden. Many people poured into the colony, which did not suffer the terrible hardships that most of the earlier colonies had endured. This was because Penn managed the colonization so well. He made friends with the Indians, he encouraged the more useful kind of settlers, and he made wise laws for the colony.

The laws that Penn made were very liberal. No one was to be troubled for any matter of religion, the punishments for crime were not so harsh as they were in New England or Virginia, and men could get land on easy terms. In 1683 the city of Philadelphia, which means Brotherly Love, was laid out, and soon grew to be a handsome town with broad streets and brick houses. Later on the Penn family were to have trouble holding their colony just as the Calverts did, but Pennsylvania did not have the troubles in the beginning that Maryland had. In 1681 Penn succeeded in having Delaware included in his territory, since Pennsylvania did not have any seacoast.

All the colonies that we have told about so far have been on the middle or northern coast. Now we come to some farther south. As early as 1629 Charles I had granted the "province of Carolana" to Sir Robert Heath, but no attempt was made at settlement. As the years went on restless men from Virginia moved southward, and here and there men from other places settled along the coast, where they were under no law or government but their own will. Indeed, the creeks and inlets along the coast became the favorite hiding-places of pirates and buccaneers.

When Charles II was restored to his throne in 1660, some of his friends asked him for a grant of land in America. Charles was happy to be able to reward his faithful friends so easily, and in 1663 he granted to eight lords proprietors a strip of land south of Virginia, three hundred and fifty miles long, and extending, as many of the other royal grants did, clear to the Pacific Ocean. This was called Carolina. Some of the most important of these proprietors were the

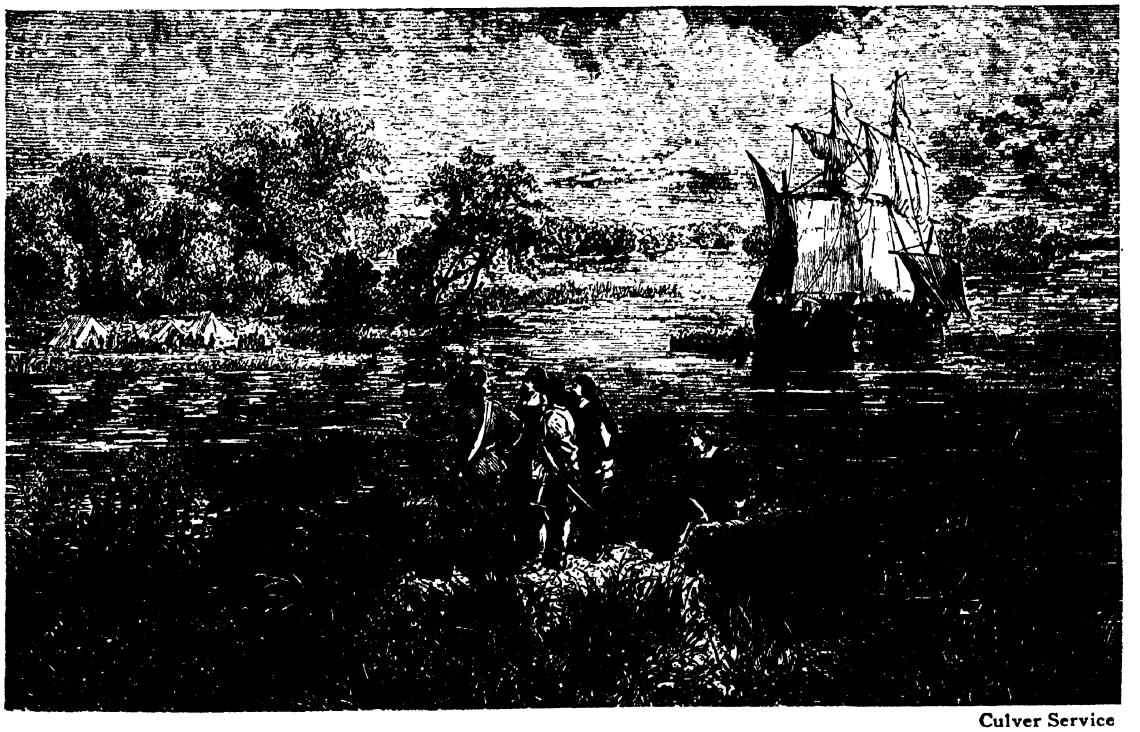
Duke of Albemarle, who, as General George Monck, had made it possible for King Charles to regain his throne; the Earl of Clarendon, whose two granddaughters, Mary and Anne, became queens of England; and Lord Ashley, afterward Earl of Shaftesbury. In 1665 the grant was made larger, so that it took in all the land in what is now North and South Carolina, Georgia and the states west of them. Indeed, as we said before, it was supposed to extend all the way to the Pacific Ocean.

The proprietors published advertisements for settlers, offering land on easy terms. A number of persons took up land in Carolina, but they did not pay much attention to the proprietors. If they liked the looks of some land on which no other white person was living, they settled on it without asking anyone's consent or paying any rent. It was easy to get enough to eat in Carolina. The waters were full of fish; turkeys, ducks, deer and other wild game were plentiful, and the winters were not so severe as they were farther north.

Settlers from Virginia occupied the coast next to that colony, and a governor of Carolina was appointed in 1664. Another settlement was soon made near the present site of Charleston, South Carolina. There was still another tiny settlement at the mouth of the Cape Fear River, but it did not last.

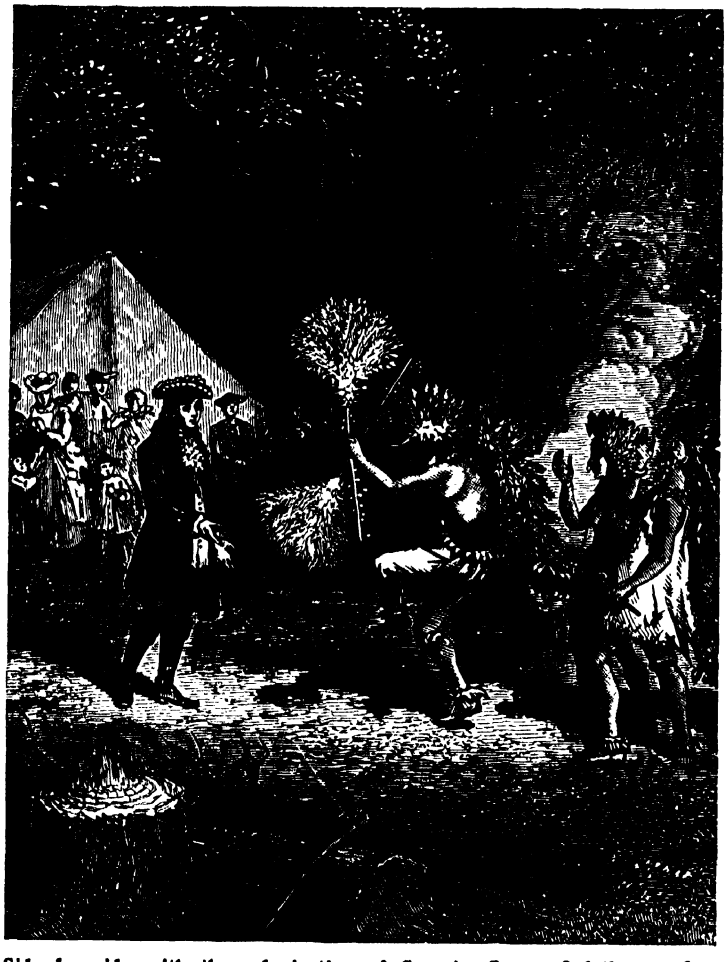
In 1669 the proprietors adopted a very curious form of government for the colony, called the Fundamental Constitutions. It had been worked out by the famous English philosopher, John Locke, and it showed that this wise man had little knowledge of the needs of a pioneer country. The plan was to have three social ranks, nobility, freemen and serfs. The serfs were to be little better than slaves. If a man was born a serf he must remain one all his life. The people in Carolina had been entirely free, and they paid no attention whatever to this constitution. It was not even suited to England at that time, and was silly in a country where there were only hunters, fishermen and small farmers. It was done away with in 1693.

The settlement in the south around Charleston grew faster than any in the northern parts of the province, and finally, in 1691, the province was divided into North Carolina, Albemarle and Charleston. The proprietors had not started the province for purposes of religious or political freedom, or to benefit the settlers in any special way, as Lord Baltimore and William Penn had.



Culver Service

Where the Schuylkill and Delaware rivers meet, William Penn and his colonists established Philadelphia. It was laid out with broad straight streets; and English, Welsh and Germans flocked to the "green country town."



Side by side with the colonization of Georgia, James Oglethorpe also made peace and opened up trade with the Indians there. Here, deep in the forests, the Indians are performing a ceremonial dance for him.

When they found that they were not likely to get much profit from it, they paid little attention to it. Some of the proprietors sold their shares for small sums, and were glad to get rid of the troublesome affair.

Most of the governors whom the proprietors sent out were not fit to rule. Twenty in all were sent out to the northern province, and the people forced six of them to leave. Once, for two years, North Carolina had no governor or ruler of any kind, but the people did not care. If there was no governor, there were no taxes to pay, and that pleased them very well.

Many French Huguenots and some Germans and Swiss came over. A town was founded and called New Berne, after Berne in Switzerland. Before they were entirely settled the whole northern province was attacked by the Tuscarora Indians, and for four years there were many battles. The proprietors would not send aid, and for a time it seemed that the colony could not survive. At last, with help from South Carolina and Virginia, the Indians were driven away entirely. The Tuscaroras then moved to New York and joined the Five Nations of the Iroquois Confederacy, which then became the Six Nations.

The people were so tired of the proprietors that they asked the King to take over the government of the colony. This he did in 1729, paying each of the proprietors about $12,000 for his share and dividing the colony into North and South Carolina. One of the eight proprietors, Earl Granville, refused to sell, and a strip of land seventy miles wide was set off for him along the border of Virginia, but he no longer had rights of government.

Just about this time the last southern colony was begun. At that time in England a man could be put in prison for debt, even if he was not to blame for not being able to pay. He would be kept in prison, at his own, or his friends' expense, until somehow the debt was paid. This, of course, meant that many unfortunate people spent years in prison, for a man who was in prison could not work to make the money to pay off his debts, or even to support his family. General James Oglethorpe, a brave soldier and a member of Parliament, asked the King to give him some land in America to which he might take some of these men, so that they might have a chance to begin life anew. In 1733 Oglethorpe brought 114 settlers to his new colony, which had been named Georgia in honor of King George II.

Many other settlers came besides the debtors, but the colony was not a success at first. As had happened so often before, many of the colonists were not suited to the life and the work of building a colony, and the English trustees of the colony had made

plans for its development which were too elaborate to be carried out successfully. In 1752 the King took over the government of the colony himself, and later on it began to flourish.

We have told how the Puritans of the Massachusetts Bay Colony tried to keep all religious beliefs but their own out of their colony. They established a government in which the Church had absolute power. Only church members could vote, and the head men in the Church were the head men in the civil government. Anyone who did not believe or act as the ministers and elders told him was punished or banished from the colony. Punishments were severe. Offenders were sometimes whipped out of the colony.

Naturally, differences of opinion arose about the policies of the government, and a number of little congregations moved away from the colony and started new colonies of their own. One of the congregations that

In 1675 the Virginia colony was again in danger from Indian raids. The settlers asked Governor Berkeley for aid, but he refused—as shown here. However, troops were raised under Nathaniel Bacon. When Berkeley called this action treason, Bacon seized and burned Jamestown. Known as Bacon's Rebellion, it collapsed when Bacon died.

moved away from Massachusetts was that of the Reverend Thomas Hooker, of Newton, now Cambridge. These people went in 1635 and 1636 to the Connecticut Valley, where they founded the town of Hartford. A group of people from Dorchester moved and settled Windsor, Connecticut, and another group from Watertown founded Wethersfield. These three river towns joined together in 1639 to form an independent republic.

THE NEW HAVEN COLONY TRIED TO HOLD ALOOF FROM THE REST OF CONNECTICUT

At about the same time a colony was started at New Haven by a party of people from England who were very strict in their ideas and considered the Bible to be their only law. In 1662 the younger John Winthrop, who was Governor of Connecticut, obtained a charter from the King, and this charter included the New Haven settlement. The New Haven people did not wish to be joined to the rest of Connecticut, but they could do nothing to stop it.

One more colony is to be mentioned. This was the colony of New Hampshire, which was founded by Captain John Mason, who obtained a grant of land in 1629. A few settlers came from the British Isles, and a number from Massachusetts. After Captain Mason died, no one paid much attention to his rights, and in 1641 Massachusetts took the government. It remained under that colony until 1679, when it was made a separate province.

Now let us carry forward a little the story of some of our colonies, which we left as soon as they became self-supporting. We shall not tell you here about the way the people lived, for you will find much about their manners and customs, their schools and their work in two other articles; Child Life in Colonial Days, on page 965, and The Thirteen Colonies on the Eve of the Revolution on page 1039.

VIRGINIA'S YEARS AS A ROYAL PROVINCE

We left the Virginia Colony just after the important happenings of the year 1619. After the Indian massacre of 1622 King James I took the Virginia Company's charter away and Virginia became a royal province, with governors appointed by the King. Some of these governors were well chosen, but sometimes they were very unsatisfactory indeed. In 1642 one of Virginia's greatest governors, Sir William Berkeley, was sent out to the province from England and held the office most of the time for the next thirty-five years. At first he was very popular, but in time he came to be hated for his dictatorial government.

After Charles I was beheaded in England many of his followers, called "cavaliers," came to Virginia, and the colony invited his son, the exiled young King Charles II, to come over and rule his loyal dominion. Charles did not come. He probably thought he would have a much better chance to get back his throne if he stayed in Europe, nearer to his friends in England. In spite of Indian troubles, and a tragic uprising of the people under Nathaniel Bacon, the colony continued to grow. It had the largest population of any of the colonies up to the time of the Revolution.

The Plymouth Colony grew very slowly at first. At the end of twenty years it had only three thousand people, but afterward it grew faster. In 1692 the Plymouth Colony was joined to the Massachusetts Bay Colony to form the Colony of Massachusetts.

PURITAN OPINIONS REMAIN THE GUIDE IN THE MASSACHUSETTS BAY COLONY

The Bay Colony had grown rapidly from the beginning, in spite of the Indian wars. The people as a whole held steadily to their Puritan opinions, though many settlers came to the colony who were not Puritans. Some men from the Bay Colony went back to England to fight under Cromwell in the war between the Parliament and the King, for Cromwell, as you know, was a Puritan. Nevertheless, Massachusetts did not welcome interference from Cromwell's government any more than from the King's government.

NEW ENGLAND, NEW YORK AND NEW JERSEY COME UNDER ONE GOVERNOR

In 1684, King Charles II took away the Bay Company's charter, and all of New England, New York and New Jersey were put under one governor, Sir Edmund Andros, so that they would be better able to resist the Indians and the French. When King James II was deposed from the throne, in 1688, Andros was no longer governor, but the people of the colonies had no greater freedom than before. For the following sixty years or more all of the colonies were affected by the great struggle for the continent between the French and the English, and the people of the colonies played an important part in this struggle. You will read all about this series of wars in the article which begins on page 777.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 729.

All the living things in this picture—man, horses, trees—are made up of billions of tiny units we call cells.

THE CELL, THE SEAT OF LIFE

IF you look through a microscope at the tiny creatures dancing or crawling about in a drop of pond water you will notice that the inside of their bodies consists of a transparent substance something like a very soft jelly. If you peel off a piece of skin from an onion and magnify this you will see a similar substance in each of the brick-like cells. Study the tissues of any living thing, a man, a fish, a pine tree or a seaweed and you will find this jelly-like matter in every living cell. We call it protoplasm, a word that means "first material." It is the life-matter.

As you probably know, some parts of our bodies are not alive—for example, the dry, scaly outside layer of the skin. The dry, outer bark of a tree and the sharp points of the kitten's claws are other examples of non-living structures in living things. Claws and bark do not grow of their own accord; they are produced by the living tissues underneath. Scientists have decided that the only living material in any living thing is half-liquid, transparent protoplasm.

All protoplasm looks much the same and is made of the same chemical substances, whether it comes from a man, a mouse, a microbe or a tree. But this does not mean that man's protoplasm is the same thing as mouse protoplasm. Not at all! Every living thing has its own kind of protoplasm; the chemical substances are put together differently.

Suppose a living seed and a stone are both planted in the ground. What will happen? Pretty soon the seed absorbs water; the skin of the seed cracks open; then a little root grows down into the earth and a stem forces its way above the surface of the soil. In a few weeks there is a plant many times larger than the original seed. Many years later the seedling may have grown into a giant tree which has by this time produced thousands of seeds. What has the stone done? Nothing at all. Except that acids in the soil-water may gradually dissolve it, it will probably be the same a hundred years later.

The protoplasm in the seed had the same abilities that all protoplasm has. What are they?

1. Protoplasm takes in other substances and builds them into more protoplasm. The tree seedling absorbed water, carbon-dioxide gas and some mineral matter from the soil. In the tiny chemical laboratories of the seedling these materials were worked on by the plant's protoplasm and changed into more protoplasm of the very same kind. As a result the plant grew in size.

Another example is furnished when a robin eats a worm. The robin's protoplasm will soon turn part of the worm into robin protoplasm.

2. Protoplasm carries on respiration. This means that it makes food combine with oxygen to release heat and other forms of energy. Frogs and plants which feel cold to you produce heat, only they lose the heat almost as fast as they produce it. The pro-

toplasm of the electric eel produces enough electricity to give you a violent shock, and many creatures, like fireflies and some deep-sea fish, release energy in the form of light.

3. Protoplasm can move. If you study the transparent hairs from living plants under the microscope you will see the protoplasm going around and around the cell. The ameba (a one-celled animal) travels by simply pushing out part of its protoplasm and letting the rest of its body "flow" into the pushed-out part. All our movements are due to the contraction of the protoplasm in our muscle cells.

4. Protoplasm can make substances and structures useful to the living thing. Our bone cells make bone, certain plant cells make wood, protoplasm of the tear glands produces tears, that of the digestive canal makes digestive juices.

5. Protoplasm digests food, which means it changes food to a simpler form which the protoplasm can use.

6. Protoplasm excretes (gets rid of) waste matters.

7. Protoplasm is very sensitive. If the light on one side of a plant is only a little stronger than on the other, the leaves and stem will grow toward the stronger light. The slight difference in the light will affect the protoplasm of the plant so that the cells grow faster on one side of the stem than on the other. Furthermore, protoplasm usually reacts (answers back) to anything that irritates it, and in this way it protects the living thing.

ORDINARY CHEMICAL ELEMENTS MAKE UP THE MYSTERIOUS LIFE-MATERIAL, PROTOPLASM

What is protoplasm? It is a mixture of several chemical compounds with a great deal of water. Next to water, the compounds most abundant in protoplasm are the food substances called proteins.

When we analyze protoplasm in the laboratory we find it is made up principally of the elements carbon, hydrogen, oxygen, nitrogen, phosphorus and sulphur. As pure elements these substances do not in any way resemble protoplasm. The element sulphur is a brittle yellow solid. Hydrogen, oxygen and nitrogen are colorless gases; pure carbon may be found as graphite (pencil lead) or as diamond, and pure white phosphorus is a deadly poison which bursts into flame when exposed to plain, ordinary air. These are the elements (with others) which nature combines and arranges to make jelly-like living protoplasm.

Every living thing—from tiny germs to big, complicated animals such as elephants—is made of cells. Some very small creatures—such as amebas and bacteria—consist of only one cell. Larger creatures—man, elephants, trees, etc.—are composed of billions of cells. Even a baby mouse has billions of cells.

All cells are much alike in some ways. Even though they are very different in size and appearance, the single cell of a diphtheria germ, the cells in a rose petal, the cells that manufacture bone, the cells in the human brain, all take in food and oxygen, give off waste products, produce heat and repair themselves.

WITHIN THE CELL THERE ARE STILL TINIER PARTS

All living cells contain protoplasm, for protoplasm is the life-material. Except in the bacteria, part of the protoplasm is denser than the rest and is separated from the more liquid part by a sort of skin or membrane. The denser part of the protoplasm is called the nucleus; the more liquid part is called the cytoplasm. Usually the nucleus looks like a microscopic football or tennis ball embedded in the cytoplasm, but sometimes the nucleus has a peculiar shape; it may be star-shaped or like a string of beads.

Bacteria cells do not have a nucleus. However, we believe that the material which forms the nucleus in other cells is scattered in little grains through the cytoplasm in the bacteria.

When we study a one-celled animal, such as the ameba, the cytoplasm at first seems to be doing all the work of the tiny creature. The cytoplasm pushes out in projections (pseudopodia, or false feet) by which the ameba crawls; the cytoplasm captures prey by pushing these projections around the victim; the cytoplasm produces digestive juices which dissolve the prey so that it can be absorbed. A little clear space in the cytoplasm, called the contractile vacuole, acts like a pump, squirting water and waste materials out of the cell. And the cytoplasm is always in motion inside the animal, flowing around endlessly. All the while the nucleus seems to be doing nothing at all. It seems to be dragged around by the cytoplasm.

Scientists at New York University made a glass needle so small that it could be used to remove the nucleus from an ameba. When this was done the ameba continued to crawl as if nothing had happened. But it could no longer digest and use its food; it could

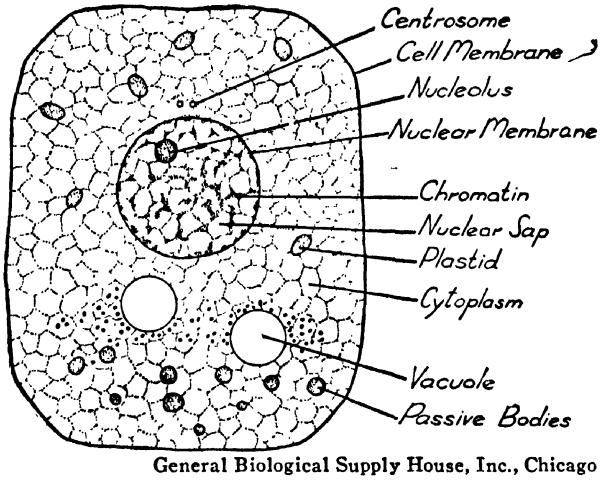
not grow; it could not repair injuries. After a few days amebas which had lost their nuclei always died.

Also, the amebas which had lost the nucleus could not reproduce. Most one-celled animals and plants reproduce by splitting in half. The nucleus divides first, then the rest of the cell. Besides removing the nucleus from the ameba, scientists perform surgical operations with microscopic glass tools on other one-celled animals. They always find that if they cut the animal into two parts, the part without a nucleus dies in a few days without reproducing. The part with a nucleus frequently lives in a normal way and splits in two at regular intervals to produce new individuals, just as if nothing had happened to it in the laboratory.

If the nucleus in a cell of any living thing is destroyed, the cell is sure to die. If a nerve cell is cut in two, the part without a nucleus dies; the part with the nucleus not only lives, but it repairs itself and grows a new part to replace the part which was cut off. Nerve cells are so slender that they have to be magnified several hundred times to be clearly visible. Yet those that go from the spinal cord to the hands or the feet may be two or three feet long. Suppose a person's finger is injured so badly that the nerve cells are cut. For a while he will have no sensation in the tip of the finger. Eventually, though, the finger will again become sensitive.

What happens is this. When the nerve cell is cut through, the long, thin part which extends *beyond* the cut dies. But the other part, which runs up to the spinal cord, quickly repairs the injury—because it contains the nucleus. Presently the cut end of the surviving part of the cell starts growing. It will grow all the way down to the tip of the finger. Such a cut nerve cell can do this through the influence of the nucleus, though the nucleus might be a foot or two away.

Perhaps you have heard that we have cells in our bodies which do not have a nucleus—the red blood corpuscles which carry oxygen from the lungs to all parts of the body. It is true that our red blood cells do not have a nucleus. But as a result they do not live very long. When they are formed (in the marrow of the bones) they have a nucleus. This disappears before they go into the blood stream. A red blood cell lives about a month. You do not need to worry about this, however, as the bone marrow makes new blood cells as fast as the old ones break up.



General Biological Supply House, Inc., Chicago

Diagram of a typical cell, with its many parts. The large body in the center is the nucleus.

The cells in the human body are all so small that we need a microscope to see them. In a small drop of blood there are about five million red blood cells. Bone is made and kept in good condition by the bone cells which are scattered through even the oldest and hardest bone in the body. All our movements are due to the contraction of long, slender muscle cells.

Rounded fat cells, each with a drop of fat stored in it, act as cushions in many parts of the body and serve as a source of reserve energy. There are many other types of human cells. Perhaps the most interesting are those of the brain, with their hundreds of long, thin branches which make it possible for impulses, or messages, from any part of the brain to reach any other part.

Bacteria (each of which consists of a single cell) are much smaller than any human cell. In fact, one of the ways in which we are protected from infection is through our white blood cells, which crawl like amebas and eat bacteria which get into our bodies.

Not all cells are so very small. Next time you eat an orange, notice the little swollen structures inside the orange sections. Each of these juice-filled objects is a single cell. For real giants among cells, though, the best examples are the yolks of the eggs of birds. The yolk of a hen's egg is one cell. So is the yolk of an ostrich egg. The nucleus in such cells is microscopic, but inside the cytoplasm there is considerable food material.

By THOMAS G. LAWRENCE.

THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 661.

THE RISE AND FALL OF JAPAN

THE sight of the blazing sun rising from the sea, its beams making the waves look like moving, molten gold, calls up visions of unearthly splendor. As the wise men of ancient China gazed eastward on this glory, they wrote down stories of gods and warriors living on the islands hidden in the eastern ocean. So Japan, the Land of the Rising Sun, came to be looked on as a mysterious and sacred country. As for the Japanese, they proudly claimed descent from the gods, and until 1945 the emperor of Japan was revered as a god.

The beliefs which grew up around the old legends led in the course of time to the worship of many gods and spirits, of ancestors and the powers of nature. This religion was called Shinto, a word that means "the way of the gods."

It is generally thought that the first people, after the cave-dwellers, to settle in Japan were the Ainus, who probably crossed over from Siberia; and a delightful change they must have found it in the warm climate of the southern islands.

The Ainus, however, were pushed back from the more desirable parts of the land by two streams of newcomers. Some were of the Mongolian race, like the Chinese. These men came across the Sea of Japan from Korea and Manchuria. The other newcomers came floating along the warm, dark current from southern Asia. These were of Malay stock. Waves of these two races came, time after time, and they are the ancestors of the Japanese people of today. The Ainus were never pushed out entirely; thousands of them still live in the north, especially on Hokkaido, apart from other people. The Ainus are remarkable for their general hairiness.

The first Japanese emperor was Jimmu, who is said to have lived more than twenty-five centuries ago. The Japanese claim that from him their one dynasty, or family, of emperors has ruled in unbroken line ever since. But the dates for the first part of this

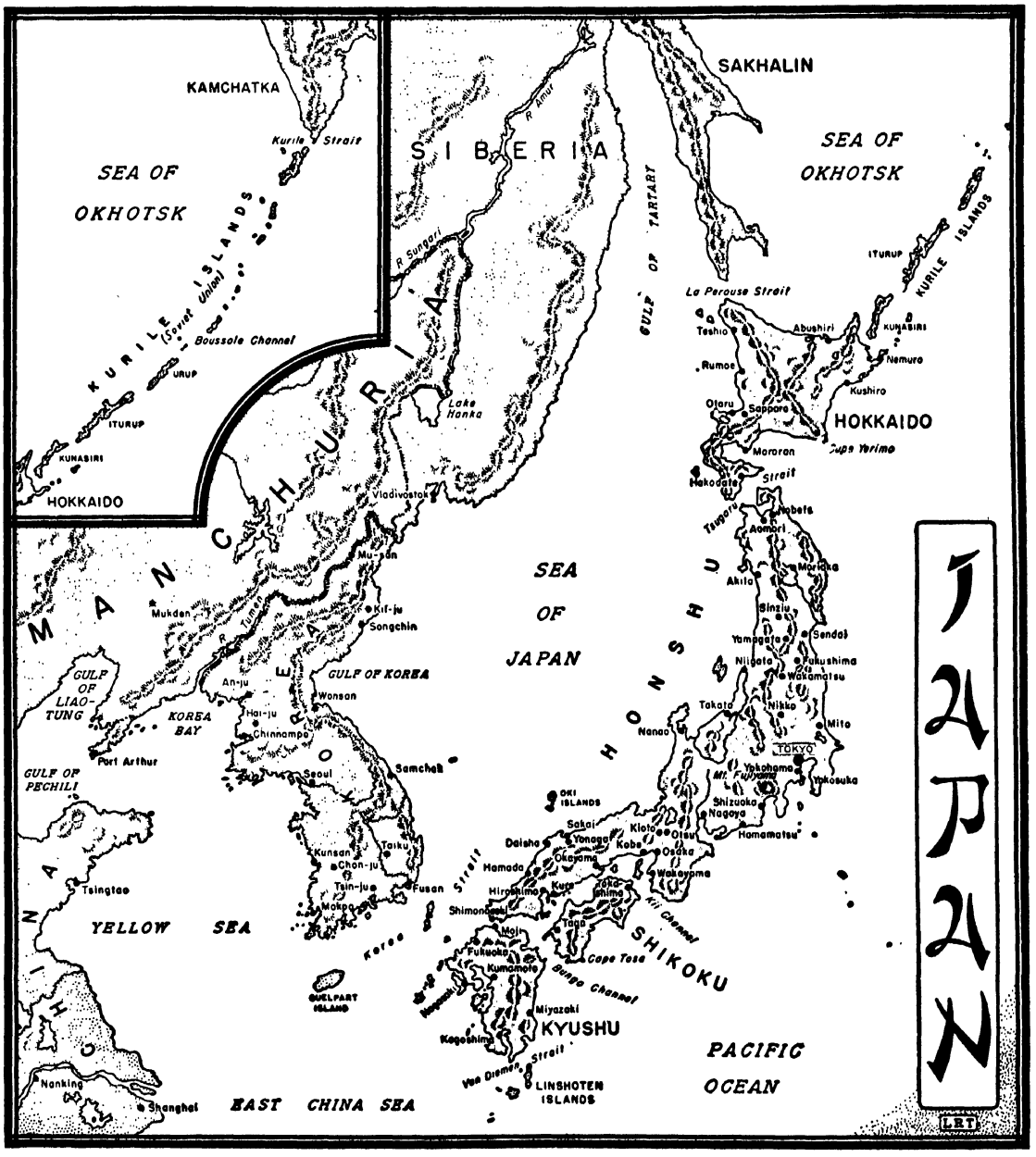
In the early morning sun a barefooted farmer carefully strews his precious hoard of fertilizer in preparation for new planting. This upland patch is unsuitable for rice.

© W. D. Harris from Black Star

long time are very uncertain. Besides, it was long the custom in Japan to adopt a boy to carry on a family's name, if sons were lacking. So we can not be sure that the line of emperors has been unbroken in our sense. We do know that the early independent tribes were passing under the leadership of one dominant tribe centuries before Julius Caesar "discovered" Britain.

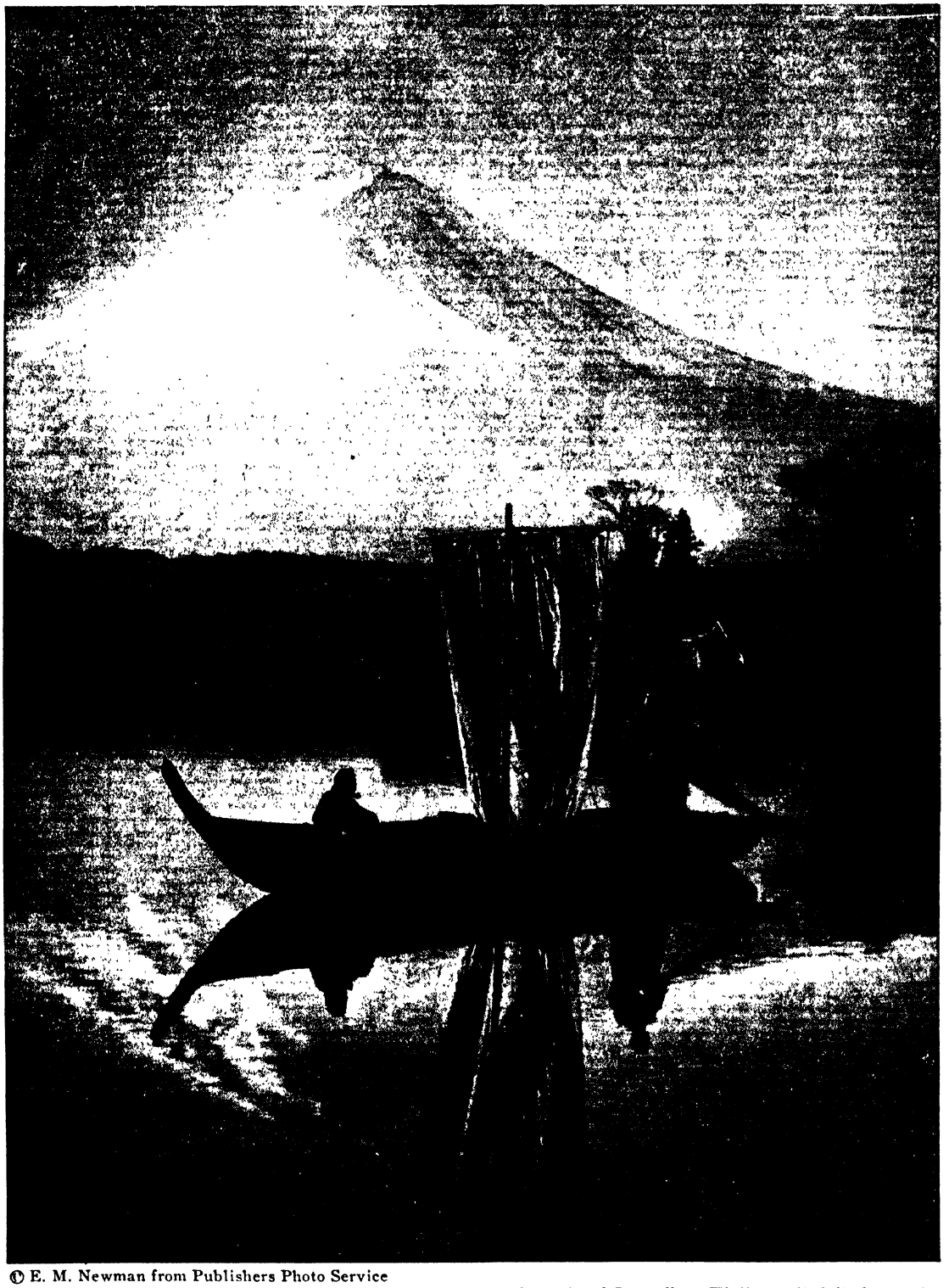
A great stream of Chinese and Koreans poured into Japan and merged with its people during the centuries before and after the birth of Christ. Meantime, the Japanese busied themselves with bringing water to their rice fields, making canals and developing trade and manufactures.

About the sixth century A.D the religion of Buddha spread into Japan by way of China and Korea. Eventually it took its place side by side with the older national



Insert shows the Kurile Islands, now lost to Japan, which continue the chain north to the Kamchatka Peninsula.

FUJIYAMA, THE SACRED MOUNTAIN OF JAPAN



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The lofty cone of the snow-tipped volcano of Fujiyama, "the keynote of Japan," as Kipling called it, leaps at a bound 12,461 feet into the air unchallenged by surrounding hills. It is sixty miles from Tokyo and dominates many of the most beautiful views near the capital of Japan, and it can be seen from a great distance out at sea.

religion of Shinto. Beautiful Buddhist temples, as well as Shinto shrines, rose up over the country.

Troubled times came to the land during the period that we call the Middle Ages. There were many grades of nobility all fighting to be first. The emperor became more and more a mere puppet as the real government of the kingdom passed into the hands of officers and ministers. For seven hundred years the real head of the government was the Shogun, though the emperor was still revered as a god. Yoritomo, the first Shogun, was a great general and organizer. He died in 1198. The last Shogun gave up his power in 1868.

THE FEUDAL AGES, UNDER THE SHOGUNS

During the rule of the Shoguns life in Japan resembled that of feudal times in Europe. Quarrels between rival families were fought out in pitched battles; nobles lived in their strong castles, surrounded by armed retainers called samurai.

About 1500, the Portuguese found by an eastward route what Columbus had tried in vain to find by sailing westward. From the rich Indies they passed to China and thence to Japan. Christian missionaries soon followed the traders and explorers. The famous Jesuit, Francis Xavier, came to the southern island of Kyushu in 1549, and conducted, under difficulties, a short but brilliant mission.

Toward the end of the sixteenth century Nagasaki became a Christian city. The largest Portuguese vessels could ride at anchor in this fine southern harbor. Trade flourished. Churches were built on the sites of old Buddhist temples; but the progress of the new religion was stopped before long. A soldier of fortune, Hideyoshi, rose to the highest power. He is often called the Napoleon of Japan, so great were his victories. He conquered Korea and even planned the invasion of the Chinese Empire.

JAPAN CLOSES ITS DOORS TO MISSIONARIES AND TRADERS

Hideyoshi's successor, Iyeyasu, also a great general, overthrew all his rivals and founded a dynasty of Shoguns that ruled a united Japan in peace for 250 years. To secure this peace, the Christian missions and the foreign traders were sent away, and the country was closed to all but the Dutch. Under narrow limits they alone were allowed to trade at Nagasaki. Some of the most beautiful Japanese work is to be seen at The Hague, Holland, gifts from the Japanese emperors of those days.

In the middle of the nineteenth century there came an astonishing change in the country. Japan had gone on all those peace-

A Japanese emperor of early times carried on the shoulders of four honored subjects.

ful years making improvements in the produce of the country, in the fields, in the tea gardens, in the hand looms, in the pottery factories and in the many other arts and crafts. But at the same time there was a growing desire for expansion.

COMMODORE PERRY'S ARRIVAL BRINGS JAPAN INTO WORLD RELATIONS

When Commodore Perry arrived in 1853 with a United States fleet to insist on pulling down the barriers which had kept Japan away so long from the rest of the world, the old system seemed to fall at a blow. Treaties with various powers were signed; Yokohama was opened to foreign trade; the Shogun had to retire with all his old-fashioned ideas and ways; and the emperor was restored to the full and ancient powers of his office and reigned over the people in fact as well as in name.

Japan leaped out of the Middle Ages into the stream of modern life. New inventions and movements from the West were adopted ardently. Students were sent to Europe and America to gain Western knowledge. European and American instructors were brought to the country. Roads were improved and bridges built; railways, telegraphs and eventually telephones spread their networks over the country. Banks, warehouses, mills and factories seemed to spring up overnight. Law

Both pictures © Gendreau, N. Y.
A great bronze Buddha, or Daibutsu, almost fifty feet high, broods over the landscape near Kamakura.

courts were established; and a constitution was granted in 1889, which provided for a House of Representatives elected by the people.

China now thought it was time to proclaim her sovereignty over Korea, which maintained that it was an independent country. The Japanese, who had designs of their own on Korea, rushed to the defense of that country; and thus began the Chino-Japanese War of 1894-95. China was no match for Japan in military might, and the Japanese won a series of smashing victories. At last the Chinese were forced to sue for peace. China ceded Formosa and other territory to Japan and acknowledged the independence of Korea.

Now Russia came into the picture. Russian influence had been growing strong in Manchuria, and in Korea, too. Japan looked on this as a threat to her own interests. The struggle flared out in the Russo-Japanese War of 1904-05, from which Japan again emerged victor. The war was settled by the intervention of President Theodore Roosevelt, who urged both countries to lay down their arms. The peace treaty was signed at Portsmouth, New Hampshire, on September 5, 1905. By it Japan obtained part of the island of Sakhalin, to the north of Japan. Russia also promised to withdraw from Manchuria and acknowledged Japan's special interests in Korea. Both countries made concessions in Manchuria.

Only nine years later a much more terrible war broke out, World War I. Japan, as an ally of Great Britain, declared war against Germany. The Japanese fleet took over the German islands in the Far East and searched the seas for the German raiders which were destroying commerce. When the war ended Japan joined the League of Nations. From the league she received a mandate to govern most of the former German possessions in the Pacific Ocean.

Taking advantage of the war, Japan had in 1915 made a series of far-reaching demands upon China. If they had been granted, China would have become little more than a Japanese colony. The Chinese protested bitterly and they had the powerful support of the United States. At last an attempt was made to reach an agreement. At a conference held in Washington, in 1922, it was acknowledged that Japan had special interests in China. For her part, Japan promised to maintain the open door (equality of opportunity for all nations) in China and also promised not to occupy Chinese territory.

The Japanese now proceeded to strengthen their position in China. Thousands of Japanese settlers went to live in Manchuria, and the Japanese started the industrial development of the region. But soon the Japanese pioneers were complaining of being harassed

The entrance gate, or torii, of the ancient Shinto shrine on the islet of Miyajima, in the Inland Sea.

by Chinese soldiers and bandits. This gave the Japanese army an excuse to take matters into its own hands. Without bothering to obtain the backing of the Japanese Government, Japanese troops invaded Manchuria in 1931. Within a comparatively short time, most of Manchuria was occupied by the Japanese. The next year the Japanese set up a puppet government in Manchuria, and called the state Manchukuo.

JAPAN WITHDRAWS FROM THE LEAGUE OF NATIONS

Still not content, the Japanese tried to get control of industry and business in northern China. They used every means, including acts of violence, to get what they wanted. Japan resigned from the League of Nations, which had denounced her, and in 1934 declared herself the "guardian of peace in the Pacific." Clearly, she meant to become the center of a wide empire.

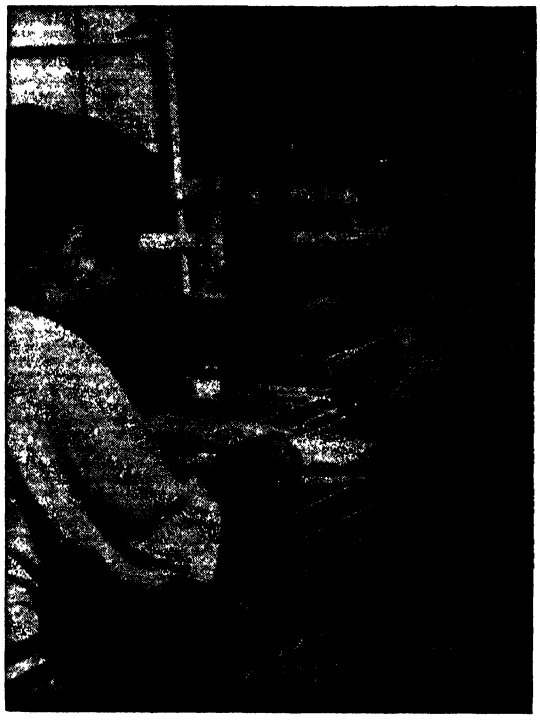
Relations between Japan and China grew steadily worse. At last, without a declaration of war, the Japanese launched a series of terrible attacks on China, in July 1937. Although the Chinese resisted fiercely, the Japanese captured the Chinese seaports, one by one. In December of that year the Chinese capital, Nanking, was likewise taken. The Japanese now waited for the foe to surrender. After all, the Chinese had been thoroughly beaten and their capital was in the hands of the enemy—surrender was only to be expected.

The Chinese, however, did not surrender. Their armies continued to fight stubbornly as they retreated toward the west. A new Chinese capital was set up in Chungking, in the province of Szechwan.

THE PLAN TO CONTROL ALL OF EAST ASIA

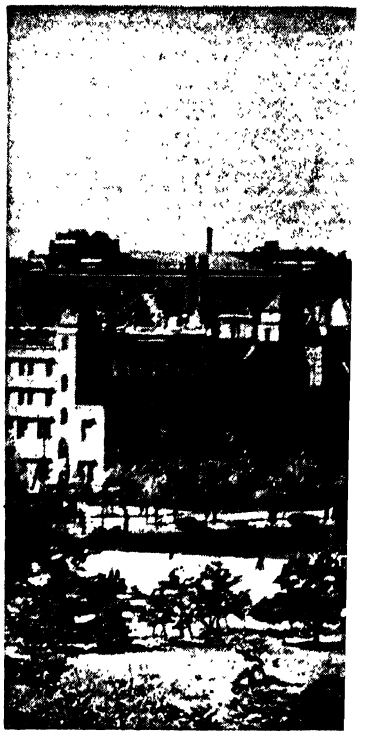
In the meantime, the democratic countries, particularly the United States, had repeatedly condemned the Japanese for their breaking of treaties and for the brutality that their armies had shown in the Chinese war. In July 1939 the United States announced that in six months it would give up its trade agreement with Japan. Japan drew closer to Germany and Italy. From this time on the Japanese made no secret at all of their design, to control not only China but also the whole area of the South Pacific. They announced their plan to preside over a Greater East Asia Co-Prosperity Sphere.

In 1941 the United States, Great Britain and the Netherlands stopped almost all their trade with Japan. Balked in China, facing



Old and modern occupations for Japanese women. Above, lengthwise threads are carefully arranged on a loom for weaving silk. The telephone operators below have discarded the picturesque kimono and wear slacks —with the further Western touch of spike heels!

Photo by U. S. Army Signal Corps



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Eastern and Western customs mingle on the Ginza, the "Fifth Avenue" of Tokyo. The sweeping view of the city was taken from the grounds of the Imperial Palace. On the right is the Diet Building; and Fujiyama glimmers in the distance.

ruin at home from the trade boycotts, the Japanese determined to strike. On December 7, without any warning, they launched a terrible attack by air and submarine against the strong United States base of Pearl Harbor, in the Hawaiian Islands. About the same time attacks were made on the Philippines, Hong Kong and Malaya. Then the Japanese declared war on their foes. When the war came to an end at last, September 2, 1945, Japan, an utterly defeated nation, was occupied by United States troops under General Douglas MacArthur.

Though she was beaten at last, Japan had acquired a vast empire in her career of conquest. At the height of her power, in the middle of 1942, this empire included Formosa, British Malaya, Burma, the islands of the Netherlands East Indies and many other islands in the South Pacific. Japan also held the Philippine Islands and huge areas in China. Manchuria and Siam were Japanese puppet states. Japanese soldiers occupied bases in French Indo-China. With the defeat of Japan all these regions were freed from her rule.

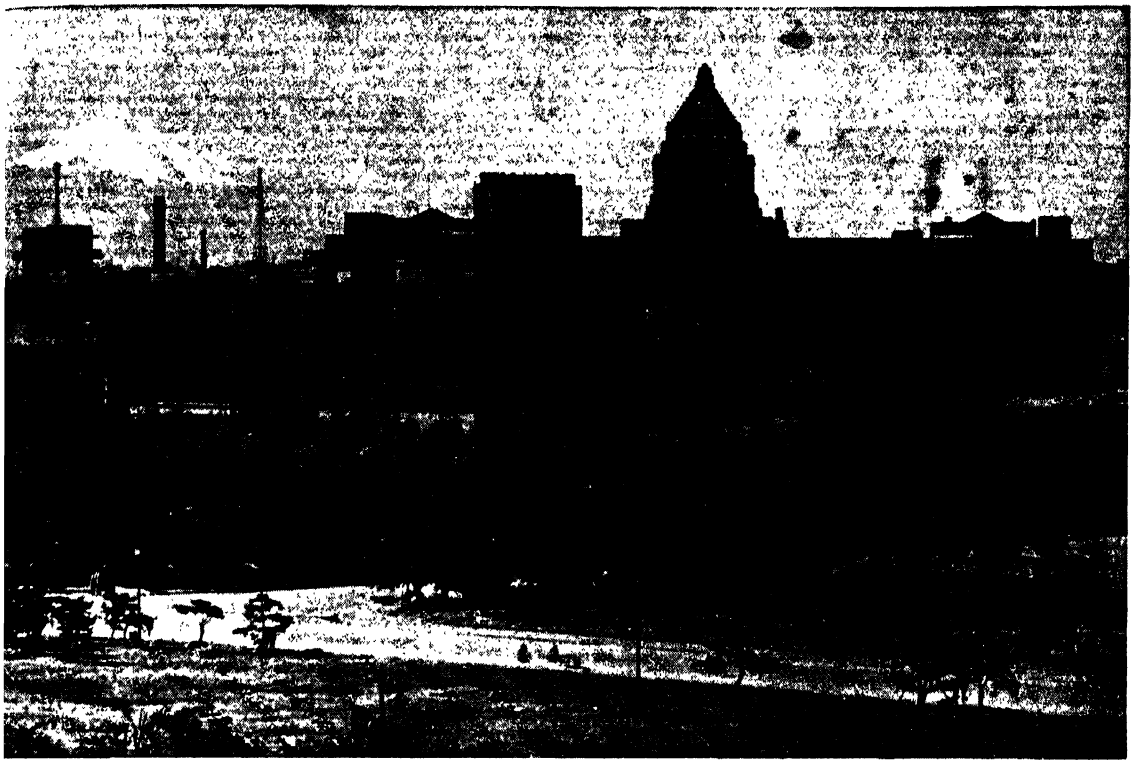
The shape of Japan used to be compared to that of a dragon-fly. Its body consisted of Japan's four chief islands (Honshu, Shikoku, Kyushu and Hokkaido); the Kuril, or Kurile, Islands to the north represented the feelers; the Ryukyu Islands formed a fine tail. But Japan has lost the Kuril and Ryukyu islands, and Formosa and Korea as well, as a result of the war.

The area of Japan proper, including the four principal islands and a number of smaller near-by islands, is 147,492 square miles. Honshu is the largest and is considered the mainland of Japan. More than 75,000,000 people live in Japan proper.

The climate of Japan resembles that of the eastern seaboard of the United States, except that Japan is much more damp. In the south it is semitropical; and Hokkaido, in the north, has short, warm summers and long, cold winters. In late summer and fall the typhoons come, when high winds and torrential rains lash the land. Such storms are often very destructive.

Off the eastern shores of Japan is one of the deepest parts of the Pacific Ocean. Through the sea bed runs a fault, a place where the earth's crust frequently cracks. The islands, in fact, are on the line of several such faults, and these are the cause of the dreadful earthquakes from which Japan so often suffers. The quakes are usually followed by huge tidal waves which rush in and devastate large areas.

The islands are really a mass of mountains, with the ranges running north and



south. Lofty summits have been piled up by volcanic action. There are about five hundred volcanoes, of which sixty are more or less active. The most famous is Fujiyama, near Tokyo, which the Japanese hold sacred. It is partly surrounded by a series of lovely lakes, and on the south it slopes unbroken to the sea. West of Tokyo is a region of jagged peaks called the Japanese Alps.

Because of the mountains, the rivers of Japan are short and broken by shallows and rapids. Their water-power possibilities could be developed to a greater extent if it were not for the fact that there are so few places where the water could be stored in reservoirs.

In spite of Japan's rugged surface and its industrial development, it is still a nation of farmers. This is so in the face of enormous difficulties. Only about one-eighth of the total area can be used for agriculture. The fields are in small isolated plains, and the soil is poor. Every square inch of farm land is cultivated with painstaking care; and the use of fertilizers is a necessity. More than half the crop area is used for rice. Some other grains and some fruits and vegetables are grown. Tea is important. Here and there in the Japanese landscape is the green of mulberry trees, which provide food for silkworms. Silk is the most valuable "crop."

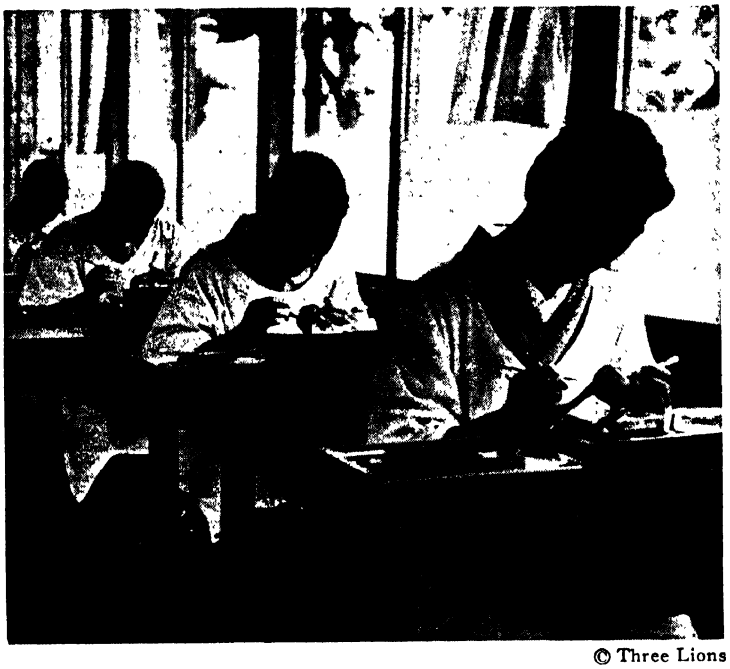
Hardly any livestock is bred, except on Hokkaido, where there are some dairies. In place of meat, the Japanese depend on fish. The greatest fishing grounds in the world girdle the Japanese islands, and ordinarily they yield about half the world's catch.

Forests still cover more than half of Japan, cloaking the mountains, from palms and orchids to maples and pines. The color of the northern trees in autumn rival those of northeastern United States. The Japanese use the woods to make charcoal, which is the chief fuel used in homes.

Japan has fairly large quantities of coal, copper, gold, silver and sulfur, but not enough iron and very little petroleum. In fact, while the country has a wide variety of natural resources, they are not enough for the needs of its enormous population. To be prosperous Japan must first import raw materials and then export manufactured goods. Before the war Japan had a large iron and steel industry, but after the surrender all industries that could provide weapons of war were prohibited. The manufactures that remain are cotton goods (made from cotton usually imported from India), rayon yarn, silk-weaving, pottery, exquisite cloisonné (enamel) and lacquer work, and articles made from bamboo and bronze.

There are a number of large cities in Japan. The largest of all, the capital city of

TASKS FOR INDUSTRIOUS HANDS—IN

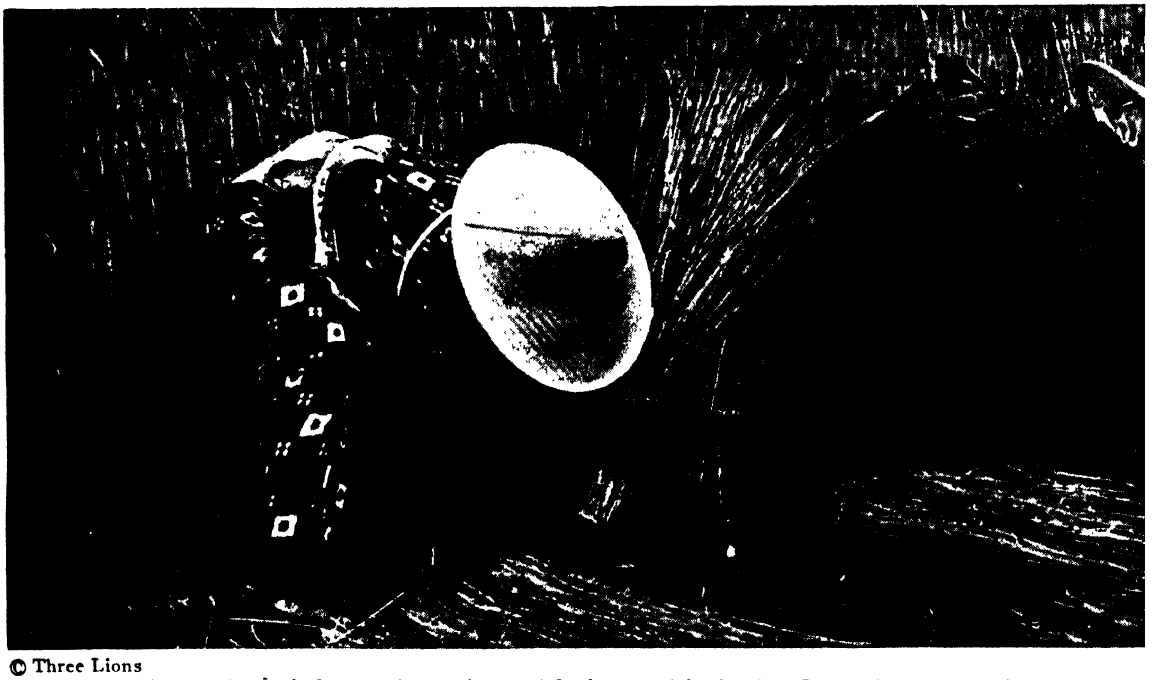


© Three Lions

Japan is the only country where the making of cultured pearls has been developed to any great extent. Each of these girls is inserting a tiny bit of grit in a live oyster. In time, if all goes well, the grit will be smoothly covered with nacre, the lustrous substance of pearls. Placing the irritating matter inside the oyster's shell is a delicate operation, requiring great skill, because the oyster itself must not be injured in the process. The Japanese are a nation of artisans, clever and quick with their hands; and the same talents have served them well in meeting the demands of the machine age. On these pages we show a few of the various kinds of workers.

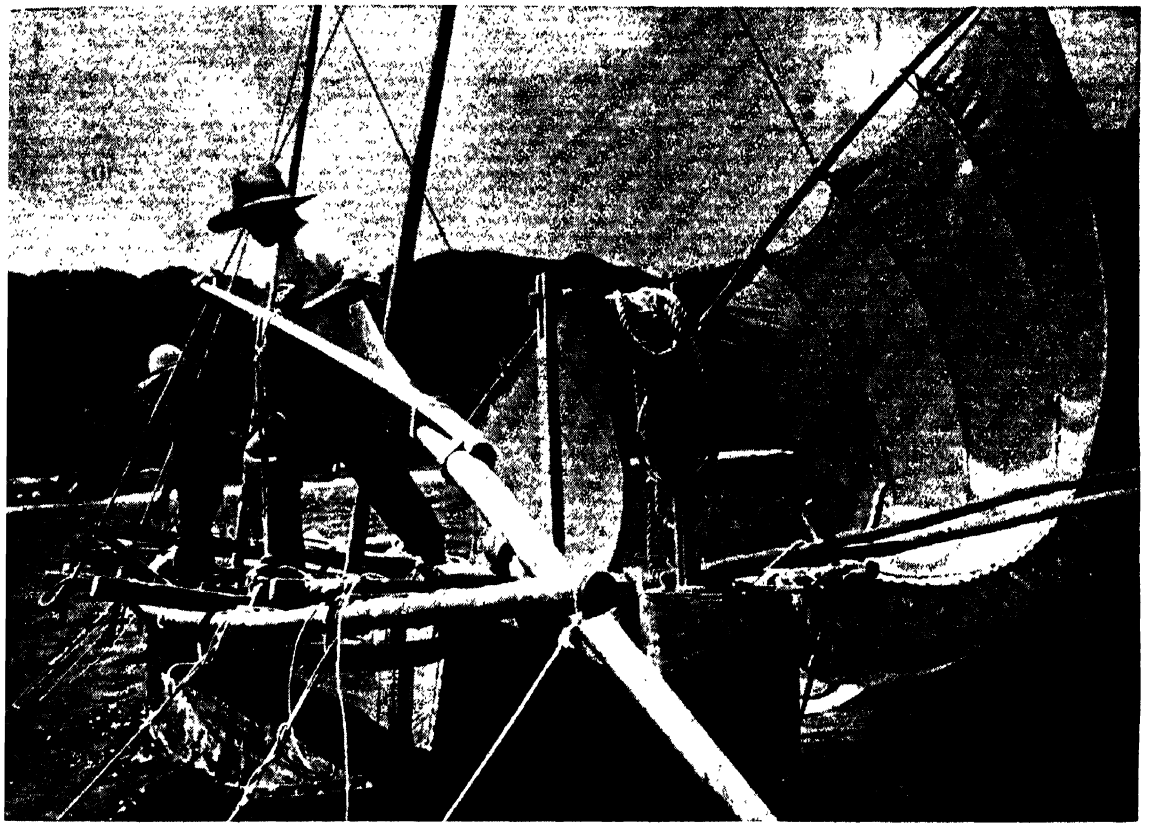
© Black Star

A part for an electric generator.



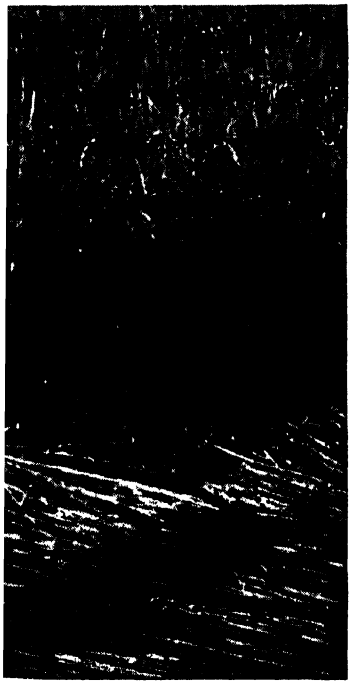
© Three Lions

Toilsome and slow as the method seems to us, rice must be harvested by hand in Japan. Most of the rice fields is not firm enough to permit the use of heavy machinery. Besides that, the plots are much too small for modern



© Black Star

Japan's great haul of fish is caught in thousands of tiny boats. This one is working the deep waters offshore.

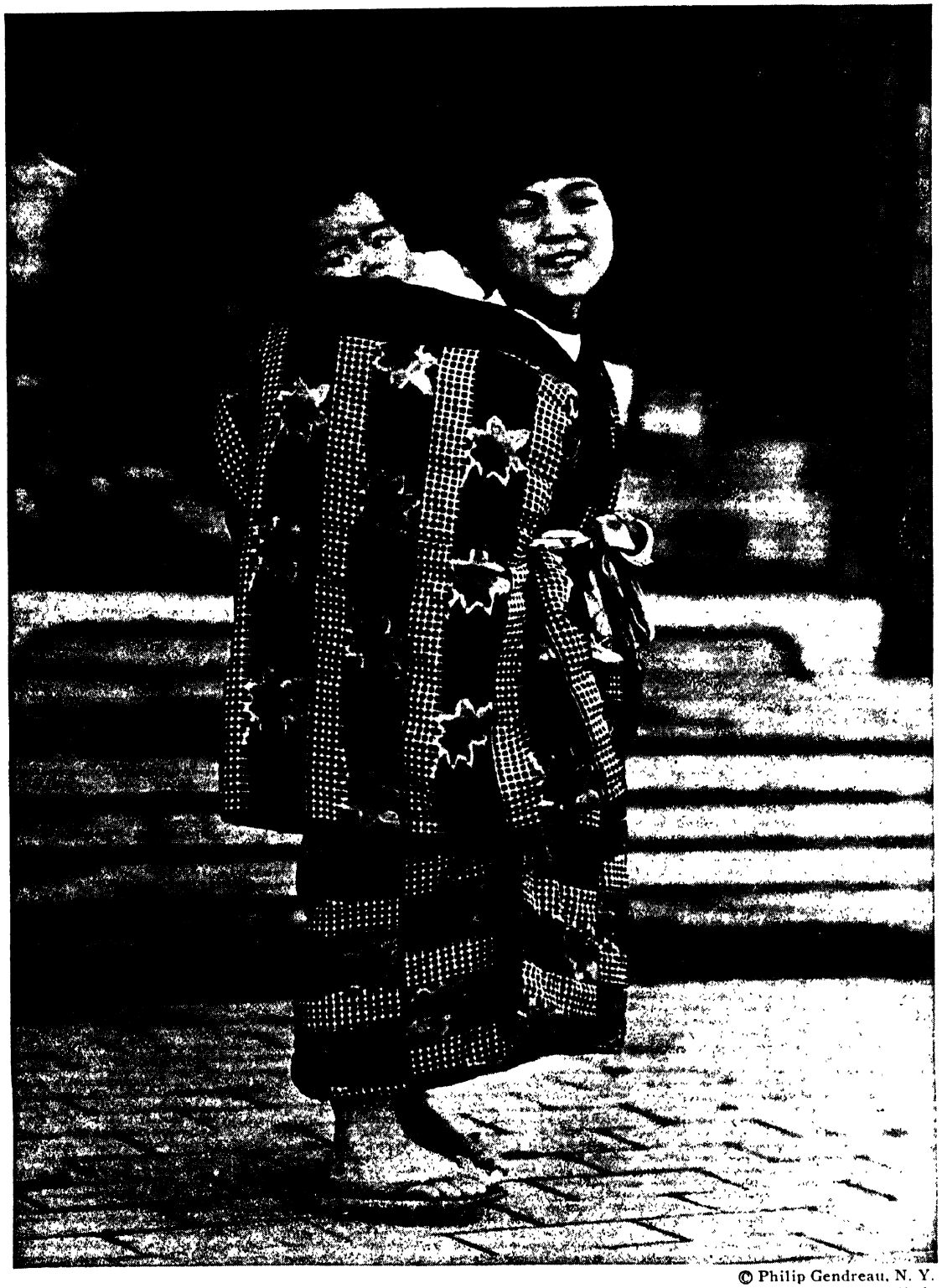


are irrigated, and the ground methods.

© Philip Gendreau, N. Y.

In making cloisonné enamel, fine wire is attached to the base so that the surface is divided into tiny "cells." These are filled with several layers of enamel.

A JAPANESE "PAPOOSE"



© Philip Gendreau, N. Y.

A kimono "built for two." It has purposely been made large enough so that when the sash is tied securely, the little girl's baby brother may be carried on her back, safe and snug. Both seem quite happy with the arrangement.

THE LIGHTER SIDE OF JAPANESE LIFE

Both pictures © Philip Gendreau, N. Y.

Geisha girls, who are trained from childhood in singing, dancing and other arts of entertainment.

A dinner party at home. The main dish is sukiaki, a mixture of meat and vegetables. With chopsticks each guest helps herself from the large dishes, adding the serving to her small bowl of rice.

Tokyo, on the island of Honshu, has a population of almost seven million. Taxis, street cars and busses throng the wide streets. Rapid transit is provided by a subway. There are theaters and large department stores, and parks and gardens. The city is crossed by a network of canals that empty into the Sumida River. Yokohama, nearer the entrance to Tokyo Bay, is the port for Tokyo, and the area between them has been so built up that they really form one large city.

PAPER HOUSES—WITHOUT CHAIRS OR BEDS

Japan retains many features of the past. For one thing, the average Japanese lives in the same kind of house his ancestors have lived in for generations past. This house is rather flimsy; it consists of thin wooden frames upon which paper is stretched. The only solid part of the house is the roof. There is generally only one floor and practically never more than two. Each floor has only one large room; this is divided into smaller rooms by partitions which can be slid back and forth as desired. The rooms are almost bare of furniture; the members of the family sit on the mat-covered floor. At mealtimes they have their meals set beside them on low tables. Everybody sleeps on the floor, too, between padded quilts.

The Japanese have long been famed for their elaborate rules of politeness. It is considered good manners to praise to the skies the person to whom one is speaking and to speak slightingly of oneself and of one's possessions.

The Japanese have a natural love of beauty, and the charm of Japanese scenery has beguiled thousands of visitors. Japanese gardens, with their dwarfed plants, in perfect proportion, delight the eye. For many centuries the decorative arts have flourished in Japan; the porcelain, cloisonné enamel, lacquer work and embroideries are famous.

There are in Japan a number of different religions. We have explained how Shintoism, the worship of ancestors and nature, began. There are a multitude of Shinto shrines and thousands of priests. Buddhism also has a large number of followers. Some Japanese have a form of worship based on the teachings of the Chinese philosopher Confucius. Not a few Japanese are Christians.

Of the many festivals in Japan, quite a number are set aside for children. Girls delight in the Festival of Dolls. On that occasion the dolls which have been carefully kept from generation to generation are brought out and proudly displayed. The dolls are placed on shelves covered with red cloth and arranged in tiers, or steps, suggesting a grandstand. These dolls represent the emperor and empress and many other favorite characters. The little girls receive presents of dolls and other articles.

The boys have their turn on the occasion of the Festival of the Flags. Images of various heroes and wrestlers (wrestling is an extremely popular sport in Japan) are bought for them, as well as helmets, flags and bows and arrows. One of the features of this festival is a sham fight, recalling the old feudal days.

After the war ended, as we have said, Japan was occupied by United States forces. The Japanese Government still administered the country's affairs, but they carried out the policies laid down by the Far Eastern Commission, made up of representatives of the Allied Nations. General Douglas MacArthur was appointed Supreme Commander for the Allied Powers. In 1947 a new and democratic Japanese constitution went into effect. One of its most important provisions is that Japan renounces war or aggressive acts forever.

© International News Photos

Though meeting the Emperor is a rather solemn occasion, these small subjects are not afraid to look at him.

KOREA

PERHAPS, as one looks westward toward Korea, veiled in morning mist, the land does look calm and peaceful. At any rate the Japanese called it Chosen, meaning Land of the Morning Calm. But its troubled story belies the poetic name.

In very early times, Korea was divided into several kingdoms, which were not united until the tenth century. For hundreds of years the Koreans were allies of China, paid tribute to her, and were deeply influenced by Chinese art, architecture, literature, practical sciences and philosophy. Many Koreans were educated in China. For a long time, Buddhism, which also came by way of China, was the chief religion of Korea. The eighth and ninth centuries were a golden age of Korean art, architecture and literature. Now here is an ironic fact. Japan was still in a barbaric state when China was highly civilized; and the Chinese culture spread slowly to Japan by way of Korea as a bridge.

Korea, as an ally of China, first was devastated by the Japanese in the latter part of the sixteenth century. Again Korea was laid waste, about twenty-five years later, when she went to the aid of China in her unsuccessful struggle with the Manchus. These destructive wars led Korea to isolate herself behind her forbidding rocky shores. Foreigners were not welcome, and the world called Korea the Hermit Kingdom. During the nineteenth century, however, Christian missionaries gradually opened the country's doors. They built many churches and schools; and today it is estimated that there are about a half million Christian Koreans.

A treaty of commerce and friendship was signed with the United States in 1882, which dealt with Korea as an independent country. However, after the Russo-Japanese War of 1904-05, Korea was made a Japanese protectorate. And in 1910 Japan annexed Korea outright. Many promises of "growing prosperity and welfare" were made, but actually Japan ruled the peninsula with a heavy hand. Trade with other countries was broken off; and most Koreans became little more than serfs, denied even an education.

In 1919 there was a rebellion which the Japanese put down with great cruelty. Nevertheless, Korean patriots never gave up the struggle for their country's freedom. Many of them worked from foreign lands, where they had gone to obtain an education.

After the defeat of Japan in the second World War, Korea was occupied by United States forces, in the south, and by Soviet forces, in the north. Japan had controlled Korean life so thoroughly that the transfer of authority back to the Koreans themselves could not be accomplished at once.

Fritz Henle

Plump fresh vegetables set out in an open-air market to tempt Korean housewives.

Presbyterian Board of Foreign Missions

Ambling along in an odd two-wheeled cart, a farmer wears a "chimney hat," held on with an inner cap and a headband.

The long, narrow peninsula of Korea dips down into the seas between China and Japan. It has an area of about 84,000 square miles and is about 660 miles long by 130 miles wide. On the west is the Yellow Sea; to the southeast, Korea Strait; and on the east, the Sea of Japan. Its neighbors to the north, on the mainland of Asia, are Manchuria and the Soviet Union. Vladivostok, the Soviet's chief Asiatic port, is only a few miles away, along the coast to the northeast. The capital of Korea, Seoul, is in the center of the peninsula, a few miles in from the western coast. Its port is Chemulpo (Jinsen). On the southeast coast is the most important port, Fusan. Part of the Korean railway system connects Seoul and Fusan.

There is hardly any place in Korea where one may not see mountains, range after range, stretching off to the horizon. The longest chain rises steeply from the eastern shore. Farther in, in the center of the peninsula, are the famous Diamond Mountains, or Kongo San. Most of the rivers flow west and south. The longest is the Yalu, or Amnok, River, which forms the dividing line between Korea and Manchuria. It falls from the highest peak in Korea, White-headed Mountain (or Paitou Shan, in Chinese). The only important river to drain to the northeast, the Tumen, begins on the north side of the same mountain.

The climate of Korea is very much like that of the middle Atlantic coast of the United States. But partly because of the effect of the mountains, most of the rain falls in July and August.

Of all Korea's natural resources, water power is the most important. The rivers tumble down from the mountains to sea level in comparatively short distances. The great difference between high and low tide on the west coast, as much as forty feet in some places, could also be used for water-power development. But only the river falls have been harnessed to any extent as yet.

RICHES IN THE GROUND YET TO BE DEVELOPED

There are large coal reserves, much of it anthracite, but there is no petroleum. Fairly large reserves of iron ore, mostly of low grade, as well as magnesium, lithium, aluminum, lead, zinc, gold, graphite and mica exist.

All of Korea was once heavily covered with forest, but it has been used wastefully in the south. In the north, however, there are good stands of spruce, fir, larch and pine.

In spite of the fact that Korea is so mountainous, agriculture is the chief occupation of the people. But intensive cultivation for hundreds of years has robbed the soil of much of its fertility. Most of the farms are very small, under four acres. On such tiny farms whole families depend for livelihood.

Rice, especially in the south, has long been the principal crop. But many Koreans live on the second most important grain, barley, grown in the north or, during the winter, raised in fields which yield crops of rice during the humid summer. Another southern crop is cotton. Millet, wheat, oats, grain sorghum, buckwheat, corn, white and sweet potatoes, turnips and cabbages are grown in the north and in the upland valleys.

Thomas B. Hollyman from Monkmeyer

A Western hat and shoes rather spoil the effect of the white robe, the usual costume in Korea.

Under the Japanese, water-power resources were developed; iron and gold mines were worked; and aluminum, chemical and refining plants were built. Crop yields were also increased, particularly rice. But the products went to Japan. The improvement of industry and agriculture brought no aid to the Koreans. The mass of the people is among the most poverty-stricken in the world.

The Koreans—the population is about 25,000,000—are a distinct branch of the yellow race. They are taller than the Japanese and less Mongolian in appearance than the Chinese. The Koreans have their own customs and language. At an early period they invented an alphabet based on sound. (Most alphabets are based on pictures.)

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 649.

A decorative mosaic from an old castle in Sicily.

A GREAT LIGHT SHINES

THE dying-out of Classic art left the world cold and bare, and something like ten centuries were to pass before a new glory rose on the ashes of the old. Meanwhile, in an obscure corner of Asia Minor the greatest event of the world's history had taken place—the birth of Jesus at Bethlehem. Let us think of the influence of Bethlehem on the fortunes of those days. It was the shining of a great light for art.

For many generations Christianity had no real home, but was the guest of several countries and states. It was impossible for a people so scattered to have in themselves the masterful power which produced the art of Egypt, Assyria or Greece; it was equally impossible to be neighbors to such greatness without copying it. In early Christian art, therefore, it is natural that certain influences should be traced—Greek, Syrian and, to some extent, Persian.

Alexandria in Egypt was then the centre of Greek painting, and although the Grecian genius was worn out, and its ideals were rather battered, it still had command of technique and was able to give valuable lessons to a new art. Greek painters taught the Christians how to fill spaces and how to group figures and ornament. The secret of great composition—to avoid overcrowding—was still a part of the Greek tradition, but the early Christian artists, like the Romans, failed to learn this lesson. To its dying day the spirit of Greek art was beauty for beauty's sake. A very different purpose underlay Syrian art.

The Syrians were less interested in their painting than in the subjects they portrayed. It was their instinct to represent the gentle Jesus as a haughty figure, tinged with the egotism of the Egyptian and Assyrian art of which the Syrians themselves were heirs. The Founder of their religion was always in a central position and drawn on a larger scale than any other figure. We can always recognize this Eastern influence, so contrary to Greek ideals, when we see pictures by the early Christians painted in what is called *inverted perspective*. The peculiar treatment showed the foreground figures, which should have been larger than the rest, actually smaller, so that the Christ in the middle of the composition might stand out more convincingly. The Syrians, in a word, did not paint pictures as pictures: they merely illustrated an idea in color and shape; their art was the expression of their religious thought.

The Persians, on the other hand, who also had an effect on this new art, were without any sense of perspective whatever. In its place they adopted a curious convention. Their compositions of groups of people show figures always painted in flat tints, with no attempt at

modeling, no rendering of a background. And, in order to show that some persons were nearer the front of the picture than others, they painted figures in zones, or layers, one set above another; the highest group in the picture was supposed to be in the farthest background. The Persian influence on early Christian art is shown mainly in this strange un-lifelikeness and in the introduction of a certain kind of ornament—a conventional scroll of vine leaves and branches wherein birds and beasts are most incongruously set.

PICTURES IN THE MEETING-HALLS OF THE FIRST CHRISTIANS

Generally speaking, Christian art of the first few centuries was divided into two branches, that of the Western world, centring in Rome and Ravenna, and that of the Eastern world, centring in Constantinople. The Constantinople school is known as Byzantine, and takes its name from Byzantium, the ancient name for Constantinople, which the Christian emperor Constantine in the fourth century made the new capital of the Roman Empire.

Traces of the work of early Christian artists, gold and enamel objects, and pottery, have been discovered in most of the Mediterranean cities. The chief monument to their art is found in the wall-paintings of the catacombs during the first four centuries. These were burial places, and, in the years of their persecution, the secret meeting-halls of the followers of Jesus. Catacombs were known to exist in Naples, Syracuse, Alexandria, Cyrene and in the Holy Land. The most famous are at Rome, where about fifty have been discovered from time to time.

THE UNDERGROUND GALLERIES WITH THE SECRET ENTRANCES

The Christians, like the Romans, built their catacombs outside the city-wall, on the great high-roads that led from Rome to the outer parts of the empire. Some of them lie in the famous Appian Way; one of these, the catacomb of St. Domitilla, is supposed to be the most ancient.

The catacombs were long narrow underground galleries, with recesses and small chambers breaking their gloomy lines. When, during the bitterest persecution of the Christians, the emperor Diocletian ordered the catacombs to be closed, the worshipers burrowed fresh entrances and made new and mysterious passages whose winding mazes were known only to themselves.

As time went on, the existing catacombs proved in some cases insufficient for needs of burial. The workmen then sank shafts until they found a lower stratum suitable for excavations; when those galleries became over-full of their ghostly burdens another stratum was found, and then another. Visitors can still go from one to another of the four floors of the catacomb of St. Calixtus.

In the walls of the catacombs horizontal rectangular spaces were cut to hold the dead, and these were closed by marble slabs. At a later period it was the habit to place beautifully chiseled stone coffins in these niches. When the "peace of the Church" came with the reign of Constantine, the practice of burying the dead in catacombs ceased. Cemeteries and chapels were made, and the underground galleries and chambers became meeting-places for the cult of martyr-worship which arose. In later centuries the catacombs ceased to have this hold on the Christian community. Then they became merely a dim tradition.

HOW THE CATACOMBS WERE LOST FOR AGES AND FOUND AGAIN

Medieval pilgrims who walked across Europe to Rome, the Eternal City, used to visit a catacomb in the Appian Way, near the little Church of St. Sebastian, but for the most part the ancient burial places were forgotten. Late in the sixteenth century the accidental falling of a vault laid bare some wall-paintings, and these excited the interest of archæologists. Most of the catacombs have since been excavated, and thus a period of remote Christian history of unusual interest comes to light.

In spite of the dim light and most unpleasant and foul air, the chambers and recesses of the catacombs were decorated. Some of the wealthiest families of Rome were Christian, and spared no pains or expense in making beautiful the halls of their dead. The Christian religion had taught them that death is the least misadventure that can befall a man, and thus there was nothing morbid in their interest and devotion to this mural art. Just as in Syrian paintings it seemed that the artists were speaking aloud, saying a tremendous creed about a Great and Jealous I AM, so in the timid, shy art of the catacombs it seemed that the artists were praying aloud and holding communion with their beloved dead in Paradise.

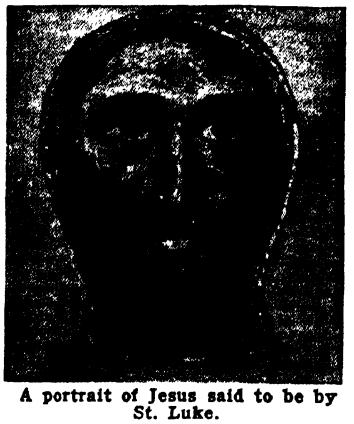
PICTURES ON THE WALLS OF LONG-AGO

A splendid Ravenna mosaic of the sixth century.

St. Michael in an old mosaic.

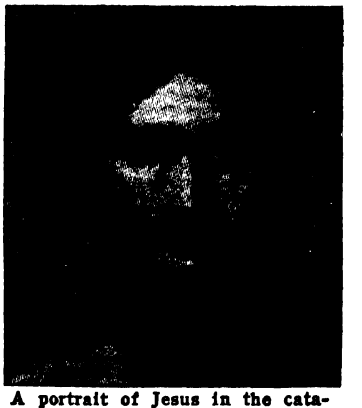
Figures from the wonderful mosaic walls of St. Mark's, Venice.

From a sixth-century mosaic.



A portrait of Jesus said to be by St. Luke.

Pictures on the walls of a catacomb in Rome.



A portrait of Jesus in the catacomb of St. Calixtus.

There is no surprising merit in the paintings of the catacombs; but looking now across a span of about twenty centuries, one can see in those dark underground places the first blossoming of the eternal springtide and hope and Christianity, the spirit of the One who said, "Behold, I make all things new."

This "joyful sorrow" for those who had found a happier home was never far from the thoughts of the Christian artists; and so they painted dainty friezes of peacocks, typifying eternity; trees which meant the garden of Paradise; the turtledove, the picture of the soul at peace; the lyre, signifying the Divine Word. It was the early Christians who inscribed on their tombs that most beautiful phrase *Sit tibi terra levis*—"May the earth rest lightly on thee"—a whole poem in one line.

The Roman catacomb-decoration of the first century was chiefly of this delicate, lyrical kind—symbols, floral designs, vine tendrils. At first only the walls were painted. In the second century the treatment of the figure in design appears, the walls were set apart for subject paintings, and the daintier symbolic work was in a very literal sense skied—reserved for the ceilings of the chambers.

THE FIRST PICTURES IN THE WORLD OF MARY AND JESUS

Some of these ceiling-decorations are a delightful mixture of paganism and Christianity. On the roof of the catacomb of Lucina a delicate geometric pattern appears, with tiny inconspicuous figures fitted into the lines of ornament. Looked at casually, it might seem to be a repeated ornament on a ceiling-paper in our grandmothers' houses; closely examined, it reveals a figure of the Good Shepherd in the centre, persons representing the four seasons at corners of the design, and little heads and praying figures set round about, which appear very Greek in their treatment. Another ceiling decoration—the famous catacomb of St. Calixtus—shows Orpheus with his lute in the centre, surrounded by small scriptural groups, such as the raising of Lazarus, Moses drawing water from the rock, Daniel in the lions' den. This same catacomb of St. Calixtus has excellent examples of the wall-work of the early artists.

In the catacombs we find the first of the innumerable representations of the Madonna and Child which Christian art has given to the world. These pictures are very simple, and, as in the case of the paintings of Christ in his manhood, are not portraits of the ones represented. Mary is shown as an ordinary Roman woman with her baby. In the early paintings Jesus the young man has the appearance of a Greek youth. The traditional bearded face in the pictures of Christ dates from a later time.

CHRISTIANITY SET FREE BRINGS ABOUT A CHANGE IN ART

The art of the catacombs was a mere apprenticeship, leading up to the important work which followed when Christianity became a great power. In the fourth century Constantine issued an edict giving full liberty to the followers of Jesus, and permission to build churches. The Christians had been waiting for this; their faith had assured them of ultimate freedom; their suppressed activities blazed into life. As we look back on these early centuries it almost seems that we can watch the progress of Christian art as of a living thing.

Within a few years of her release from suppression Christianity had evolved a church entirely unlike any other religious building in existence, and lavished a wealth of beauty on its decoration. In two hundred years or so art in Italy developed on these lines. During that time the centre of progress had moved from Rome to Constantinople, and the splendor of Byzantine art expanded to find its highest expression in the Church of St. Sophia, which is one of the miracles of the world.

While thus the art of church-decoration became a great force, the quality of Christian art, the motives which had inspired it, had changed. The spiritual feeling of the catacomb-pictures, born in a period of persecution and humility, gave place to the proud glorification of Jesus, Mary and the saints. The artists were no longer praying aloud: they were singing the songs of the Church triumphant.

THE GREAT THING THE FIRST CHRISTIAN ARTISTS DID

Paintings in fresco and colored friezes were not rich enough as a medium for this glorious sentiment; the artists began to make pictures in mosaic—in small squares of gold and colored glass imbedded in cement. Only in the less important churches did wall-painting continue.

The Romans had learned the art of mosaic work from the Greeks, and had

A mosaic figure of the Virgin in St. Mark's, Venice.

Mary and Jesus—a mosaic in the Church of St. Gregory, Messina.

A seven-century-old mosaic in St. Mark's, Venice.

used it beautifully in their pavements. The Christians took up mosaic work at this point; that is to say, their first mosaic pictures were executed in colors on a white ground, after the manner of the Italian floor-mosaics. Very soon, however, they had gained a style of their own, and a mastery of technique; in two or three centuries they evolved a distinctive scheme of decoration.

THE SHINING COLOR OF THE BYZANTINE ARTISTS REACHES ITALY

The early churches were peculiarly suited to this wealth of color-display. They were huge buildings erected, with certain adaptations, on the plan of the Roman basilica—a large hall for public gatherings. Their lines were long and straight, the dimensions on the ground counting more than height. On the outside these churches were severely plain, and on the inside, simple in line without breaks in the walls. Rome and Ravenna were the home of the most famous basilican churches. Several were built by Constantine himself.

From the mosaics that still exist we can faintly surmise how beautiful their interiors must originally have been, what a glory of shining color must have mapped the walls! Some of them Time has ravaged; many have been destroyed by fire; those that remain mark a period in the development of Christian art. When the tide of progress had set toward the Byzantine shore, a backwash touched the ground of Italy, and for two or three hundred years an art flourished that was half Italian and half Byzantine. We can trace the curious development from the basilican structures of this time in many Italian towns, such as Milan and Brescia, but chiefly in Ravenna, which during the sixth century became really a Byzantine city.

THE LIGHT FROM THE EAST THAT SPREAD ITSELF IN THE WEST

It would seem that the mosaics in the basilicas showed almost at once that tendency toward the Eastern influence in Christian art which was to become so marked in the Byzantine churches. Just for a short time there was the same artless mixture of paganism and Christianity which we have noted in the catacomb-paintings. There is, for instance, a beautiful narrow frieze in the architecture of the nave in Sta. Maria Maggiore, Rome. The mosaic is blue and red on a gold ground, and it shows a long spiral design based on the acanthus. Little doves flutter through the Classic ornament; every now and then the design breaks and there is a white lamb standing alone —the symbol of Christ. A great many of these mosaics proclaim that Western Christian art was born in a land soaked through with Classic influence. Very soon, however, the work was given up more to religious subjects, and the art native to Italy showed itself only in the border-friezes and curious garlands which the mosaic-makers crowded in abundance about their figures.

The growing Eastern influence in Christian art showed itself in several ways. The Syrian idea of a magnificent deity crept into the work, and we see Christ enthroned on a shining seat beneath a cross sparkling with jewels; Christ between Peter and Paul; Christ between the old law and the new; Christ surrounded by hosts of shining ones. But, generally speaking, the chief characteristic of the mosaics of the Christian churches, Italian and Byzantine, was a kind of narrative art—stories told in color. The walls are unending illustrations of the history of the Church, the life of its Founder, and tales from the Old Testament.

THE MOSAIC-LIKE JEWELS AND THE CHURCH'S CROWN OF GLORY

So real was this instinct to preach, to have the very building itself proclaim the belief of the worshipers, that the art of the churches developed a scheme of ornamentation. The dome was usually set aside for paintings of a visionary nature, and the body of the church for more earthly subjects. From this grew the idea of portraying Christ in the crown of the dome with heavenly legions of angels and archangels ranked around. In the apse the Virgin was generally shown and subjects connected with the sacraments of the Church. The upper walls of the nave were set apart for figures from Old Testament history and scenes from the life of Jesus.

The mosaics were not ordinary pictures. Artists took advantage of the fact that they were working in a very artificial medium to fill in spaces with wedges of color and brilliance. They were not content to place isolated panels or circular decorations in the sacred halls; they literally filled them with mosaic following the lines of the arches, and running

up to the roof. The work reached its height in the jewel-like mosaics of the later Byzantine churches which sprang up; its crown of glory was St. Sophia in Constantinople.

This very brilliance presently led to the death of Byzantine art. The life it should have portrayed became pomp and glitter, Oriental pageantry and display. Convention overrode beauty; and mural decoration of the church, which had begun in the mysticism of the catacomb-paintings and grown to the imagery of the basilicas, became under later Byzantine sway a mere mass of gorgeous but cold and lifeless ornament.

How the first churches were decorated fourteen centuries ago—a mosaic in the church of San Vitale, Ravenna.

In the meantime, although early Christian art was centred in Italy and Byzantium, the religion had spread over Europe, founding a new civilization. North of the Alps, after the reign of Charlemagne, this spiritual force found its expression in a new class of architecture. The timber-roofed structure of the south gave way to vaulted buildings called Romanesque. The churches of this period stand midway between the severe basilican and heavy Byzantine styles and the upward-reaching, airy Gothic which was to transform medieval Europe. A great many beautiful Romanesque churches were built in France; the oldest and most famous lie south of the river Loire. In England the Romanesque tradition, taking root with the Norman Conquest, gave rise to another kind of architecture adapted to the island genius. These new buildings were known as Norman, to distinguish them from the earlier Saxon edifices.

The Gothic style followed hard on the heels of the Romanesque. By the twelfth century it was established in England and France; by the thirteenth, in Germany. With it came an instinct for internal decoration on the lines of sculptured figures and reliefs. The reason for this change

was that the Romanesque churches had proved unsuitable for wall-paintings or mosaics, owing to their bad system of lighting, and the lines of Gothic buildings did not lend themselves to long friezes.

Of the Romanesque wall-paintings only a few fragments remain. A fine example is in the Church of St. Savin in Poitou, France; another in St. George's Church at Oberzell, on the Reichenau Island on Lake Constance. There is a beautiful painted altar-panel in the Münster Museum; another in the Berlin Museum.

By a pleasant exchange, as the art of wall-painting died out, that of window-staining arose, and enriched the churches with a shadow of the Byzantine brilliance. A school of colored-glass painters grew and reached its highest power in the thirteenth century.

Side by side with this smaller branch of religious art was growing another—the illumination of manuscripts.

From about the first century of our era books were made of sheets of vellum—a fine parchment, originally made from calf-skin—beautifully and marvelously inscribed. There was no limit to the loving and laborious care spent on these manuscripts. Some were written in black ink, with red ink used in headings and titles.

THE LOVELY OLD BOOKS ILLUMINED WITH PURE GOLD

Some were written in gold and silver. The British Museum possesses a copy of the Gospels written entirely in gold.

Vellum was very costly, and in many cases sheets were cleaned of their original matter and used again. Manuscripts written on second-hand vellum are called palimpsests, and are of the greatest value to archæologists, as the ghost of the original characters lies under the new. By restoring the first writing scholars have sometimes found texts of great value.

When paper was introduced for literary purposes, in the thirteenth century, the character of the writing and illumination changed with the rougher surface of the new medium. The invention of the printing-press was naturally the beginning of the decline of both writing and illumination, except for specific purposes. A very beautiful and spiritual art has thus been almost lost to the world.

The real meaning of illuminated manuscripts is a book "lighted up" with gold and clear, radiant colors. The earliest Gospels and prayer-books are in this form. Lovely colors run riot in their pages; the earliest reflect the spirit of Classic art, but for the most part their ideal of ornament was Byzantine, the style of illumination which reached its highest point in the ninth century and for two hundred years was a strong influence. Its decadence, in the thirteenth century, is marked by the same stilted artificiality that stamped the later church-mosaics.

THE FAITHFUL MEN WHO SPENT THEIR LIVES IN MAKING LOVELY BOOKS

The decorations of these illuminated manuscripts took the form of full-page pictures, vignettes and miniatures, marginal designs and very lovely initials. The initials of the finest vellum books are truly a great joy. They fling out their dainty designs to any part of the page; some of them hold a picture within the compass of the letter.

The monasteries were largely the source of illuminated manuscripts, and as monasteries spread over Europe the art of vellum-painting was taken up in England, Ireland, France, Germany and Flanders. Numberless copies of the Gospels, Books of Hours, missals, hymnals and the lives of the saints were produced. They were made for members of the wealthy class and for the inmates of the abbeys and monasteries themselves. There is a wonderful collection of illuminated manuscripts in the Grenville Library of the British Museum. There we can see displayed the strangely lovely design in which little birds and animals and vine tendrils get so delightfully mixed up, and strands of ornament are flung about the text as if they had been living things and the wind had entangled them.

THE MARVELOUS BOOK OF KELLS MADE BY IRISH MONKS 1,000 YEARS AGO

One of the most beautiful things in the world is an illuminated manuscript made by the monks of the Irish monasteries. It is a copy of the Gospels known as the Book of Kells, written and illumined about the eighth century, and now treasured in the library of Trinity College, Dublin. The Irish monks, unlike Byzantine scribes, did not use gold; their ornament is both dainty and rich at the same time. When we see a page of text of the Book of Kells containing an initial or a marginal design we feel that our own illustrated books seem hardly entitled to exist beside these shining glories of long ago.

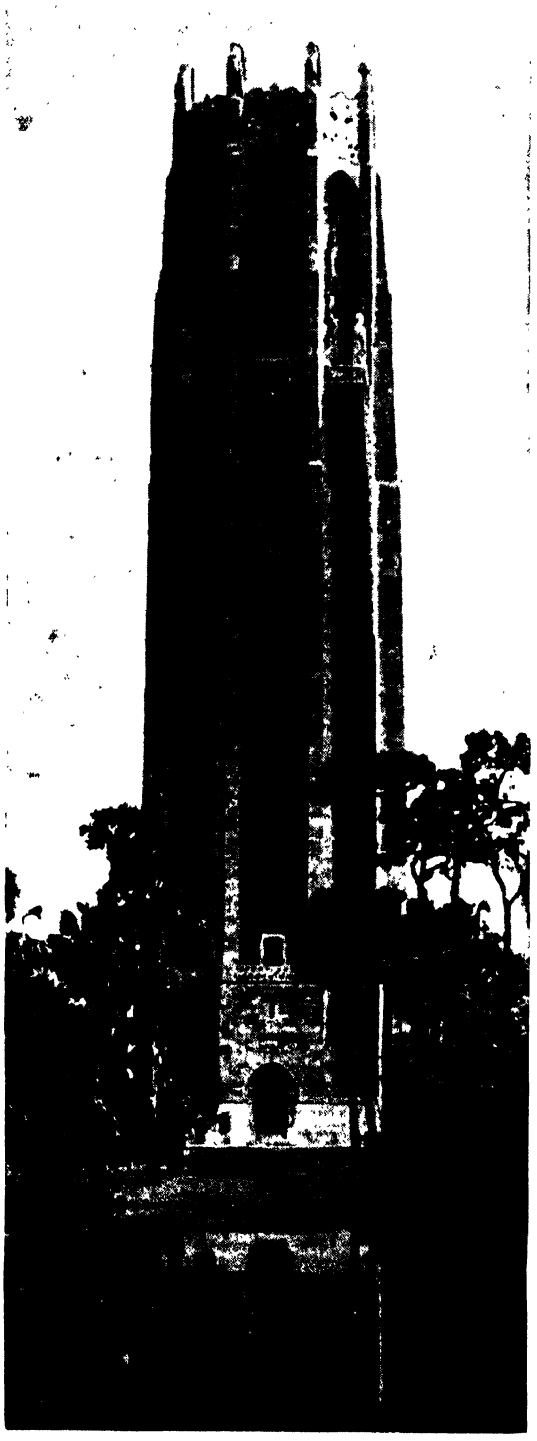
THE NEXT STORY OF THE FINE ARTS IS ON PAGE 691.

Why Have the Eggs of Birds So Many Colors?

IF you have ever had the fun of discovering a robin's nest full of eggs, you have noticed that the eggs are blue. A wren's eggs are so covered with brown spots that they sometimes appear to be almost a solid brown. The eggs of any special kind of bird are usually the same color, although there may be slight differences in individual eggs. Each mother bird has in her body a special kind of pigment or coloring matter which colors her eggs.

Very often eggs are so colored and marked by nature that it is difficult to see them against the nest and its surroundings. This gives protection against the bird's enemies by helping to keep the eggs hidden. A ringed plover's eggs have the same general coloring as the sand on which they lie.

The eggs of birds which build their nests in dark places are often not spotted at all, since the darkness of the nest is protection enough. Sometimes, where the eggs are bright in color, the shape and structure of the nest give enough protection.



Philip Gendreau, N. Y.

Tower and bird sanctuary near Lake Wales, Florida. The mirror-like pool is part of a moat.

WHAT IS THE SINGING TOWER?

On top of a lofty hill, near Lake Wales, Florida, in a park and bird sanctuary, stands a beautiful tower. This tower, 205 feet tall, is a shaft of color rising about the green of the surrounding forest. It is built of Florida stone and pink Georgia marble.

Round the tower at the top is a marble band on which are carved flamingoes, cranes and other birds native to Florida. The grillwork at the windows represents animals and plants of Florida. The brass door tells the story of the world's creation as it is reported in the Bible. Surrounding the tower is a moat, crossed by marble drawbridges and lengthening in front into a mirror-like pool.

In the tower are seventy-one beautifully toned bells forming one of the largest carillons (sets of chimes) in the world. Four times a week the carillon-master gives public recitals, and visitors come from all over the state to listen to these magnificent concerts.

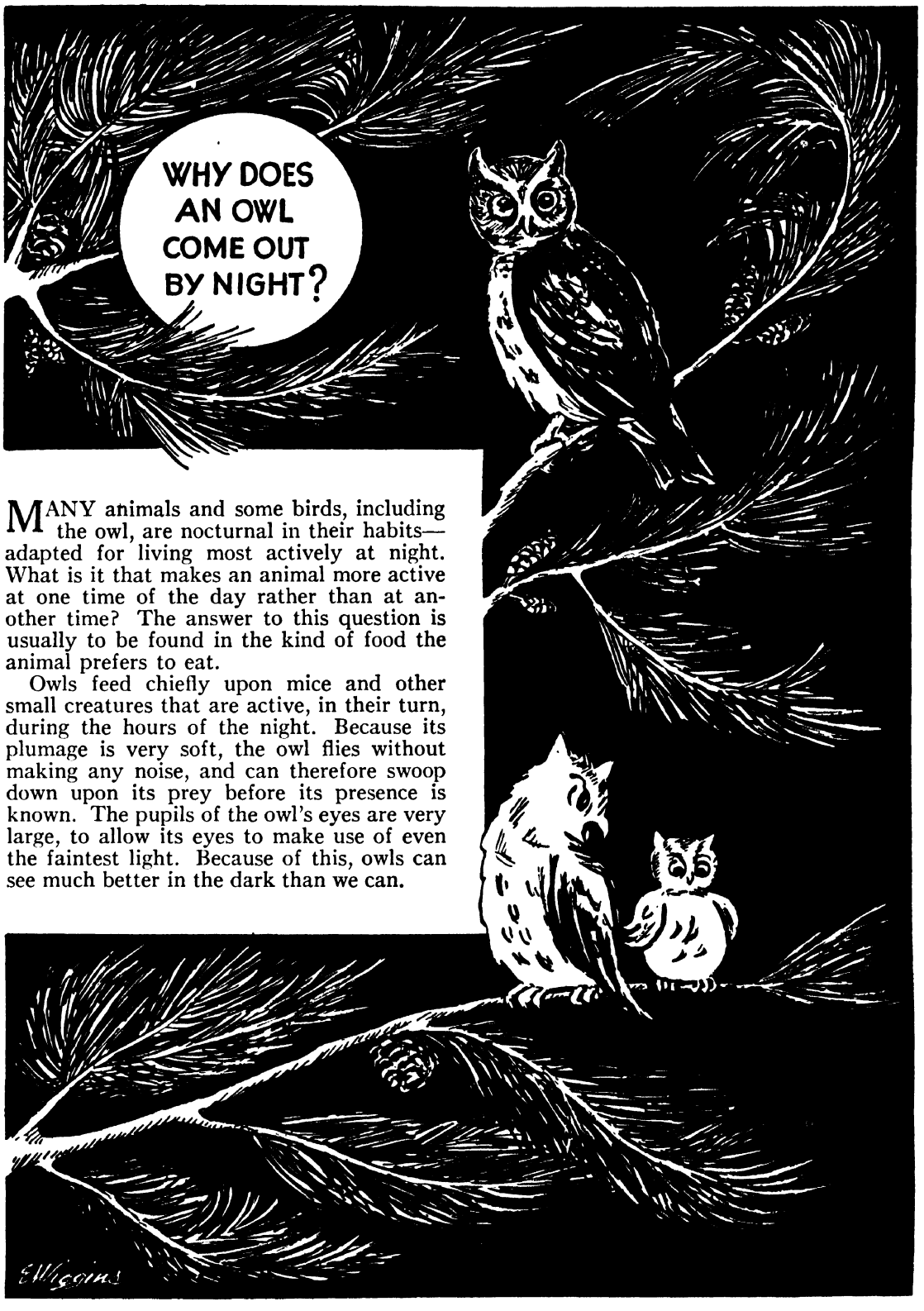
The Singing Tower and the bird sanctuary in which it stands were presented to the people of the United States on February 1, 1929, by Edward W. Bok, a philanthropist who started life as a poor immigrant boy from the Netherlands and rose to great wealth in America. Mr. Bok died in 1930, and lies buried in a crypt at the base of the tower.

WHY DOES A BIRD FORSAKE ITS NEST IF ITS EGGS ARE TOUCHED?

Most wild birds are too timid to allow human beings to come near them. Many birds can be tamed, however, and will become friendly and responsive to the care and affection of their human friends.

Some wild birds will desert their nests if their eggs are touched. Possibly, even though all the eggs are left unharmed, the bird may be aware of a strange scent in the nest. More probably it notices that something about the nest or the eggs has been disturbed.

Other birds, however, are not so timid, and will not go far from their nests even when they actually see human beings touching their eggs. Some will even try to entice the human intruder away from the nest by pretending that their wings are broken. They flutter pitifully on the ground, trying to draw attention to themselves and away from the nest. It is amazing that birds, which have only instinct to guide them, should for the moment, become "actors."



MANY animals and some birds, including the owl, are nocturnal in their habits—adapted for living most actively at night. What is it that makes an animal more active at one time of the day rather than at another time? The answer to this question is usually to be found in the kind of food the animal prefers to eat.

Owls feed chiefly upon mice and other small creatures that are active, in their turn, during the hours of the night. Because its plumage is very soft, the owl flies without making any noise, and can therefore swoop down upon its prey before its presence is known. The pupils of the owl's eyes are very large, to allow its eyes to make use of even the faintest light. Because of this, owls can see much better in the dark than we can.

WHY MUST WE CUT THE CLAWS OF CAGED BIRDS?

Some parts of the bodies of living creatures go on living so long as the body is alive. In the case of human beings, the hair and the nails continue to grow always, but the teeth do not. In many animals, however, the teeth never stop growing. The teeth of a hare, for instance, grow constantly; but because the hare uses his teeth in gnawing his food, the teeth do not ordinarily become too long for comfort.

A bird's claws, like the hare's teeth, are meant by nature to be constantly in use. When we keep birds captive in cages, they have no opportunity to wear their claws down, as they would in a wild state. This is true also of the claws of dogs which are kept in the house and are not allowed to run. In both cases, the claws must be cut now and then, to enable the bird and the dog to move about easily.

WHAT BIRD HAS THE LONGEST WINGS?

The albatross, a sea bird that is commonly seen in southern seas, but seldom in the North Atlantic, is noted for its great wingspread. It is said that this bird sometimes measures ten to twelve feet between the tips of its outspread narrow, pointed wings. The bill of the albatross, which is about five inches long, is hooked at the tip. Its feathers are very thick, forming a wonderful protection against cold and ice. The albatross, a strong and tireless bird, has been known to follow a ship for days without alighting. These birds nest on the barren islands of the Antarctic. The female lays one egg, white and about four to five inches long, on the hard ground. After the egg has hatched, both parents care for the young bird until it is able to look after itself. It is the albatross which plays so large a part in Coleridge's THE RIME OF THE ANCIENT MARINER.

HOW DOES A BIRD KNOW HOW TO BUILD ITS NEST?

All living things perform certain important acts in their lives without ever having been taught how to do them. A pair of young birds builds its first nest without any difficulty, although the birds have never been taught how to do it. A force of nature, perhaps inherited knowledge, shows them how to build. This force we call instinct. Through instinct the spider weaves its web and the young chick pecks its way through the egg shell. None of these creatures have ever been taught how to do these things, and yet they do them perfectly. Human beings also do certain things by instinct. A newborn baby, for instance, sucks upon its bottle by instinct.

DOES A BIRD ALWAYS SING THE SAME SONG?

There are few bird songs more beautiful than the bell-like notes of the thrush heard in the early morning or the evening. If you have ever heard the thrush's song, you will recognize it when next you hear it, for it is not like any other song. Each bird has its own particular song, which is as much its own as its color or the color and shape of its eggs. It is true, however, that some birds do not sing exactly the same notes as those of the typical song of its species.

Certain kinds of birds change their song as the year advances. The tune is not quite the same in the early spring as in summer.

Sometimes a bird of one kind tries to teach its song to birds of another kind. It is remarkable, however, that young cuckoos, though they are hatched in the nests of birds of other kinds, always keep their own song.

WHERE IS THERE A MONUMENT TO THE SEA-GULL?

At Salt Lake City there is a monument to the sea-gull in memory of a great service the gulls once did for the state of Utah. That state was once invaded by a vast army of grasshoppers. These insects devoured every green thing in their path, so that the farmers despaired of saving any of their crops. Disaster seemed at hand. At the most critical time, however, an immense flock of sea-gulls flew in from the Pacific Ocean. Settling down on the areas which were threatened with destruction, they set to work to eat up the billions of winged pests. They did their work so well that the plague of grasshoppers was stopped, and ruin was averted.

HOW CAN A PARROT BE TAUGHT TO TALK?

There are no hard and fast rules for teaching a bird to talk. It takes more patience and perseverance than anything else. At first, the parrot should be kept in a room by itself, in a cage covered on three sides. Say nothing to the bird except to repeat the simple phrase you want it to learn. Use only phrase at first, and then gradually add other phrases, repeating them over and over each day. The bird will soon be imitating what it hears.

WHAT DOES A BIRD SING ABOUT?

WHEN you hear a bird singing as though its throat would burst with beautiful melody, it is difficult to realize that all that sound may not be just for the joy of living. Undoubtedly the bird often does sing because it is warm in the sunshine, because it has just found a nice juicy worm or merely because it feels like singing. No bird, of course, has ever been able to say why it sings.

Usually the male bird sings the most beautiful songs. He sings when he wishes to attract the attention of a female bird, and later when he and his mate are building their nest. He sings also to warn off other males and to proclaim his own right to his territory.

Birds have other ways than song of communicating with their kind. If you have ever heard the wild cries of a mother robin when a cat prowls near her nest, you know that birds can express fear and anxiety. But this they never do in song. When a bird sings, it is usually at ease and in good health.

THE NEXT WONDER QUESTIONS ARE ON PAGE 684.

Pythagoras.

All three pictures, Culver Service
Democritus.

Heraclitus.

MEN OF SCIENCE

I. ANCIENT AND MEDIEVAL TIMES

WHEN we think of a scientist we usually picture a laboratory. The scientist looks at deadly germs through his microscope, or he holds a test tube containing a bubbling chemical up to the light. The astronomer gazes at the stars through a telescope bigger than he is. In the electricity laboratory, bolts of man-made lightning leap with a blinding flash.

The first scientists had no laboratories, no microscopes, none of the wonderful inventions which help research workers to make such rapid progress today. In fact, the microscope, the telescope, the X-ray machine and all these other tools of science could not be invented until scientists had discovered the principles on which they are constructed.

Science seems to have developed first in Egypt and in Mesopotamia, where there were great and splendid kingdoms more than 5,000 years ago. The pyramids of Egypt and the remains of the palaces of Babylon and Nineveh show that these countries had fine engineers. When we visit our great art museums and admire the charming Egyptian statuettes of cats and hippopotamuses and the jewels worn by Babylonian queens, we realize that there were fine artists, too, in those far-off days. Yes, and there were already scientists studying the moon and the stars, as you read on page 660. Other men were teaching themselves about the different kinds of trees and smaller plants and about the treatment of diseases; and still others were devising ways to measure things.

In Egypt the Nile River overflows the farm lands every year, leaving behind a deposit of rich mud which makes the land yield enormous crops. But frequently the flood washes landmarks away so that even in early times the Egyptians needed a good system of land measurement to make sure that each farmer always got back his own tract of ground. For this reason one of the first scientific studies to develop was the branch of mathematics called geometry. The word "geometry" comes from two Greek words meaning earth measurement.

By about 2000 B.C. the Egyptians had a fairly good knowledge of arithmetic and of an elementary geometry. No books of theirs on chemistry remain, but in the practical chemistry involved in preparing metals, paints, wines, perfumes and cosmetics, and in the making of many kinds of beautiful glass, the Egyptians were expert. The oldest known work on surgery was edited (with references to older works) by Egyptian physicians in 2500 B.C. A copy made 800 years later is still preserved. It is a roll of papyrus fifteen feet long.

The Babylonians and Assyrians made at least as much progress as the Egyptians. On page 658 you may read of the great library of King Assurbanipal, who lived in Assyria in the seventh century before Christ. The books in his library were clay tablets into which the strange writing of that ancient land had been pressed. Now it is an interesting fact that many of Assurbanipal's books were on scientific subjects. There were 660

tablets on medicine and 120 tablets devoted to lists of plants. The greatest attention was given to the date-palm, because that tree was one of the chief sources of the country's wealth.

Thousands of miles to the east of Babylon and Nineveh, in China, civilization may have begun almost as early as it did in Egypt and Mesopotamia. There also progress was made in science long before the time of Christ, but we know even less about early Chinese science than we do about that of Egypt and Mesopotamia.

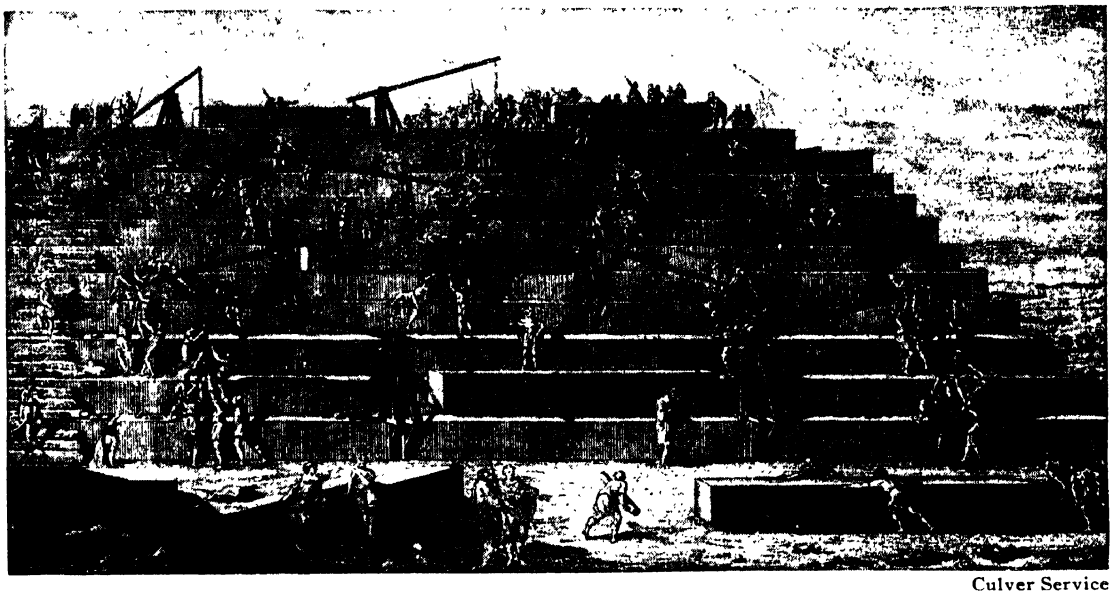
You will notice that we have so far not mentioned any names of scientists. The names of these pioneers of four and five and seven thousand years ago have all been forgotten. We do not know what they looked like or how they were rewarded for their discoveries.

The first people to study science purely and simply for the satisfaction of learning about nature (in other words, for the fun of it) seem to have been the Greeks. No doubt the astronomers of Mesopotamia must have been thrilled by the cold beauty of the far-off stars. No doubt the Egyptian mathematicians were happy when they found the solution to a hard problem. But the Egyptian, Chaldean and Chinese scientists worked entirely for practical, or would-be practical, ends, as far as we know.

The Greeks, however, loved knowledge for its own sake more than any other people who ever lived. Their scientists sought knowledge regardless of whether it would serve any practical use. And they made enormously greater progress than any other ancient people. However, some modern thinkers believe that the Greek scientists would have made even finer progress if they had been more interested in everyday practical affairs and had sought to make their scientific studies yield useful inventions and products.

The oldest important name in Greek science is Thales (624-565 B.C.), who is mentioned also in the story of astronomers.

Thales and the other very early Greek scientists did not live on the mainland of Greece, but in Ionia, as part of the coast of Asia Minor and the near-by islands were called. About 582 B.C. a Greek boy was born on the Ionian island of Samos; and he was named Pythagoras. When he grew up he is said to have left home because he opposed the tyrant who ruled the island. The story is that he was a great traveler and lived a long time in Egypt.



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Building the Great Pyramid of Egypt, according to the description given by the Greek historian Herodotus.

At this time the coasts of southern Italy and of Sicily were studded with Greek colonies, small independent city-states. Pythagoras finally settled in one of these, the town of Crotona, just below the instep of the Italian boot. Here he founded (started) a school which was something like a fraternity or secret society, devoted to study. His followers were called Pythagoreans and it was

The Lyceum, Aristotle's school in Athens. Aristotle strolled about as he taught, with students clustered around him.

their custom to give the credit for all of their discoveries to the "master," Pythagoras. They were students of moral and religious questions as well as science, and they finally mixed in the politics of several of the city-states. When Phythagoras was an old man, his enemies drove him from Crotona. The Pythagoreans continued their studies, however, until about fifty years later, when mobs burned their meeting-houses and their leaders had to flee from Italy.

Pythagoras' greatest work was in mathematics. He also started the scientific study of music, discovering that the pitch of musical notes depends on the length of the string which is plucked or struck. (You can check this for yourself with the strings of any musical instrument or with a rubber band, or by blowing against different lengths of grass.) Pythagoreans found that if two strings were of the same thickness and one was half as long as the other, the shorter string would give a note an octave higher than the longer one. Since the Pythagoreans thought that numbers were the basis of everything, they were delighted, for now they could say that even music was based, in a sense, on mathematics. They developed a strange and beautiful theory that the starry heavens themselves made music. Many of the ideas held by his followers were not taught by the teacher. In the article on Astronomers we tell you of the Pythagorean belief that the earth is a globe and that it revolves around the sun. In fact so many of the early men of science were interested in astronomy that you should read, side by side with this story, the story of Early Astronomers. Then you will get a more complete idea of the search for knowledge that filled the souls of a few men in those days.

One of the great problems today is that of smashing the atom, to release the tremendous amount of energy of their very, very small particles. All scientists now accept the theory that matter is made of tiny atoms (and that the atoms themselves are made of tinier particles and quite a lot of vacant space).

Anaxagoras (about 499-428 B.C.) was probably the first to teach a sort of atomic theory, though he did not use the word atom. He was a Greek, born in Ionia. Much of his life as a teacher was spent in Athens, where he had some brilliant pupils, including Pericles, the statesman, Euripides, the writer of

plays, and Socrates, the philosopher. He studied the problem of squaring the circle (a problem that has not yet been solved). He began the study of perspective to aid in producing plays in the theater. In spite of his friendship with Pericles, whom the Athenians loved dearly, Anaxagoras was condemned to death, for impiety, by the citizens of Athens. Later the sentence was changed to exile. Anaxagoras believed that there were many different kinds of elementary particles. We know at the present time of some ninety-odd elements, of which all matter is composed.

Leucippus (fifth century B.C.) and Democritus (about 460-370 B.C.) also developed an atomic theory. Leucippus called the tiny particles "seeds"; Democritus was the first to use the word atom in science. All things, he taught, are made of atoms with empty space in between. Water was a liquid, in his theory, because its atoms were smooth and could glide over each other. The atoms of metals, however, were hard and rough; they stuck to each other firmly. The atomic theory of today, as you doubtless know, is very different from that of old Democritus; but scientists still admire him for his boldness and originality.

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Theophrastus.

The father of Democritus was rich, but Democritus seems to have sold his property when he inherited it. He used the money to travel in the East in search of knowledge. Like Thales and Pythagoras he studied in Egypt. There is a story that the people of his native town, Abdera, once thought him insane and called in Hippocrates, the great physician, to cure him. Hippocrates is reported to have had a very pleasant conference with Democritus and then to have announced that if there was any madness in that town it was among those who had called him there and not in the mind of Democritus.

Whether the men of Abdera finally decided Democritus was a genius or mad or both, they gave him a striking nickname, "the Laughing Philosopher." He is said to have died at 90; one of the old historians says this is incorrect, that Democritus really lived to 110!

What is the world really composed of? What is matter? That problem fascinated the Greeks as it fascinates the greatest scientists today. If some of their conclusions seem fanciful, remember that 2,500 years have passed since the Ionians began to puzzle their heads with these problems.

Heraclitus of Ephesus, Ionia (about 540-475 B.C.), held that the only reality is change, that everything is always becoming something else. He thought that fire was the principle of life—the single element of all matter. Heraclitus was sometimes called "the Weeping Philosopher."

Empedocles (about 490-435 B.C.) was born in Agrigentum, Sicily. He decided that all matter was made of four elements: earth, air, fire and water. He said that other substances were produced by combinations of these primary elements.

Sooner or later, before we finish school, someone is sure to inform us that we can not walk all the way from one side of the room to the other. "Before you walk all the way across the room you must first walk half-way," he will say. That is true, of course. We can not deny it. "All right. Then before you go all the remaining distance you must go half of what is left." True. Then he will tell you that you can never go all the way across the room because you must always cover half the remaining distance before you cover all of it.

When children "prove" to each other that it is impossible to travel the whole distance across a room, they are using a type of reasoning based on certain problems set by Zeno of Elea, Greece, which gave philosophers and mathematicians something to ponder on for hundreds of years. Using the method described above, Zeno "proved" that Achilles, who was a swift runner, could not catch a tortoise (which, as everybody knows, waddles along very slowly) if Achilles gave the tortoise a start.

What Zeno was really dealing with of course, was not the problem of how to catch a real tortoise, but certain puzzling mathematical questions. Zeno flourished about 462 B.C.

Aristotle (384-322 B.C.), the greatest of all the Greek scientists, was born in the far

north of Greece in the little town of Stagira. His father was physician to the King of Macedon. The Greeks of Athens and other famous cities thought of the Macedonians as dull peasants. They did not know that within two generations a Macedonian king, Alexander the Great, would conquer most of the known world and spread the Greek language and Greek culture wherever he went!

At this time Athens was at the height of her glory. Plato, a pupil of Socrates, had followed his master as the greatest of Athenian philosophers. At the age of eighteen Aristotle made the long trip from Stagira to Athens to study at Plato's school, much as boys nowadays go off to famous universities. Soon Aristotle became prominent in the Academy, devoting himself to science in all its branches. He became a popular lecturer. Later he married the adopted daughter of King Hermias, who ruled one of the tiny Greek city-states, Atarneus. Aristotle lived for a while in Atarneus, then moved to Mitylene.

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Pliny the Elder.

When he was forty-five years old, he received an invitation from King Philip of Macedon to become tutor to Philip's thirteen-year-old son, the headstrong Alexander. He was Alexander's teacher for perhaps five years, until the future conqueror was eighteen. Then Aristotle returned to Athens and opened his own school, in a building called the Lyceum. During his classes he used to walk up and down in the covered paths of the gardens, his scholars trailing along behind him as he talked. So his way of teaching came to be called Peripatetics, or walking about. The school became famous as the place where scientists gathered to work out problems and extend the boundaries of knowledge.

Although Aristotle wrote books about astronomy, physics, politics, poetry and almost everything else, the work that modern scientists admire most is his study of animals. He founded the science of living things, biology. He was the first to dissect fishes and insects, snakes and octopuses scientifically. Some of his descriptions of animal structure are so accurate that they could be put into modern textbooks without change. He was the first to study the development of creatures inside the egg (embryology) and the first to classify animals. Working in another field, he created the science of logic. So important was his work that he was looked upon as a sort of master-mind.

For nearly 2,000 years after his death, Artistotle was the supreme authority in science. This was especially true in the Middle Ages in western Europe. It took a very brave man to question any statement found in Aristotle's books. You have perhaps read how certain professors attacked Galileo for making discoveries which did not agree with Aristotle. And this was about 1,900 years after Aristotle's death!

The curious thing is that Aristotle would have sympathized with Galileo. Like every other real scientist, Aristotle knew that sooner or later some of his theories might have to be discarded as future men discovered new facts.

Following Aristotle as head of the school in the Lyceum was Theophrastus (about 372-287 B.C.). He was Aristotle's most brilliant pupil. He founded the science of botany (the study of plants).

As you already know, that handsome and headstrong pupil of Aristotle's, Alexander, conquered most of the civilized world known to the Greeks. As soon as Alexander died, his generals carved kingdoms for themselves out of his empire.

Several of these Macedonian kings were lovers of literature and science, and one of them, Ptolemy of Egypt, founded a sort of university, called the Museum, in Alexandria, the brilliant Egyptian city founded by Alexander and named for him. For the next 700 years Alexandria was the most important scientific center in the world, scholars from far-off lands coming to study in the Museum and to consult the 400,000 papyrus books in its library. So many branches of science were studied there that it is possible to mention only a few.

Heraclides (388-312 B.C.) was a Greek astronomer who taught that the earth turns on its axis once in twenty-four hours. Eratosthenes (about 276-194 B.C.), librarian of the great library, measured the earth and came very close to the correct figure. He was the first to suggest that men might be able to sail around the earth. Dionysius Thrax (flourished about 100 B.C.) made the first scientific study of the laws which govern

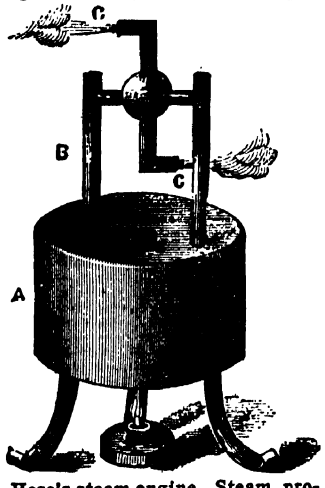
Both pictures, Culver Service

Hero demonstrating his curious steam engine before the learned men of the school of Alexandria, in Egypt.

language—that is, the subject of grammar.

Another Alexandrian Greek named Euclid (about 330-260 B.C.) wrote a series of textbooks that were still being used practically unchanged 2,000 years after he wrote them. In English novels of the last century you frequently read that the boys had to study something called "Euclid." What they were studying was geometry, but Euclid's fame was so great that they still referred to the subject by his name. Probably the works of Euclid have been studied more in Europe than any other book ever written, except the Bible.

King Ptolemy is said to have asked Euclid if there was not a shorter way in geometry than plowing through these books. "There is no royal road to geometry," answered Euclid. Many generations of pupils agree with this remark.



Hero's steam engine. Steam, produced in the boiler A, passes through the tube B, then into the hollow sphere and out through CC. The reaction of the air makes the sphere turn.

Archimedes (287-212 B.C.) was a Greek, a native of Syracuse, a city in Sicily. He was a great friend and probably a relative of the two kings of Syracuse under whom he worked. Like other young scientists of his day, he studied in Alexandria. His greatest work was in pure mathematics, and unlike many of the Greek thinkers he applied his science to practical ends.

His friend, King Hiero, ordered a golden crown, and gave the jeweler a certain weight of gold with which to make it. When the crown arrived it was very handsome, but the jeweler was suspected of substituting silver for some of the gold, and the King ordered Archimedes to find out the truth. The crown weighed the same as the gold which the King had given to the jeweler. For a time Archimedes was puzzled by the question—

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An alchemist at work. Alchemists failed to make gold out of other metals, but they learned many useful facts.

was there some silver mixed with the gold in the crown? Archimedes solved the problem while taking a bath in one of the public bathing places of Syracuse! As he stepped into the bath, some of the water ran over the top. The solution flashed into his mind, and the story is that without taking time to dress he rushed down the street toward his home, shouting, *Eureka! Eureka!* ("I have found it! I have found it!")

What was the solution? The crown (like his own body) would displace a volume of water equal to its own volume. But since gold is heavier than silver, a pure gold crown would be smaller in size than one of the same weight alloyed with silver and hence would displace less water. Tests showed that the jeweler had stolen some gold. The idea of specific gravity was developed from this.

Once Archimedes said, "Give me a place to stand and I can move the earth!" The King answered that he would be satisfied if Archimedes would move a heavy ship in the harbor. By using a compound series of levers, Archimedes moved the ship with a slight effort.

Albertus Magnus.

You have probably read of the great wars between the two ancient cities of Carthage and Rome—the terrible struggles which are known to historians as the Punic Wars. Syracuse sided with Carthage and was attacked by a powerful Roman fleet and army. The overwhelming forces of Rome finally conquered, but the Syracusans held out for two years.

According to Plutarch (who reported the event three hundred years

later), machines designed by Archimedes terrified the Roman soldiers. Said Plutarch, "Huge beams were shot over the ships from the walls, sinking some of the ships. Other ships were seized at the prow by iron claws, or beaks like the beaks of cranes, drawn straight up into the air, and then plunged down into the depths. . . . At last the Romans became so fearful that, whenever they saw a bit of rope or a stick of timber projecting a little over the wall, they cried, 'There it is! Archimedes is training some engine,' and turned their backs and fled."

When the Romans finally burst into the city, Archimedes was quietly working at a mathematical problem, which he had traced in the sand. If the story told by the old historians is true, a Roman soldier rushed up with drawn sword, demanding his name. The old scientist ordered the soldier to be careful that he did not spoil the figure in the sand. Enraged, the soldier ran him through with his sword.

Lucretius (about 95-55 B.C.) was a poet of Rome, and not a scientist. Yet he merits our notice here because he wrote a long poem, ON THE NATURE OF THINGS, based on science. Pliny the Elder (23-79 A.D.) was also a Roman. He wrote an important book of facts which he called NATURAL HISTORY. In it he quoted from about 2,000 works by 146 Roman and 326 Greek authors. Most of the books he quoted from have been lost; but you can gain from Pliny's work the knowledge that the study of science had made great progress by that time.

Hero, who lived about 100 A.D., was a Greek inventor. He made a steam engine (a sort of primitive turbine) and many scientific toys and conjuring tricks, as well as a number of practical inventions.

In the story of astronomers in Volume 11 we tell you about the theories of Ptolemy (about 170 A.D.). He is not to be confused with the Ptolemies who were kings of Egypt. He was a Greek geographer and astronomer whose system of astronomy had enormous influence for centuries. He believed that the earth was the center of the universe, and that the sun revolved around it. This is known as the Ptolemaic theory.

After the Mediterranean countries were conquered by Rome, Greek science began to decline. With all their other great qualities, the Romans did not care much for pure science and did little to advance it, although they were great builders and engineers, as their aqueducts and palaces show. During the decline of Rome and during the early Middle Ages, things grew worse. Not only was there no advance in science, but most of the science of the Greeks was forgotten. From about 400 to about 1200 little advance was made in science in Europe.

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Arabian cosmographers (describers of the universe).

We tend to think of the West (that is Europe) as the home of science, and of Oriental countries as unprogressive. But liberal caliphs of Bagdad, such as Haroun-al-Rashid (about 765-809), caused the works of the great Greek scientists to be translated into Arabic and studied. Later, when science began to revive in the West, the Europeans made use of Arabic discoveries, and, in fact, only recovered much of the work of the great Greeks by translating it from Arabic. The words algebra and chemistry, for instance, came to us from the Arabic.

Although little progress was made in theoretical science during the early Middle Ages, some very important practical inventions were made. Paper came into use, supplanting the clumsy papyrus and expensive parchment (made from the skins of animals). Spectacles were invented (imagine a near-sighted botanist or astronomer without glasses!). The mariner's compass came into use and so did better timing devices. Toward the end of the Middle Ages came printing,

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Roger Bacon, from his prison-study, sends off a manuscript to the Pope.

and that meant, of course, the spread of knowledge.

There was a Syrian named Geber who lived about 850 A.D. He was the father of Arabic alchemy, that strange half-science that was the far-off ancestor of our modern chemistry. There was an unknown Hindu, whose date also is uncertain, who introduced the sign for zero. This made figuring much easier than it was before. Our "Arabic" numerals, as we call them—1, 2, 3, 4 and so on—really came from the Hindus.

Avicenna the Persian (980-1037) is called "the most famous scientist of Islam" (Islam is another name for Mohammedanism). Avicenna wrote a textbook on medicine that continued to be the most important medical work, both in the East and in Europe, until the middle of the seventeenth century.

Alhazan (965-1038) was an Arabian. He is believed to have been the first to study lenses. He wrote a book called THE TREASURY OF OPTICS, on light, color, reflections and optical illusions.

Averroës (1126-1198) was an Arabian philosopher and general scholar, born in Spain. He wrote many books in Arabic, including a commentary on Aristotle that was translated into Latin and widely read for three hundred years.

We come now to four men of the thirteenth century who, together, gave the study of science such a big push forward that it has never stopped. The first of these, Alexander of Hales, was an Englishman. He taught at the great University of Paris and died in Paris in 1245. He encouraged the study of Aristotle. Among his pupils were a number of brilliant men. The second of our group of four is Albertus Magnus (1193-1280), a German count who became a Dominican monk. He was the foremost scholar of his day in physics and chemistry, and the most learned and most widely read of his time. The last two of our group were his pupils, Thomas Aquinas and Roger Bacon.

Thomas Aquinas (1227-1274) was an Italian, related to several royal houses in Europe. He also became a Dominican monk. He studied at Naples, Cologne, Paris and other universities. Many of his studies were in theology, and after his death he was canonized. He was keenly interested in science, however, and was probably the first to say that matter and energy are indestructible.

Some authorities believe that the first person to suggest the use of lenses for spectacles was Roger Bacon (1214-1294), a Franciscan friar who foresaw several modern developments: flying, mechanically propelled vehicles, sailing around the earth, the use of explosives. He wrote a sort of encyclopedia. Bacon had an unfortunate habit of referring to fellow-scholars in such terms as "absolute fool" or "full of puerile (childish) vanity." Whether it was because of the enemies he made or on account of the views in his books we do not know, but he was imprisoned in his old age for fifteen years.

In the Middle Ages there sprang up great universities, such as those in Pisa, Bologna, Paris and Oxford. An intense love of learning was slowly growing. By the fifteenth century this blossomed into one of the brightest periods mankind has ever known. We call it the Renaissance, or Rebirth of Learning. Let us remember, however, that the Renaissance was no sudden thing, but a natural flowering from seeds planted in the Middle Ages.

By THOMAS GORDON LAWRENCE.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 641.

American Museum of Natural History

Gray or timber wolves hunting their prey. The gray wolf is a large species, weighing over a hundred pounds.

THE WILD DOGS

THE previous article in the Department of Animal Life told you about the Order Carnivora, or flesh-eating mammals, and described the cat family (page 493). Now we shall speak of another family of carnivores, the dogs. Our domestic dogs are so many and so interesting that they have a chapter by themselves (page 711). The wild dogs: wolves, coyotes, jackals, foxes and other, less familiar, kinds are described here. They have a wide range. Wild dogs are found from the ice and barren tundra of the Arctic to the southernmost tips of America, Africa and Asia, and even in Australia; in the desert and the forest or jungle; on the plains, in the depth of Death Valley, the lowest spot on earth, and high on the Himalaya Mountains, almost as high as men have ever reached in their climbing. In the long-settled parts of Europe foxes are common, and in the suburbs of American cities coyotes (in the West) or foxes still steal chickens from the backyard.

Unlike the cats, the wild dogs band together; they live and hunt in pairs or family groups and some kinds, wolves and hunting dogs for instance, unite into great packs when food is scarce. The wild dogs hunt both by stealth and ambush as many cats do, but they may run down their prey by great endurance. They can not climb trees (except for some foxes), nor do they catch their prey with claws and hold it, for their claws are long and blunt.

The dogs can dig, however, which cats can not, and they catch some small mammals in that way. They are also able to dig dens in which the young can be born and sheltered. The wild dogs can not strike killing blows with their front feet, like the grizzly bears, and no modern dog is so large as the grizzly bear and many wild cats, although some extinct kinds were large. The way dogs can run, swiftly and untiringly over long distances, their high intelligence and keen senses, their ability to work together, their loyalty to the pack and their courage, together with their strong, slashing jaws, make them among the most successful animals of prey.

Best known of the wild dogs and, until recently, most widely distributed, the wolf is worthy of first place among his relatives. In the early days of mankind the wolves not only killed the game on which men depended so much and the domestic animals men kept, but they occasionally even killed and ate human beings. Men lived in small groups

and their weapons of wood and stone were not sure protection against these fierce and daring beasts, which were urged on by the pangs of hunger and found women, children and unarmed men easy victims of the pack.

A NOTORIOUS MAN-EATING WOLF OF THE EIGHTEENTH CENTURY

Even the better weapons of the Middle Ages were not completely able to protect men from the wolves, and as late as the time of Louis XV of France a great wolf terrorized the country, killing and eating about ninety persons before he was brought to bay by a small army. The development of the rifle and its commonness in the frontier settlements of the American West have been important in changing the wolves from dangerous, bold animals to cautious ones.

Wolves no longer attack humans; they have learned to fear men and men's far-killing guns, wicked steel traps and poisoned baits. Only a man-fearing wolf has a chance to grow up to-day. In most of us, however, there remain traces of the old, traditional dread of wolves. Their weird, chilling howls make all but the experienced woodsman uneasy. Even the night-song of the coyote on the western plains is hard on a tenderfoot's nerves.

Once wolves were found throughout Europe and most of Asia, as well as in North America, from central Mexico to the Arctic Ocean. Gradually they were killed off and driven out of much of this great territory. The last wolf was killed in the British Isles about the middle of the seventeenth century, but in most European countries there are still some of these beasts. In the forested and mountainous parts of France, Italy, Spain and the Balkans there are small bands, while in parts of Russia they are common, and there are many throughout northern Asia. In North America a few are found in the Ozark Mountains and some in the southeastern forests, and they are still common in northern Canada and Alaska. That large animals, so hated and feared by men, have continued to hold out is full proof of their cunning and daring.

THE TWO CHIEF CLASSES INTO WHICH ALL WOLVES ARE DIVIDED

Although wolves show a great variety of color and size, there are only one or two distinct kinds—the common wolf of Europe, Asia and most of North America; and the small red (or sometimes black) wolf of central and southern United States. Among the common wolves in Alaska and the Canadian North may be found individual animals that are almost white, and some that are black; they may be brothers of the same litter. The wolves of southern Europe are much smaller than those of Alaska and northern Siberia, at least on the average. Wolves of warm climates have short hair, very unlike the long-furred animals of the Arctic wastes.

People who have studied wolves find that in intelligence and courage, and in other ways, they show many differences. Many of their habits we should call "good" in men. They are faithful mates, often for years or for life, and the father hunts food for the young ones and helps to take care of them. Fights between mates are virtually unknown and members of a pack work together much like men on a football team.

DIFFERENT KINDS OF PREY HUNTED BY WOLF PACKS, LARGE AND SMALL

Small packs are usually family groups, the parents and their partly grown-up young. Such a pack hunts over an area of several hundred square miles, making a great circuit and coming back to the same parts every week or so. During the summer, rabbits, woodchucks, and even mice, are their chief food; for variety there may be an occasional young deer, or an animal found dead. Where fish is plentiful, as when spawning time comes for the Pacific salmon, the wolves feed on them, catching the fish in the shallow parts of the streams. In the early days on the American plains, the wolves preyed on the old, sick or injured bison, of which there were many out of the vast herds. Even healthy animals were sometimes taken. The wolves of the forest depended chiefly on the deer, caribou or even moose during the winter, for deep snow hampers these animals more than it does the wolves.

HOW WOLVES BRING UP THEIR YOUNG IN NATURAL CAVES OR BURROWS

Dens of these beasts are in natural caves, or if there are no caves they dig holes, often enlarging the burrows of badgers or other diggers. The young are as helpless as puppies and if not hidden safely away might fall victim to any of the other carnivorous mammals, or to certain birds. Even when the cubs are fully haired and able to run they need a safe retreat. There are usually six or eight cubs, born about the end of March or the first part of April.

A pair of wolves in the Mount McKinley region in Alaska were seen to drive two grizzly bears away from the neighborhood of their den; the parents snapped viciously at

the bears' heels, almost like a dog chasing cattle, and the bears spent no time disputing the rights of these courageous animals. At the same time young children of the naturalist who photographed this scene played around the den in safety, and the wolves allowed the

The Indian jackal. Its fur is of a yellowish color.

photographer to come within a short distance of the cubs.

Before the cubs do any hunting of their own the parents bring animals for food. By the time winter comes the young are large enough to catch most of their own prey, but it is about two years before they are fully grown.

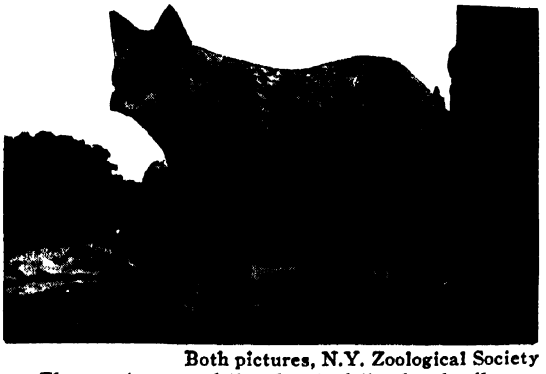
The coyote looks much like a small wolf, but its big ears and sharp muzzle are jackal-like. In the animal stories of the western Indians it is often mentioned with respect as the wisest and most cunning of the animals, like the fox of the European stories. While the great gray wolves have retreated before the settlers, the coyotes have increased in number and are now found in many places where they were not known earlier. They do not do the damage to the larger livestock that the wolves did, but they often kill sheep, especially lambs, and they take many chickens and other fowl.

It should not be forgotten, however, that coyotes feed chiefly on rabbits, ground squirrels and mice, and by keeping these plant-eating mammals from increasing they do a great deal of good for the farmers. Carcasses of animals that die from various causes provide feasts now and then, and coyotes clean up the remains of the kills of larger carnivores, but they are usually lean and hungry. Only a very fast dog can catch one and the dog must be larger or the coyote will turn the tables and chase the dog home.

Coyotes usually hunt in pairs and often take turns chasing a jack rabbit—which runs in large circles, as a rule—until the relay race tires out or confuses the poor rabbit. When hunting prairie dogs, another trick is used. The prairie dogs, large fat-bodied ground squirrels, live in colonies and are always on the watch for danger, but they are curious and like to bark saucily at their enemies when they think they are safe. When a pair of coyotes approaches a prairie dog "town," one coyote lies quietly outside. Its mate then walks openly, without any stealth, into the colony. The prairie dogs bark and dive into their burrows, and this coyote walks on through the town. The prairie dogs stay in their burrows until the enemy has passed. The coyote that hid on the edge of town now slinks into the colony and crouches low near the mouth of a burrow. The prairie dogs cautiously stick out their heads and see the first coyote walking away on the other side of the town. First one and then another comes out and sits up to yelp at the disappearing enemy. Then the coyote that hid rushes at the nearest prairie dog and the pair of cunning hunters dine.

Jackals are a little smaller than coyotes and look much like them. While they hunt small animals themselves and eat a variety of fruits, insects, mice and ground-dwelling birds, they depend for much of their food on the leavings of the great hunters, the lion and tiger, or even of the sportsman, that most wasteful of all hunters. There are several species of jackals in Africa, one of which, the yellow jackal, is found from Morocco through southern Asia to India, and is the best-known kind. It is of a dirty yellowish color, quite unattractive-looking. The side-striped jackal of eastern and southern Africa is named because of a black stripe on each side; it is hardly more handsome. Very different is the African black-backed species, which is foxy red except for a black mantle from its neck to its tail.

The Abyssinian "wolf," a large red jackal of the Ethiopian Plateau, is one of the most



Both pictures, N.Y. Zoological Society

The coyote, one of the slyest of the dog family.

interesting members of the dog family. While we class it here with the jackals, it resembles the wolf and fox. It has a restricted range. Long-legged and slender-bodied, it behaves very much like a fox, preying on the field rats that are common in the upland Ethiopian meadows and other small animals.

New York Zoological Society

The dingo, the handsome wild dog of Australia whose ancestors were tame dogs.

Jackals are usually found in pairs, although when there is a special attraction a number may come together. Like the coyote, they are not very courageous, but they sometimes rush in and seize a piece of meat while the animal that did the killing is still gorging. When the victim is large there is usually a good part left over, and when the master of the feast retires, the hyenas, jackals and vultures move in to clean up the remains. A few splinters of bone are all that is left when these scavengers slink away from the meal.

The yellow jackals act as the sanitation service in many Eastern towns, eating up the garbage and refuse. In this they are helped by the cur dogs that so much resemble them. Dead natives, buried in shallow graves, are frequently dug up and eaten by these "bellies that run on four feet" as the Eastern saying goes.

There is very little doubt that our domestic dogs are the descendants of the wolf and the yellow jackal. Some breeds, like the Eskimo dogs, are mostly wolf, while the dogs of southeastern Asia are very much like the jackal. The dingo, on the other hand, is a domestic dog that has gone wild. Even in the eastern United States dogs go wild now and then and live for years, killing deer and small mammals. The dingo is very much like the dogs whose remains have been found in the rubbish left by early men in Europe. The dingos were probably brought to Australia a few thousand years ago by the primitive Blacks when they came from the Pacific islands and Asia. No doubt a number of the animals either ran away from their masters or were left to take care of themselves when a family or small tribe perished in some catastrophe, and so became wild. Now the Australian natives catch young dingos and tame them. The dogs spread over all of the continent, finding hunting good. They were able to catch and kill all except the largest kangaroos. Hunting in a pack, they could take these too. The native mammals of prey were not so sly or swift or powerful as the dingo, and so they offered little competition. When Europeans began to raise sheep in Australia, the dingos were very destructive. They have now been pretty well killed off in the more settled areas.

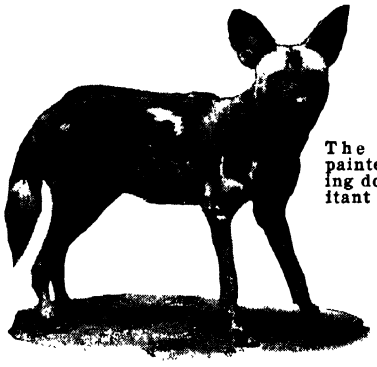
The African hunting dog is a strange-looking wild animal. Its ears are large and its coloration is a patchwork of black, yellow and white and no two of these dogs are alike. Its body is lean, its legs long and its head massive. Some people think it looks like a hyena and call it "hyena dog." Packs of a dozen or less are common and some packs contain sixty or more. Throughout most of the bush country of Africa, south of the Sahara, these hunters roam, traveling over great distances, appearing suddenly in a region and then leaving it as suddenly. All the game leaves a region when the hunting dogs come through and does not return for some time. The dogs follow their prey like well-trained hounds. They depend chiefly on the smaller and medium-sized antelopes and run them down, though the antelopes are the fleetest of the plant-eaters. The natives fear these large dogs (they are about the size of wolves) but there is no reliable account of the dogs attacking a man.

The hunting dogs make a twittering chatter, very bird-like and mild for such fierce animals, and their hunting call is a "hoo-hoo," soft, but carrying a long distance, much like the hoot of an owl. Once dogs of this kind occurred in Europe, but long ago they became extinct everywhere except in Africa.

The dhole or red hunting dog of India, China and the Malay region is a close relative of the African dog, but it is smaller, about the size of a coyote. The dholes, in spite of their small size, are fearless hunters, even driving tigers from their kills and sometimes attacking the gaur, a large wild ox, when their pack is big. They occasionally kill a bear or a leopard. They do it by surrounding the victim, those in front holding

its attention while others rush in and tear the flanks and the thighs. The prey is partly eaten while it is still alive. For all their ferocity the red dogs are not known to attack man and in some places natives drive them away from their kill.

The little bush dog of tropical America, is usually thought to be another relative of the hunting dog. It is less dog-like in appearance, with short legs and tail, and a very large head. In habits it is shy and cunning. The Indians of the forest sometimes take the cubs from the dens in order to raise them. Although they stand in considerable fear of the vicious old dogs, the natives find that cubs raised in captivity become quite tame, and can be used in hunting.



The odd-looking painted or hunting dog, an inhabitant of Africa.

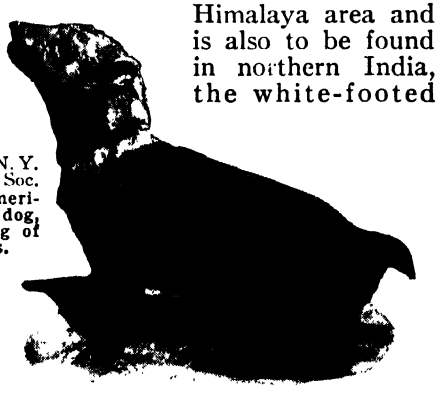
A raccoon-like dog of China.

The raccoon dog lives in China and Japan and looks more like a raccoon, with its sharp nose, black mask and bulky body, than a dog. It is a true dog, however, and no relation to the "coon." Raccoon dogs live near streams and depend on fish and fruit, besides catching mice and rats. The fur of these small wild dogs is valuable and because of this fact there is danger that the species may be exterminated.

Among the wild relatives of the dog, the red fox is the best known to most people. Civilization holds no terrors for this animal. Give it a limited amount of woodland, a bush lot or two, or a meadow in which to hunt mice, and it is at home, even using the cultivated fields of a farm as hunting grounds. The red fox has a very extensive range. In North America it is found throughout Alaska, all of Canada except the northernmost part, and in every state in the United States except Florida. During, and before, early colonial times it was unknown in the southeastern states but since that time it has spread southward. It is known that some of the colonists imported the European red fox into Long Island and Virginia. Many people believe that the foxes of the southeastern states are descendants of those European red foxes, which mixed with the native foxes from farther north.

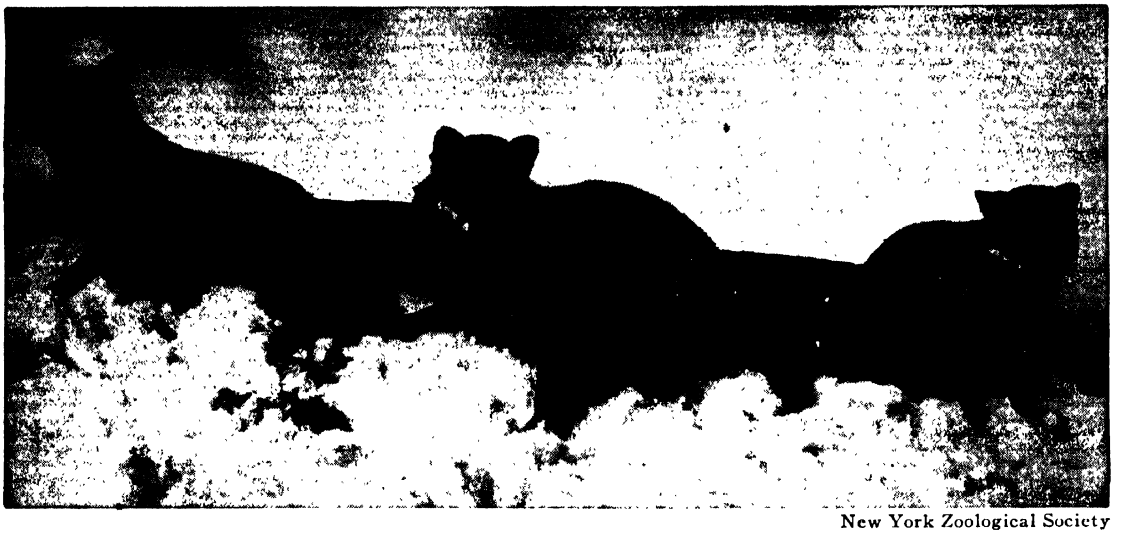
As the red fox is found in so many different environments throughout this extensive range, differences of size, shade of color and texture of coat would naturally occur; consequently many different forms are recognized. The red fox is not limited to North America. In its many species and sub-species it is found throughout much of the Northern Hemisphere—in Europe, most of Asia and northern Africa. It has also been introduced into Australia.

Of the many forms of the red fox, the European is the best known of all. Included in the kinds found in Asia are the North China red fox, the South China red fox, the desert red fox of the Gobi district, the Tibetan or hill fox, which dwells in the Himalaya area and is also to be found in northern India, the white-footed fox found in the drier districts of northwest India and Persia, and the Bengal fox found throughout most of India. This last species is one of the few forms of the red fox which lacks the white tip on its tail.



Pictures, N. Y. Zoological Soc.
South American bush dog, a wild dog of the tropics.

The Egyptian red fox and the Barbary fox are found in the arid regions of north Africa. The small, long-nosed foxes, known as sand foxes, and the Corsac fox are relatives of the red fox. The Corsac fox is found in central Asia, and the Asiatic sand fox in Tibet and Nepal, while other sand foxes are



New York Zoological Society

Group of gray foxes. The gray fox is found in the southern part of North America and the northern part of South America. The fur of the animal, a grizzled gray and black in color, has no great commercial value.

found in the desert regions of southern Asia and northern Africa.

Throughout his range, mice and other small rodents make up a large portion of the food of the red fox; but other small mammals, also birds, eggs, reptiles, insects, fruits and berries are included in his fare. Many people believe that poultry and game birds form the red fox's chief bill of fare, but these fowl make only a small percentage of his diet. Recently a competent scientist examined more than 200 stomachs of red foxes killed in New York and New England and discovered that only 7 per cent of them contained poultry or game birds; almost 50 per cent contained mice and 25 per cent contained rabbits. However, these particular foxes were killed between the months of October and March. It is likely that in the spring and summer more game birds, insects and fruit would have been eaten.

The home of the red fox is generally a hole dug in a bank by the foxes themselves, although in the eastern United States they may enlarge an old woodchuck hole to suit their needs. In the spring the young are born in this den. They may number from four to nine. Both the father and the mother are devoted parents and scour the countryside for food which they bring home to the young. The cubs are blind until they are nine days old and do not venture above ground until they are more than three weeks old. They stay in or near the den for about three months; after that they follow their parents on hunting expeditions. At first they learn to catch grasshoppers and mice, but soon become skillful in capturing larger and more difficult prey.

The red fox is constantly being hunted by men with dogs, and is being trapped and poisoned. Yet for all that the animal is well able to take care of himself. In Europe and in some sections of the United States hunts are held, where a fox is followed by trained hounds and mounted hunters until he is run down and captured by the dogs. In the eastern United States he is chased by trained hounds until he is driven past a waiting hunter, when he is shot. In the east, north and west he is trapped for his fur. So he is made a victim for recreation and profit.

Color phases (changes) of the red fox frequently occur, especially in Canada and Alaska. The black fox, silver fox and cross fox are all true red foxes and a litter may contain any of these colors and red as well. Due to the fact that the black and silver skins are of considerable value, large numbers of these foxes are being bred in captivity and many fox farms are now in existence. In this domestic state a new phase of the silver fox has been developed. It is of a light smoky blue color and is known as the platinum fox.

The kit, or swift fox, and the desert, or long-eared fox, are small relatives of the red fox and inhabit the plains and deserts of western North America. The kit fox is found on the plains from Saskatchewan and southern Alberta, south to northern New Mexico. The long-eared fox is a desert-dweller and his

range extends from California and Nevada south into Mexico and Lower California. These little foxes are very close relatives and are of a buff color, with gray flecking on the back and sides. The long-eared fox differs from the kit fox in his lighter color and larger ears. Their food consists of small mammals, birds, eggs, reptiles, insects and vegetable matter. The home is a burrow and the young are generally three to five in number. Surprisingly little is known about the habits of these foxes. They are exceedingly fast afoot and often seek refuge in a burrow when chased or surprised by an enemy. Over a large part of their range they are rapidly decreasing, for they are easily trapped, and their habit of feeding on poisoned bait, put out for coyotes, leads to their downfall. Their fur is of little value.

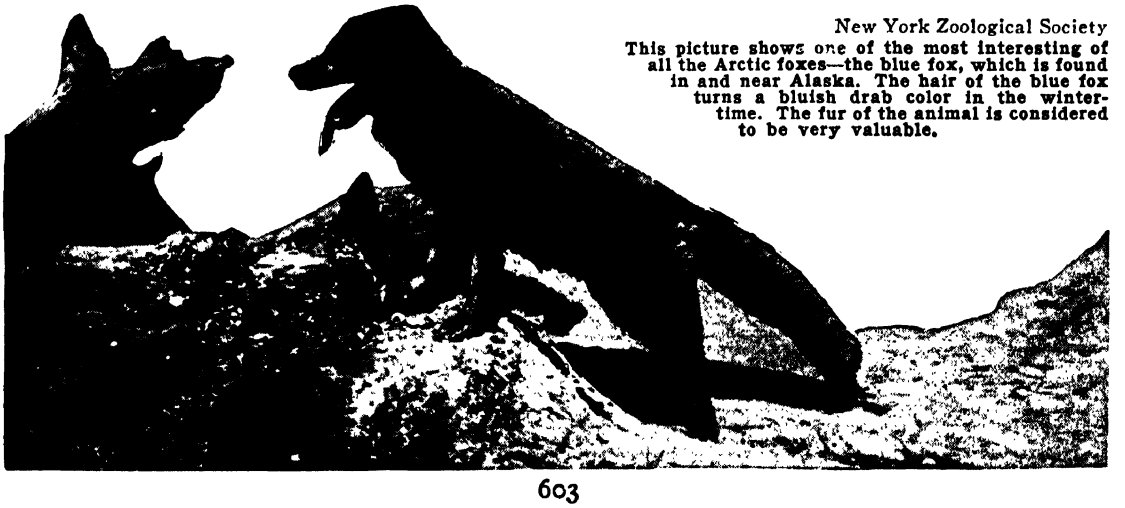
The gray fox is found throughout southern North America, its range extending as far south as Colombia in northern South America. Over this extensive territory numerous forms are recognized. In color this fox is a grizzled gray and black, lighter on the sides. On the back of the ears, sides of the neck and sides of the forelegs, the color is reddish brown, differing in intensity in the different sub-species. The tail tip is dark. The fur is coarser than that of the red fox and is of little value commercially.

In the east the gray fox is partial to the wooded areas and prefers the more extensive forests to the open farm lands. Although lacking the cunning of the red fox and being consequently more readily trapped, he still multiplies close to civilization. The writer has seen the den of one of these foxes and observed four of the cubs within the limits of New York City. In the East the den is generally among rocks or it may be a burrow under a large rock. Occasionally the family may have a burrow in a hillside. Hollow trees are sometimes used as a den. There are three to five young in a litter. These are born in the spring and they are cared for by both parents.

In the Southwest the gray fox lives in the semi-arid districts and is as much at home among the thorn bushes and cacti of that region as he is in the forests of the East. He is also found on several of the islands off the coast of California. The gray fox differs from the red fox in the fact that he has a number of dens in which he sleeps and retires during bad weather. A red fox prefers to sleep in the open under a bush or near a stump, and the worst winter weather has no terrors for him.

The gray fox does not afford so much sport in the chase as does the red. The country he inhabits is not open enough to follow him on horseback and when hard pressed he will generally seek refuge in one of his numerous dens. Neither is his pelt of sufficient value to pay for the difficulties of hunting him. The gray fox is noted for his ability to climb; in this skill he exceeds all the other dogs. Not only will he seek shelter in a tree when pursued, but on numerous occasions he has even been observed sleeping or sunning himself on a hawk's or a squirrel's nest high up among the branches.

The Arctic fox is an animal of the open treeless tundras of the Far North. His range is as far north as that of any mammal. In summer he is brownish with light underparts but in winter his hair is pure white. However, in certain sections of his range, chiefly in and near Alaska, some of the specimens



New York Zoological Society

This picture shows one of the most interesting of all the Arctic foxes—the blue fox, which is found in and near Alaska. The hair of the blue fox turns a bluish drab color in the wintertime. The fur of the animal is considered to be very valuable.

are bluish drab in color. The pelts are valued as this is the color phase of the Arctic fox which produces the blue fox of the fur industry. On some of the smaller islands off the coast of Alaska these blue foxes have been introduced and there they are kept in semi-domestication for the production of their fur. Arctic foxes feed on lemmings, hares, birds and, in fact, on anything edible that they can discover. In many places they visit the large sea-bird rookeries, where they feed on the eggs, the young and the adult birds. They have also been observed following polar bears and dining on the left-over remains of the luckless seals which the bear has killed and on which he has feasted.

The den of the Arctic fox is often among rocks along the coast, although he sometimes digs his own burrows. The young, from two to ten in number, are generally born some time in June.

Another member of the fox family is the Chama or silver fox of South Africa. This animal has much the same coloring as the gray fox of North America. He is found in Africa, south of the Zambezi River. He is a creature of the dry plains and never enters the forest. His food consists of insects, rats and other small rodents, birds, reptiles, fruits and berries.

N. Y. Zoological Society
The African long-eared fox.

The fennec is the prettiest of all the foxes. He can be recognized by his small size, exceedingly large ears and light buff color. His home is on the deserts of North Africa where he feeds upon insects, rodents, reptiles and eggs. He is also fond of dates and it is said that he has been observed crawling up the sloping trunk of a date palm to procure the fruit. Very little has been recorded concerning the habits of this handsome little fox. If procured young he makes an attractive pet, although he is quite delicate in captivity.

The African long-eared fox is a somewhat larger animal, reminding one of a small jackal. He is characterized by his large, upstanding ears and short, pointed nose. In color he is grayish brown with dark feet and legs and a dark stripe through the eye. He is found throughout much of the plains region of Africa from southern Sudan and Ethiopia south to the Cape of Good Hope. He roams chiefly by night but is occasionally seen during the day. These foxes generally go about in pairs but sometimes in small parties. They feed largely on insects, termites being one of their chief foods, but they are also known to eat small mammals, birds, eggs, reptiles, fruit and other vegetable matter. The young, from three to five in number, are generally born in a burrow.

The largest and most brightly colored of the wild dogs of South America is the maned wolf. He is a long-legged animal with large ears and of a bright reddish yellow color with black feet and legs. He lives a solitary life; seldom are more than one or two seen at a time, though a mother may be followed by her pups. The animal never hunts in packs, as is the custom of many wild dogs. He is a timid creature and stays out of sight of man. His chief food is rodents and other small mammals, but he also eats birds, reptiles, insects and fruit; only on rare occasions does he prey on domestic animals when hunger overcomes his timidity.

There is a fairly large group of smaller wild dogs to be found in South America; many of them are fox-like in appearance. The crab-eating dog, of which numerous forms occur, is found from Colombia south to Argentina, in both plain and forest. The small-toothed dog is found in south central Brazil and the small-eared dog in the Amazon River basin and Peru. This last is a very rare species and few specimens have found their way into the museums. The colpeo is found in many sections of the Andes Mountains and is particularly common in the south. At times it is said to be destructive to sheep and consequently is not very popular with the ranchers.

One of the most interesting of the wild dogs of South America was the Falkland dog, also known as the Antarctic wolf. He was found only on the Falkland Islands and was very tame and unsuspicious. The settlers on these islands found him easy to kill and consequently he has become extinct. At one time he was thought to be a close relative of the coyote but is now believed to have been related to the wild dogs on the mainland of South America.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 711.

The Diverting History of John Gilpin

By WILLIAM COWPER (1731-1800)

Illustrated by Robert Lawson

JOHN GILPIN was a citizen
Of credit and renown,
A train-band captain eke was he
Of famous London town.

John Gilpin's spouse said to her dear,
"Though wedded we have been
These twice ten tedious years, yet we
No holiday have seen.

"To-morrow is our wedding-day,
And we will then repair
Unto the Bell at Edmonton,
All in a chaise and pair.

"My sister, and my sister's child,
Myself, and children three,
Will fill the chaise; so you must ride
On horseback after we."

He soon replied, "I do admire
Of womankind but one,
And you are she, my dearest dear,
Therefore it shall be done.

"I am a linen-draper bold,
As all the world doth know,
And my good friend the calender
Will lend his horse to go."

The morning came, the chaise was brought,
But yet was not allowed,
To drive up to the door, lest all
Should say that she was proud.

So three doors off the chaise was stayed,
Where they did all get in;
Six precious souls, and all agog
To dash through thick and thin.

Smack went the whip, round went the wheels,
Were never folk so glad,
The stones did rattle underneath,
As if Cheapside were mad.

John Gilpin at his horse's side
Seized fast the flowing mane,
And up he got, in haste to ride,
But soon came down again;

For saddle-tree scarce reached had he,
His journey to begin,
When, turning round his head, he saw
Three customers come in.

So down he came; for loss of time,
Although it grieved him sore,
Yet loss of pence, full well he knew,
Would trouble him much more.

'Twas long before the customers
Were suited to their mind,
When Betty screaming came downstairs,
"The wine is left behind!"

"Good lack!" quoth he—"Yet bring it me,
My leathern belt likewise,
In which I bear my trusty sword,
When I do exercise."

Now Mistress Gilpin (careful soul!)
Had two stone bottles found,
To hold the liquor that she loved,
And keep it safe and sound.

Each bottle had a curling ear,
Through which the belt he drew,
And hung a bottle on each side,
To make his balance true.

Then over all, that he might be
Equipped from top to toe,
His long red cloak, well brushed and neat,
He manfully did throw.

Now see him mounted once again
Upon his nimble steed,
Full slowly pacing o'er the stones,
With caution and good heed.

But finding soon a smoother road
Beneath his well-shod feet,
The snorting beast began to trot,
Which galled him in his seat.

So, "Fair and softly," John he cried,
But John he cried in vain;
That trot became a gallop soon,
In spite of curb and rein.

So stooping down, as needs he must
Who cannot sit upright,
He grasped the mane with both his hands,
And eke with all his might.

His horse, who never in that sort
Had handled been before,
What thing upon his back had got
Did wonder more and more.

Away went Gilpin, neck or naught;
Away went hat and wig:
He little dreamt, when he set out,
Of running such a rig.

The wind did blow, the cloak did fly,
Like streamer long and gay,
Till, loop and button failing both,
At last it flew away.

Then might all people well discern
The bottles he had slung;
A bottle swinging at each side,
As hath been said or sung.

The dogs did bark, the children screamed,
Up flew the windows all;
And every soul cried out, "Well done!"
As loud as he could bawl.

Away went Gilpin—who but he?
His fame soon spread around;
"He carries weight!" "He rides a race!"
" 'Tis for a thousand pound!"

And still, as fast as he drew near,
'Twas wonderful to view,
How in a trice the turnpike-men
Their gates wide open threw.

And now, as he went bowing down
His reeking head full low,
The bottles twain behind his back
Were shattered at a blow.

Down ran the wine into the road,
Most piteous to be seen,
Which made his horse's flanks to smoke
As they had basted been.

But still he seemed to carry weight,
With leathern girdle braced;
For all might see the bottle-necks
Still dangling at his waist.

Thus all through merry Islington
These gambols did he play,
Until he came unto the Wash
Of Edmonton so gay;

And there he threw the Wash about
On both sides of the way,
Just like unto a trundling mop,
Or a wild goose at play.

At Edmonton his loving wife
From the balcony spied
Her tender husband, wondering much
To see how he did ride.

"Stop, stop, John Gilpin! Here's the house!"
They all at once did cry;
"The dinner waits, and we are tired";—
Said Gilpin—"So am I."

But yet his horse was not a whit
Inclined to tarry there!
For why?—his owner had a house
Full ten miles off, at Ware.

So like an arrow swift he flew,
Shot by an archer strong;

So did he fly—which brings me to
The middle of my song.

Away went Gilpin, out of breath,
And sore against his will,
Till at his friend the calender's
His horse at last stood still.

The calender, amazed to see
His neighbor in such trim,
Laid down his pipe, flew to the gate,
And thus accosted him:

"What news? what news? your tidings tell;
Tell me you must and shall —
Say why bareheaded you are come,
Or why you come at all?"

Now Gilpin had a pleasant wit
And loved a timely joke;
And thus unto the calender
In merry guise he spoke:

"I came because your horse would come.
And, if I well forbode,
My hat and wig will soon be here,—
They are upon the road."

The calender, right glad to find
His friend in merry pin,
Returned him not a single word
But to the house went in;

Whence straight he came with hat and wig;
A wig that flowed behind,
A hat not much the worse for wear,
Each comely in its kind.

He held them up, and in his turn
Thus showed his ready wit,
"My head is twice as big as yours,
They therefore needs must fit.

"But let me scrape the dirt away
That hangs upon your face;
And stop and eat, for well you may
Be in a hungry case."

Said John, "It is my wedding-day,
And all the world would stare,
If wife should dine at Edmonton,
And I should dine at Ware."

So turning to his horse, he said,
"I am in haste to dine;
'Twas for your pleasure you came here,
You shall go back for mine."

Ah, luckless speech, and bootless boast!
For which he paid full dear;
For, while he spake, a braying ass
Did sing most loud and clear;

Whereat his horse did snort, as he
Had heard a lion roar,
And galloped off with all his might
As he had done before.

Away went Gilpin, and away
Went Gilpin's hat and wig:
He lost them sooner than at first;
For why?—they were too big.

Now Mistress Gilpin, when she saw
Her husband posting down
Into the country far away,
She pulled out half-a-crown;

And thus unto the youth she said
That drove them to the Bell,
"This shall be yours, when you bring back
My husband safe and well."

The youth did ride, and soon did meet
John coming back amain:
Whom in a trice he tried to stop,
By catching at his rein;

But not performing what he meant,
And gladly would have done,
The frighted steed he frighted more,
And made him faster run.

Away went Gilpin, and away
Went postboy at his heels,
The postboy's horse right glad to miss
The lumbering of the wheels.

Six gentlemen upon the road,
Thus seeing Gilpin fly,
With postboy scampering in the rear,
They raised the hue and cry:

"Stop thief! stop thief!—a highwayman!"
Not one of them was mute;
And all and each that passed that way
Did join in the pursuit.

And now the turnpike gates again
Flew open in short space;
The toll-men thinking, as before,
That Gilpin rode a race.

And so he did, and won it too,
For he got first to town;
Nor stopped till where he had got up
He did again get down.

Now let us sing, Long live the king!
And Gilpin, long live he!
And when he next doth ride abroad
May I be there to see!

THE NEXT POEMS ARE ON PAGE 734.

MOLECULES

BUILDING BLOCKS OF MATTER

YOU know that all ordinary substances are made of molecules; that molecules in turn are formed from various combinations of atoms; and that every one of the ninety-odd different chemical elements has its own particular kind of atom. Going one step farther, every atom has its own complicated structure on a very small scale.

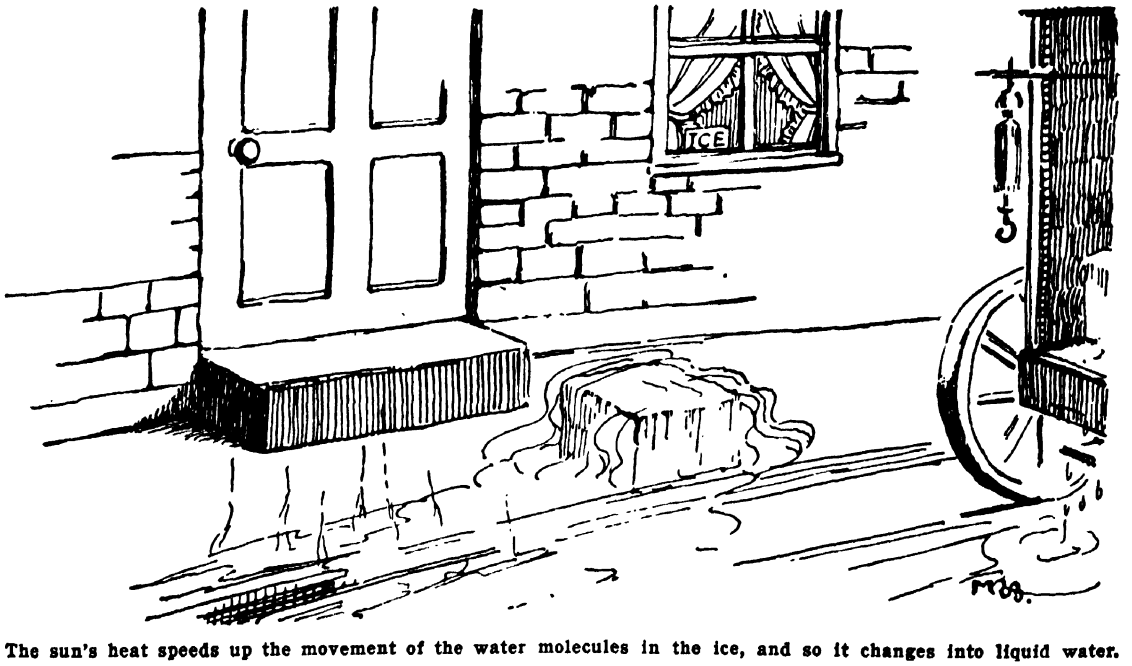
To make these ideas more definite, let us perform in imagination what scientists do in a laboratory or in a chemical works. If we took a piece of wax from a candle, and cut it into smaller and smaller pieces, soon the pieces of wax would be too small to see separately, even in any ordinary microscope. But we could always melt them together again to get the lump of wax we started with, at least until we got down to pieces of wax about two millionths of an inch long. We should find, however, that if we could somehow break up those final bits of wax into still smaller bits, they would not be wax and we could not get wax just by melting the bits together. In that final breaking up, we have secured bits that no longer behave as wax. The smallest piece of material which behaves as wax is called a molecule of wax.

What would we have, if we broke one wax molecule into bits? We should have an assorted collection of *atoms* of carbon, of hydrogen and of oxygen, because these are what a molecule of wax is made of. These three substances would be gases. There would be thirty or forty atoms altogether. They are three of the ninety-odd different kinds of elements.

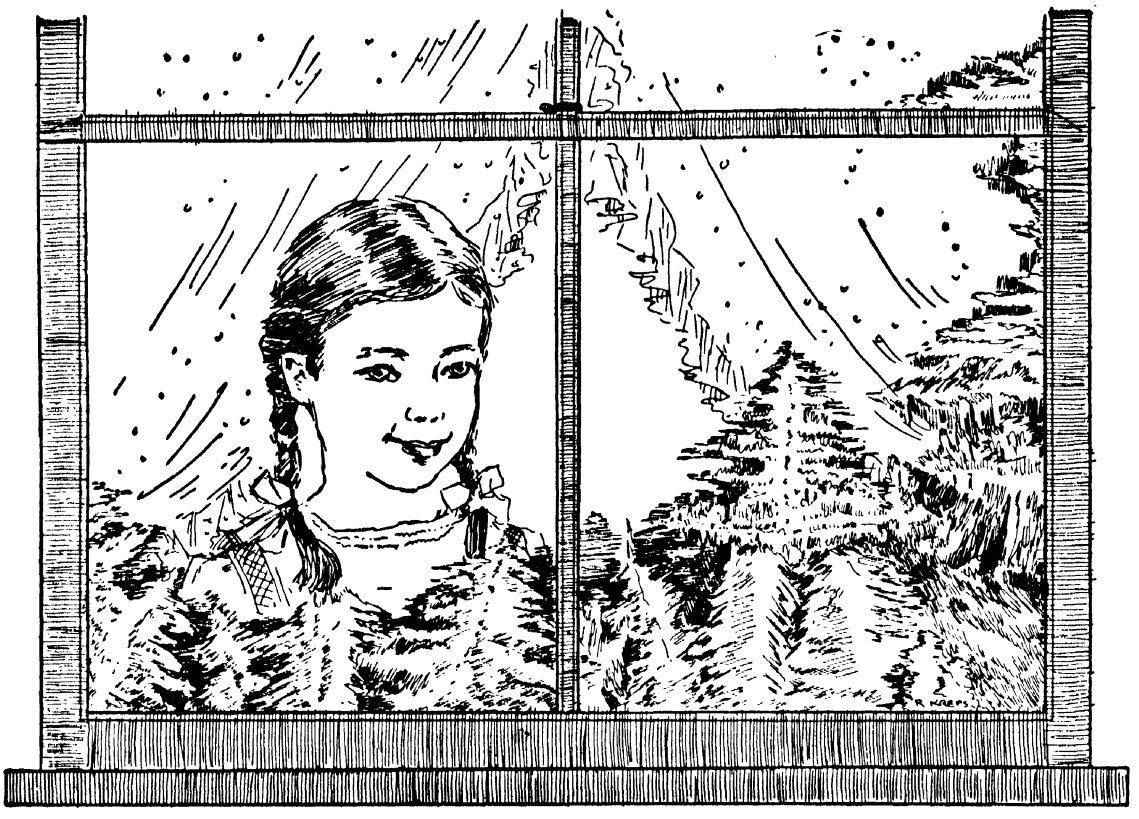
The atoms in a molecule, whether it be a molecule of wax or of water, of iron rust or of any other substance, are held tightly together by electrical forces of valence, forming one unit, unless rather violent methods, such as extreme heat or strong chemicals are used to break them apart.

Now we must learn something about how molecules cling together to make substances; for example, how wax molecules cling together to form a candle. First we must understand something that seems to have little to do with the subject.

The Three Forms of Substances. There are three forms of substance, or three states of matter—solids, liquids and gases. A substance like water is familiar to us in all three forms. When it is kept below 32° F., as in



The sun's heat speeds up the movement of the water molecules in the ice, and so it changes into liquid water.

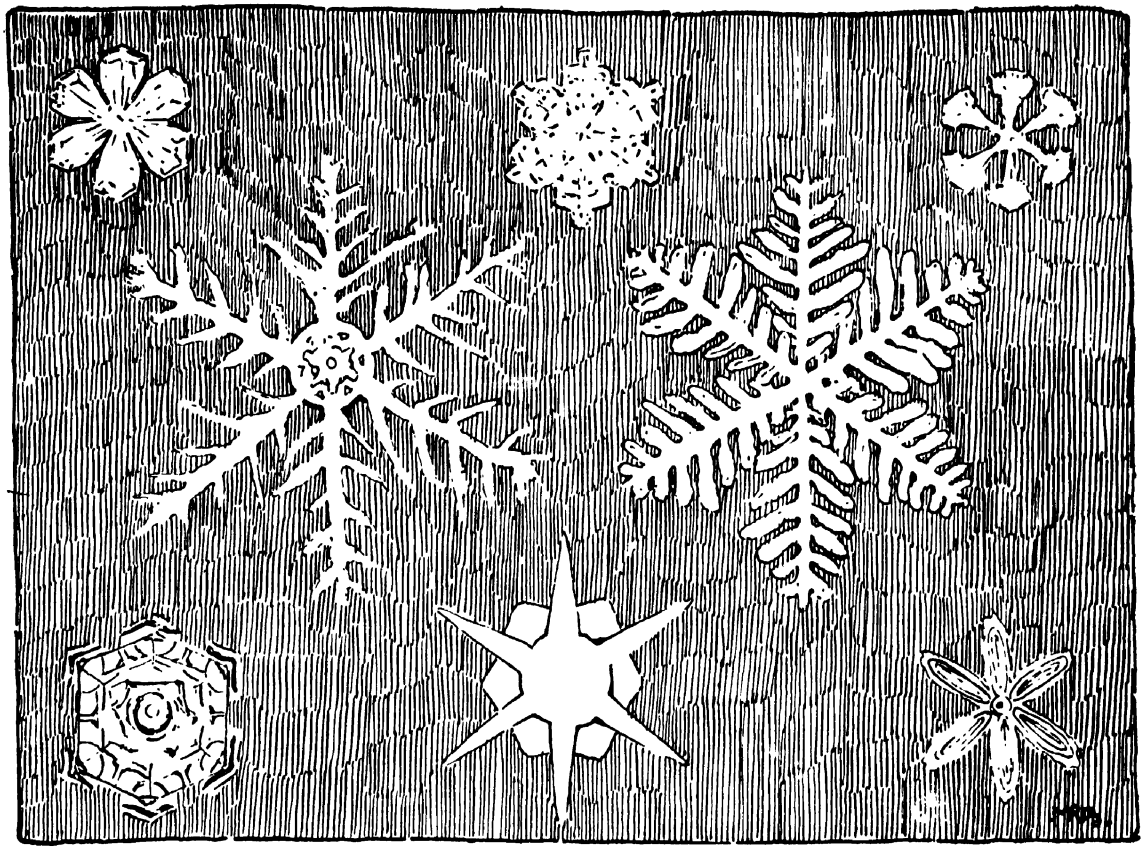


Frost is really tiny crystals of ice formed from the water vapor in the air when the temperature drops below freezing. The water molecules are slowed down so quickly that the liquid state of water is skipped.

the ice trays of a refrigerator, it is *solid.* Between 32° F. and 212° F. it is a *liquid,* and above 212° F. it is *steam.* If it were heated considerably above 212° F., it would be spoken of as superheated steam. It would then be called a *gas.* Each of these three forms of water is composed of identical water molecules. What makes the difference between solid ice, liquid water and superheated steam is simply the way in which the molecules are acting. All matter everywhere in the universe is in one of these three forms, or states—all matter is solid, liquid or gas. A great many substances, like water, may occur in all three states at different times—it is the way their molecules stick together that makes the difference.

Water molecules stick together very tightly in ice, not so tightly in liquid water, and very loosely or not at all, in steam. A hundred and fifty years ago it was not very clear even to the best scientists why molecules acted in these three different ways. It was known, of course, that heat had something to do with the change. But heat was not well understood. However, as a result of the experiments of the American Count Rumford (1753-1814), followed by those of the Englishmen Humphry Davy (1778-1829) and James Prescott Joule (1818-89), it was proved that heat was merely motion, or more precisely, energy of motion of molecules. This means that when a substance is heated, its molecules all begin to move faster. This motion of molecules is correctly thought of as a vibration in which each molecule wriggles backward and forward extremely fast, while at the same time it moves (if at all) only comparatively slowly from one locality to another.

What is likely to happen when molecules of ice begin to vibrate faster and faster? A picture from everyday life will help us here. What does a boy do when he wants a specially fine apple that is far out on a thin branch of the tree? He climbs partway up the tree and shakes the branch. The apples on the tree all shake violently backward and forward, swinging sharply on their stems. The extra motion makes them break their stalks and down they fall, not only the one special apple, but many others as well. The stems were strong enough to hold the apples to the tree when they were relatively quiet, but the increased energy of motion caused them to break off. In much the same way,



Molecules in crystals arrange themselves in definite positions, resulting in many lovely patterns.

single molecules escape from heated ice and flow away as liquid water.

Crystals. The molecules in different solids herd together in different ways. Many substances, such as ice, diamonds and rubies, are what we call crystals. One of the most remarkable things about a crystal is its beautifully regular geometrical shape. If you take a pinch of salt, drop it on a piece of dark paper and look at it with a powerful magnifying glass you will see that salt crystals are perfect little cubes, the same shape as most of the blocks your little brothers and sisters play with. Sugar crystals likewise come in regular shapes, though their shapes are not usually as regular as those of salt. Ice crystals are easy to see if you look at hoarfrost through a microscope. This regularity of shape of a crystal means that in the solid form the molecules can stick together only in certain positions. You can not imagine a lot of bricks making a firm wall unless the bricks are stacked neatly, every brick in its proper place.

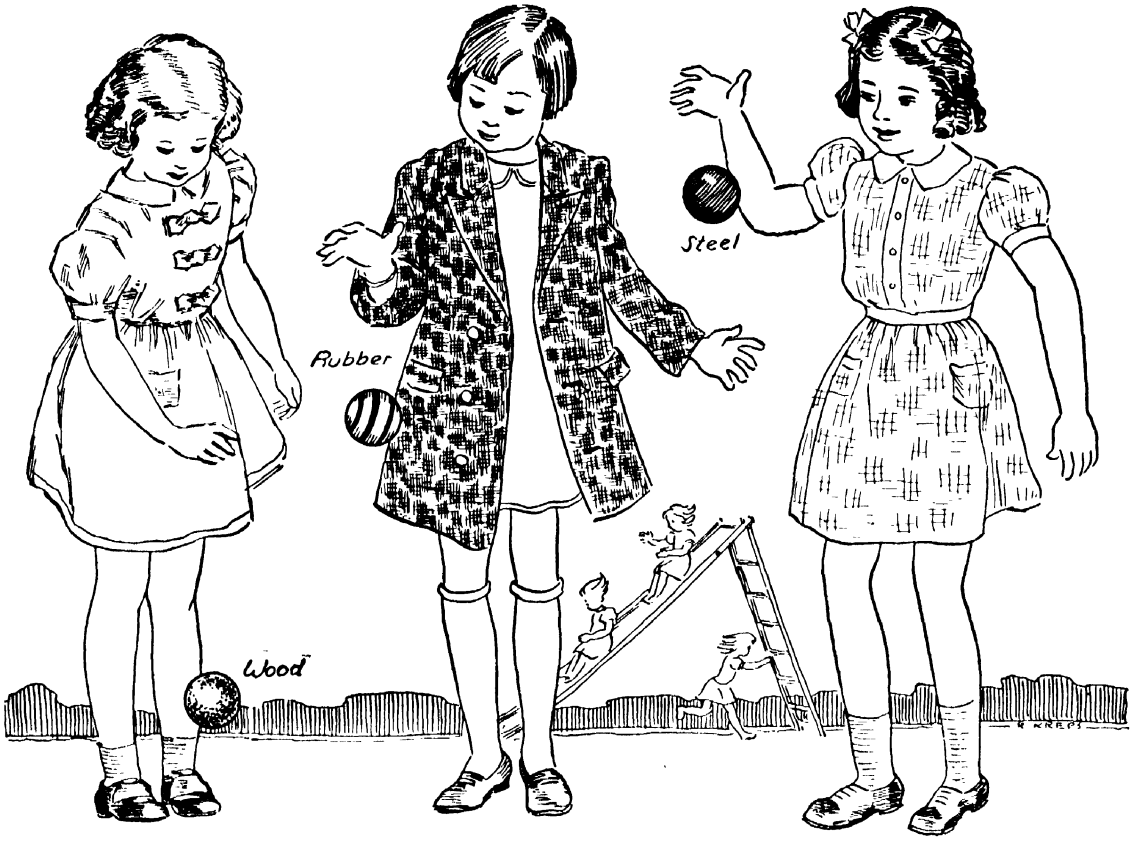
To get a clearer idea of the regularity of the molecules in a crystal, it will help you to have your Chinese checkerboard in front of you. It is easy to fill the shallow holes with marbles and form them thus into triangles or parallelograms. You are now playing the game of crystal building. At first sight you will think it difficult to make a square, corresponding to the little cubical salt crystals. To do this you will have to put marbles only in every other hole. If you asked why the molecules of salt join together only in the form of regular cubes, the answer would be very complicated, but it has to do with the forces which exist between different molecules and atoms when they do not have much energy of motion.

We can keep on playing this game with the Chinese checkerboard. If you move the board carefully, the marbles stay in their holes and do not change places. The marbles may wobble a bit, but still not get out of their proper holes. You are seeing how a solid crystal behaves. Each molecule may wobble or vibrate a little, but does not get out of its assigned place.

In order to change a solid to a liquid, we must warm it up. As we said before, this corresponds to giving the molecules more movement. Shake the Chinese checkerboard

very gently. At first nothing will happen, except that the marbles may rattle a little. The solid has not yet been made hot enough. So shake the board a little harder, and some of the marbles will come out of their holes and run into new holes where they will settle down with occasional wobblings. You will have to shake the board carefully to get this effect. In other words, there must be just the right degree of heat (or of motion) to make the marbles run from one hole to another without rolling off the board entirely. This is a very important thing to notice, for it tells you that the molecules of a crystal must possess just exactly the right degree of heat to cause melting; most crystals melt exactly at certain temperature. Ice, for instance, melts to water at 32° F. or 0° C. If the temperature were even half a degree too low, the ice would not melt.

There is one more play in this game. Take the board and shake it backward and forward quite hard. The marbles will fly off the board in all directions. They are now behaving as molecules would in a gas, and the only way to keep them from leaving the board is to put a high rim around it, like a deep fence. This shows why a closed tank must be used to store gases like oxygen or carbon dioxide or the gas for gas stoves. When the gas is to be used, a valve is opened and the molecules rush through a pipe to the place where they are to be used.



A steel ball will actually bounce higher than a rubber one because steel molecules have more "give." But, of course, you will find it difficult to lift a steel ball as big as the one shown, since it is very heavy.

It is the motion of molecules of superheated steam which drives a steam locomotive. When the engineer opens the throttle, or valve, the molecules rush to the cylinders where they bang against the piston—millions upon millions of bangs every second; they push the piston and its movement makes the wheels go around. (See page 406.) The pushing takes away a great deal of the energy of motion from the molecules, so that when the exhausted steam is allowed to escape through the smokestack, it is not nearly so hot as it was in the boiler.

Molecules are so small that it is, of course, impossible to see them, and to watch their motion. The most direct evidence can be obtained by looking at smoke through a microscope. Instead of a fuzzy cloud of smoke, little individual particles are seen.

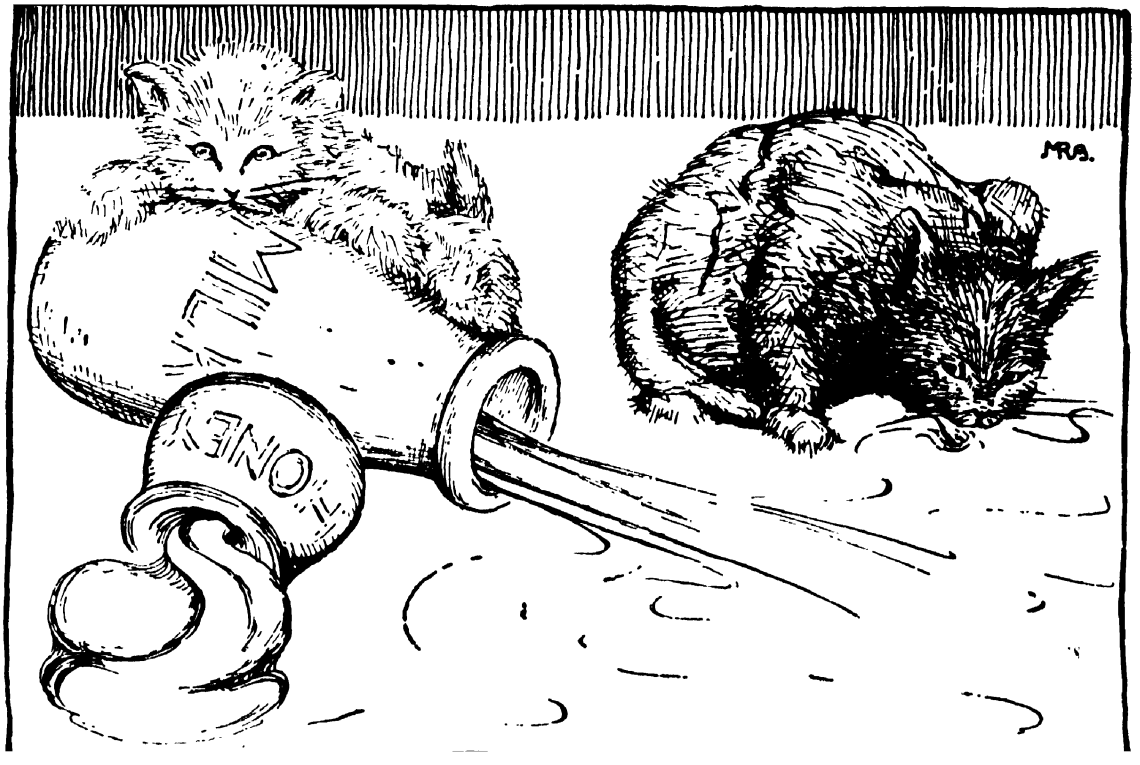
On close watching, these particles of smoke are observed to be moving all the time, not in just one direction, but in little jerks backward and forward. The movement of these smoke particles is caused by blows of large numbers of molecules of air striking on all sides. Sometimes more hits occur on one side than on another, and hence the motion of the smoke particles is very irregular.

Elasticity. Those of you who play the violin know that the E string, which is often made of steel wire, will stretch quite a noticeable amount without breaking. Remember that the steel wire is made up of molecules. When it is stretched, the molecules are pulled slightly farther apart. It is not easy to pull the steel molecules apart. How difficult it is you may judge by the force needed to stretch the wire even a little. If you relax the force, the wire goes back to its original length. The steel wire is springy, or, in scientific language, it possesses elasticity. Elasticity is due to the forces holding molecules together. The steel molecules can "give" just a little. Elasticity is a very common property of solids, but all substances are not equally elastic; that is, they do not all return with the same readiness to their original places when the stretching forces are removed. Steel and quartz are among the most perfectly elastic or springy solids. We think of rubber as being very elastic. Actually rubber is rather poor in elasticity, for though it stretches easily a long way, it does not go back accurately to its original length.

The tensile strength of a substance is the force needed to break it by pulling. The tensile strength of steel is about 140,000 pounds for a bar one square inch thick.

Liquids also are elastic, though they can not be tested by stretching, but by the opposite of stretching—by compressing them in strong containers. All liquids are very difficult to compress. A cubic foot of sea water at the surface weighs about 64.3 pounds. A cubic foot from a place five miles deep, where the pressure would be nearly 12,000 pounds per square inch, would weigh only a little more, about 66.7 pounds. This shows that it is very difficult to push water molecules closer together than the normal distance which they naturally keep, while they still remain liquid.

Viscosity. If you put two flat pieces of glass or metal together with a little water or oil between, you will find that it is almost impossible to pull them straight apart. Yet



The milk molecules move apart readily, and so the milk streams out of the bottle. But honey is a viscous fluid; its molecules do not separate directly, but slide and slip over each other; and so the honey only oozes out.

if you push sideways, one piece will slide quite easily over the other. This shows that although the molecules may be very hard to pull directly apart, they roll or slide quite readily over one another. Different liquids show this slipperiness in different degrees. A special name, viscosity, is used to describe it. A viscous liquid is one that changes its shape, or flows, slowly. Honey, molasses, and thick oil are good examples of viscous liquids. A place where viscosity is very important is in the bearings of motors. A bearing is just a smooth shaft which turns inside a fixed collar called a bushing. It would not do to have a clean metal shaft rotating inside a clean metal bushing, for the two metals would tend to stick together, and one would soon be worn away by friction or melted by the heat generated. A thin film of oil must surround the shaft at all times, and then the shaft turns easily; the molecules of oil slip easily over one another, and the shaft never quite rubs on the bushing at all.

Raindrops join because of molecular attraction.

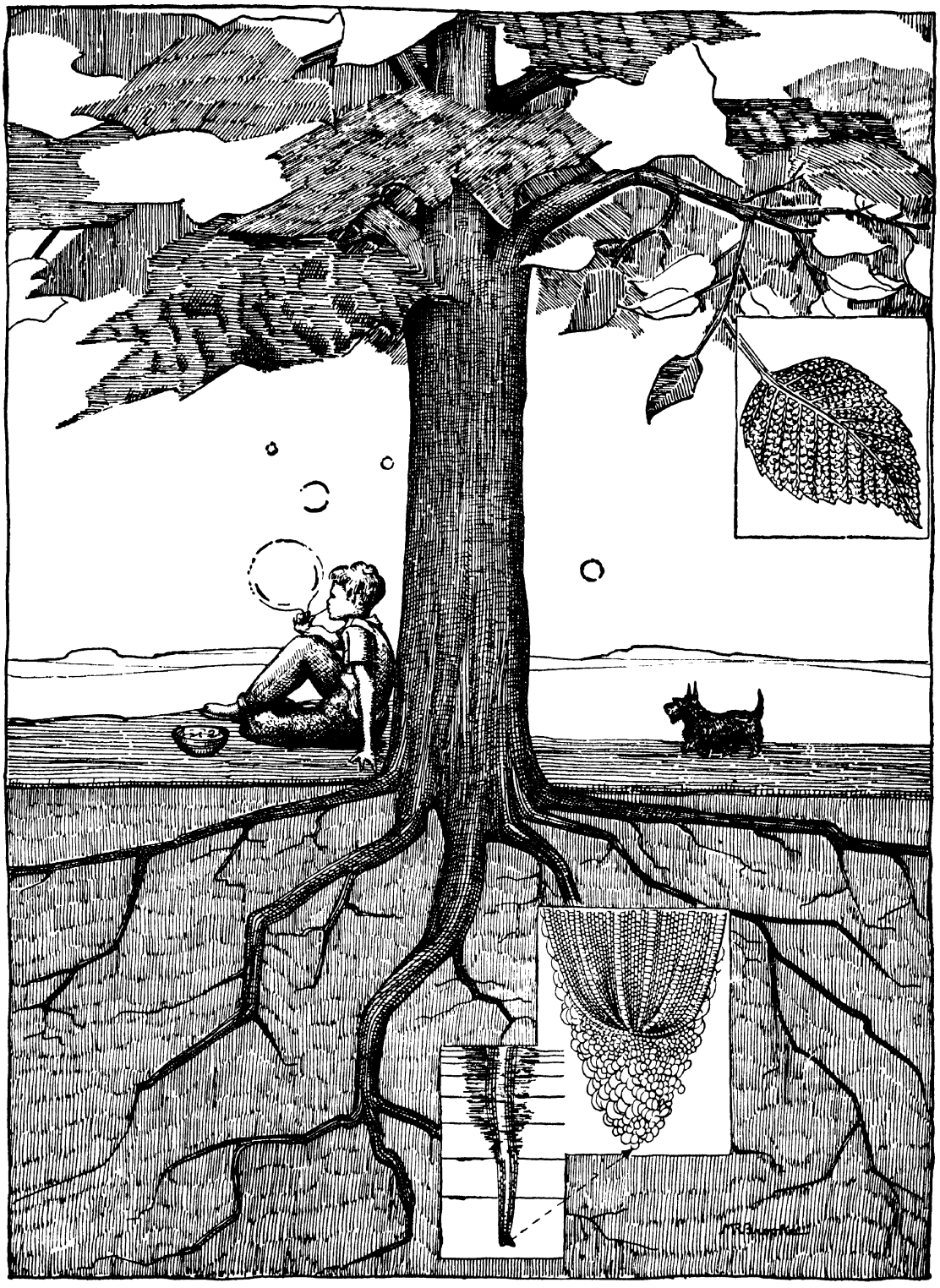
Different oils have different amounts of viscosity; and viscosity changes with temperature. Oil when warm has smaller forces of viscosity than when cold. It is easy to understand why. Just remember that extra heat simply means greater activity, or motion, of molecules. When the oil is warm, a molecule is already wiggling about quite a lot, and is ready to change its position. But if the oil is cold a molecule is not able to break away to a new position unless it gets a big push from the outside, that is, from the shaft which is turning.

If, in very cold weather, an oil with high viscosity is used in an automobile engine, the engine is very hard to start. So we use different oils in our automobiles in winter and summer—one of low viscosity in the winter, to make starting easy, and one of higher viscosity in the summer, so that even if the engine overheats, as it is most likely to do only in summer, the oil will not become so thin that it will be squeezed out of the bearings and cause a burn-out. One of the greatest problems in automobile and airplane engines is to keep a steady flow of oil at just the right temperature to all the bearings. A choked oil line usually means a burned-out engine.

Surface Tension. The molecules in a liquid tend to stay together. Little drops of water on an automobile windshield join up after it has rained for a while because of this attraction between the molecules. The effect is particularly noticeable at the surface of a liquid, for there one side is liquid and the other is air. The pull of the molecules is then all in one direction. This makes the liquid behave as though it had a thin stretchy skin on it, and explains why tiny drops of water are round although the surface of a pond is flat. A rubber balloon is round for the same reason. The rubber is quite strong and therefore you have to blow hard to burst it. But it is very easy, when blowing soap bubbles, to blow hard enough to break a bubble. The skin of soapy water is not very strong. The strength of the skin on a liquid is called its surface tension.

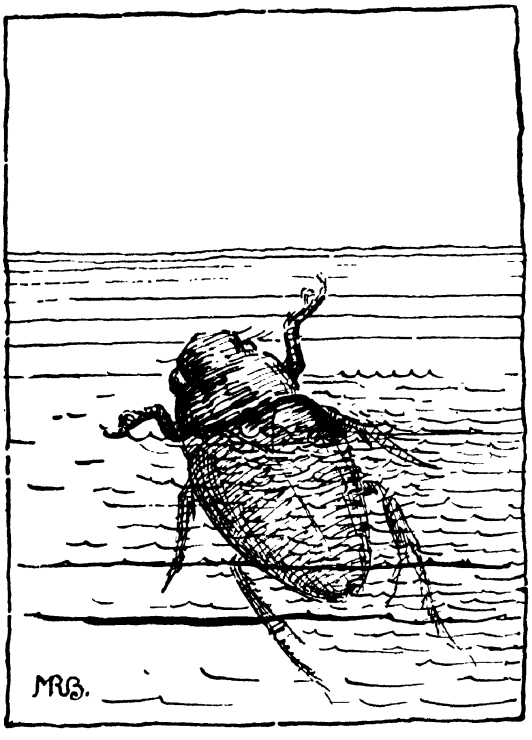
Molecules of the same liquid always attract one another, but molecules of different substances sometimes cling together and sometimes stay apart. For example, water does not wet an oily surface because oil molecules and water molecules push one another apart. Clean glass is easy to wet, particularly with soapy water, as you have probably noticed when washing the dishes. If you lower a candle slowly into a glass of cold water you will notice that the water is pushed down a little around the candle; but

A TREE'S DIGESTIVE SYSTEM



Liquid food from the soil is drawn by osmosis into the tiny root-hairs near the tip of the roots. The left-hand insert shows the root-end magnified; the right-hand insert shows the tip much more magnified. From the roots the nourishment rises, partly by capillary action, to every part of the tree.

if you use your finger, just after you have washed your hands well, the water will be pulled up a little, as though it wanted to drag your finger down. This effect of surface tension is important for some insects. A water beetle can walk on the surface of the water with his front feet because the feet are oily and though they make little dents in the surface, they do not break the surface



The water beetle treads on top of the water with its two front legs, and swims with its four other legs.

film. On the other hand, once a fly gets wet in milk, he usually drowns because the wet liquid keeps pulling him down.

When a substance like paper which is easily made wet is dipped into water, the molecules of water are pulled up into the tiny crevices by the force of surface tension. That is why soft paper with many pores is good for blotting. The blob of ink runs up into the tiny spaces between the fibers of paper.

In partly the same way, sap is pulled up from the roots to the leaves of trees, through tiny tubes in the tree trunk. In these cases the effect of surface tension is called capillarity, from the Latin *capilla*, a hair. A liquid can climb up quite a distance through a tube the size of a hair, though in a wide tube it can go up only if forced by a pump.

Osmosis. Although capillarity undoubtedly helps the sap to flow from the roots to the branches and leaves of trees, it can not do the job alone. Another effect, called osmosis, is important as well. It works in the following way.

Usually there is plenty of moisture in the ground where the roots of trees grow. Inside the roots there is sap which may be thought of as a thin syrup. Sap is often sweet. There is, of course, a skin on each root which separates the sap inside from the purer water outside. Whenever this happens, the water from the outside tends to seep through the skin to make the sap weaker. The big sugar molecules which are part of the sap can not get out through the skin, so there is a slow flow of liquid one way only, from the moist earth into the roots.

Osmosis does not take place unless the skin is of the right kind. The skin which covers roots has a strange ability to let water molecules through and to hold the bigger sugar molecules back. This is actually quite a common behavior of membranes taken from plants and animals; they are often called semi-permeable membranes.

You may wonder why water does not go equally in both directions through such a membrane. It is because the water molecules are more concentrated on one side than on the other. Inside the root many of the molecules are big sugar molecules which obstruct the motion of water molecules as they move around. Outside, all the molecules are water molecules.

Thus we see that as a result of osmosis, there will always be a flow of water into the roots of trees, provided the ground is moist around them. When a plant or bush shows signs of withering from drought, you water the ground close to it, not the leaves and branches. Only in this way can the water inside the plant be replenished. But it all happens only because the molecules of water are continually moving.

Did you ever notice how a raisin swells when placed in water? This is another example of osmosis. The skin of the raisin permits the water to pass through to the inside. There it dissolves the sugar, forming a sugar solution which can not pass out. And so the raisin swells. Osmosis plays a part in the functions of the human body, particularly in the blood capillaries. But it alone does not explain such processes as the absorption of food.

By THOMAS H. OSGOOD.

THE NEXT STORY OF SCIENCE IS ON PAGE 739.

MAKING A MODEL-AIRPLANE

THE building and flying of model-airplanes will give you many hours of pleasure and will help you understand why planes fly. "But," you may say, "model-building is much too hard and too expensive." Actually, it is quite easy to make a model-plane, once you know how to use the various materials. And you can make the model described in this article for something like fifty cents; half of this amount will be for the rubber motor. As for tools, all you will need will be a single-edge razor, ordinary pliers, pins, a board, a sharp knife and some sandpaper.

SUPPLIES

You will need:

- Balsa wood; see the specifications shown in figure 1.
- 2 feet of .032 wire, for the landing gear and propeller shaft.
- 1 propeller block, 1 3/8" x 7/8" x 8".
- 6 washers, 3/16" in diameter.
- 2 wooden model wheels, 7/8" in diameter.
- 1 hardwood dowel, 1" long and 1/8" in diameter.
- 8 to 12 strands of 1/8" rubber.
- Several sheets of colored tissue paper to be used as covering.
- 1 ounce of model cement.
- 1 ounce of model dope.

You can buy these supplies at any airplane-model shop. If there is no such shop near you, consult a model magazine for a list of supply companies. Write to these for free catalogs, so that you may order what you want by mail.

GENERAL REMARKS

Try to work in a basement or workroom where shavings and dust will cause as little annoyance as possible to other members of the family. If such a place is not available, work in the kitchen and sweep up shavings after you finish. Put on old clothing when you plan to work.

It is best to work on a large board, on

Frederic Lewis

There is no better way to begin a career in aviation than to build your own model-airplane.

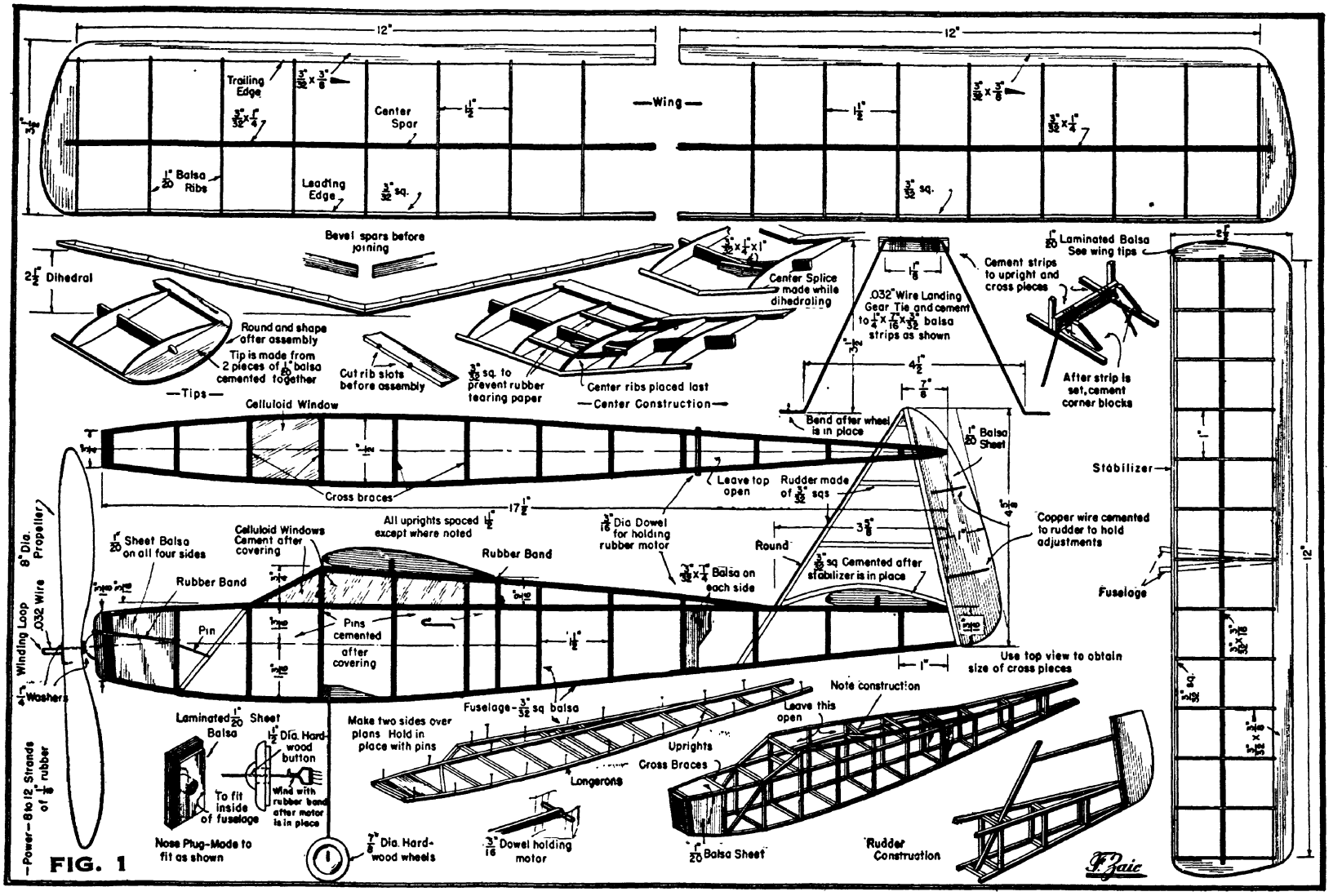
which you can set the plans of the model. When your working hours are over, simply put your board out of the way until the next session. In selecting the board, keep in mind your future projects. If you intend to make big models later, get a large-size board, made of soft wood.

To prevent spilling your cement and dope, use containers with wide bases, such as cans. All containers should be kept closed when not in use, to keep the liquid from evaporating and from being spoiled by too long contact with the air. You will find that a little of the liquid, which has become solid, will collect at the opening of the container. You can cut this off with a sharp razor.

The tools mentioned above are all you will need to construct this particular model. If you do a lot of model-building later on, you will find the following items useful: a small block plane; various grades of sandpaper; soap or wax; a steel-edge ruler; a T square; a French curve; a compass; drawing paper and thumbtacks; good soft brushes; a hack saw; a hand drill; several files.

PLANS

We give you the complete plans of the various parts of the plane in the diagrams that accompany this article. Before you be-


12"
12"
Trailing Edge
Center Spar
Wing
Leading Edge
1" Balsa Ribs
Bevel spars before joining
2½" Dihedral
Center Splice made while dihedraling
Round and shape after assembly
Tip is made from 2 pieces of 1" balsa cemented together
Tips
Cut rib slots before assembly
prevent rubber tearing paper
Center ribs placed last
Center Construction
.032" Wire Landing Gear Tie and cement to strips as shown
Cement strips to upright and cross pieces
Laminated Balsa See wing tips
After strip is set, cement corner blocks
Celluloid Window
Cross braces
Bend after wheel is in place
Leave top open
Rudder made of sqs
Balsa Sheet
Stabilizer
Fuselage
All uprights spaced except where noted
Dia Dowel for holding rubber motor
Round
Cemented after stabilizer is in place
Balsa on each side
Copper wire cemented to rudder to hold adjustments
Use top view to obtain size of cross pieces
8" Dia. Propeller
Sheet Balsa on all four sides
Celluloid Windows Cement after covering
Rubber Band
Pin
Pins cemented after covering
.032 Wire Winding Loop
Washers
Power—6 to 12 Strands of rubber
Laminated Balsa Sheet
Dia. Hard-wood button
To fit inside of fuselage
Wind with rubber band after motor is in place
Nose Plug—Made to fit as shown
Make two sides over plans Hold in place with pins
Fuselage—sq balsa
Longerons
Uprights
Cross Braces
Leave this open
Note construction
Dia. Hard-wood wheels
Dowel holding motor
Balsa Sheet
Rudder Construction
FIG. 1

gin work on the wings, fuselage, stabilizer and rudder, you should make full-sized plans of these parts, using the dimensions as shown.

FUSELAGE

Most model-builders begin by making the fuselage. You should work from a full-size plan of the side view of the fuselage, as shown in figure 1. Place the strips which are to make up the longerons, or lengthwise pieces, over the plan, holding them in place with pins. Next, make the fuselage uprights, which are the connecting pieces between the longerons; they should be the exact size shown in the plan. Then cement the uprights into place along the longerons, using plenty of cement. Note the construction at the fourth upright from the rudder. This is

You are now ready to make the nose plug, which is to fit in the inside of the fuselage at the front end, as shown in figure 1. The nose plug is built up of $\frac{1}{20}$" sheet balsa, which is cemented together in layers. A hardwood button is then to be set in position, as shown. If you can not obtain one, you can cement washers on each side of the nose plug to provide bearings for the propeller shaft. The propeller shaft is to pass through the center of the nose-plug assembly. Note how the plug is held in place with a rubber band.

Now make the landing gear. Bend the .032 wire that you use for the gear to the shape shown. Slip on the wheels, which are to be of $\frac{7}{8}$" diameter hardwood. Bend the ends of the landing gear upward, so as to prevent the wheels from falling off. Next, cement the top of the landing gear to a strip

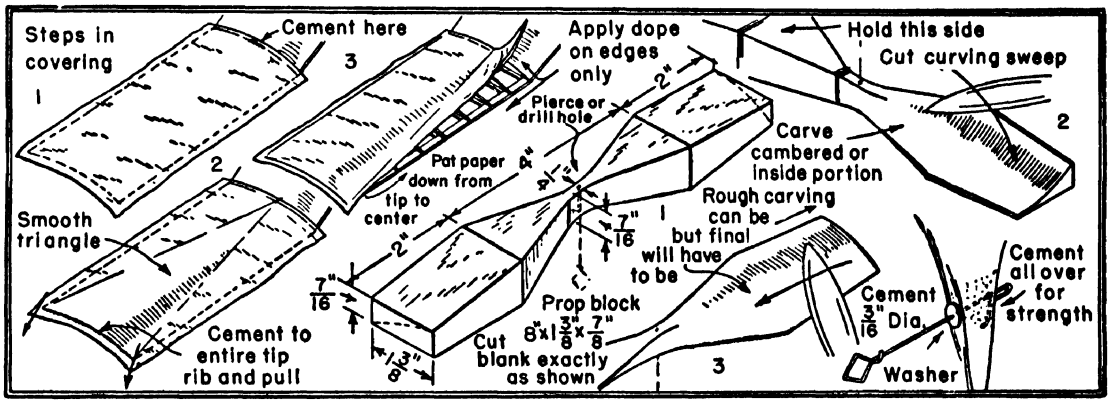


Figure 2. Important steps in making the model-airplane. These diagrams show you techniques by which the wings can be covered and the propeller carved in the easiest, most satisfactory ways.

made up of two pieces of $\frac{3}{32}$" x $\frac{1}{4}$" balsa, cemented together so as to leave a round hole at the joining. The hardwood dowel which is to hold the rubber motor is to pass through this hole and the one on the other side of the fuselage. Figure 1 shows you how the dowel will fit.

When one side of the fuselage has been made, let it dry for about thirty minutes. Then remove the pins that held the longerons in place and take the completed side off the plan. Make the other side just as you did the first. The two sides are assembled into a fuselage by cementing them together with cross braces of balsa, $\frac{3}{32}$" square, as indicated in the plan. Cement the tail end together first; next, insert the cross braces at the windows. Finally, put the rest of the pieces in place. Note that the front end of the fuselage is covered at the top, bottom and sides with $\frac{1}{20}$" sheet balsa, cemented in place.

of balsa and bind it with thread, as shown in the drawing. Cement this balsa strip to the fuselage at the point shown in the diagram. Add two corner blocks to hold the landing gear firmly in place when the model lands.

WING AND TAIL

The hardest job in making the wing and tail is the cutting of the ribs, which have the shape known as the wing airfoil. The ribs are to be cut from $\frac{1}{20}$" sheet balsa. You will have to make yourself a rib pattern and then use this as a guide in cutting the ribs. Trace the full-size airfoil outline, as shown in figure 3; paste the tracing on a piece of stiff paper, such as the covering of a notebook. Then cut the pattern. Use this to guide the razor blade as you work on the balsa sheet. (In kits the outlines of the airfoils are printed right on the balsa sheet.) The leading edge of the wing will fit in the

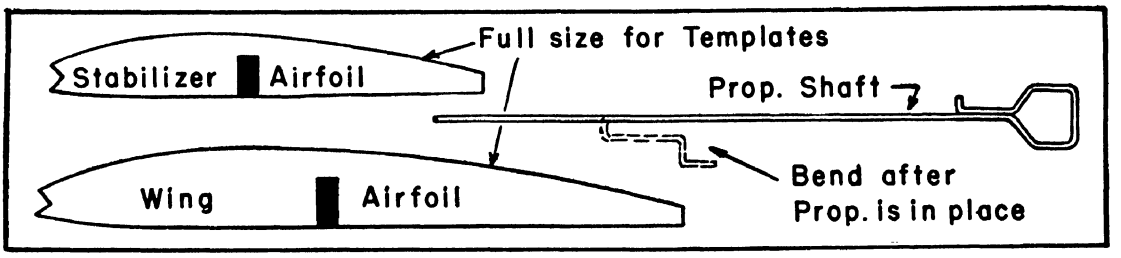


Figure 3. Full-size stabilizer, wing airfoil outlines and propeller shaft. Trace airfoil outlines; paste tracing on a piece of stiff paper. Then cut pattern and use it in working on the balsa sheet.

notch at the front end of the rib; the center spar will fit through the notch (represented in black) at the center.

Before assembling the wings, make a full-size plan of each of the two halves and do each half in turn. First, set the two trailing (rear) edges upon the corresponding places on the plan, holding them in place with pins. Note the slots made in the trailing edge of the wing. The ribs, serving as cross pieces between the trailing and the leading (front) edges of the wings, fit in these slots.

Place the center spar over the drawing; keep it lined up by means of pins. Put the ribs in place, beginning at the end of the wing and working toward the center. It is not necessary to use much cement at first; but be sure to go over all the joints after the wing is taken off the plan. After all the ribs are in place, cement the leading edge. Apply cement to all notches before putting the leading edge in position. Pin it firmly against the ribs while the cement is drying.

The wing tip is made up of two pieces of $\frac{1}{20}$" sheet balsa, cut to shape roughly and then cemented together. When the cementing is done, place the tip under the wing end and cut it so that it will go in position. Cement the tip to the wings; you can make the exact outline afterward.

When you have finished the two halves of the wing, you are ready to put them together so as to form the dihedral angle, as shown in figure 1. To form this angle, place one wing-half flat on the table. Prop up the other half by means of books so that the extreme tip will be five inches from the surface of the table. Bevel the ends of the center spars so that they will fit tightly. Then cement the two wing-halves together. When the cement is dry, strengthen the center splice by adding strips of $\frac{3}{32}$" x $\frac{1}{4}$" x 1" balsa on each side. Because of these strips, you will have to make the spar slots on the center ribs larger so that they will slide over the reinforcement. After the ribs are set and the cement is holding them firmly, cut small $\frac{3}{32}$" square slots to take the $\frac{3}{32}$" strips, as shown. These strips will prevent the rubber band from tearing the paper when you put the wing on the fuselage.

The stabilizer is made in the same way as the wing, except that there is no dihedral angle to worry about. The rudder is cut from $\frac{1}{20}$" sheet balsa and shaped as shown in Fig. 1. The rudder assembly is shown clearly in the diagram.

PROPELLER

In figure 2 we give you a diagram of the propeller, as well as the method of carving. Make the blank as shown from a balsa block 8" x 1$\frac{3}{8}$" x $\frac{7}{8}$" (first step). Carve the inside portion (second step); then sand it smooth before starting the outside part (third step). Apply two coats of model dope to the propeller; then sand it. Insert through the center of the propeller the straight end of the propeller shaft, which should be bent to shape as shown, to provide a winding loop and anchorage. Be sure that you have the nose plug and washers in the proper place before inserting the shaft. The washers on each side of the propeller should be well cemented in place.

COVERING

Start with the fuselage. First cut off enough tissue to cover one side of the fuselage, leaving a certain amount of surplus material at the edges. Apply dope to two uprights under the wing on each side of the fuselage, and also the parts of the longerons which are between these two. Place paper over this area and tap it against the strips so that the dope will seep through. Let the dope dry. This will give you a firm starting place. The rest of the side is covered by raising the ends of the paper, covering two or three uprights and the longerons between them with dope and then placing paper over them. Stretch the paper a bit while you tap it down against the strips and dope. After the entire length of the fuselage is covered, trim off the

surplus with a razor. Cement all loose edges to the longerons. Cover the rest of the fuselage in the same way. Cut out the paper on the top section over the dowel, as shown in figure 1.

After you have covered the four sides of the fuselage, crumple into a ball the bits of excess tissue paper that you have cut off at the edges. Dip this ball of tissue in water, and then wet the entire surface of the fuselage with it. Apply it gently, as paper is very weak when it is wet.

In covering the wing and tail, you are to use a special technique (see figure 2). Cut a strip of tissue the general size and shape of half of the wing, allowing for excess material at the edges as before. First cover the top of the wing. Apply dope to the middle of the center rib and cement the tissue paper at this joint. When this is dry, coat the ends of the wing tip rib. Pull the tissue paper over the wing tip rib, smoothing the triangle formed by the middle of the center rib and the ends of the tip rib.

The part of the wing between the last vertical rib and the wing tip is covered by slitting the tissue lengthwise and working each segment into position separately. Next, cement the tissue paper to the leading and trailing edges; do *not* apply dope to any of the other ribs. Trim off the excess tissue paper. Do the other half of the wing top in the same way. Next, cover the lower halves of the wing. A dope brush, passed along the edges, will provide a smooth finish.

Wet the tissue paper as you did in the case of the fuselage covering. While it is drying, be sure that the wing is not being warped. Set one wing-half flat on the table and be sure that the extreme tip of the other wing-half is still at a distance of five inches from the surface of the table.

The next step is to give the entire model one coat of model dope. You can use rolled-up tissue for a brush. After the dope is dry, cut out the paper where the windows are and cement strips of celluloid, as shown. (You can omit this step, if you wish.) Finally cover and dope the stabilizer and the rudder.

FINAL TOUCHES

Pins are now cemented to the fuselage after covering, as shown in figure 1. The wings are fastened to the top of the fuselage by means of a rubber band passed under the curved tops of pins. The stabilizer is cemented in place. As we have already mentioned, the nose-plug assembly is held in place by means of a rubber band.

The motive power of the model is supplied by a continuous piece of $\frac{1}{8}$" rubber, which is fastened at the ends and then looped to form from eight to twelve strands. Eight strands are enough for ordinary flying conditions; twelve are better for windy weather. These strands of rubber are to be our motor. Fasten one end of the rubber motor to the end of the propeller shaft. Tie a piece of string to the other end of the motor and drop it through the fuselage. Pull it out at the place where the top of the fuselage has been left open. Slip the dowel through the various strands of rubber and then set it in place. Untie the thread. Now put the nose plug in position, holding it fast by a rubber band.

FLYING

Lubricate the rubber with glycerine before you insert it in the fuselage. After the rubber is in place, you must wind it up. You can do so by holding the fuselage of the model in your left hand and turning the propeller with the forefinger of your right hand. You can wind the propeller by hand from 80 to 150 turns (depending upon the elasticity of the rubber). You can wind it many more turns by using an ordinary hand drill, replacing the drill with a bent nail. Have a helper hold the model. Remove the rubber band from the nose-block assembly. Then pull out the propeller, which is still connected to the rubber motor, and stretch the rubber to about four times its normal length. Insert the wire hook at the nose of the propeller in the hook formed by the bent nail in the hand drill. Turn the handle of the latter so that you will have from 300 to 500 turns on the motor (depending again upon the elasticity of the rubber). Holding the propeller firmly so that it will not turn, replace it in position and secure the nose block to the fuselage with the elastic band.

Pick a grassy and open place for flying. Face the wind and launch your plane. If it dives into the ground, add a bit of modeling clay to the tail. If it points upward after launching and then drops, add clay to the front part of the fuselage. If you move the trailing edge of the rudder to the right (looking from the rear), the model will circle to the right. It will fly much better than if it were headed in a forward direction.

This model will not have much of a glide after the rubber-band motor has unwound itself, as the propeller will act as a brake. Larger models may have folding or free-wheeling propellers for longer glides.

By FRANK ZAIC.

THE MAGIC OF A GLASS OF WATER

FOR every mystery there is an explanation. We are sometimes a very long time finding the explanation, but the more we know about the true meaning and the properties of things, the more mysteries we are able to explain; and as soon as we can explain a mystery, it ceases to be one.

A simple siphon, showing how water flows upward.

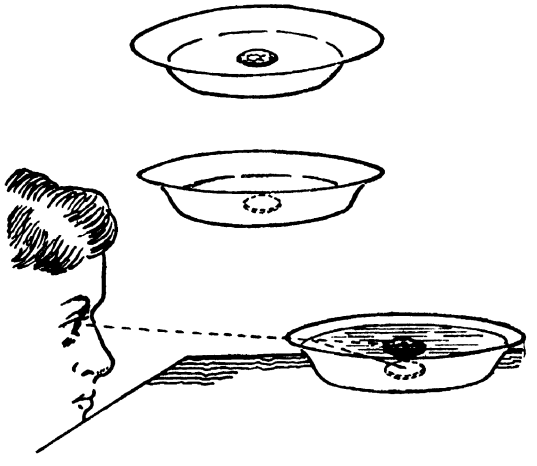
Look at your face in a mirror. Why does the mirror show everything in front of it? Because it has the property of *reflection.* Throw this book into the air and see what happens. It falls downward. Why not upward? Why not sideways? It falls downward because of what we call *gravitation.*

Now we will make a curious experiment, which you will understand if you understand what gravitation is. All you need are two tumblers, or cups, a little water, and a short piece of rubber tubing. Almost any sort of tubing will do. Remember, however, that it should be as small and thin as possible. Put an ordinary tumbler of water on a box or some books on a table—on anything that will cause it to stand a few inches higher than it would stand if you were to put it on the table.

Now put an empty tumbler on the table near the high tumbler. The tumbler holding water will now be higher than the empty tumbler. Put the end of the rubber tubing into the glass with water. Let it go down in the water. Now put the other end of the tubing into your mouth, and suck some of the water up. When the tubing is full of water, squeeze the end of the tube which you have in your mouth. Take it between your finger and thumb, holding it tightly, and put this end into or over the empty tumbler, still keeping the other end of the tubing below the surface of the water in the high tumbler. The part of the tubing dangling over the side of the full tumbler should be longer than the part inside the full tumbler.

Now if you take away your fingers, thereby letting the lower end of the tubing open, the water will begin to flow, and will continue to flow until the high tumbler is empty, or until the water in the high tumbler is below the end of the tubing up which the water has been flowing. You have made what is called a *siphon*—not the kind that holds soda water, for that is not a true siphon, but what men of science and engineers call a siphon.

Can you explain what has happened? Suppose you take a string, tying to one end a large stone or weight and to the other end a small stone or weight, and suppose that you put the middle of the string over a wheel or a smooth rail. You know what will happen: the heavy stone or weight will fall and pull up the little weight until it



How to make a penny rise up in water.

follows it down the other side of the wheel or rail.

The water in the long leg of the tube is like the heavy weight, and the water in the short one is like the small weight. But you say that the two weights would be tied together, while water is not tied to water.

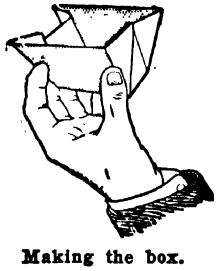
That is true; but unless air gets into the tube of your siphon the effect is just as if the heavy column of the water were tied to the light column of water. Perhaps it would make it clearer if I were to say that the heavy column of water falls down and *sucks* up the lighter column. The light column of water then becomes the heavy column, and sucks up more water, and so on until all the water possible has been sucked up and has flowed down the tube.

We shall make another experiment—how to make a penny rise up in water. It will not really rise up, but it will seem to do so, and the experiment is a very curious one. It shows that we do not see through water quite in the same way as we see through air.

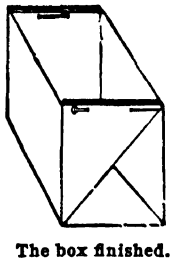
Put a saucer on a table or on a sideboard, and put a penny in the middle of it, as it is shown in the second picture.

Now get someone to look at it. Ask him to sit a little lower until the penny is just hidden by the rim of the saucer. He will then see the saucer but not the penny.

Now, while your friend sits still, pour water into the saucer. Do it very steadily so as not to spill the water. The penny will come into sight. It does not really rise. It is the water that makes it seem to do so. This is because, when you look through air, you see in a straight line. When you look through air and water you see along two lines.



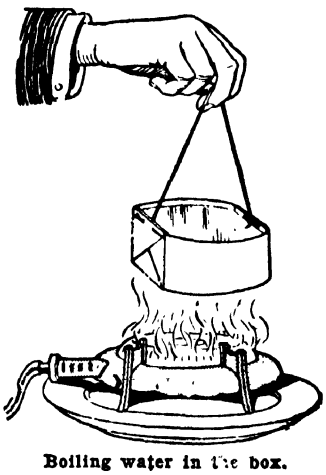
Making the box.



The box finished.

This curious property of water is called *refraction*. You will know more about this property of water when you begin to study the subject which we call *physics*.

Another experiment shows yet another curious thing. To talk about a paper saucepan seems absurd, but it is not so ridiculous as it sounds. We can really make water boil in a paper saucepan without much difficulty. First, we must make the saucepan. Take a piece of paper—ordinary writing paper will do. Fold it over something of square or oblong shape, as seen in the first picture on this page. Put a pin through the folds at the sides, as seen in the next picture, to make the box keep its shape. Now put a thin piece of string around the parts of the two pins inside the box, and hang up the paper box on something, or hold it in your hand. Pour some water into the paper box until it is almost full. Do it very gently, so as not to break the paper box. Put a lamp, a candle, or a gas-flame under the box. The



Boiling water in the box.

paper will not burn, but the water will get hotter and hotter until it boils. This result is caused by the water, which will not allow the paper to retain the heat, but draws it to itself. This effect is due to what is called *radiation*. Instead of getting hotter and hotter until it burns, the paper gives its heat to the water, which gets hotter and hotter until it boils.

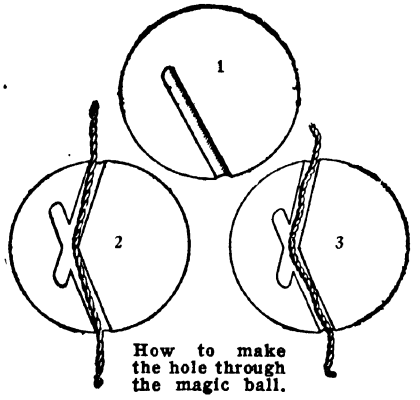
Another piece of magic is connected with a glass of water, a needle and some tissue paper. Fill the glass up to the top with water, and on the water place a piece of tissue paper ¼ inch wide and of the same length as the needle. Very gently drop the needle upon the paper. After a moment or two take a pencil and very carefully push the paper down toward the bottom of the glass. If you have pushed slowly, you will find that the needle is left floating on the surface of the water! The explanation is that the molecules of the water surface cling together. The paper sinks, but the clinging molecules support the needle.

The mysteries of magicians may be explained, as we shall show you in other chapters of this book. The mysteries of nature are more baffling, but such experiments as the above show us how they, too, may be solved.

THE BALL THAT ANSWERS QUESTIONS

ONE of the most interesting toys is a ball that seems to count and answer questions. To people who do not know the secret of its manufacture it is very mysterious; and any boy can derive much amusement by making one, and showing it to his friends after he has practiced with it a few times and become expert in its use.

First, we get a wooden ball, of any size we like, but not too tiny. A croquet-ball



How to make the hole through the magic ball.

will do nicely, or one about the size of a golf-ball; but, whatever size it may be, it had better be of wood.

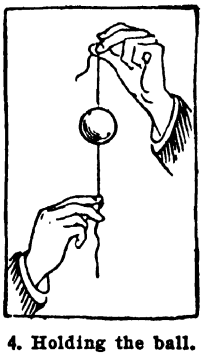
The first thing to do is to mark upon the outside of the ball two points exactly opposite each other. In most wooden balls we find two centre-points that the wood-turner has used when making the ball. Then we use a gimlet, and make a hole in the ball, but *not* in a straight line toward the other point. Picture 1 shows how the hole is made; it is not through the centre of the ball, but to one side. The hole is not made to go right through the ball, but it must go more than halfway.

Now we bore another hole from the opposite point. This is the only difficult part, for the second hole must be made so that it goes right into the first hole, and the result is that we have a continuous hole right through the ball, but not in a straight line. Pictures 2 and 3 show how the hole would look if we were to cut the ball right through the middle. Remember, however, that we are not actually going to cut the ball through the middle. The pictures are only to help us to make the hole properly; they present what is known as a cross-section view. Views of this type are valuable in showing clearly the construction of a variety of objects, and how they work.

Now we pull a string—any kind of fairly strong cord or twine will do—through the hole from side to side, and after doing so we had better put something—say, a button—on each end of the string, to prevent it from slipping out of the hole. Now, if we hold up the ball as the boy in picture 4 is doing, pulling the string tightly as we do so, we find that the ball remains fast at any part of the string we like. Let the string loose just a little, and the ball begins to slip down. If you pull on it tight again, the ball will come to rest again as if by magic.

Now we can ask the ball questions. Hold the string tightly, with the ball at the top of it. "Ball, how many do 2 and 3 make?" we ask; and, for reply, the ball takes 5 short steps down the string. Of course, we are making it do so by making it tight and loose as we wish. Then we say: "Ball, I am going to ask you some questions. If you mean yes, move once; if you mean no, move twice." We can ask any questions we like, and the ball can always answer them if we are allowed to hold it up by the string. A little practice will enable us to move the ball without anyone's detecting how we do it.

If the ball is large, a long string may be used. One end should be held in the right hand and the right arm is stretched


4. Holding the ball.

at full length from the side. The other end can be held under the foot. It is a good idea to start the ball a couple of times near the hand and let it slide freely down the string. Then suddenly say "Stop" and pull the string. The magic ball, of course, will stop. After a moment or two you say: "You may go now," and the ball will continue on its journey down the string. There is no end to the fun you will have with the ball.

KNOTTY PROBLEMS TO SOLVE

THE problems given below may be performed with burnt matches or toothpicks, which should be of the same length and the same thickness. The great advantage of problems such as these is that they may be performed with material which everybody has on hand. No special equipment is necessary. On rainy afternoons or at parties such problems will supply just the right entertainment.

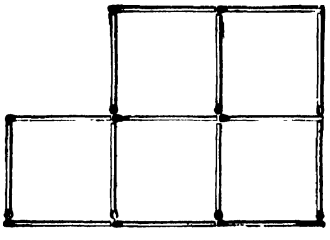
1. Take 11 burnt matches or toothpicks and place them so as to make 9 of them.

2. Arrange 15 sticks so as to form 5 squares of equal size as seen in picture 1, and then remove three sticks so as to leave only 3 instead of the 5 squares.

3. Take 9 sticks and place them so as to make 3 dozen of them.

4. Take 3 sticks and place them so as to make 4 of them.

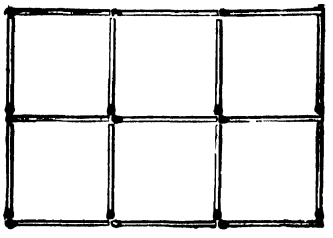
5. Place 3 sticks in such a position that they will make 6.



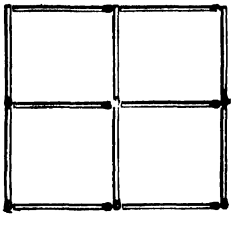
1.

6. Arrange 17 sticks on the table so as to make 6 squares as shown in picture 2, and then by taking away 5 sticks, leave 3 squares only.

7. Arrange 12 sticks on the table so as to make 4 squares as shown in picture 3; then after removing 4 sticks place them so as to make 3 squares of the same size as the first squares.



2.



3.

8. Arrange 17 sticks on the table so as to form 6 squares as shown in picture 2, and then take away 6 sticks so as to leave only 2 squares remaining.

These problems may look simple, but you will find that it takes a little thought to find the correct solutions. Anyone who solves the problems will not find it difficult to think up other and similar ones with which to puzzle his friends.

THE ANSWERS TO THESE PROBLEMS WILL BE FOUND ON PAGE 752.

SUGGESTIONS FOR YOUNG MECHANICS

THE practical suggestions which are given on this and later pages are intended to aid you in taking better care of your tools and in doing your work more easily and quickly. Remember that your tools must be well cared for if the best results are to be had. You cannot do your best work if your tools are dull, broken or rusty.

How to Remove and Prevent Rust. The following method has been found highly satisfactory for removing any rust from the iron and steel surfaces of your tools: First cover the metal with sweet oil, rub it well, and allow it to stand for over a day. Then cover it with another coat of oil which should be applied freely with a piece of cotton-wool or cloth after the steel has been rubbed. Next rub with unslaked lime which has first been reduced to as fine a powder as possible. If the rust has not been entirely removed, this process should be repeated.

One method of keeping tools from rusting is to take ½ ounce of camphor and dissolve it in 1 pound of melted lard. Then take off the scum and mix in as much fine black lead (graphite) as is needed to give it an iron

color. Now clean the tools and cover with this mixture. After about a day rub the surface clean with a soft linen cloth. The tools should remain clean for months under ordinary use.

Another good method is to melt 2 ounces of tallow, or 6 ounces of lard, and 1 ounce of resin together. These should be strained while hot to remove the specks which are in the resin. Then apply a thin coat of the mixture on the tools with a brush.

A satisfactory method is to place 1 quart of freshly slaked lime, ½ pound of washing soda, and ½ pound of soft soap in a bath with sufficient water to cover the articles. Then put in the tools as soon as possible after they have been used. Either wipe them dry next morning, or allow them to remain until they are used again.

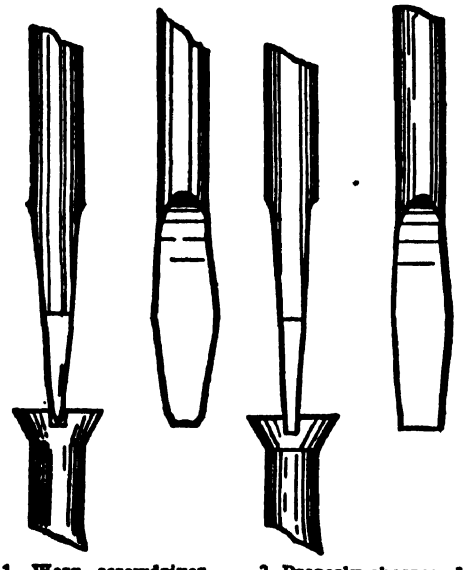
Still another method is to slake a piece of quicklime with just enough water to cause it to crumble in a covered dish. While hot add a little tallow to it and work into paste. Use this to cover over bright work. It may be easily wiped off when desired.

How to Mark Your Metal Tools. First, use either sandpaper or whetstone to clean off all rust, gum and dirt from the place where the letters are to be made. Then cover the metal with a thin coat of beeswax or tallow. Next, take a pencil or any sharp-pointed instrument and mark the letters through the wax, being careful to remove all of the wax from the bottom of the letters. Now make an etching fluid from equal parts of common salt, bluestone and water, and dip your pencil in the fluid to fill all the letters in the wax.

By the time you have finished your work the acid in the first letters will have done its work, so you may clean your tool to see what kind of job you have done. The acid should have etched out the letters in a clear-cut manner.

HOW TO RENEW THE EDGE OF YOUR SCREWDRIVER

WHEN the point or edge of a screwdriver is worn away, so that it jumps the nick in a screw, it is time to sharpen it again. This difficulty is caused by a section of your screwdriver which has the sides of the wedge worn so that they curve with the convex sides outward, as shown in picture 1. When the screwdriver is in this condition, it is certain to slip out of the nick in the screw. The best form is that shown in picture 2, where the sides of the wedge are straight or even curve with the concave side outward. To grind a screwdriver into this form it is necessary to use a very small grindstone.



1. Worn screwdriver with blunt edge. 2. Properly sharpened screwdriver.

Another way to sharpen a screwdriver is by filing, holding it in a vise with the bevel of the point lying in a horizontal position and projecting above the surface of the vise jaws. By using a medium flat file you may give a forward thrust and keep a horizontal position. Now turn the screwdriver over and repeat the operation until the edge becomes somewhat thin. Then file it down to a perfectly straight margin and regulate its width for the size that is required.

A screwdriver point should be neither too hard nor too soft. Use a file on the edge of the screwdriver; if the file refuses to take hold, the screwdriver edge is too hard; if it can be filed easily it is too soft. In either case it should be re-tempered.

The surest way to ruin a good screwdriver is to use it as a can-opener. But many people do this and then wonder what on earth the matter can be with their tool.

MAKE AND USE A SIMPLE BOOKLET

A USEFUL booklet may be made by folding a long strip of paper back and forth several times, vvvvv. It is interesting to note that the first booklets which man made with pages were constructed in this simple manner. A collection of pictures or drawings may be prepared for this little book. These may deal with one or more subjects. These pictures or drawings should be pasted into this book formed with the folded strip of paper. Care should be taken in placing each picture upon the folded page form. The name of the book may also be printed on the outside sheet, which may be made to serve as a cover, upon which you place the appropriate title. This suggested use for such a simple booklet is only one of the many which will occur to you.

Another easily made booklet is constructed by fastening together the pages (these may consist of regular sheets of paper 8½ inches by 11 inches or 5½ inches by 8½ inches) by means of punching and lacing. A satisfactory cover may be made from flexible paper. If a suitable cover design is added, this booklet will prove attractive as well as useful. The design may be drawn in India ink or it may be painted with water colors, according to the liking of the maker of the booklet. Care ought to be taken to choose matching colors if paints are used. The title should be "lettered" on.

A FAIRY FOUNTAIN EXPERIMENT

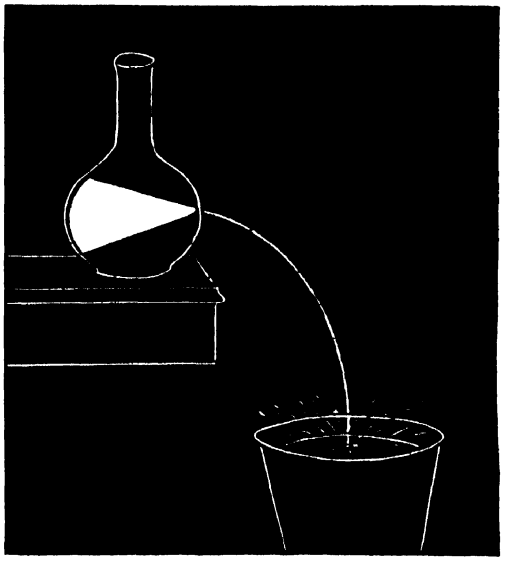
HERE is an interesting experiment which any boy or girl can try. It requires little in the way of apparatus and it produces a beautiful effect.

First take a good-sized water-bottle of clear glass, and carefully cut in the middle of the body of the bottle a round hole a quarter of an inch in diameter.

Now prepare a room for the experiment by covering a window with a black blind in which is cut a round hole 4½ inches in diameter. Through this hole the light can come, and the bottle is so placed that the sun's rays can pass through the bottle and out at the small hole, shining in a bright spot on the opposite wall of the room. Having placed the bottle in position, blacken with soot all the rest of the bottle through which the rays are not to pass.

Next place on the floor any large pail to catch the water pouring from the hole in the bottle. Now all is ready for the fairy fountain. The room, of course, is dark except for the light passing through the bottle and shining on the opposite wall.

Placing one finger tightly over the small hole in the bottle, pour from a jug which has been prepared, clean water into the bottle, filling it up to the neck. Now remove your finger, and a most extraordinary sight meets your gaze. The water pours from the hole in the bottle into the pail in a curve, but it looks not like water but like liquid light or fire, and the pail too seems to be filling with fire. At the same time the beam of light through the hole to the opposite wall has disappeared.



You will be fascinated as the water gets lower and lower in the bottle. Then suddenly the glorious curve of light is gone, and the beam shines once more straight upon the opposite wall, as it did before. The fairy liquid gold has disappeared.

What is the explanation of this amazing fact? It is simply that the light is imprisoned in the stream of water, and light and water flow out together in the same direction. The water acts as a kind of tube in which the rays of light that pass through the bottle are reflected from side to side so that many of these rays are unable to escape, and so are carried into the pail,

where the illumined water appears like liquid fire.

If you hold something in the way of the stream of water, so as to break the stream, the splashing water will look like sparks of fire. Still more beautiful effects may be obtained by placing between the bottle and the hole in the blind, as the water runs out, pieces of colored glass, red, blue, green and yellow, one after the other.

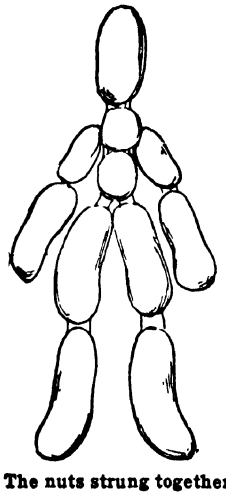
You can display your fairy fountain even during those times when sunlight is not available. A flashlight may be used to send a strong beam of light through the water in the flask to the small hole opposite from which the water pours.

To make the flow of water from the bottle more permanent, you may connect the bottle with a tap by means of a piece of hose, or if that is not possible, place a pail of water above the bottle and connect this with the bottle by means of a piece of piping or rubber tubing, forming a siphon. The effect is more startling the longer the golden liquid flows. Your audience will certainly suspect you of using magic.

A CHINAMAN MADE OF PEANUTS

DOLLS are sometimes made from the oddest kinds of materials—from rags of every description, from carved blocks of wood, even from fruits and nuts! For example, you can make a fetching Chinese doll out of peanuts and a few odds and ends.

The doll shown on this page is made from eleven peanuts threaded together. By looking at the first picture you will see how the peanuts have been chosen—a large one for the head, two smaller and two larger ones for the body, two more for the upper part of the arms, with a larger one below each to complete them, and two long, curved nuts for lower parts of legs and feet. String them together with strong cotton, as shown in the picture; then draw the face with a black lead pencil or in ink, giving the eyelashes a slanting line to make them look like a Chinaman's.



The nuts strung together.

Take three pieces of black wool and braid them together; this will form the hair, which you can stick with glue at the top of the head, or fix by means of the strong cotton used to thread the peanuts. To dress this doll, make a little pair of trousers with two square pieces of bright-colored material; hem each piece on one side, and join halfway at the back; then join the two together. Tie the trousers around the waist.

The smock is made in the shape of a little sack, simply drawn in at the neck. Two very wide sleeves are next made, each one like a small bag, sewn on the smock quite close to the neck. When choosing the materials for these Chinese dolls, it is better to secure bright reds, blues and yellows, as these give the prettiest effects.

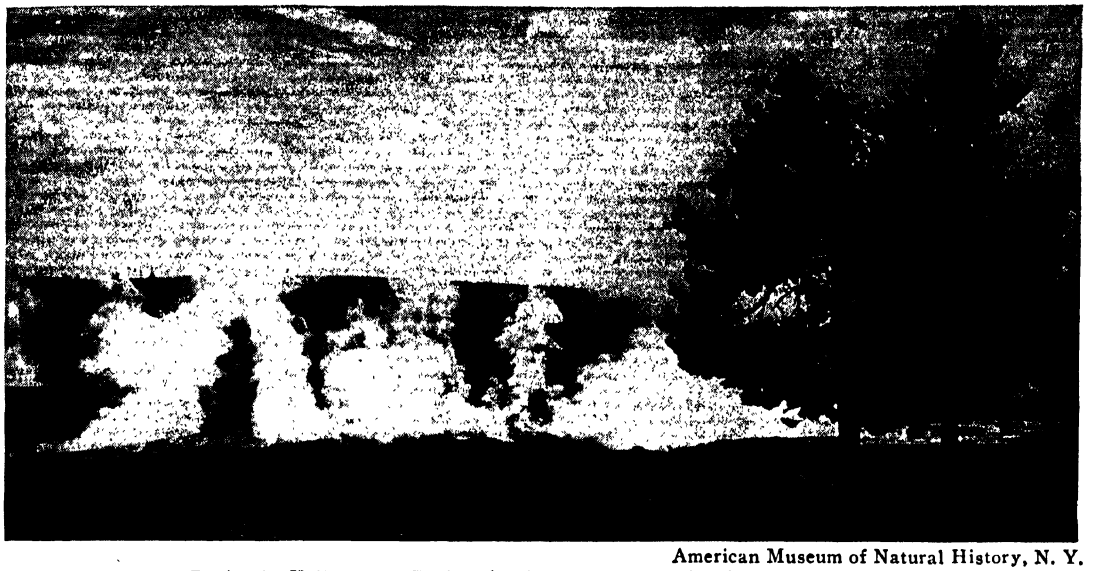
The hat looks very nice made out of two round pieces of cardboard, covered with silk, and joined together with a little silk cord overstitched all round. It is kept in place with a colored glass-headed pin stuck right through the head.

The black lines seen on the smock can either be made by putting a little braid round the bottom and at the edge of the sleeves, or by working on it some fancy feather-stitching. If you will paint in the shoes with a little black paint or India ink, it will give the Chinaman a good "finish."

The Chinaman's costume.

If you think that your Chinaman will be lonesome all by himself, you can easily make a wife for him. She is made almost exactly like her husband. Her smock should be a little longer than his, and more wool should be glued on her head. A wee Chinese baby can be made out of a single peanut of good size. All that has to be done is to draw the face; then wrap the doll in a tiny square of cloth.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 749.



American Museum of Natural History, N. Y.

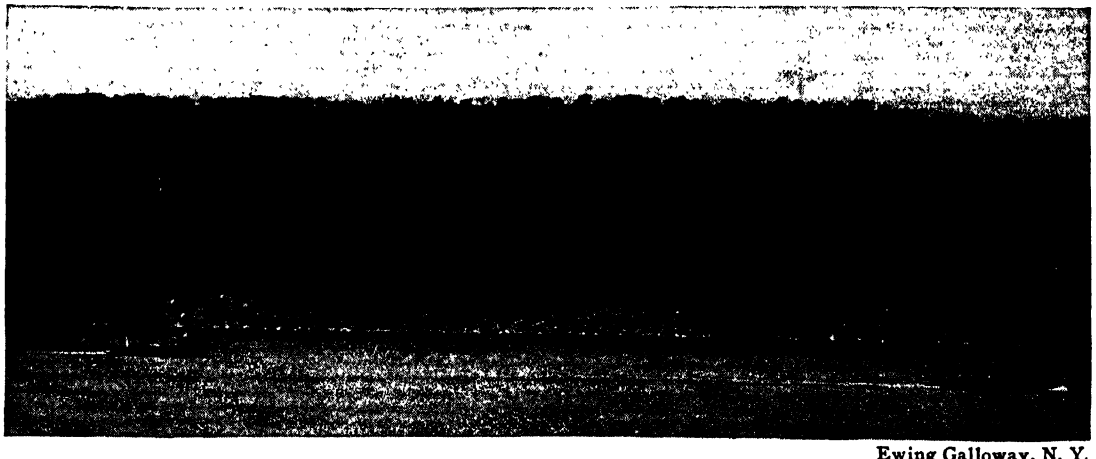
The Norris Geyser Basin, in Yellowstone Park, with its geysers spouting heated water and steam. Underneath geyser basins there is a huge body of hot rock, which keeps renewing the heat spent at the surface.

THE EARTH'S ROCK SKELETON

IN earlier chapters we spoke about areas of the earth's crust rising and falling, about mountains growing and being worn away, and about land where seas once were. All of these changes and all of the processes responsible for the appearance of the land as we now find it are part of the science of geology.

As the earth cooled it formed a crust, sealing down below the high temperatures of molten rock, and compressing the lower rocks so that they can not be considered truly liquid. Yet all igneous (fiery) activity did not come to an end. We know that when we see the volcanoes which form when some of the internal energy leaks to the surface. There are also many examples of magma rising, or intruding, into the rocks of the crust and never reaching the surface.

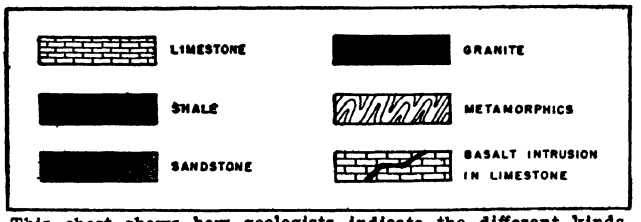
Yellowstone Park is thought to overlie a tremendous intrusion of igneous rock which worked its way up near the surface, but broke through only in one small area. There



Ewing Galloway, N. Y.

The Palisades, a rocky cliff that extends for about fifteen miles along the right bank of the Hudson River. This famous cliff was formed by the intrusion of igneous (fiery) rock between layers of sandstone and shale.

it gave birth to rhyolite lava flows, in which, today, we see the geyser basins. The activity which has continued there for so many years, despite all the water and all the cooling, can only be explained on the basis that underneath is a tremendous body of hot rock which keeps on renewing the heat spent at the surface.



This chart shows how geologists indicate the different kinds of rock. By consulting this chart you will be able to identify the rocks shown in the diagrams in this article.

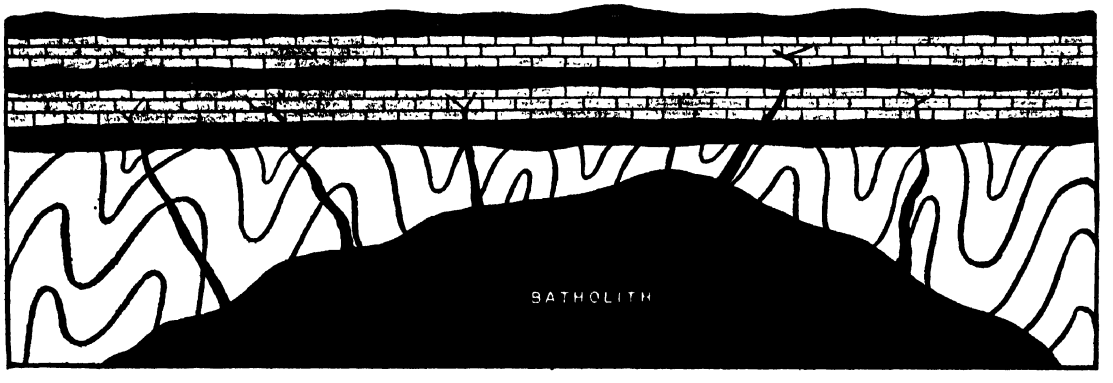
Such a large body of intruded magma, which may lie at the roots of mountains, is known as a batholith. No one knows how deep such batholiths go. We have had a chance to observe such bodies a mile thick—where top layers of rock have been worn away. But the rock type shows little change in all that thickness. Batholiths probably extend downward for miles. The magma apparently eats its way into the lowest rocks of a folded trough and cuts across all formations, making an elongated mass many miles across and stretched out parallel to the mountain range. These magma intrusions can be seen later, through exposure to the surface by wearing away of the overlying sediments.

Smaller intrusions of igneous rock also occur. If they are masses resembling batholiths but on a smaller scale, they are known as stocks. Still smaller masses are called volcanic necks or plugs. In the Henry Mountains in Utah there is a very interesting type of intrusive magma which arches up the overlying beds and forms what have been called laccoliths. Sometimes, as in the Palisades across from New York City, the intrusion may spread out between two beds and make an intrusive sheet or sill.

Later erosion has since removed the sedimentary bed that lay on top of that broad sheet which forms the Palisades. Because of this, many people today mistakenly think of the sheet as a lava flow. The jointing effect, which gives the Palisades the appearance of columns, is typical of such sheets. They cool, and as they grow solid they shrink, first at the top and bottom. The shrinkage cracks radiate and merge, to make six-sided columns. Many years later, when the bed on top has worn away and the sheet is exposed to the air, the cracks become the lines along which the cliff crumbles. And so the columns stand forth.

Similar sheets and still smaller ones cutting across the bedding of the rocks make dikes. Basaltic dikes are common wherever igneous rock are quarried. Dikes cut through granite, sometimes in several generations, with dikes cutting dikes, and being cut in turn by other dikes. Sometimes we see such dikes in sedimentary rocks as well; and since they are often harder than the surrounding sediments, they stand up as ridges when the other rocks wear away. The famous Falls of Yellowstone are caused by such a hard dike cutting vertically through the soft decomposed rhyolites in which the colorful Yellowstone Canyon has been cut.

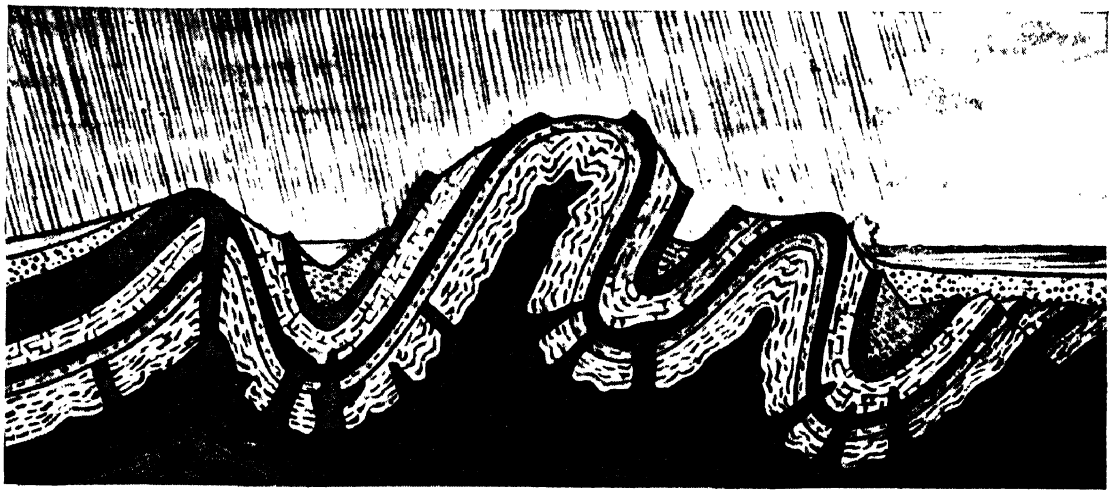
Sedimentary rocks, too, have interesting structures for the geologist to study and for the traveler to note. Of course, sedimentary beds are laid down horizontally, but in the course of crustal movements they are moved



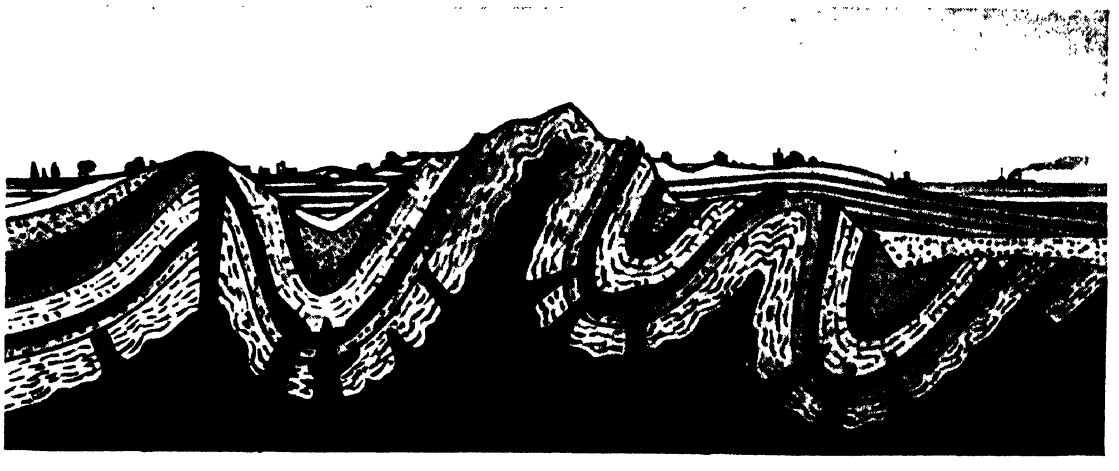
This batholith, or large body of molten rock material, lies at a considerable distance beneath the surface, and it may extend downward for miles. An old batholith may be seen if the overlying layers are worn away.

CRUMPLING AND WEARING OF THE EARTH

The great crumples and folds in the early crust of the earth, with molten igneous rock forced into them.

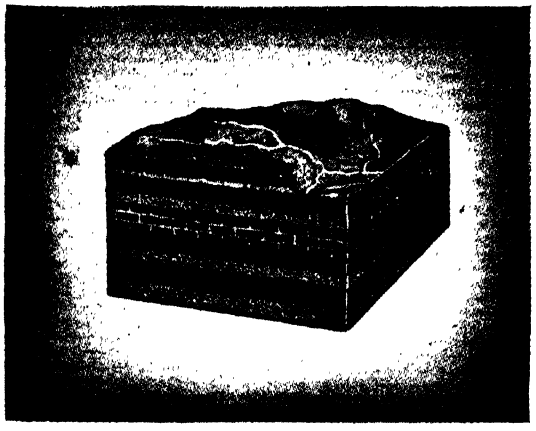


Many years later. Rain, rivers, frost and wind have worn down the tops and partly filled in the folds.

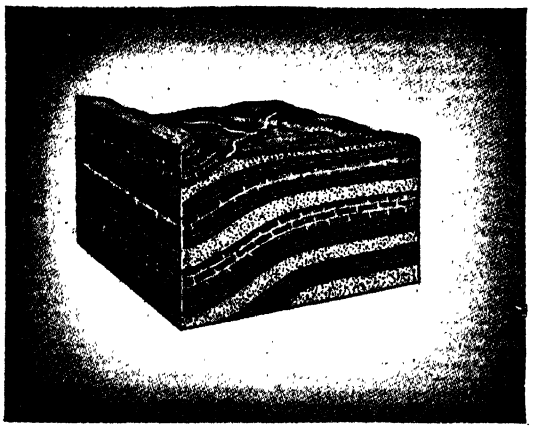


The folds in modern times. The tops are still more worn down. Sea and soil have covered most of them.

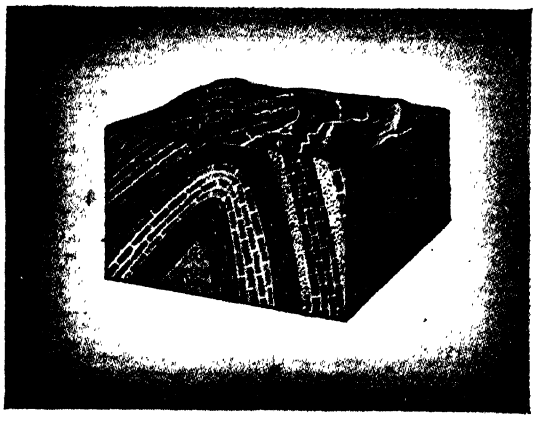
HOW MOUNTAIN RANGES ARE FORMED



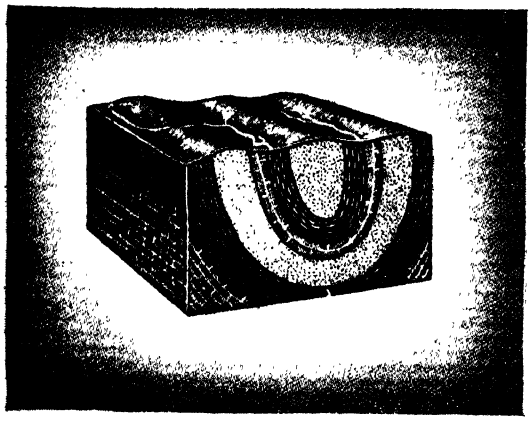
Mountains are formed by folding of the rocky layers.



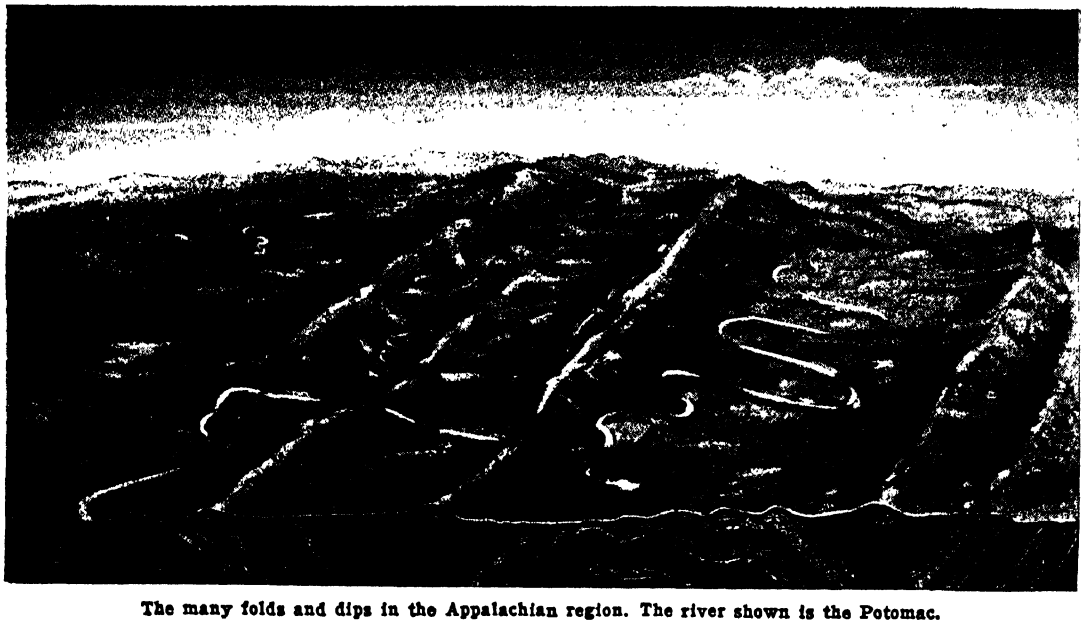
Monocline, a simple dip in the layers.



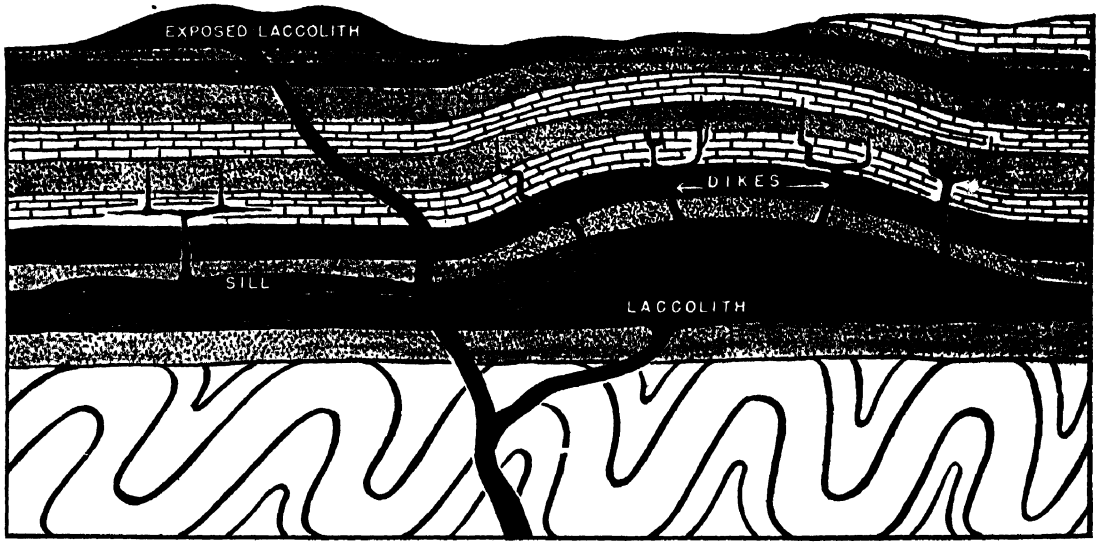
Anticline, or upward arch of rocky layers.



Syncline, or downward arch of rocky layers.



The many folds and dips in the Appalachian region. The river shown is the Potomac.



This diagram shows a laccolith at work. A laccolith is a mass of molten rock material that makes its way between beds of sedimentary rock, spreads out and then arches upward. As it does so, it makes the upper layers of rock bulge in the form of a dome. Note that a part of the laccolith has made its way to the surface.

from that position far more often than not. The amount of disturbance may vary from a slight tilting or arching all the way to a tight folding, such as one may see in the Appalachians or the Alps. The folding in the Alps is believed to have shortened the earth's crust by scores of miles. According to some geologists, 400 to 750 miles of land are now compressed into less than 100. This compression has resulted in extremely complex types of folding and breaking. Older beds have been thrust over younger beds, and sequences may be repeated several times in one vertical section.

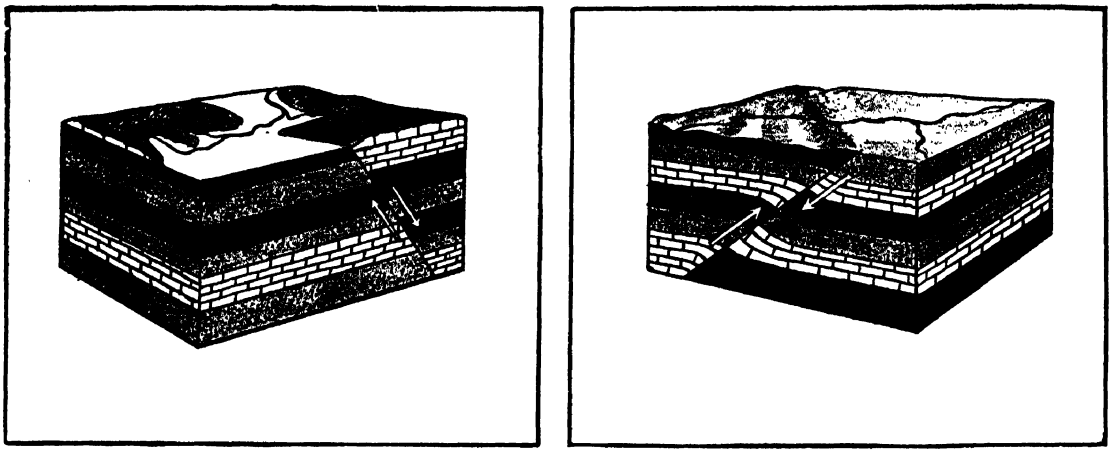
However, the Alps are a special case and nowhere else do we find quite such complexity. A cross section through the Appalachians shows a beautiful series of upward and downward arches, known as anticlines and synclines. This structure is seen in the lay of the land, even though the whole Appalachian mass may have been raised as a long dome. The topography is caused by the presence of harder and softer beds and by erosion which has brought out the underlying structure. Elsewhere we find more open anticlines and synclines; sometimes they are not evident on the surface.

Sedimentary-rock structures are very important to the economic geologist, since they are responsible for gas and oil pools. Both of these valuable sedimentary deposits are often found in the crest of a porous sedimentary bed underlying an impervious shale in an anticline.

Sometimes movements of the crust are more local and concentrated. They may cause an actual fracture of the rocks, and a differential (unmatching) movement on either side of the break. These are known as faults, and are most easily seen in the sedimentary beds, where a series on one side of the fault may be displaced in relation to the series across the fault. (That is, the rock-pattern along a seam does not "match up.") When the fault is inclined (slanting), the upper surface is known as the hanging wall, and the lower surface as the foot wall. If the fault were an open fissure, or crack, the meaning of these old mining terms would be clear.

When the movement on the fault is a downward dropping along the hanging wall, it is called a normal fault. If the movement is upward on the hanging wall it is a reverse fault. Sometimes the fault line may be nearly horizontal. Then underlying beds may be thrust up on top of much younger beds, just as Chief Mountain, near Glacier National Park, has, at its base, geologically ancient beds which rest on top of the recent Cretaceous series. This mass, since eroded into an isolated peak, was pushed at least seven miles by a famous fault known as the Lewis Thrust Fault, a break which must have occurred toward the end of the Cretaceous period. We shall learn more later about the periods on geology's time clock. See also the top picture on page 513.

Faulting can be of great importance in mining, for a break may occur in an ore



These diagrams show faults in rock structure. As the result of a break the various layers do not "match up."

body, cutting it off as sharply as if cut by a knife. Then the owners must call in the geologist and have him try to work out the direction and total amount of movement along the fault, in order to find their ore body again. Sometimes this is easy, sometimes very difficult. And if you add several later intersecting faults to the original fault, you can see what a problem in practical solid geometry the geologist has who wishes to work on rock structures.

By FREDERICK POUGH.

SOME WORDS WE USE IN SPEAKING OF THE EARTH'S ROCK SKELETON

Batholith—a large, irregular area in the earth's upper crust, into which hot magma from deep layers has leaked up (intruded).

Laccolith—a kind of batholith where the hot magma has spread out and arches upward, lifting upper layers in dome shapes.

Intrusive sheet, or sill—laccolith where the hot magma has forced its way between two layers of sedimentary rock and spread out.

Palisades—columns which formed by the way in which an intrusive sheet cooled and hardened. Palisades are laid bare when the overlying layer of sedimentary rock has worn away.

Dikes—intrusive sheets that cut across rock layers. Dikes also cut across each other.

Stock—a small batholith.

Volcanic neck, or plug—a still smaller batholith.

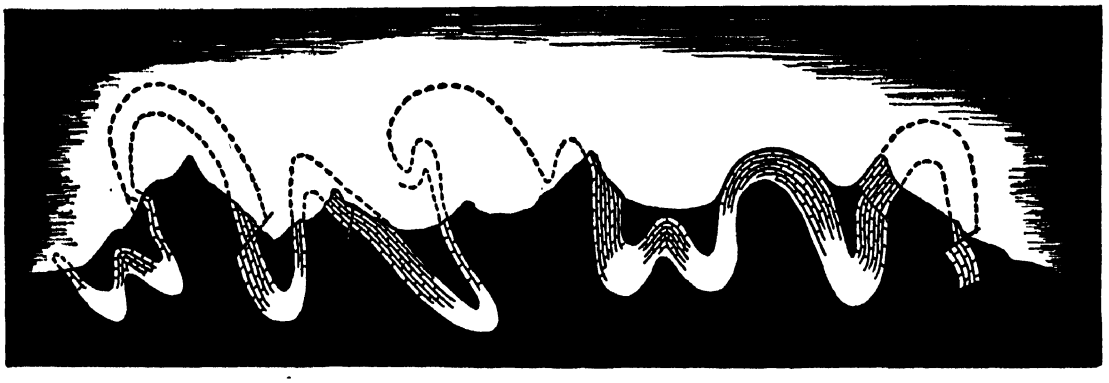
Sequence—pattern, or order, of rock beds.

Anticline—an upward arch of the rock layers, caused by folding.

Syncline—a downward arch of the rock layers caused by folding.

Fault—a break, or crack, in the crust, caused by movement, resulting in an unmatched layer on either side of the crack.

THE NEXT STORY OF THE EARTH IS ON PAGE 773.



A cross section of the Alps. These mountains are a result of the folding and breaking of the earth's crust.

BY-PRODUCTS

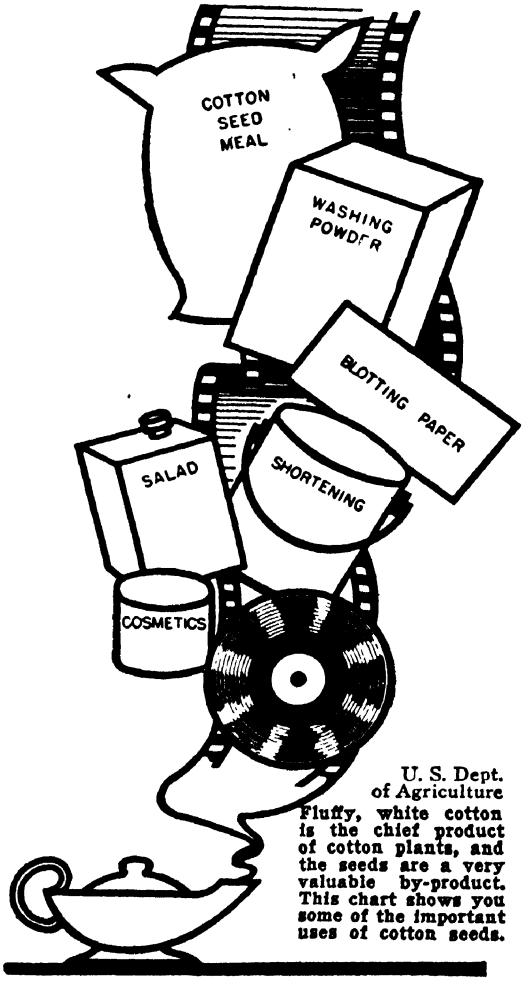
THINGS THAT WERE ONCE THROWN AWAY

YOU know how useful gasoline is. We need it to run our automobiles, airplanes and other vehicles; and it serves us in other ways, in cleaning clothes, for example. Such quantities of gasoline were needed to drive planes and military cars in the war that we at home could buy only a small amount each month. Yet this precious fluid once was thrown away.

You know, of course, that we get most of our gasoline from a crude oily fluid called petroleum (rock oil) which is found in places in the earth's rocky layers, and brought up by drilling. Men learned how to take from the petroleum an oil called kerosene, which they burned in lamps to light their buildings. The remainder of the petroleum, left after the kerosene was taken, used to be run off in ditches, as there seemed to be no use for it. It does not seem strange to us now that fires have broken out from time to time in the neighborhood of the oil refineries for we know how very dangerous gasoline is when exposed to air. At that time, however, the exact cause of the fires was not known, although it seemed that this waste material might have something to do with it, and laws were made to prevent the dumping of the waste in the open. Not long after, scientists discovered ways of using the waste material which we know as gasoline; and today it is used far more than kerosene.

A substance, such as gasoline, that is obtained in addition to one already being produced is called a by-product. You come in contact daily with many by-products, and it has often been found, as in the case of gasoline, that the by-product becomes much more important than the original product.

Years ago in the canning factories where tomatoes were canned, most of the juice was thrown away as only a small portion could be put into the cans with the tomatoes. Then someone discovered that tomatoes contain vitamin C, which is necessary in our diet; and it was decided that the valuable juice should be bottled. The same thing happened in the case of sauerkraut juice, although it is not used to so great an extent as tomato juice. Pineapple juice is also a by-product.



U. S. Dept. of Agriculture
Fluffy, white cotton is the chief product of cotton plants, and the seeds are a very valuable by-product. This chart shows you some of the important uses of cotton seeds.

Other examples of by-products can be found at your table and, in fact, everywhere about you. Much of the leather from which shoes and gloves are made comes from the hides of cattle or pigs, and these hides are a by-product of the meat-packing industry. The buttons on your coat, as well as the glue you use, may have been made from the horns or hoofs of these animals. Your hairbrush and your toothbrush may have been made from pig bristles, and your soap from animal fat.

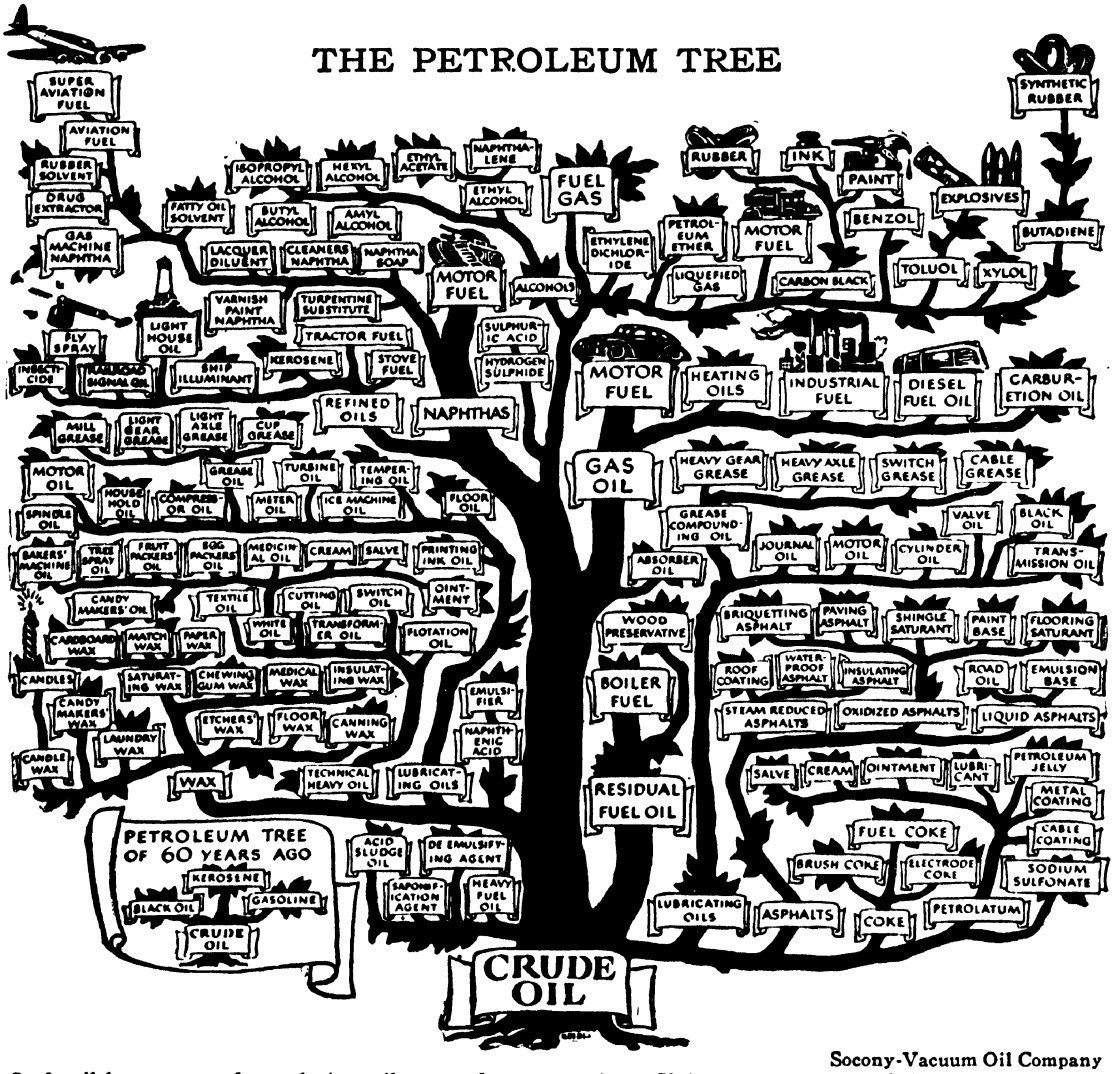
These are a few of the many by-products from the great slaughterhouses where cattle, sheep and hogs are killed principally for their meat, which is packed and shipped to all parts of the world. It is claimed that some use is found for every part of a pig but the

squeal, and, as you will see, this is really true.

When animals are killed, the blood is caught immediately, and some of it is taken for the preparation of blood sausage, which is a great favorite with many people. Some is used also in making blood puddings. The rest of the blood is dried, then made into blood meal, a nourishing food for livestock and poultry.

The hides of animals are sold to leather-goods manufacturers, who make them into all kinds of leather articles. But first the hair is carefully removed from the hide, for the hair has many important uses too. The mattress on which you sleep, the upholstered furniture in the living room and the cushions of the automobile may have for stuffing some of the hair from cattle. The hair from horses is considered particularly fine and is, therefore, used in high-grade mattresses. The very delicate hairs inside the ears of some animals make paint brushes for the use of artists, while the bristles from pigs make high-grade hairbrushes and other brushes of many kinds. Hairs not suitable for the purposes mentioned may be mixed with plaster and mortar as a binder. Perhaps you have noticed it on the walls of a house that is just being built. Coarse hairs are a useful addition to some kinds of fertilizing mixtures.

The excess fat from hogs is removed and the best is made into lard and lard com-



Socony-Vacuum Oil Company

Crude oil has as many by-products as there are leaves on a tree. Sixty years ago, most of them were unknown.

pounds. The best of the fat from beef is used in making oleomargarine and other butter substitutes. Poorer grades of fat are useful for the purpose of tanning hides and in the manufacture of soap. Tinted soaps of green, blue, yellow, lavender or pink that match so well the color of your bathroom are, some of them, made from animal fat as well as those soaps used in the kitchen and in the laundry. Many soaps are made from vegetable oils. Soap chips and soap flakes, cleaning powders and liquid soaps often use animal fat.

TALLOW AND SOME OTHER ANIMAL FATS

Fat from sheep and some of that from beef is taken for tallow, the best of which is manufactured into candles, while low-grade tallow becomes axle grease and lubricating oil. The remainder of the fat is worked into poultry feed and also into fertilizer.

There is a fat around the kidneys, which is carefully removed and then pressed, for it, too, contains oleo oil, used in making oleomargarine. But what is most remarkable, the hard mass, left after the oil has been taken out, is used in making cheap candies and chewing gum.

BY-PRODUCTS GIVE YOU MARSHMALLOWS, GELATINE, JUNKET AND CHEESE

You would find at slaughterhouses that certain parts of the animals which are not good as food themselves can be made into substances that are useful in the preparation of foods. For instance, rennet, which is obtained from the stomach of a calf, becomes an important ingredient in the manufacture of cheese, and another form of it is in the custard-like dessert you know as junket. From certain portions of the hides, bones, hoofs and other parts of animals, a gelatinous substance is made which, after many refining and cleansing processes, comes to you as the gelatine you eat in desserts, in salads, in ice cream and in some candy, such as marshmallows. It is also used in photography, in dyeing and in paper-making, to name a few other uses.

From the intestines of sheep are obtained the thin delicate casings which form the outer cover for sausages, bolognas and various cold meats. Catgut, which the doctor may use when he has to put stitches in a cut, does not come from the cat at all but from the intestines of sheep. It is also used for strings on violins and other stringed instruments, and on the heads of tennis rackets.

Other important by-products of the meat-packing industry are the medicines which modern science has found, or made, from animal parts and which help to make us well when we need them. Pepsin, found in the stomach of pigs, is an aid in digestive troubles, and is heard of, too, as an ingredient of chewing gum. Insulin, a substance secreted by the pancreas, is used in the treatment of diabetes, while extracts from other glands, such as the lymphatic, thyroid and spleen, are helpful in cases of gland diseases and other ailments.

From the sheep's wool, there is obtained a greasy substance called lanolin, which has been found valuable as a base for ointments, and it is also used in making face creams. There are also other greases obtained which are especially important in making salves and ointments.

ANIMAL BONES HAVE MANY USES, FROM BUTTONS TO BONE MEAL

The bones of animals, which at one time were not considered of any value, are now used to make buttons, knife handles, toothbrush handles and similar articles. Some bones are taken for the manufacture of glue and some are made into food for livestock and poultry. Bones heated in a vacuum become bone black or bone charcoal, useful in the refining of sugar. The rest are ground and made into fertilizing material that comes to your home as powder to be sprinkled on the garden or in the fields.

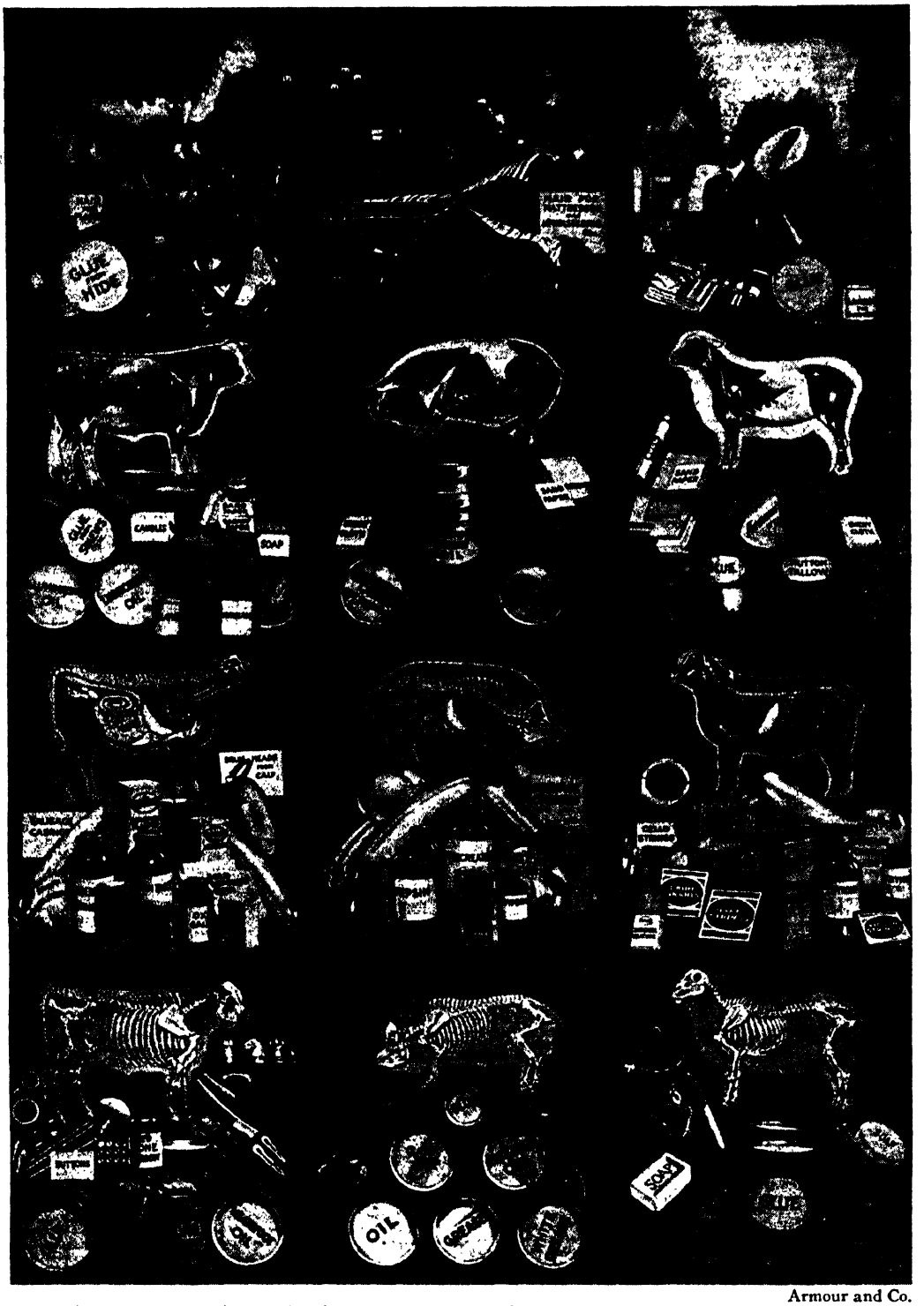
The horns and hoofs of animals are important, too. They are made into high-grade buttons, umbrella and knife handles, toilet goods and other fancy articles of that sort, while certain parts are used in making glue. What remains, after these by-products are taken out, is combined with other ingredients and made into fertilizer.

IN THE MEAT-PACKING INDUSTRY, EVEN THE SCRAPS ARE USEFUL

Even the blood and scraps that accumulate on the floor during the day have a use. They are washed up carefully and this liquid, or "stick," as it is called, is put through various processes that produce ammonia and other elements used in fertilizing material. Thus, plants, too, benefit from meat-packing by-products.

In fish canneries and in large fish markets, as in slaughterhouses, very little is allowed to go to waste. Formerly fish scraps were thrown away, and there was a considerable waste, especially when filet of haddock, filet of flounder or filet of sole was prepared, as these are specially choice cuts from the fish. Now the waste parts are ground into fish flour which is used in making crackers, and which

BY-PRODUCTS FROM ANIMALS YOU KNOW



Armour and Co.

Cattle, hogs and sheep give us delicious meat as well as by-products of great value. The top row shows by-products made from the outer parts of these animals, including leather goods, bristle brushes and warm woolen clothes. The second row shows how animal fats, sinews and other parts are used. The third row shows things made from the animal's inner parts. Even the skeletons serve mankind, as the bottom row makes clear.

you may have had as fish flavoring in soups and chowders. Bones and other waste parts of the fish are dried and ground, then made into food for poultry, or into fertilizer.

CASEIN—THE WONDER-WORKER FOUND IN SKIM MILK

Milk, too, has several by-products. After the butterfat has been removed, one of the principal substances left in the skim milk is casein. Casein has been adapted commercially in a number of interesting ways. One market is the paper mill where it is made into a coating or finish to give a glossy surface to some kinds of paper. It serves also as a finish for leather and for certain textiles. Casein has strong adhesive properties and when made into glue or cement is utilized by cabinet-makers and wood-workers for gluing wood. Parts of ships and parts of airplanes are stuck together with this by-product of milk. Casein buttons and casein paints are well known. Cloth resembling wool, and warm, is made from casein; and felt hats are also manufactured from it.

Modern science has discovered many by-products in the coal-and-gas industry, and they are sometimes shown by drawing a large tree, the branches and twigs of which represent its by-products. It is said that they are about two hundred in number.

In the manufacture of gas from coal, many substances, which would make the gas unpleasant or dangerous to use, have great value and are removed for both reasons. Ammonia, sulphur, benzene or benzol, cyanogen, a highly poisonous gas, and tar are some of the substances removed. All of these are important, for other by-products are obtained from them, but coal tar is the most wonderful of all.

YOUR MEDICINE MAY COME FROM COAL TAR

Coal tar is a thick, oily, black liquid with a disagreeable odor, which used to be burned under the furnaces to produce heat, but chemists have been able to get from it about two hundred substances of great importance in industry and in medicine. The tar is distilled in great retorts; and as the heat is increased various substances come off in the form of gases, and after they are condensed they are again distilled.

Benzene, toluene and naphtha are among the first to be obtained. Some benzene is used in dry cleaning, but more often benzene or gasoline obtained from petroleum are used for this purpose. Benzene is useful in the paint-and-varnish industry and as a solvent for rubber and resins. More amazing still, it is used as a base for coal-tar dyes by which we get the lovely soft shades of red, blue or green that color fabrics for upholstery and the brilliant shades that color ribbons and textiles from which dresses, scarfs and other things are made. Coal-tar dyes are very important to the dyeing industry. Their colors are cheaper and some are more lasting than most vegetable dyes, and it is possible to obtain many more tints and shades of any one color than were ever produced before. Some of the coal-tar dyes are called aniline dyes.

FLOWER-LIKE PERFUMES THAT HAVE A STRANGE SOURCE

It is very difficult to believe that a substance having a rather disagreeable odor, from which dyes and cleaning fluids are obtained, could possibly be used in the making of perfumes. Nevertheless, it is true that many of the sweet-smelling flower odors or other delicate scents which you may like to put on your handkerchief have been made from benzene. Scientists have discovered ways of using it to imitate the flower odors almost exactly. Benzene is also used in the manufacture of drugs. Some of our most important medicines are obtained from it.

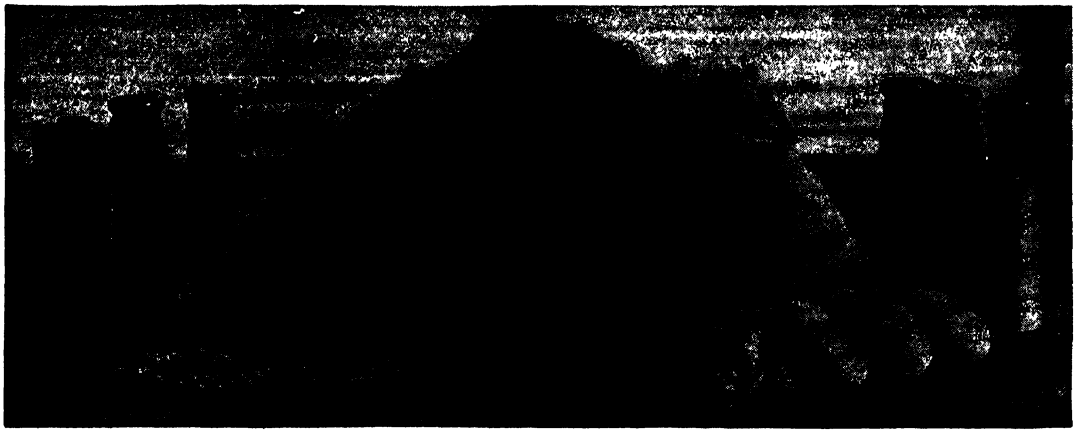
TNT. ITS FULL NAME IS TRINITROTOLUENE

Along with benzene, toluene is obtained. While toluene furnishes some dyes, the main uses seem to be quite unlike those of benzene. Toluene is made into the high explosive TNT.

Scientists did not stop even after they had found all these valuable by-products from coal-gas. The light oils obtained in addition to the crude naphtha from the first distillation of the coal tar are heated to still higher temperatures, and from this distillation is obtained carbolic oil from which carbolic acid is made. This is one of the most valuable disinfectants. Separating from the carbolic oil as a white crystalline mass is a substance known as naphthalene, which you may know in the form of moth balls and disinfectants. It is also used in the preparation of dyes and medicines.

Still other by-products obtained by distillation at a high temperature are creosote oil used in preserving lumber, and as a base for materials that destroy bugs, and anthracene oil from which are made certain kinds of valuable and high-priced dyes.

After all the distillation has taken place, there is left a dark heavy mass, which is known as pitch. Even this is valuable as it

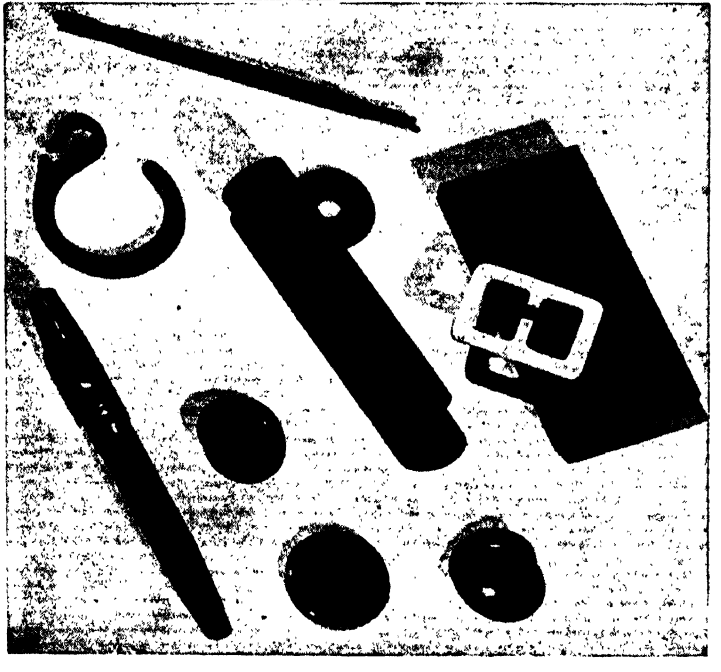


These spools of thread and other fibers are made of casein, which is the chief ingredient of skim milk. Casein fibers can be woven into a warm cloth resembling wool. Doesn't it seem odd that cheese is made of casein too?

A skim-milk skirt. One manufacturer of casein fibers calls his fleecy product aralac.

Courtesy, Borden Company

Skim milk again! This time we see it in the form of casein plastics, made into a pen, buttons, buckles and other things.

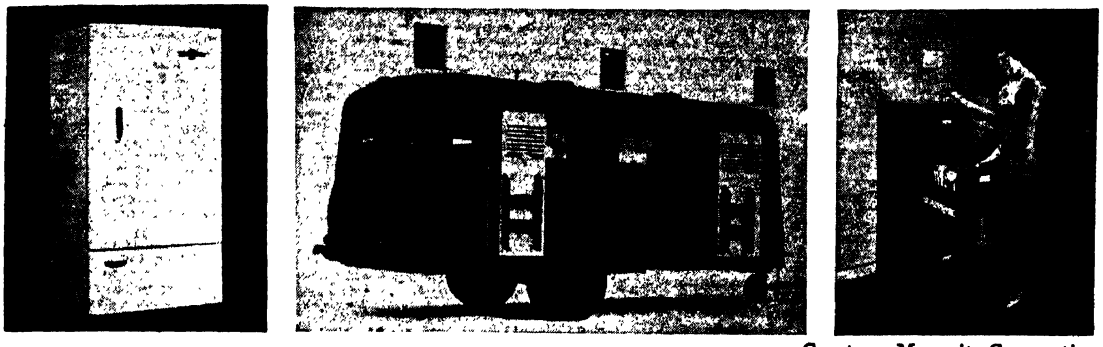


is used in making asphalt, and in the manufacture of varnishes, tarred paper and roofing paper.

Ashes from hard and soft coal are not thrown away nowadays. They are made into cinder concrete, cinder bricks and fireproof cinder cement. It is found that cinder bricks are lighter in weight and less expensive than other bricks; so this discovery has resulted in great savings especially in large buildings.

By-products may be obtained by distillation of many other substances. Gasoline, which was the first by-product mentioned, is not the only by-product of crude oil. When the oil is distilled naphtha and benzene, which are also products of coal tar, are produced. In addition, lubricating oil, paraffin wax used in making candles and also to protect jellies and other preserves from the air, and vaseline, which all of us know, are obtained. Other crude oils yield asphalt instead of paraffin.

Various by-products are produced in the smelting of metals such as copper. At first, when this process was taking place, a gaseous substance was given off that killed the grass and the plants for miles around. Later a means was found of collecting this gas, and from it is now made sulphuric acid. The gas is sometimes used as a solvent for phosphate rock



Courtesy, Masonite Corporation

The objects in these pictures are made of pressed wood. In the old days, bits and scraps of wood were thrown away or burned. Then it was discovered how to press them together to make pressed wood, a very useful material.

which makes good fertilizer. Other important chemicals are also obtained from the process of copper smelting as well as from the smelting of certain iron ores.

While wood is burned usually for the heat it gives, it is sometimes burned for its by-products, the most commonly known being charcoal. There are also gaseous substances formed in burning wood which by distillation produce wood alcohol, acetic acid, creosote, turpentine and resin. The thick black substance remaining after all these products have been removed is of value in making axle grease, shoemaker's wax, lampblack and similar things.

Wood waste is also used in other ways. Some of the slabs and pieces, left after lumber is taken out, are broken down into fibers and manufactured into boards and pressed into shapes of various kinds. Another wood by-product is a material known as "balsam wool" which is placed in walls and partitions of buildings such as theaters and auditoriums to deaden sound. Sawdust is ground up and used in the manufacture of dynamite, cartridges and linoleum.

Bits of cork, which were once swept out, are today mixed with a substance to hold them together and then pressed into sheets or other forms. Numerous articles, such as floor coverings, similar to linoleum, table mats and coasters, to name but a few, are made from sheets of cork scrap. As bricks, they are put in the walls and partitions of buildings to deaden sound; in the form of discs, they serve for buffing, or polishing.

If you have seen a cotton plant growing, you would think, perhaps, that it could not possibly have any other use than the cotton which is made into cloth. Others thought that, too, until the seeds became such a nuisance that it was necessary to find some way of disposing of them. When the cotton-gin was discovered and cotton was separated from the seeds much faster than it had been before, seeds naturally accumulated faster. Some were mixed with stable manure and used for fertilizer, but it was often the practice to throw most of the seeds into streams. That was stopped because it tainted the water. Then it

Courtesy, Du Pont Company

These crystals are a by-product of turpentine; and from them chemists make a perfume that smells like lilac blossoms.

was discovered that the seeds yield an oil when pressed. From that time cottonseed oil became an important by-product of the cotton industry. Cottonseed oil has many uses. It is a principal ingredient in many salad dressings, and it is made into oleomargarine and into shortenings for cooking. The oil is also used in making soap and cold cream and a number of other products. Over a billion pounds of cottonseed oil are consumed each year.

After the oil is pressed out, the cottonseed cake which is left may be broken up for use in various ways, or ground into meal. Cottonseed cake and meal make good food for farm animals, and excellent fertilizing material.

The seed has another use. Linters, which are bits of cotton that cling to the seed, are removed by a special process and made into cotton batting and cotton wadding, and are also used in the manufacture of cellulose.

The hulls of the cottonseeds have been removed before the seeds are pressed, and these are mixed with the meal in feeding livestock. The hulls have food value and they supply bulk, or roughage, which is needed in the animal diet.

The fibrous mass left after the juice is pressed out of sugar-cane was once considered a nuisance. Now, bagasse, as it is known commercially, is made into wallboard which replaces wood for a number of purposes.

Peanuts used to be valued only for the nuts and for the products made from the oil pressed from the nuts. Now the vines and the hulls are fed to cattle. The thin skin over the nuts is mixed in the fodder. After the plant has been cut, the roots are left in the soil for the nitrogen they give to the earth. This is but a small part of the story of peanuts. George Washington Carver (1864-1943), a famous Negro scientist, made many chemical studies of the peanut plant and found that nearly 300 useful substances could be produced from it. Among the surprising things that this great scientist made from peanuts were milk, ink, butter, soap, coffee and breakfast food.

Carver's work — finding ways through chemistry to get greater value from farm products — is called chemurgy, or farm chemurgy. Now the governments of most great nations have research bureaus in which scientists with imagination are devoting themselves to farm chemurgy. Part of their study is directed to the wider use of by-products. Cornstalks and straw are used in plastics; oil is extracted from seeds of oranges, lemons and grapefruits; and many other substances formerly thrown away are now important in industry, through the work of the chemurgists. The world is growing a little bit wiser, a little bit thriftier and, in consequence, much richer.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 760.

Courtesy, The Celotex Corporation

Do the walls of your room look like these? Then perhaps they are a by-product of sugar-cane. The wallboard in this room is made of bagasse, which is the name of sugar-cane fibers left after the juice has been pressed out.

"Gold!" An alchemist displays to his admiring patrons the precious metal he claims to have made from lead.

MEN OF SCIENCE

II. THE RENAISSANCE AND AFTER

IN the article beginning on page 588 we told about the men of science in ancient and medieval times. We brought the story along to about the year 1400.

Now we come to a period in Europe—from about 1400 to about 1700—which was a kind of bridge between medieval times and modern times. Some people call these three centuries the Renaissance; others divide the period into Renaissance and Post (after) Renaissance. The article beginning on page 5088 will give you a good general picture of this bright era.

Of course the Renaissance did not happen all at once, like an electric light suddenly turned on. It was a slow matter, like the gradual blossoming of light on earth between early dawn and noontime. It developed first in Italy, and spread westward; and in Italy as elsewhere, it blossomed most beautifully among the arts. Painting, sculpture and architecture throve in the fifteenth to the seventeenth centuries; literature flowered also.

One feature of the Renaissance was this—many of its greatest minds were great in more than one field. Michelangelo, for instance, was both sculptor and painter. Leonardo da Vinci (1452-1519), painter, sculptor, architect, engineer, scientist, inventor and scholar, has often been called a typical man of the Renaissance because he excelled in so many ways. His was a questioning mind, ever seeking more knowledge; and we are not surprised to find that he was the first of the important scientists of the Renaissance period.

In Leonardo's time, a man's first name was usually his only formal name, except among the great houses where family names were used. Leonardo was born in the little Tuscan town of Vinci, and so he came to be called Leonardo da (from) Vinci. When he was a boy he showed skill in art, and so he was apprenticed to Verrocchio, a painter, sculptor and goldsmith of Florence. Leonardo lived and worked in Florence for almost twenty years. He became a member of the Painters' Guild, one of the foremost organizations of the day. Artists of the time generally sought the patronage of kings or other rich persons; and while in Florence, Leonardo enjoyed the favor of Lorenzo the Magnificent, head of the house of Medici, a bountiful, intelligent and sympathetic patron of the arts.

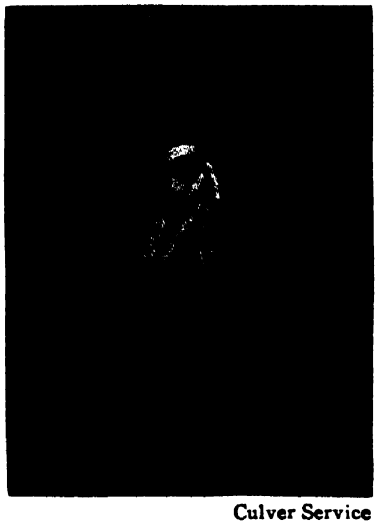
For twenty-five years after that, Leonardo lived at the court of Milan, working for the duke, Ludovico Sforza. At Milan, however, he worked more as engineer than as painter.

Both pictures, Culver Service

Galileo before the court of the Inquisition. He had to avow that he did not believe in the Copernican system.

The last years of Leonardo's life were spent in France, under the patronage of Francis I, and it was in this country that he died.

Leonardo felt that he needed an exact knowledge of anatomy to be a fine painter; and since there were no good pictures of the structure of the body in existence, he made many for himself from careful studies. His anatomical drawings are so beautiful that they are considered to be works of fine art, and so accurate that they could be used as illustrations in textbooks today.



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Leonardo da Vinci.

Leonardo made a vast number of scientific studies, but he wrote down very little about his scientific researches. Sir William Dampier thought that if Leonardo had published his work, science "must at one step have advanced almost to the place it reached a century later"; and few people would disagree.

A hundred years before Harvey re-discovered it, it seems that Leonardo already understood the principle of the circulation of the blood. Like some of the Greeks long before him, he recognized the true nature of fossils and he pointed out that the presence of fossils of salt-water animals in high mountains shows that the mountains must once have been below sea level.

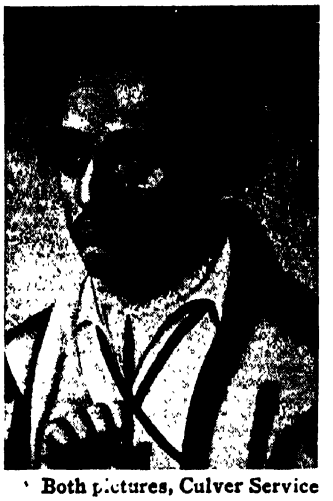
Leonardo's keen imagination foreshadowed many of the great inventions of recent times. He understood the impossibility of "perpetual motion." He experimented with gliders and some authorities believe that if the gasoline engine had been developed in Leonardo's day, he would have invented the airplane.

While Leonardo's tireless brain was busy with a thousand new projects and inventions, a Polish astronomer, Copernicus (1473-1543), was patiently working on an epoch-making

theory of the universe. He cast aside the old theory of Ptolemy, who believed that the earth was the center of the universe and that the sun revolved around it. Copernicus came to the conclusion that the sun was the center of a vast "solar system" and that the earth and the other planets moved around the sun. We tell you about Copernicus in the chapter on astronomers in Volume XI.

Practical chemistry, including the arts of making dyes, paints, glass, pottery and other useful things, was developed by the Egyptians and other ancient peoples. The theoretical side of chemistry did not develop as early as the practical, and the early theories seem rather wild to us today. For hundreds of years many men gave up their lives to the study of alchemy, a kind of chemistry whose chief object was to change (or transmute) cheap metals to gold. The alchemists believed that gold was the most perfect of metals and that if one could only find the right formula one could achieve enormous wealth by changing lead or tin or silver or mercury or even iron to yellow gold. They also believed that the "philosopher's stone" had these strange and magical powers.

Andreas Vesalius.



Both pictures, Culver Service
Paracelsus.

During the Middle Ages many so-called alchemists wandered from country to country. Some were scientific experimenters; some were rogues who disappeared in the night with the treasures intrusted to them for their experiments. Emperors and kings were among the alchemists. Many of the unfortunate alchemists were executed by kings for whom they had promised to make gold. One prince built a special gilded gallows devoted entirely to hanging alchemists.

Philippus Aureolus Theophrastus Bombastes von Hohenheim (1490-1541) was the first great chemist (and also one of the first great physicians) of the Renaissance. As if he had not been christened with enough names he called himself Paracelsus, meaning better than Celsus, one of the ancient philosophers. Although Paracelsus was also an astrologer and an alchemist and many of his ideas were mistaken, he tried bravely to reform the crude medical practices of the time.

He was a Swiss. When appointed lecturer at the University of Basel, Paracelsus celebrated the appointment by publicly burning the works of the ancient writers on alchemy and medicine. He then announced his own superiority to the ancients and to most men of his own day. Apparently, in spite of his egotism, his methods really were superior to those of physicians of his time. However, within a year the other doctors of Basel managed to have him driven from the city, and he spent most of his life wandering from place to place. Paracelsus died at fifty.

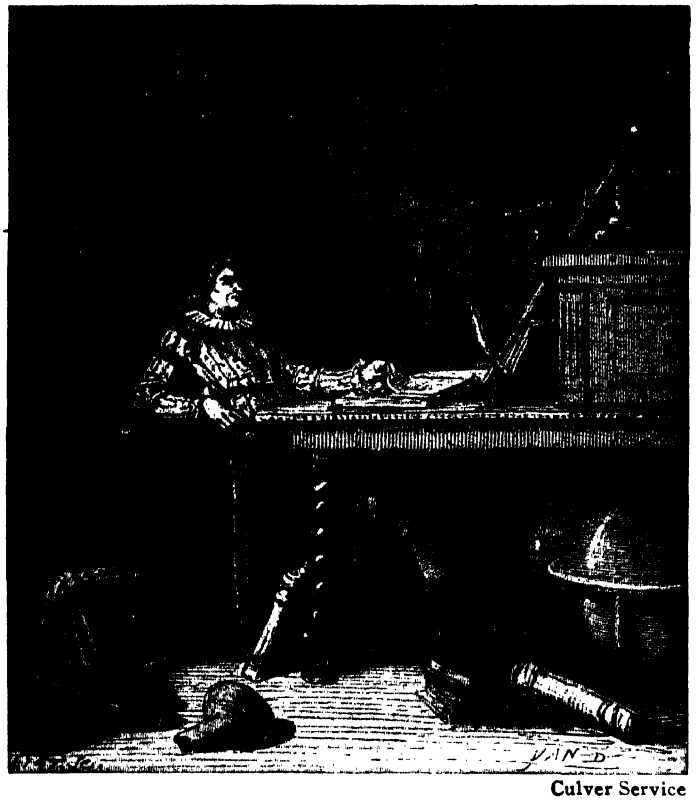
Bernard Palissy (1510-1589), a French potter and artist, famous for the beautiful glazed earthenware he made, was also a scientist. He was one of the first to realize that fossils are the remains of animals and plants.

Andreas Vesalius (1514-1564) was one of the first to make great progress in the study of the anatomy of the human body. Since the people of the Middle Ages considered it wicked to dissect a dead human body, nearly everything that was known about anatomy was based on the writings of Galen, the ancient Greek physician.

Vesalius, who was born in Brussels, Belgium, dissected many animals. He also collected human bones from places of execution until he could put together a complete skeleton, a rare thing in those days. He based his teachings on his own observations, and not merely on the writings of Galen. He even claimed that Galen had described anatomy from the lower animals and not from man.

Vesalius became physician to Emperor Charles V and later to Philip II, King of Spain. One of his duties was to give public dissections, which he always did during winter so that the body would not putrefy during the three weeks the work required. He discovered the small branches at the ends of arteries and veins, but did not realize the part they play in the circulation of the blood.

While returning from a pilgrimage to



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William Gilbert, the physician of Queen Elizabeth, writing his famous treatise on magnetism. In this work he described certain experiments which revealed that the earth is really a big magnet.

Jerusalem, Vesalius was shipwrecked on the island of Zante, where he died.

The Chinese discovered the magnetic needle in the eleventh century, and it was used by Arab sailors for navigation soon afterwards. All sailors knew that the needle pointed to the north or somewhere near the north and Thales, the Greek, in the sixth century B.C. knew that a lodestone would attract pieces of iron.

It was Queen Elizabeth's physician, William Gilbert (1540-1603) who discovered the greatest of all magnets. He found that while the two poles of the magnetic needle pointed approximately north and south, the north pole *dipped downward* in England and that the farther north one went the more the needle dipped. From this he inferred that if one traveled far enough north, the needle would dip straight down. He made a model of the earth from a sphere of iron, magnetized it by rubbing it with a lodestone, and found that when he brought a magnetic needle near it the needle would come to rest dipping straight down at the poles of the model; it would lie parallel to the model's surface at the Equator, and at intermediate angles at points between the Equator and the Poles. Gilbert came to the correct conclusion that the earth is a giant magnet. It was Gilbert who gave electricity its name (from *elektron*, Greek for amber).

Another official under Queen Elizabeth, Francis Bacon, Baron Verulam, Viscount St. Albans, Lord Chancellor of England (to give him all his titles), was one of the first to defend the experimental method as the very basis of science. Perhaps because he was kept so busy in his various political offices and by his writing, Bacon did almost no original scientific work himself. However, it was a scientific experiment which caused his death. Wishing to learn whether cold would delay the decay of dead bodies, he bought a fowl and stuffed it with snow. While doing this in the cold air he was seized with a chill and died a few weeks later. Bacon lived from 1561 to 1626.

Simon Stevin (1548-1620) was a Dutchman who proved that a heavy weight and a light weight will fall to the ground in the same time, before the great Galileo tried the same experiment.

Galileo Galilei (1564-1642) was another man of the Italian Renaissance, gifted with brilliant, many-sided genius. He made so many discoveries and explained them so clearly that he has been called the "father of experimental physics." Elsewhere you may read of his discovery of the principle of the pendulum and his important work in astronomy. Galileo was a dramatic genius, but his ideas were too bold, too modern for many people of the day. This man's life shows that the whole period in which he lived was a kind of bridge, as we have said. Some minds still looked backward to the past, and were reluctant to accept new knowledge; while others were charged with the excitement of learning. Galileo belonged to the latter group.

Some authorities today think that Galileo's work in other branches of science is even more important than his astronomical work. He invented the first thermometer, using air (where we would now use mercury) in a glass bulb. The ancients had said "nature abhors

(hates) a vacuum," but Galileo is said to have remarked that Nature apparently does not abhor a vacuum above thirty-four feet, since he found that no suction pump, however powerful, could raise water above that distance. He knew that it does not take any force to *keep* objects moving; that force is needed only to *start* motion or change its direction.

The Belgian doctor Jan Baptista van Helmont (1577-1644) made many valuable discoveries and at the same time clung to old errors. He invented the word "gas" to describe the bubbles he saw rising in fermenting beer and from vinegar in which he had dropped shells. He thought this gas was made of water.

In a famous experiment Van Helmont grew a tree in a pot. After five years he dug up the tree. He found it had gained 164 pounds 2 ounces. Since the soil had lost only 2 ounces in weight Van Helmont decided that all the rest of the gain had come from the distilled water he had used to moisten the soil. What he did not know was that some of the weight had come from a gas in the air (the same gas he had seen in fermenting beer!). The article on photosynthesis explains this process of plant growth. See Index.

Van Helmont still believed that a way might be found to transmute mercury into gold, but in the years after his time this notion was gradually given up, and the study of chemistry went forward. Beginning in 1606 a sort of professorship of chemistry was established in France and public lectures were given at the Botanical Garden in Paris. One of these French chemists, Nicolas Lémery (1645-1715), wrote a 500-page textbook, COURSE IN CHEMISTRY, in 1675, which made the author a fortune. Lémery made a miniature volcano by burying moistened sulphur and iron in a heap of earth. After a while the two elements combined, causing heat which turned the water to steam and presently there was a volcanic eruption on a small scale.

Culver Service
Blaise Pascal.

Robert Boyle.

William Harvey (1578-1657) is remembered as the man who first explained the circulation of the blood as we now understand it. He was born in Folkestone, England, the eldest of seven children. William was small, with black eyes, black hair and a quick and alert manner.

After studying at Cambridge and then in Italy under Fabricius (who demonstrated the valves in the veins), Harvey became royal physician in England. Thus he had the opportunity to examine the hearts of animals wounded in the chase, being the first man since Galen to work this way.

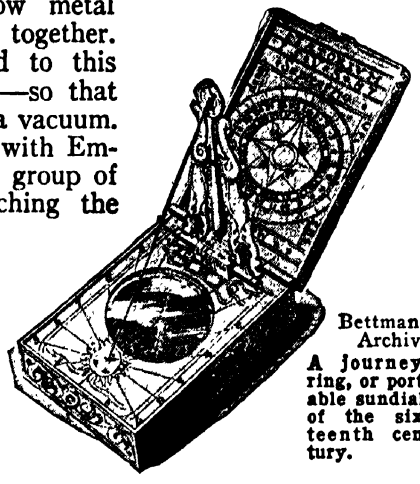
In his experiments, Harvey measured the amount of blood which passed by a spot on the release of a ligature and realized that far more blood was pumped in an hour by the heart than the whole body contained. Therefore, he concluded, the blood must circulate and return. Lacking a microscope, he could not prove the passage of blood from arteries to veins. Ten years after his death, Malpighi showed this capillary connection in the lung of a frog.

Harvey was one of the most modest of scientists, giving great credit to his predecessors, and scarcely claiming that his great discovery was original.

Evangelista Torricelli (1608-1647), a pupil of Galileo, was the first to construct a mercury barometer and to prove that the air exerts pressure. Aristotle had said that air has no weight or pressure.

Another early worker on the problem of

air pressure was Otto von Guericke (1602-1687) of Magdeburg, Germany, who invented the air pump and carried out ingenious experiments with vacuums. He discovered that "a clock in a vacuum can not be heard to strike; and a flame dies out in it; a bird opens its bill wide, struggles for air, and dies; fishes perish; grapes can be preserved for six months." In his most striking experiment he had two hollow metal hemispheres placed tightly together. Through a pump attached to this globe he drew out the air—so that inside the globe there was a vacuum. One day, in an open field with Emperor Ferdinand III and a group of distinguished persons watching the show, he hitched horses to the two hemispheres. Not until sixteen horses attached to each side strained their utmost could the hemispheres be pulled apart. The air, pressing against the hemispheres from all sides held them together (since there was no air inside to equalize the pressure). Yet when Guericke turned a valve in the air pump, letting air flow into the globe, the two hemispheres could easily be separated by one man.



Bettmann Archive
A journey-ring, or portable sundial, of the sixteenth century.

It is not easy to explain the great work of René Descartes (1596-1650). He was the author of the first textbook of physiology (science of the functions of the body), the originator of the branch of mathematics called analytical geometry, and one of the world's greatest philosophers. Descartes was born near Tours, France, of wealthy parents. A sickly youth, he was allowed to do about as he pleased. He formed the habit of sleeping late and he claimed that he thought out most of his scientific problems in bed. Although sickly, he stated that he intended to die of old age; but after a lifetime of getting up late and pampering himself, he accepted an appointment from the Queen of Sweden. Lessons in philosophy were to begin at five in the morning. The strain was too much; after one winter of getting up early in a cold climate, he developed inflammation of the lungs and died soon after, at the age of fifty-four.

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Christian Huygens.

Blaise Pascal (1623-1662) was a French man of the Renaissance. He was a philosopher, a student of mathematics and of science. He was ill nearly all of his short life, but he made important discoveries in mathematics and science. He heard of Torricelli's mercury barometer, and he went further. He decided that if the mercury in the barometer was forced up the tube by the pressure of air, there should be less air at a high altitude and therefore the pressure should be less and the column of mercury shorter.

At Pascal's request his brother-in-law climbed a mountain, the Puy-de-Dôme, and to Pascal's delight they found that the mercury dropped three inches during the ascent. Among other discoveries, Pascal found that fluids transmit pressure without loss. This is called Pascal's law of fluid pressure. When you use a hydraulic jack to raise a 3,000-pound automobile with only a slight effort, you have a demonstration of Pascal's law.

Robert Boyle (1627-1691), born in Munster, Ireland, spent most of his life at Oxford and in London. A Frenchman, Rey, had already shown that metals *increase* in weight when burned. Boyle confirmed this and found that a candle would go out and a mouse die in a vacuum in about the same time. He also showed that even fishes require air (dissolved in water). Apparently Boyle was the first to produce the gas hydrogen by treating iron filings with mineral acid. Boyle's greatest discovery was what is known as Boyle's Law —*if we double the pressure on any gas the volume shrinks to one-half; if we reduce the pressure by one-half, the volume (amount of space occupied) doubles, if the temperature remains the same.*

One of the greatest problems of early chemistry was that of burning. When wood burns the ashes weigh less than the wood. But when metals burn, the resulting "calx" weighs *more* than the metal. Why? Johann

Becher (1635-1682) thought that something was given off whenever a solid burned. Georg Ernest Stahl (1660-1734), physician to the King of Prussia, called this something "phlogiston." The phlogiston theory seemed to explain many things, but since metals gained weight when they burned, it was assumed that phlogiston was a substance which weighed *less than nothing*. Chemists continued to believe in this strange theory until the time of the French Revolution, when it was overthrown by Lavoisier.

Robert Hooke (1635-1703) was an Englishman, a mathematician. He put some lenses together to make a miscroscope, and with it was able to see the cell walls in cork. He was the one who named these tiny structures cells. He believed that light is a series of waves, or vibrations.

HUYGENS ADVANCES THE THEORY THAT LIGHT CONSISTS OF A SERIES OF WAVES

Euclid, in the third century B.C., believed that vision was due to particles sent out from the eye. One of the first scientists to form a theory of light resembling the modern idea was Christian Huygens (1629-1695) of Holland, who decided (as had already been suggested by Robert Hooke) that light is a series of waves. By this means he explained the refraction (or bending) of light when it goes from one medium, such as air, into another, such as water or glass. All our microscopes and telescopes are due to this fact that light changes its direction when it goes from air to glass or glass to air.

The Dane, Olaus Roemer (1644-1710), studying the moons of Jupiter, concluded that it takes light a definite length of time to travel a given distance. Roemer estimated the speed of light, getting a figure surprisingly near the truth.

We come now to Sir Isaac Newton (1642-1727). Modern science owes much to him, and you will find him mentioned many times in our book. (See Index.) Newton may be called the English man of the Renaissance, the many-sided genius, who may be compared to the Italian Leonardo. He was the first to show conclusively that white light can be split up into the colors of the spectrum by passing it through a prism—and that the colors of the spectrum can be combined again into white light, by passing the spectrum through a prism. He also formed a theory of light. He thought it consisted of streams of little particles which he called corpuscles. Even today scientists do not know exactly what light is —whether Newton or Huygens was right.

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The great René Descartes at Amsterdam, Holland.

But Newton's fame was so great that his theory was more generally accepted at the time.

Newton's three laws of motion (which you will find on page 1152) have served for 250 years, as the basis of the study of how things move. His discovery of the law of gravitation (see page 739) was possibly the most important single contribution to knowledge ever made by one man. Albert Einstein and other modern scientists have pointed out certain things we must consider in relation to gravitation, which Newton did not guess. But Newton's basic discovery helped generations of men to learn more and more about our world.

Some of Newton's greatest discoveries were in mathematics. For example, he developed the advanced branch of mathematics called calculus. Unfortunately, he did not publish this at the time, and in 1684 the German scientist, Gottfried Wilhelm Leibnitz (1646-1716), whose admirers called him the Aristotle of the seventeenth century, worked out and published the very same thing, independently of Newton. The result was that there was a tremendous row between the friends of the two scientists. Some of Newton's followers accused Leibnitz of copying

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Sir Isaac Newton passing the white light of the sun through a prism.

Newton's ideas (although these had not been published).

Anthony van Leeuwenhoek, born in 1632 in Delft, Holland, made innumerable discoveries by examining all sorts of things under simple microscopes. He was a brilliant observer, and he constructed with his own hands every microscope, including the lenses, which he used. His microscopes were eagerly sought after, but though he occasionally gave one as a gift, he refused to sell them. He was no more interested in worldly advancement than he was in money. The only language he knew was Dutch, but he reported his discoveries to the Royal Society in England, which published them in English or Latin. Leeuwenhoek was the first to see and describe bacteria, protozoa and yeast cells. He described many forms of tiny plant and animal life. He died in 1723, having spent his whole life in the town of his birth. He was not the inventor of the microscope, as is sometimes said, but he did much to perfect the instrument.

John Ray (1627-1705) was an Englishman, one of the first men to make a natural classification of plants and animals.

Francesco Redi (1626-79), an Italian, showed that maggots were the offspring of flies. People had thought they "arose by spontaneous generation," that is, without parents.

The Italian Marcello Malpighi (1628-94) was another brilliant observer. His discoveries under microscopic lenses included the capillary vessels which connect arteries and veins, and the tracheae and breathing holes of insects.

Nehemiah Grew (1641-1712), a pious Englishman, believed plants and animals were both part of God's design, hence would show some similarity in structure. He made endless microscopic studies of both, and published a valuable work, THE ANATOMY OF PLANTS.

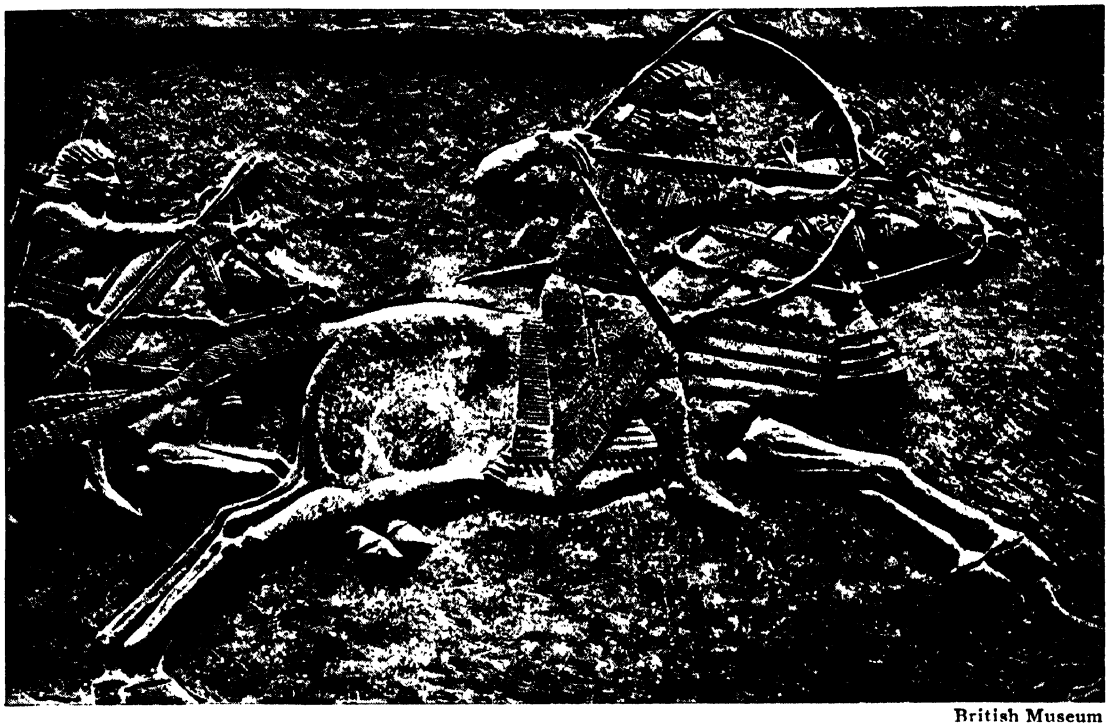
The noted naturalist Jan Swammerdam (1637-80) was a fellow-countryman of Leeuwenhoek. His skill as a dissector was unsurpassed, and with the aid of his microscope he gave detailed descriptions of the anatomy of bees, gnats and dragon-flies. His manuscripts and drawings on the metamorphosis of insects, published after his death as the BIBLE OF NATURE, are still consulted today.

As we can not give an exact date for the beginning of the Renaissance, so we can not point to a particular year and say "Then the Renaissance ended." The period declined slowly, first in Italy, then to the west. By 1700 the civilized world had lost much of that special urge to create beauty and to pursue learning for its own sake.

The world was growing up. Modern times were on the way, a period when learning was to lose much of its dreamy quality, and take on a more practical aspect. And, as we shall see, science sprang forward in modern times.

By THOMAS GORDON LAWRENCE.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 700.



British Museum

A wonderful stone-picture of long ago—Assurbanipal, king of Assyria, and an attendant hunting wild beasts.

ANCIENT EMPIRES

SUMER, BABYLONIA, ASSYRIA AND CHALDEA

CAN you listen to the names Sargon, Assurbanipal, or Nebuchadnezzar without seeing visions of fighting hosts and dashing huntsmen and strange old palaces in distant lands? And what comes to your mind when you hear of the Hanging Gardens, the Tower of Babel or Ur of the Chaldees? These names are magic keys that can open doors into four ancient and mighty empires that rose and prospered and fell along the Euphrates and the Tigris rivers in the southwestern part of Asia.

The first of these four empires was Sumer, one of the oldest countries in the world. No one can say just when the story of Sumer began, but we know that the Sumerians were learning to live in a civilized way as long ago as 3500 B.C., and perhaps even earlier. The next thousand years saw the rise and growth of a Sumerian empire which spread Sumerian culture and civilization over most of western Asia.

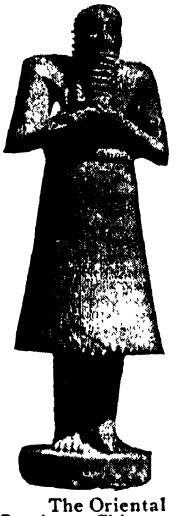
Meantime, Semitic peoples had been coming from the west to live in Sumer and gradually they began to get the upper hand. These people were nomads, which means that they led a wandering kind of life instead of settling contentedly in one place. First came the Akkadians, then the Babylonians. Down the centuries we can watch these Semites fighting the Sumerians, mixing with them and adopting their civilized customs. At last the Semites became masters of a shining empire, the Babylonian, which endured until about 1550 B.C.

The third of these great empires was Assyria. The Assyrians were ferocious warriors who conquered far and wide. Well might distant nations tremble at the approach of those mighty armies! Assyria built an empire that, from 750 B.C. to 612 B.C., was the largest and most powerful that the ancient world had ever known.

The Bible often speaks of the last of these empires, Chaldea, whose days were so fleeting but whose splendor was so fabulous. And the Bible tells us the story of Nebuchadnezzar, Chaldea's greatest king. He it was who built the Hanging Gardens—one of the Seven Wonders of the World. The

glory of Chaldea lasted for only seventy-four years. In 538 B.C., less than twenty-five years after the death of Nebuchadnezzar, Chaldea was conquered by a famous king of Persia, Cyrus the Great.

Where were these ancient empires? Along the eastern end of the Mediterranean Sea, where its blue waters lap against the western shores of Asia, is a narrow strip of land. This was once the home of the Israelites and the Canaanites and other people familiar to us in Bible story. Moving eastward from there across desert land you come to the home of the empires of our story, the wide valley of the Euphrates and the Tigris. These rivers rise in the hills of the north and west. They flow south and east, more or less side by side, leaving the rocky country behind them and passing over land that slopes ever more gently. The southerly part of the valley is a great, level plain, where the rivers meander on, in no hurry at all to reach the Persian Gulf. It would almost seem that the rivers have grown tired from their long trip; at any rate, their leisurely manner has made a great difference to the lands of the lower valley. Coming down from the hills, the rivers carry sand and sediment with them, sweeping it along in the force of the currents. Then, as if they had grown weary, the rivers at last lay down their burden. Instead of being carried out to sea, the sand settles down on the river beds, piling up higher as time has gone on and gradually building new land at the foot of the valley. In this way, many miles have been added to the length of the valley, and ancient cities that lay near the mouths of the rivers are now far inland. If you look at a modern map, you will see that the Euphrates and the Tigris meet on the new land that they built themselves and finish their journey together. Once they flowed into the sea through separate mouths.



The Oriental Institute, Chicago
Carved figure of a Sumerian, about 2700 B.C.

In ancient days, the level land was probably just about as big as the state of New Jersey. This was the old Plain of Shinar, later called the Babylonian Plain. The name Mesopotamia, "the land between the rivers," is often used for the entire region where the Euphrates and the Tigris flow. Today most of this region is called Iraq. East of the Tigris, beyond the valley, rises a mountain ridge which was once the land of Elam, a very ancient nation often at war with the valley folk.

Long ago the Plain of Shinar was green and fertile. The people dug canals that led the waters of the two rivers across their fields so that the crops would have plenty of moisture. On one side of these rich pastures lay the desert, and on the other—and on the north as well—rose barren hills where shepherds and their flocks must move from place to place to find enough pasturage. No wonder, then, that many desert tribes and nomads of the hills wanted to live in the pleasant valley. Again and again, the valley folk had to fight against outsiders who coveted their land.

That there had been a great past in the land between the rivers was known through all history, from echoes of old legends, from the history of the Jewish nation and from the writings of old authors, such as the Greek historian, Herodotus.

About one hundred years or so ago, first one traveler and then another began to wonder about the great mounds which dot the flat country. What could they possibly be? On some of the mounds Arab villages had been built, and crops are cultivated on their sides; in spring they are gay with wild flowers. In that land, so dry during most of the year, the rains fall heavily when they come. Little pieces of carved marble had been washed out from the mounds by these heavy rains and had given an idea of what might lie below.

So explorers began to dig down into the rounded hills. They dug with great care, so that their picks and shovels would do no harm, for they were bringing to light a whole new world—the remains of a great past in the valley of the two rivers.

Chapter by chapter its long, absorbing story was unfolded. Man-headed monsters of gray stone, huge stone-pictures, and countless little tablets like cakes of soap covered with writing lead us right back into the gorgeous palaces of the kings of Assyria and Chaldea. And centuries farther back, even, we may go into the busy country life of Sumer and Babylonia, when the rivers, kept in by embankments and connected by canals, were covered with boats and barges, carrying the produce of well-watered and fertile fields. We can almost smell the sweet hay, and see the chaff flying, and

hear the cattle lowing and enter into the bustle of sending these things to market, thousands of years ago.

All these things the clay tablets told, but at first neither the explorers nor anybody else could read them. The writing looked like a lot of little wedges, such as you might put under a door to keep it open, but much smaller, of course. This odd writing is called wedge-writing. Its scientific name is cuneiform, which means wedge-shaped.

We might still be wondering what these strange wedges were trying to say if there had not lived an ancient king who wrote the story of his triumphs in three languages, one of which was Babylonian. By comparing the languages, scholars were at last able to read the mysterious wedge-writing.

On many stone statues and stone-pictures found in the mounds, wedge-writing had been chiseled with sharp tools. On the clay tablets, the wedges had been pressed, while the clay was still moist, by a stylus with a specially shaped end. The moist clay was then dried in the sun or baked in an oven.

These clay tablets are the books and letters of the country. What would be left of our books and letters if they had gone through the changes which have passed over these, with buildings burning down around them? But those old books and letters of clay only baked the harder in the flames of burning palaces.

The Oriental Institute, Chicago
Men of Sumer rode to war in chariots like this reconstruction of an ancient model, three inches high.

About four thousand years before Christ, and perhaps even earlier, primitive peoples were making their homes on the flat Babylonian plain. At first they lived in low huts of plaited reeds, called wattle. Then they found that the sandy clay soil could be shaped into bricks and learned to make much better dwellings.

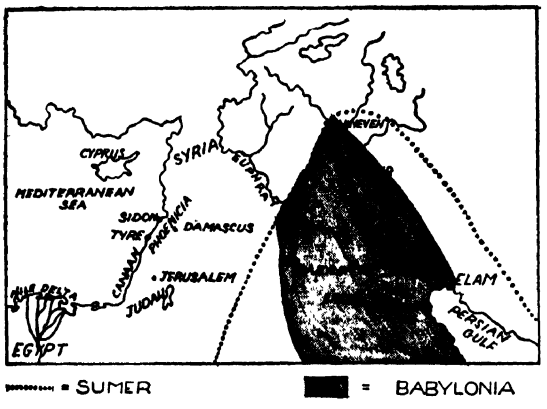
As centuries passed, different groups of people made their homes on the Plain of Shinar. Each group has its special name. The first group that we know much about settled far to the south, near the mouths of the two rivers. They called their land Sumer, and so they were known as Sumerians. Their portraits on ancient monuments show that they were a round-headed people, and usually were shaven and shorn, although a few of them wore long beards. What race they belonged to is still a mystery. In very early times the Sumerians had begun to drain the southern swamps and marshes and make them livable.

Gradually the Sumerians became more and more civilized. They built their settlements of brick huts farther up the rivers, especially along the Euphrates. They wove cloth of the wool from their flocks and made useful and beautiful things of copper and gold. These products they traded with the nations round—on the west, as far as the Mediterranean Sea, and on the east, well into Asia, at least as far as India. But their chief business was farming.

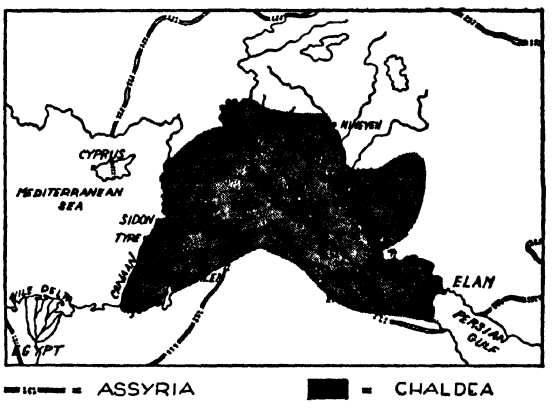
With the help of the river waters, the Sumerians grew flourishing crops of barley, wheat, dates and figs; cattle and sheep and goats grazed in their green pastures. For all this richness of plant and animal life they gave thanks to Mother Earth, whom they worshipped as their leading goddess. We shall soon hear more of this mother-goddess.

It may be around 3000 B.C. that the Sumerians learned to scratch pictures on tablets of clay. These pictures are the earliest form of writing. But drawing pictures was a slow way of setting a message down, and so the scribes thought up a number of clever and useful short cuts. Over the centuries, the early and slow picture-writing gradually developed into the much faster wedge-shaped writing which you have been reading about.

So the people of Sumer prospered, and their settlements grew into towns. The towns grew into thriving cities and these, in turn, into separate little kingdoms, each with its own ruler, called an *ensi*. By 3000 B.C. there were a number of these city-kingdoms on the Plain of Shinar, fighting with each other for power and leadership. War, in fact, kept them very busy, for they had also to drive off invaders who often



These great empires existed so long ago that no one knows exactly what their boundaries were. Oldest of all was Sumer. The dotted line shows the boundaries of Sumer somewhat roughly. Babylonia is shaded.



Assyria was much the largest of these four empires. Assyria and Chaldea reached all the way to the Mediterranean Sea. Broken lines show the northern and southern boundaries of Assyria. Chaldea is shaded.

came raiding from the desert or the hills.

Before long, one after another of the city-kingdoms of Sumer outshone the rest and became the capital of a far-flung empire, the Sumerian. First there was Kish. Then there was Erech where, according to the Bible, Nimrud, the mighty hunter, held sway. Its most famous ruler was Gilgamesh, the great hero of Sumerian and Babylonian legend, and the forerunner of the Greek hero Hercules.

When Erech's greatness dimmed, the rule of the Sumerian empire was taken over by the wonderful city of Ur, known in later ages as Ur of the Chaldees. From this time on there are written records that help us. For the first time, we know one of the kings of western Asia not only by name but from his own records. He was Mes-anni-padda, king of Ur about 2600 B.C. Mes-anni-padda founded the First Dynasty (or family) of Ur and four of his descendants ruled in turn before the dynasty ended.

What splendid days those were for the storied kingdom of Ur! Situated along the southern course of the Euphrates River, it was a bustling center of trade by caravan and by boat. Its craftsmen, working in copper and gold, had become wonderfully skillful; its sculptors excelled in the delicate art of engraving tiny figures on the hard stones that were used for personal seals.

The princes and nobles of Ur commanded great wealth and had marvelous possessions. Some of their treasures, hidden through so many ages, were found when the ruins of Ur were excavated in 1925-1926 A.D., and in later excavations. They may be seen in museums today. We may look at a golden dagger with a gold-studded hilt of lapis lazuli and a finely carved gold sheath. A queen of Ur once wore the beautiful golden headdress, and a prince or a noble may have worn the helmet wrought of pure sheet gold. A magnificent golden head of a bull, with a curling beard of lapis lazuli, was found still gracing the remains of a harp that must once have sounded sweetly.

In Ur, we meet again the mother-goddess whom the early Sumerians worshipped. The son of King Mes-anni-padda wanted to please her, so he built her a little temple and adorned it handsomely. One of its carvings shows us what a dairy was like in the days of the First Dynasty of Ur. Here is the cow yard and its gate. Here are the cows, standing quietly with their calves while dairymen do the milking. Two dairymen are busy straining the milk and another is rolling a large jar on the ground. He is churning the milk into butter.

At last the proud princes of Ur were forced to bow to a conquering ruler from another of the city-kingdoms. So that, not long after the fall of Ur, we find the king Lugal-anni-mundu, of the Sumerian city of Adab, boasting that he ruled the "four corners of the world," from the Mediterranean Sea to the Persian Gulf. But the golden age of the Sumerian Empire was drawing to an end. It had flourished on the Plain of Shinar and the surrounding territories for hundreds of years and had made great progress in civilization. Now, in the north, an enemy was preparing to vanquish the entire land of Sumer.

For some time past, a wild desert tribe had been gaining a foothold north of Sumer, making the region their home, which they called the land of Akkad. The Akkadians

belonged to a people called Semites. They spoke a Semitic tongue which was entirely different from Sumerian, and they also looked very different from their southern neighbors, for they had long beards and flowing hair. Farming seemed to them a dull way to make a living. Trading and hunting suited them much better, and they were brilliantly skillful archers.

Against the flashing arrows of the Akkadians the men of Sumer matched well-drilled armies which had learned a great deal about warfare. Sumerian troops were heavily armed. They carried shields and spears, but they had not yet learned to make them of iron. They marched side by side in a close formation which was later used and improved upon by other countries. And they were the first, as far as we know, to make use of heavy war chariots. For some time they were able to ward off the Akkadians who liked to fight singlehanded.

About 2350 B.C., a mighty leader arose in Akkad. This was Sargon, the first great Semitic chieftain in history. He conquered the cities of Sumer and created one of the mightiest empires in the story of western Asia. The next two centuries are known as the Age of Sargon.

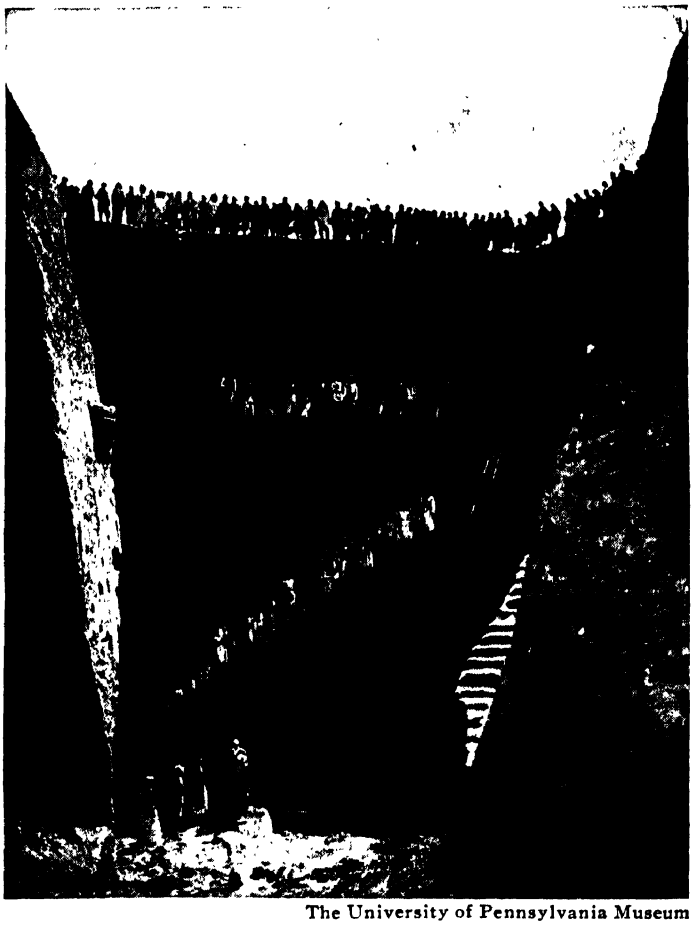
What, then, became of the people of Sumer? Were they driven from their wonderful cities? On the contrary, they remained and taught the Akkadians many things. The men of Akkad were a half-settled people who never before had tried to govern a civilized community.

The Sumerians taught them to govern and to use the Sumerian calendar and the Sumerian system of weights and measures. They even had to teach their conquerors how to write, for the Akkadians had no writing of their own. The beauty of Sumerian sculpture impressed the victors from the north, and they soon showed that they were not lacking in artistic talent. The men of Akkad learned how to carve pictures on stone and soon became even better sculptors than the men of Sumer.

After the line of Sargon declined, some of the old cities of Sumer grew powerful again, and ancient Ur rose to new splendor. But the people of Sumer had learned to live in friendship with the people of Akkad. From about 2100 B.C. to a little after 2000 B.C., the two countries were united in one nation, called the Kingdom of Sumer and Akkad. Toward the end of this period, Abraham and his family are believed to have fled from the city of Ur, to wander with their flocks in the lands on the western side of the desert.

The mounds have shown us many things about the Kingdom of Sumer and Akkad. They have shown us the wonderful temples and towers that glorified the city of Ur, and we can see how silver came to be so plentiful that it eventually was used as coin.

We even have some of the schoolbooks that were studied by the boys of Sumer and Akkad. It would seem very odd to us if we had to study from books made of clay and had to write our lessons on clay tablets. In those days, a pile of clay was kept for the school to use. When a student needed some-



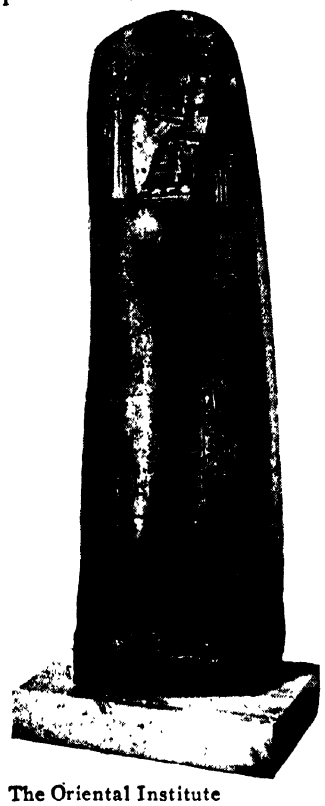
The University of Pennsylvania Museum

This neatly made excavation at Ur uncovered an ancient cemetery.

thing to write on, all he had to do was to help himself to some of the moist clay and make a fresh, new tablet.

The Sumerian myths and stories and hymns of those days are among the earliest works of literature in the world. Some of the stories remind us not a little of the first chapters of the Bible; they tell how the world was created by the separation of heaven and earth, and how man was fashioned from clay. Other stories describe the adventures of the Sumerian hero Gilgamesh; these were taken over by the Semitic Babylonians and built into man's first great epic called THE EPIC OF GILGAMESH. One very interesting story about a good and pious king of Shuruppak, a city in Sumer, who was the sole survivor of a great flood, reminds us of the story of Noah and the ark which is told so vividly in the Bible.

About this time there was a small town on the Euphrates River. Its name was Babylon. About 1830 B.C., the town was seized by new invaders from the north, the Amorites. They were a Semitic tribe, just as the Akkadians were, and they made Babylon into a city so powerful that it gave its name to the entire Plain of Shinar.



The Oriental Institute
Hammurabi's code of laws. The sun-god, seated, gives Hammurabi his commands.

Among them, one name shines out like a brilliant light —Hammurabi, king of Babylon. He has many claims to greatness. During his reign, from 1728 B.C. - 1686 B.C., he not only conquered the entire Plain of Shinar and established the empire of Babylonia, but he gave it a better system of law and order than this land had ever known.

Hammurabi's code of laws is one of the oldest yet discovered. (In 1947 a still earlier one was found, drawn up by a Babylonian king who lived 150 years before Hammurabi.) The code of Hammurabi was inscribed on a great pillar. While many of his laws were good, others were extremely harsh and cruel. He believed in the ancient principle of punishment, "an eye for an eye and a tooth for a tooth," which is spoken of so often in the Old Testament.

Quantities of Hammurabi's letters have been found in the mounds. They tell us about himself and his kingdom. He dictated many of these letters in his palace, while his secretary wrote them down in wedge-writing on small tablets made of clay. The finished letter was moist and soft and was sent with all speed to the furnace! When it was properly baked and dry, the letter was carefully carried to its destination.

Some tablets tell about the wages of workers in the fields, children as well as men and women, and about the levying of taxes and all sorts of business. Some had to do with loans and repayments and the buying and selling of houses, fields, slaves and other property.

One great industry of Babylonia, besides agriculture, was brickmaking, for stone was very scarce and clay was abundant. Enormous numbers of bricks were needed. It was the custom to build high walls of brick round the large cities. The great buildings, temples and palaces were set up on huge platforms made of sun-dried bricks, which raised them out of the way of floods. Harder bricks were used for facing and ornamental purposes. Many of the hard, oven-baked bricks, with their inscriptions, tell us about the buildings in which they were used and bear the names of the kings who built them.

Many of the old Sumerian gods were still worshiped, but Marduk, the ruler of all the gods, and Ishtar, the goddess of love and war, were Semitic. In later ages, along the Mediterranean Sea, Ishtar, from whom we get our name Esther, was worshiped under other names. The Greeks called her Aphrodite and the Romans called her Venus.

The Babylonians believed that the heavens would answer their questions about the future. Even before the time of Hammurabi, in the days of the kings of Sumer and Akkad, fortune-telling was the business of the priests, who studied the stars and planets in the hope that these would show them what the will of the gods might be.

We have followed the stories of Sumer and Babylonia from their earliest beginnings through the days of their great glory. We have seen how the early Sumerians—farmers,

traders, craftsmen and teachers—developed a wonderful civilization that blossomed in their city-kingdoms, especially in the city of Ur. We have seen how Sargon led the Semites down from Akkad and conquered the Sumerian city-kingdoms, and we have watched these two races mingle and flourish under the kings of Sumer and Akkad and finally reach their highest form of government under the famous Babylonian monarch, Hammurabi.

For about two thousand years the Sumerians and Babylonians had made almost uninterrupted progress, but now their long adventure of building a civilization was ended. After Hammurabi's death the ancient empire grew weaker, and invaders began to get the upper hand. By 1550 B.C., its fields with their network of canals and its cities with their palaces and temples had fallen prey to a rough, uncivilized people called Kassites. It is believed that they brought large numbers of horses into Babylonia. If that is true, it is probably the only good thing they did for the fallen empire. For over a thousand years to come, Babylonia would seldom be anything more than a backwater of civilization.

Gold helmet found at Ur. Private soldiers wore helmets made of copper.

Pictures, The University of Pennsylvania Museum

Gold bull's head, part of a harp. It was found in the king's grave at Ur.

Let us turn from the inglorious fate of Babylonia to watch the growth of a humble outpost along the Tigris River, in the north. This was a place called Assur, whose people were called Assyrians. We do not know whether or not they were purely Semitic, but they spoke a Semitic language very much like the language of Akkad. Assur was situated on a rise of ground that was easy to defend, and its climate was much cooler than that of the south. Far back in the days of the First Dynasty of Ur, about 2600 B.C., Assur had no doubt been under Sumerian rule. At any rate, from very early times, the Assyrians knew something of Sumerian ways. Through the centuries, the culture of the south continued to make a great impression on the warlike people of Assyria.

Ribbons of gold and golden flowers—a lovely headdress of Queen Shub-ad of Ur, still in a good state of preservation.

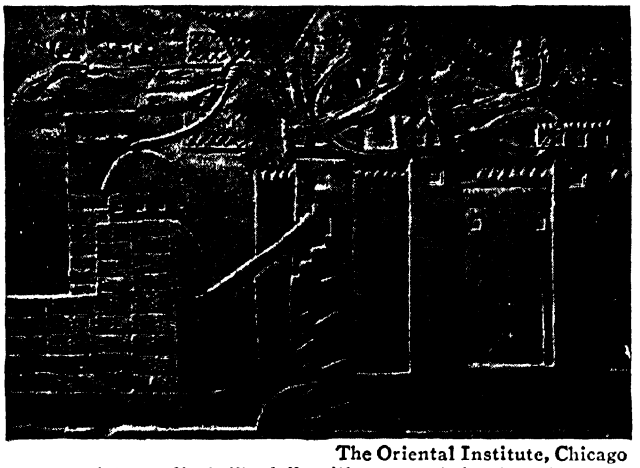
Have you ever heard that it is a dangerous thing to rear a lion cub? At first, when it is very young, the cub is helpless and harmless; but sooner or later it will grow into a tremendous beast, with powerful jaws and a fierce, wild heart—and then let everyone beware! Just such a nation was Assyria. When the lords of the south held Assur as a subject state, they did not know that one day it would grow big enough and terrible enough to tear them to pieces.

The young kingdom of Assyria had enemies on every hand and was conquered many times, but there was something in the Assyrian character that would not accept defeat. These people were as proud as they were fierce. From the yoke of each new master they contrived, in the end, to escape, shaking themselves free and emerging more warlike than before. To be great warriors seemed to them more glorious than anything else, and above all their gods they worshiped Assur, the god of war.

The people of the south, as we have seen, had no building stone. Their buildings were made of clay bricks set on brick foundations.

But the people of Assur had quarries of limestone and alabaster, and these enabled them to use stone for the foundations, although they used brick for the rest of the building. From these quarries came the great slabs which the Assyrians used for their statues and stone-pictures.

The Assyrians developed a passion for conquest. They organized their government around their armies and made their kingdom into a military state, always on the alert to defend its frontiers and to extend them whenever they were able. In particular, they wanted to enlarge their kingdom toward the west, for they were an inland power and their hope of future greatness lay in gaining a foothold on the shores of the Mediterranean Sea. But many obstacles stood in their way.



The Oriental Institute, Chicago

The world's earliest "tank," with armored front and turret, attacks a fortified town. Relief, palace of Assurnasirpal.

First, on the west, was the hostile kingdom of Mitanni, a terror to all the nations round. The Mitannians lived in the northern hills where the Euphrates curves to the east. They fought in heavy war chariots drawn by great horses raised and trained for battle. For a time, the Mitannians made themselves masters of Assyria and captured its chief city, Nineveh.

Looming behind the people of Mitanni, on the west, were the Arameans of Syria, whose chief city was the mighty bulwark of Damascus. Still farther west, near the Mediterranean Sea, were the cities of the Phoenicians and the Hebrews. What an array of enemies to face a young and growing kingdom!

The rulers who built Assyria into a strong kingdom had to be strong, and they were very cruel as well. Outstanding among them was Assurnasirpal, a great conqueror and builder, who ruled from 884 to 859 B.C. His long name reminds us that the Assyrians worshiped the war-god Assur, for it means "Assur protects his son."

Assurnasirpal built a magnificent palace in the ancient city of Calah (the modern city of Nimrud). Its walls were royally decorated with enormous slabs of alabaster most wonderfully carved. The chisel was not allowed to cut very deep into the flat surface of the rock; such sculpture is called low relief. These huge reliefs tell the story of Assurnasirpal's exploits and show him conquering his enemies, on the march and crossing rivers. Other stone-pictures show us how the Assyrians worshiped, and we see the Tree of Life that was so important in their religion. In the springtime, it was the custom to set up this ancient symbol and decorate it, in much the same way that a Maypole is used nowadays.

Guarding the entrance of Assurnasirpal's palace were huge, man-headed bulls carved from enormous blocks of alabaster. We may see these bulls today, magnificent, winged creatures bearing their great wings proudly and wearing rows of curls in their hair and beards in typical Assyrian fashion. These bulls are symbols of three qualities that every good Assyrian respected — the strength of a bull, the swiftness of an eagle, and the intelligence of a man.

Tiglath Pileser III, whom the Bible calls by his Babylonian name of Pul, was a strong monarch who came to the throne of Assyria in 745 B.C. Tiglath Pileser conquered Babylonia and marched his armies far to the west, and the Bible tells us how the King of Israel had to give him a thousand talents of silver to buy him off. The Assyrians treated the Hebrews with cruelty.

The empire of Assyria was raised to grandeur by the first of its four most famous emperors, who called himself Sargon, in honor of the great Sargon of old Babylonian days. In order to tell one from the other, we call him Sargon II. He ruled from 722 to 705 B.C. and built a magnificent new palace northeast of Nineveh. From the ruins of this splendid palace, we have many inscriptions that tell of his expeditions, and the man-headed bulls that guarded the palace gates are even finer than Assurnasirpal's.

Sargon II was the emperor who carried the Israelites into captivity. In dealing with the countries she conquered, it was an important part of Assyria's policy to carry conquered peoples far away from their homes and to replace them with others from distant parts of the empire. The captives suffered the bitterness of exile, their families often broken, their homes forever lost, the familiar sights and sound of their native lands reduced to sorrowful memories.

THE MIGHTY SENNACHERIB, SON OF SARGON II

Sennacherib, Sargon's son, came to the throne in 705 B.C. and ruled through 681 B.C. He was a statesman whose name was feared from Asia Minor to Egypt. Although he never crossed the Egyptian borders, he led his armies to the frontiers of Egypt. There, it is said, his warriors were defeated, not in battle but by a pestilence that rose from the marshes of the Nile Delta and sent them home, weakened or dying.

Sennacherib dealt severely with his enemies, as we may see in his treatment of the ancient city of Babylon when it dared to revolt against him. He destroyed the city and then, to make sure that its ruin was complete, he flooded it with the waters of a canal.

Sennacherib fought many campaigns and built and restored many palaces. The stone-pictures from one of his palaces show in a lively fashion how the important buildings in Assyria were set up on platforms. In these reliefs, the men mount with loads of stones, bricks and earth, hurl them down, and then descend to refill their empty baskets and hasten up again. There are crowds of workers in every direction—surely slaves and prisoners, for all are kept in order by overseers and taskmasters with threatening sticks in their hands. We can see rafts on the river close by, with eels wriggling about and little pigs with their mother among the reeds.

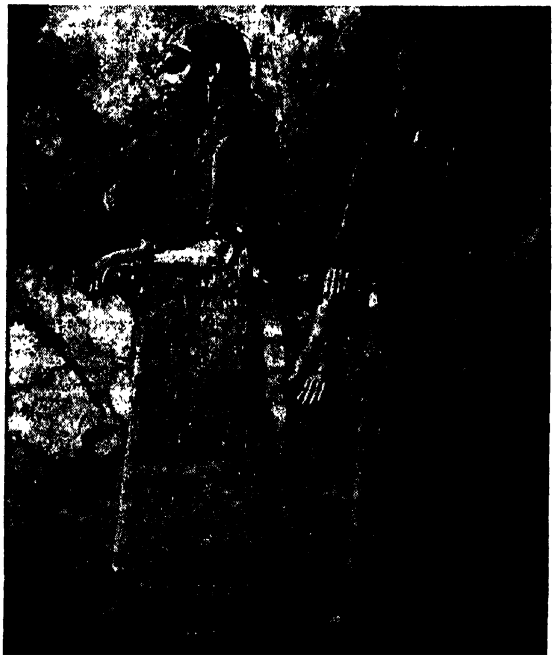
While the workmen hasten hither and thither with all sorts of tools and building materials, the impassive soldiers keep guard over the person of Sennacherib himself, gorgeous in patterned cap and fine tunic, standing in his splendid car, with a fine umbrella over his head and fly-flaps waved by his attendants. What heat and dust and noise the whole scene suggests!

The son of Sennacherib was Esarhaddon, emperor of Assyria from 681 to 668 B.C. Esarhaddon succeeded where his father had failed, and his conquest of Egypt made the Assyrian Empire larger than any that had yet existed in the history of the world. However, Egypt was very far away and when it later revolted, Assyria was not able to hold it.

Misery and destruction followed in the dreaded footsteps of the cruel Assyrian armies. Perhaps in modern days, when we hear of the burning of houses and towns and the deliberate destruction of crops, we may remember that such warfare is not new but very, very old. Today this method is called the "scorched-earth policy," and long ago the thought of it was enough to hold Assyria's subjects in terror.

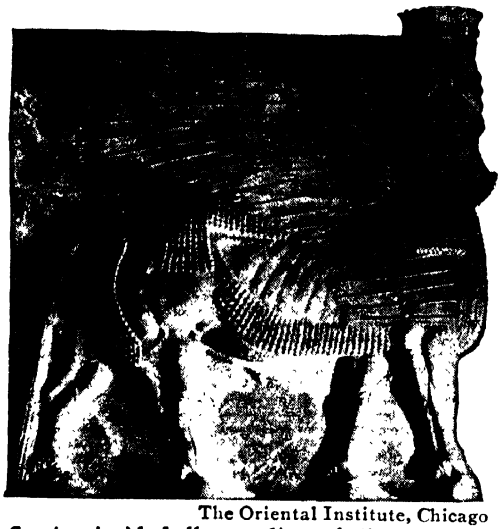
Last of the four great Assyrian emperors was Assurbanipal, who reigned from 668 to 626 B.C. It is amazing to think of the power in the hands of this one man. He was king over multitudes—not only over his own people in the valley of the two rivers, but also of the nations round, from the Persian Gulf to the Mediterranean Sea. One of Assurbanipal's greatest successes was his campaign against the Elamites who lived in the eastern mountains. He conquered their king and cut off his head, and the ancient kingdom of Elam was ended forever, while its treasures were carried over the mountains to Nineveh.

Hunting was Assurbanipal's favorite sport



The Oriental Institute, Chicago
Sargon's prime minister with attendant. This fine relief came from the palace of Sargon II.

and a very dangerous one, too. The reliefs from his palace show the Emperor hunting goats, wild asses, and even lions. These reliefs are in the finest and freest style of Assyrian art and are at their best when the wild beasts are in violent action, full of fury, terror or pain. Assyrian sculptors did not show any such warmth of feeling when their subjects were human beings. They made people all very much alike.



The Oriental Institute, Chicago

Great winged bull, guardian of the gates of the palace of Sargon II, sixteen feet high.

Assurbanipal was extremely proud of the fact that he knew how to write. Under his encouragement, literature flourished in Assyria. Like his grandfather Sennacherib and his great-grandfather Sargon, he was a book-collector. These collections of books at Nineveh are by no means the oldest libraries in western Asia. Older collections have been found in the ruins of the Sumerian cities; especially worth remembering is the library of Sumerian literature at Nippur, which dates from a little after 2000 B.C. But the Assurbanipal library is probably the largest and most complete.

Twenty-two thousand books—clay tablets, of course—were found in the library at Nineveh, where nobody had touched them for 2,500 years. In ancient days the royal library was a busy place, for Assurbanipal sought for copies of old Babylonian books and set scribes to work copying, repairing, translating and arranging, as well as writing new annals.

Let us spend a little time wandering through this wonderful library. Assurbanipal wanted to make sure that no one would take any books away, and he said so in his bookplate: "The palace of Assurbanipal, king of Assyria, who putteth his trust in the gods Assur and Bêlit, and who has eyes which see, and ears which hear. I have written upon tablets the noble products of the work of the scribe, which none of the kings who had gone before me had learned. I have arranged them in classes, I have revised them and placed them in my palace that I, even I, the ruler who knoweth the light of Assur, the king of the gods, may read them. Whosoever shall carry off this tablet, or write his name upon it side by side with mine own, may Assur and Bêlit overthrow him in wrath and anger, and may they destroy his name and posterity in the land."

We see that the books are arranged in classes, as Assurbanipal said. There are scientific, literary, historical and religious works, besides grammars, dictionaries and quantities of letters. The history section is especially full, for the kings loved to record their doings in great detail. As we read, we realize the vast stretch of centuries that goes back to old Sumerian and Babylonian times.

But it is the literary tablets in the library at Nineveh that arouse the greatest interest. For they contain copies of two great Babylonian epics, the EPIC OF CREATION, and the EPIC OF GILGAMESH. In the EPIC OF CREATION, the familiar scenes of the opening chapters of the Book of Genesis rise before us as we read of the creation of the planets and the stars, of the moon made to set a limit for the days and of the fashioning of man. In the EPIC OF GILGAMESH we read again of the flood that came upon mankind, the story of which the Babylonians borrowed from the Sumerians.

Many of the tablets are cracked and broken now, and many show marks of fire. For there came a day—some fifty years after Assurbanipal's death—when the quiet library was deserted. The high tide of Assyrian power had begun to turn even before this great emperor died. The kings who succeeded him were unable to quell revolts which grew steadily more dangerous.

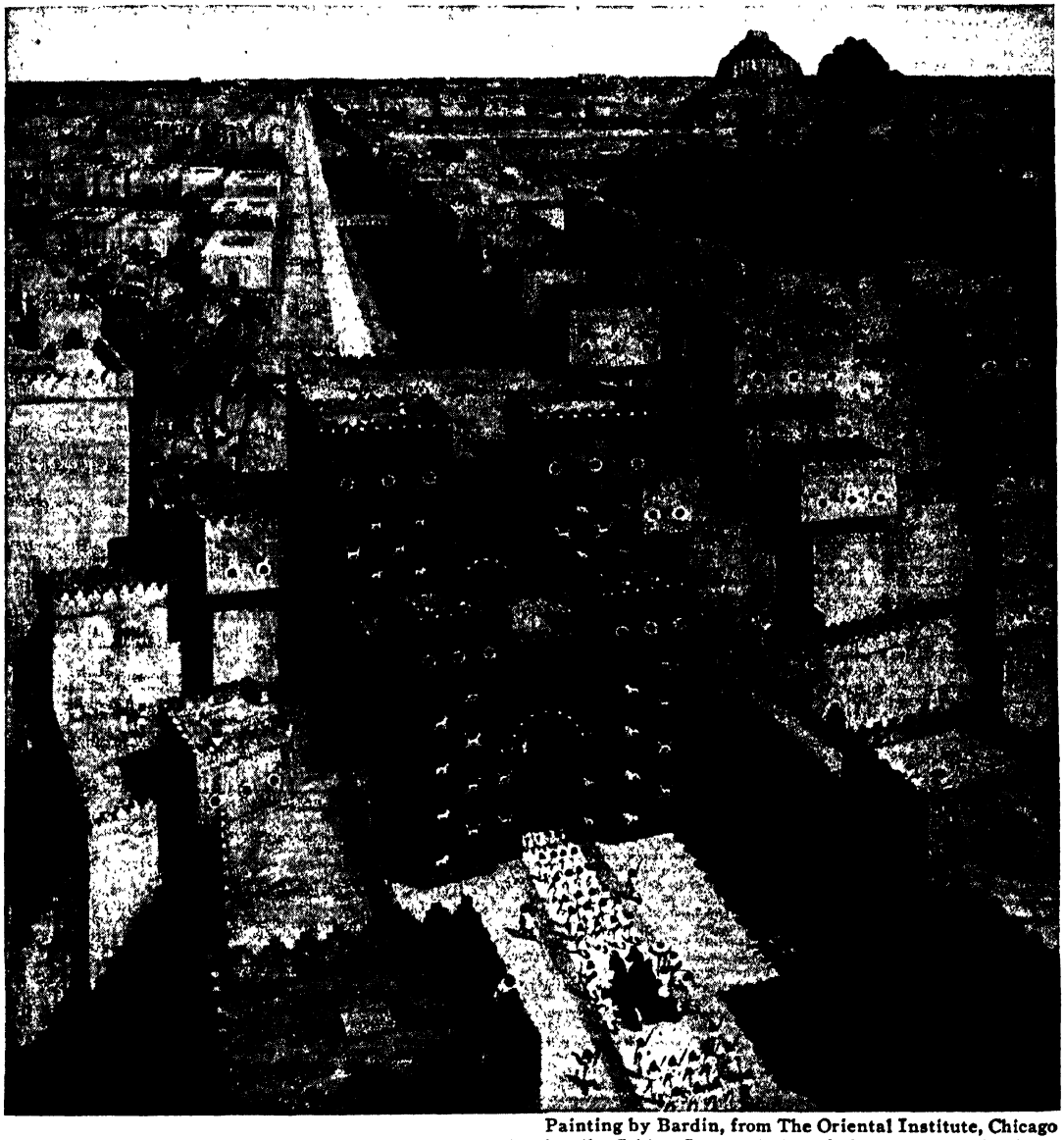
Tribes from the desert and the hills had been drifting into the empire, weakening it still more. Among them were hordes of Arameans who came from Syria on the west. There were so many of them that their language, Aramaic, was spoken even in the city of Nineveh itself. This was the tongue that would soon be most commonly used throughout western Asia, and in which, at a later date, Jesus spoke.

A new and hostile race threatened Assyria

on the north—the Indo-Europeans, whose chief tribes were the Medes and the Persians. To the south, for centuries past, desert nomads had been venturing onto the old Babylonian Plain. These were the Kaldi, whom we call Chaldeans. They were the founders of the last and most splendid of the three empires, Chaldea.

By 616 B.C., the Chaldeans were the lords of the old plain of Babylon. Their capital was the city of Babylon, which had been rebuilt after Sennacherib had so ruthlessly destroyed it. Nabopolassar, king of Chaldea, dreamed of destroying Assyria, but this was no easy thing to do. He won some great victories, but he found that he was not strong enough to finish the conquest of Assyria all by himself. For help, he turned to the Medes, who lived in the north.

Together the allies assaulted Nineveh. After a siege of two years, they conquered the proud old capital and destroyed it by fire. That was how the wooden shelves of the royal library were burned and the clay tablets fell on the floor, some of them broken and licked by flames, over 2,500 years ago. Nineveh fell in 612 B.C. and the empire of Assyria vanished forever.



Painting by Bardin, from The Oriental Institute, Chicago

The city of Babylon in the reign of Nebuchadnezzar, showing the Ishtar Gate and the fabulous Hanging Gardens.

Desolate and empty now, the ruin that was Nineveh lay open to the winds and rain. Sand and dust drifted in, and slowly the fine alabaster reliefs in the palace halls and the winged bulls at the palace gates became covered with mud. The soft, sun-dried bricks turned back to clay, until all that could be seen was a shapeless mound where weeds and wildflowers grew.

After the conquest of Assyria, the Medes went back to the mountains. The Chaldeans now ruled the lands between the rivers, and the western nations as well.

NEBUCHADNEZZAR, THE FAMOUS RULER OF CHALDEA

These were the days of Nebuchadnezzar, Chaldea's greatest king. His name has become a glittering symbol of wealth and power, but in the Bible he is most famous as a worshiper of false gods. The son of Nabopolassar, Nebuchadnezzar reigned with the utmost magnificence from 604 to 561 B.C.

Nebuchadnezzar destroyed the city of Jerusalem and carried the Hebrews into captivity, where he tried to make them worship the gods of Chaldea. His wrath was terrible when they refused to bow down before the golden image that he had set up, as we may read in the story of Shadrach, Meshach and Abed-nego in the Bible.

There seemed no limit to the gold that Nebuchadnezzar lavished upon his beloved city of Babylon. He protected it with enormous, fortified walls and rebuilt the old Babylonian temples that had fallen into decay. Near the temple of Marduk, he built a lofty temple-mount which reminds us of the Tower of Babel. Tradition says that the Tower of Babel stood outside the city at a place called Birs Nimrud, where ruins remain to this day.

On the roof of his vast palace, overlooking the Ishtar Gate, Nebuchadnezzar built gardens that were one of the greatest marvels of the ancient world. These were the famous Hanging Gardens of Babylon that rose in terrace upon terrace, a wonderful sight, luxuriant with ferns and palm trees.

It is not difficult to understand the intense pride of Nebuchadnezzar as he walked through his rich palace; but his fate was tragic. Sudden madness fell upon him, and the Bible tells us that this mighty emperor was "driven from men, and did eat grass as oxen."

More important to mankind than all these wonders was the fact that the Chaldeans made the world's first contribution to the science of astronomy. In Chaldea, as in ancient Sumer and Babylonia, some of the heavenly bodies were believed to be gods and goddesses. For this reason, the priests and astrologers watched the heavens closely, in the hope that the stars and planets would reveal the will of the gods. They made records of the motions of the heavenly bodies, and in time these records were kept with great regularity and accuracy. The Chaldeans had well-kept records covering a period of more than 360 years.

One of the ablest of the Chaldean astronomers used the records to make a timetable of the heavens and came very close to figuring out the exact length of a year. A century later, another Chaldean made the calculations once again, still more accurately. To their eternal glory, the Chaldean astronomers were the first to show mankind that the heavens were ruled, not by the whims of mythical gods, but by a great system of order.

The glory of Chaldea soon faded away. The king who followed Nebuchadnezzar was weak and unimportant, quite unfit to maintain the power of Chaldea. His son, Belshazzar, was a famous ne'er-do-well.

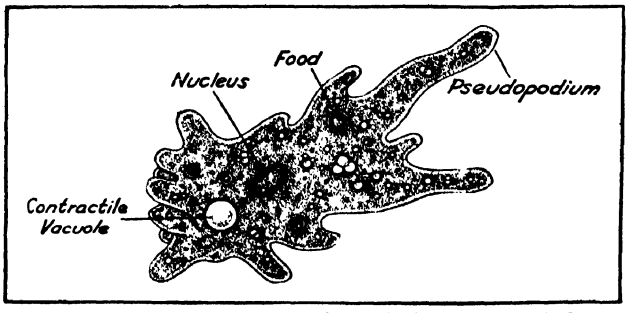
THE FEAST THAT WAS HELD FOR A THOUSAND GUESTS

Who has not heard of the feast Belshazzar gave to a thousand guests, and of the miraculous writing that appeared on the palace wall? Even the Chaldean fortune-tellers could not explain the meaning of the strange words: *Mene, mene, tekel, upharsin.* Then Daniel, in his great wisdom, told Belshazzar their meaning. "God hath numbered thy kingdom, and finished it. Thou art weighed in the balances, and art found wanting. Thy kingdom is divided and given to the Medes and Persians."

These prophetic words were fulfilled that very night. While the careless feasted within the city, hostile armies were closing in upon the great walls of Babylon. Led by Cyrus the Great, the Persians had been silently turning aside the course of the Euphrates which ran through the city, so that they could pass in over its dried-up bed. Belshazzar was killed, but Cyrus entered Babylon without fighting, sparing the splendid city. This was in 538 B.C. Only seventy-four years had passed since Nineveh had fallen. The empire of Chaldea had lasted for only a brief space in time, but in the annals of history its splendor still endures.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 807.

THE TINIEST LIVING THINGS



General Biological Supply House

A greatly enlarged picture of the ameba, the simplest of all animals. It is a one-celled creature that looks like jelly.

SUPPOSE we take a trip to the zoo. We shall see many kinds of living things, lions yawning behind the heavy bars of their cages, giraffes browsing on the leaves of trees far above our heads, ducks paddling through the green water of a goldfish pond. We shall enjoy the sight of tall trees, flowers and grass. When we get home we shall have seen so many interesting things that we find it hard to remember them all.

But there will have been millions of living things present which we never saw at all, though they were all around us. Some of them would have touched us without our knowing it. These things were so small that no human eye could see them. Most of them could be seen under a microscope, however. Such very, very tiny forms of plant and animal life are called microscopic creatures.

When the lion licked his paw he swallowed thousands of microscopic bacteria, tiny forms of plant life which lack chlorophyl, or green coloring matter. We sometimes call bacteria germs or microbes. When the little girl next to you sneezed she sent out other microbes into the atmosphere. Riding on the dust that blew across the road were other thousands of one-celled creatures, most of them harmless, but some the germs of deadly diseases.

Inside all the animals, from the elephant to the mice who steal the crumbs of the elephant's food, were other millions of tiny living things. Fortunately, most of these microbes, even those that live inside animals (and also in us), seem to be harmless.

We noticed that the water along the edge of the fish pond was green. Take a glass full and hold it up to the light. It is bright green, as if some one had poured green ink into the water. When we put a drop under a powerful microscope we discover that the water itself really is not green after all, but that the color comes from millions of tiny round green plants, which scientists classify as algae. (Not all algae are so small, of course. Seaweeds are algae and some of these grow to be very large.)

Sometimes green water is due to other living things much larger than the ones just mentioned, although these other types are also too small to be seen without the microscope. These creatures swim actively instead of merely floating. At the front end of the body they have a long, living thread which they whirl about like a propeller. Since they have many of the structures of a one-celled animal, some scientists call them animals. But as they make their own food (by means of their green coloring matter, as plants do) other scientists have called them plants. Perhaps the best thing to do is to call them plant-animals. The commonest creature of this kind is the Euglena.

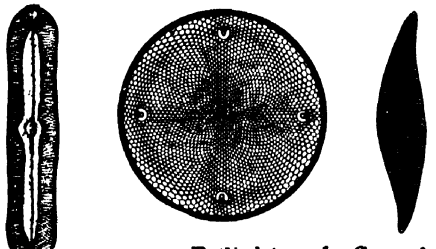
If we go back to the pond (with the microscope) we shall find whole under-water jungles of microscopic plants. Some of these tiny algae are grass-green, some yellow-green, some almost blue, and some reddish in color. In northern countries the snow is sometimes made red by billions of such plants. Many of these plants float in the water, some swim, some form a slimy coating on leaves and stones, and some consist of tiny threads. Some of these living threads are large enough to be seen with the naked eye. Others must be magnified several hundred times to be visible. Sometimes the tiniest threads grow on the larger threads much as little ferns and mosses grow on the trunks of trees.

Some of the tiny plants have shells! The diatoms, which are one-celled plants, live in transparent shells made of a substance resembling glass. The markings on these shells are so fine that they are used to test the lenses of powerful microscopes.

Prowling through these microscopic water

jungles are the one-celled animals we call the protozoa. One of these is the famous ameba, the simplest of all animals. It is hard to describe the ameba's shape, since its outline is always changing. Imagine a tiny transparent piece of jelly *crawling* along the under side of a water-lily leaf. It has no legs, no arms, no fins, no head, no mouth. It crawls by pushing part of its jelly-like body forward; then the rest of the ameba flows into the pushed-out part. Such pushed-out parts are called pseudopodia, or false feet. If you poke the front end of an ameba with a sharp needle, it will "go into reverse" and move off in another direction.

Although it has no mouth the ameba has no trouble in eating; it has no difficulty in digesting its food even with no stomach or intestines. It eats tiny plants and it frequently captures little animals which can move much faster than itself. It secures its prey by pushing out the false feet, or projections we spoke about, and letting them flow around the victim. The ameba always takes in a drop of water with the food plant or animal and frequently the victims can be seen swimming about in this drop of water (or food vacuole, as it is called).

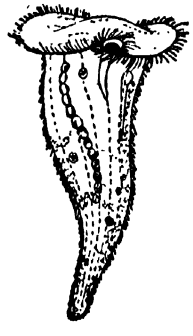


Both pictures by General Biological Supply House

Three forms of diatoms—tiny plants which live in shells made of glass-like material.

Another protozoan, about the size of the ameba is the paramecium. Often it is called the slipper animal because it seems slipper-shaped when seen through the microscope. Really it is shaped more like a submarine, but it looks flat to us through the microscope. The paramecium dashes through the water at what seems to be great speed. Like the ameba, it has no arms, legs or fins; but it is covered with rows of tiny hair-like structures called cilia. These cilia are as soft as jelly, but they beat in the water something like oars. You might say that the paramecium rows itself through the pond water with the cilia.

The paramecium, like the ameba, has no stomach, no brain, no heart. But its little one-celled body has a sort of mouth. This mouth is not at the front end of the body, but at one side and is lined with cilia. As the paramecium swims, it turns around and around like a top, and the food (tiny protozoa and bacteria) are forced into the mouth opening by the beating of the cilia.



This megaphone-shaped protozoan is the stentor.

Another protozoan, the stentor, varies from grey to blue in color. It is shaped something like a megaphone. Somewhat smaller is a beautiful pink creature, the blepharisma. Now the blepharisma is a favorite food article of the stentor, and where both are abundant the bluish colored stentors will devour their pink companions until the stentor's sides bulge out.

The principal method of reproduction among the one-celled animals and plants is simple; they split in half. Inside each of the protozoa and in each cell of the various algae is a more solid part called the nucleus. This splits first; soon after, the rest of the cell divides. Now there are two living things where there was one. And you could not say that either of the new individuals was the parent of the other.

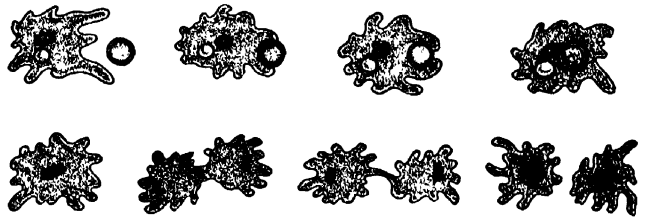
Protozoa are found in many strange places. A kind of small ameba sometimes gets into the human digestive tract when food or water supplies are not properly guarded, and causes the disease called amebic dysentery. Another tiny protozoan is the cause of malaria.

The great Chalk Cliffs of England are formed mostly of billions of tiny skeletons of ameba-like creatures called foraminifera. These little animals swarm in the waters of the ocean. When they die their shells sink to the ocean floor. Large parts of the ocean floor are covered with an oozy layer of tiny shells, mostly the chalky shells of microscopic animals and the glassy shells of microscopic plants. When you go to the blackboard you write with the remains of millions of microscopic animals. That is what chalk is.

Suppose we compare a drop of pond water under the microscope to an aquarium. The ameba and the paramecium may each be about 1/125 of an inch long. They are among the giants of our microscopic aquarium, as the shark and the large octopus might be in a large aquarium. Many smaller protozoa will be observed swimming, crawling or skipping about them, being about the same size in relation to the paramecium as

ordinary small fish are to a great shark. Soon we notice the paramecium pause when it comes to a jelly-like motionless mass attached to some decaying leaf or stick. Its cilia continue to beat and we see that it is taking little bead-like dots into its "mouth" opening. The paramecium has found its favorite food, a colony of bacteria. Each of the little dots that it eats is a single bacterium.

So far, in discussing protozoa and algae we have been talking about the larger and more highly organized among the microscopic creatures. Now we come to the bacteria, which are really tiny. For example, the bacterium which causes the disease anthrax is from 1/5000 to 1/2500 of an inch in length and so narrow that about 18,000 of them could lie side by side in a space an inch wide. The anthrax bacterium is one of the largest of the bacteria.



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Top—An ameba "eats" food. Bottom—One ameba becomes two.

Some of the smallest bacteria look like little golf balls. It would take about 170,000 of the very small ones placed side by side to make a line an inch long. And if we wished to cover a 25-cent piece with a single layer of bacteria of average size it would take 100,000,000 of them.

Small as they are, some of the bacteria are among man's deadliest enemies—and some of them are among our best friends. Tuberculosis, typhoid fever, diphtheria and many other diseases of man and of animals are caused by bacteria which invade the body. Other bacteria spoil food. Yet scientists believe that if it were not for certain bacteria we would all starve to death.

These valuable bacteria are called the nitrogen-fixing bacteria. All living things need a supply of the element nitrogen which forms 78 per cent of the atmosphere. Every time you inhale you breathe in mostly nitrogen. But when you exhale you breathe all the nitrogen out again. Although we need the element we can not make use of the nitrogen gas in the air. We have to get our supply from our food. So do lower animals. The green plants (which make their own food) can get nitrogen from certain chemical compounds in the soil, when these compounds are present. But the plants also are unable to use the nitrogen from the air.

Fortunately, certain types of bacteria which live in the soil can absorb nitrogen from the air and combine it with other elements to make compounds which the green plants can use. Some of these bacteria grow on the roots of clover, beans, peas and other members of the pea family. Let us see what happens in a clover field. The clover and the bacteria work as partners. The bacteria supply the clover with nitrogen and the clover supplies the bacteria with sugar, which the bacteria find very useful. When the plants die, the nitrogen-bearing bacteria enter the soil. As a result of this exchange, clover and other such plants are said to enrich the soil.

Other bacteria destroy dead animal and plant remains, and change them into substances which green plants can use. This process is called decay. What a world this would be if dead trees, tigers, whales and other creatures never decayed! Due to the bacteria of decay all of this material (including garbage) is turned into food substances for vegetation. Generally speaking, the richer the soil, the more bacteria it contains. A grain of garden soil may contain 300,000 bacteria.

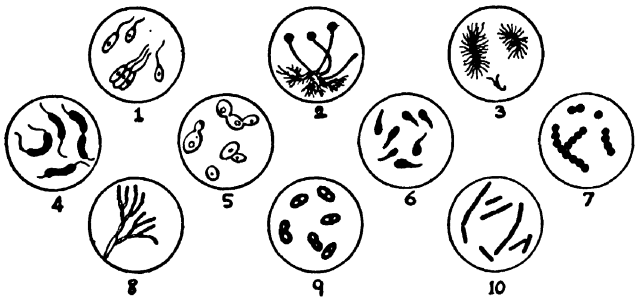
Bacteria are also useful in industry. They assist in the tanning of leather and the retting (rotting) of flax for linen. They aid in making alcohol from grain.

You know how important it is to keep fresh milk chilled. Otherwise certain bacteria will grow in it and spoil it. Milk is the nearly perfect food for children. It is also a perfect food for bacteria. Some of the bacteria which grow in milk cause diseases, but there are other bacteria frequently present which are not only harmless, but which check the growth of the harmful ones. Among these good bacteria are the ones which make milk turn sour. In many countries sour milk, buttermilk, kumiss, acidophilus and other "bacteria milks" are important foods. Bacteria also aid in the making of butter and cheese from milk.

Bacteria may be grouped in three classes, according to their shape—spherical (round); rod-shaped; and spiral. Round bacteria are called cocci, or coccus forms. The ones shaped like little rods are called bacilli, or bacillus forms. The spiral ones, or spirilla, look like little corkscrews.

We mentioned that ameba and other microscopic animals multiply by simply splitting in half. The bacteria are the real experts in rapid multiplication. Suppose we start with one bacterium and give it enough food and proper warmth and moisture. In fifteen to twenty minutes it will have absorbed so much food that it has grown to twice its original size and has split into two new individuals. Twenty minutes later each of these two will have doubled in size and divided, so that now there are four. If you like to figure out things, you will find that if conditions remain favorable there will be hundreds and hundreds of billions of bacteria present by the end of two days.

Many bacteria can stand conditions which would kill most other living things. Some of them have been kept in dry soil within sealed jars for fifty years. When the soil was moistened they were just as healthy as ever. Enough heat will kill all bacteria (and all other living things); but many bacteria can live for a long time at temperatures far below freezing; though they may appear dead, for they will neither grow nor multiply at such cold. Some bacteria can stand great heat, can grow and multiply at temperatures up to 176 degrees Fahrenheit. These are the bacteria which grow in haystacks; in their life-processes they themselves produce so much heat that finally the haystack may burst into flame.



The diagram shows samples of some primitive forms of life: 1. Flagellates 2. Black mold 3. Typhoid bacilli 4. Spirilla 5. Yeast 6. Nitrogen-fixing bacteria 7. Streptococci 8. Blue mold 9. Diplococci 10. Tuberculosis bacilli

Bacteria have many enemies. Man kills them with poisons and with heat. Many are eaten by small animals. Only recently scientists learned that many plants produce juices that kill bacteria, the most famous being penicillin produced by a green mold which grows on stale bread. Direct sunlight kills many bacteria of disease.

Another group of tiny living things are the one-celled plants called yeasts. The cake of compressed yeast you buy at the grocery store consists of millions of microscopic living yeast plants (belonging to the great group called the fungi) which have been pressed into a sort of little cake with some starch to hold them together.

When your mother mixes yeast with flour and water in making bread, the yeast plants "wake up." They absorb water and swell in size (though still far too small to be seen without a microscope) and start to feed by absorbing some of the flour. How can they feed without a mouth? Not by sending out projections in the way the ameba does, but by another method which works very well.

The yeast plant consists of only one cell. It has a wall, or membrane, surrounding it. The little particles of flour can not pass through this membrane, so the yeast produces and sends out digestive juices which break down, or digest, the flour outside of the yeast's tiny body. Then the yeast is able to take in the flour and to profit just as much as if it had digested the flour by means of a stomach and intestine inside itself. Soon the yeast plant starts to grow, and if it is not disturbed it will produce new yeast plants. These grow out as little football-shaped buds.

The yeast carries on a work called fermentation. In this process yeast changes sugar into two totally different substances, alcohol and carbon dioxide (the same gas that our lungs give off in breathing). Wine and other alcoholic drinks result from the alcohol made in fermentation, and the bubbles which make cakes and bread rise are bubbles of carbon dioxide. Even if we do not put any sugar in the flour, a chemical change will occur when moisture is added, causing some of the starch in the flour to change into sugar. Then the yeast breaks up the sugar into alcohol and carbon dioxide.

Until recently scientists believed that the smallest bacteria were the tiniest living things. But the fact that many diseases are caused by bodies too small to be seen by our finest microscopes makes us wonder if there are not living things much smaller even than the bacteria. Rabies, yellow fever, influenza, chickenpox and measles are among the diseases caused by the viruses, as these ultramicroscopic bodies are called. By means of the electron microscope several of the viruses have been photographed.

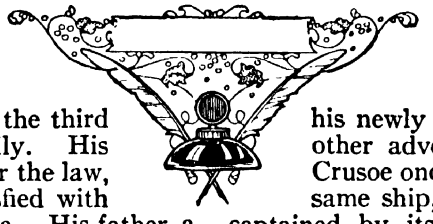
By THOMAS GORDON LAWRENCE.

THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 931.

THE GREATEST STORY OF ADVENTURE

WHEN we read the Iliad and the Odyssey, The Faerie Queene and Don Quixote, we all know that such adventures as those books describe will not fall to us. But in the early part of the eighteenth century an Englishman wrote a story of marvelous adventure that for a long time was regarded as a true narrative. The writer was Daniel Defoe, and his story Robinson Crusoe. It is a great work of the imagination, although the real adventures of a shipwrecked sailor named Alexander Selkirk may have suggested the idea of Robinson Crusoe to Defoe. The story has been translated into many foreign languages. It is on account of Robinson Crusoe that Daniel Defoe is called the "Father of English Fiction."

ROBINSON CRUSOE



AT the beginning of his story Robinson Crusoe tells us that he was born in York in 1632, the third son of a good family. His father intended him for the law, but he would be satisfied with nothing but going to sea. His father, a wise and grave man, gave him serious and excellent counsel, telling him that it was men of desperate fortunes, on the one hand, or of aspiring, superior fortunes, on the other, who went abroad upon adventures. But young Robinson soon forgot the advice of his father. On September 1, 1651, he boarded a ship bound from Hull to London.

This vessel was wrecked, but the men made their way to shore in a boat sent from a lightship. They landed near Cromer, and walked to Yarmouth. There they had money given them to carry them to Hull or London, as they thought fit. Without heeding the warning of the master of the wrecked vessel, who bemoaned the fact that he had taken one so like Jonah in his ship, Robinson Crusoe hardened his heart against going back. He went on to London, where he took passage as a gentleman adventurer on board a vessel bound for the coast of Africa. The captain, taking a fancy to him, instructed him what to buy for trading purposes, and on the voyage taught him much about navigation.

This voyage was most successful. He brought home 5 pounds 9 ounces of gold-dust. This he sold in London for £300 ($1,500). Investing $500 of his newly gained wealth in another adventure, Robinson Crusoe once more set out on the same ship, which was this time captained by its former mate. One morning when they were making their course toward the Canary Islands they were surprised by a Moorish rover of Sallee. After a severe fight all were carried prisoners into that port.

While the other men were carried up-country to the emperor's court, Robinson Crusoe was kept as a prize by the pirate captain, and made his slave.

When his new master went to sea, Robinson was left on shore to look after the garden. At other times the Moor took his white slave out fishing in the pinnace. Soon Crusoe became such a skillful fisherman that he was sent out alone or with a young Moor as his sole companion. When he had been two years a prisoner, an opportunity for escape presented itself. With Xury, a young black boy, he departed from Sallee in the long boat.

After many adventures the pair were picked up near Cape de Verde by a Portuguese ship bound for the Brazils. The captain proved very friendly and bought from Crusoe the long boat and the boy Xury.

Arriving in Brazil, Crusoe entered into partnership with a sugar planter. He wrote to England and asked that

goods to half the value of the money he had left there be sent out to him. Selling these goods at a large profit, he started a tobacco plantation. But at the end of four years he became restless. So he spoke to his fellow-planters about his early voyage to Africa.

He told them tales of exchanging trifles for ivory, gold-dust and slaves. One day three of the planters proposed that they should provide a ship if Crusoe would go with them to do the trading. Robinson Crusoe gladly agreed.

When the ship in which Crusoe and his companions sailed from the Brazils had been about twelve days out, it was caught in a violent hurricane, and they were taken quite out of their reckoning. One of the men died of fever, and a man and a boy were washed overboard.

It was resolved to make for the West Indies, the vessel being in a very battered condition. But they were taken by another great tornado, and for twelve days together they could do nothing but drive before the wind. Finally the ship struck on a sand bank. The men took to the boat, which was overturned at once by a gigantic wave. Robinson Crusoe was tossed senseless on the shore. When he recovered he found himself alone on an island. That night he spent in a tree for fear of prowling animals.

When Crusoe awoke from his sleep in the tree, he saw that the wrecked ship had been lifted from the sand bank and carried much farther inland. At the ebbing of the tide he was able to get within a quarter of a mile of her. So, hoping to get some things from her that would be useful, he swam out, and by the help of a piece of hanging rope managed to clamber on board. A dog and two cats were the only living creatures left on board, and these became his companions.

How the provisions and cargo were removed from the wreck

There being no time to lose, he filled his pocket with biscuits, which he ate as he went about, and he made a raft. On this he fastened some seamen's chests. He filled these with provisions, tools and ammunition, and then got his raft ashore.

For eleven days he kept returning to the vessel, and so brought away pretty well all that was on board. The next morning, when he left the hut he had made for himself on the shore, he looked out to sea. Behold, the ship was gone!

On a rising hill of rock, so that if any ship came in view he might be able to signal to her, he resolved to fix up a tent of sails.

In front of where his tent was to be he drew a semicircle some twenty yards in diameter and touching the rock at both ends. Along the edge of this semicircle he planted two rows of strong stakes, one six inches behind the other, driving them into the ground till they stood about five and a half feet above ground.

The ingenious defenses of Crusoe's island home

He sharpened the tops of the stakes, and filled the gap between them with cable from the ship. Then he placed other stakes inside, leaning against the others, about two and a half feet high, like a spur to a post. He thus had a fence so strong that neither man nor beast could get over it. He left no door, but made a short ladder which, when he was in, he lifted over after him.

Into this fence, or fortress, he carried all his riches, provisions and stores. Having fixed up a tent, he covered the whole with a large tarpaulin which he had saved among the sails.

In order that he might not lose his reckoning of time, he cut the following words on a large post: "I came on shore here on September 30, 1659." Making a kind of cross, he set this up on the shore. On the sides of the post every day he cut a notch, making every seventh notch as long again as the rest, to mark the Sundays.

How Crusoe waited four years to get some bread

Meanwhile he discovered that there were goats, rabbits and wild cats on the island, as well as wild birds. Of every creature he shot he preserved the skin.

When his fortress was completed, he made some chairs and a table. For every board he wanted, he had to cut down a tree, hew it thin with an ax, and smooth it with an adz. After a storm parts of the old wreck were washed ashore, and he was thus provided with planks and bolts.

One day, just before the rainy season, he emptied what appeared to be a quantity of husks and dust from an old barley-bag on to the ground. After the rains he saw a few stalks of something green shooting up. Later a number of ears of barley and rice came out. He

saved these ears and sowed them. But it was not until he had been four years on the island that he ventured to use any of the grains to make bread.

Here, in Defoe's words, is an account of Crusoe's island life, dress and a terrible fright he received when he had become accustomed to solitude and safety.

THE MYSTERIOUS FOOTPRINT IN THE SAND

BUT being now in the eleventh year of my residence and, as I have said, my ammunition growing low, I set myself to study some art to trap and snare the goats, to see whether I could not catch some of them alive; and particularly I wanted a she-goat great with young. To this purpose I made snares to hamper them; and believe they were more than once taken in them; but my tackle was not good, for I had no wire, and always found them broken, and my bait devoured. At length I resolved to try a pit-fall; so I dug several large pits in the earth, in places where I had observed the goats used to feed, and over these pits I placed hurdles of my own making too, with a great weight upon them; and several times I put ears of barley, and dry rice, without setting the trap; and I could easily perceive that the goats had gone in, and eaten up the corn, for I could see the marks of their feet; at length, I set three traps in one night, and going the next morning, I found them all standing, and yet the bait eaten and gone. This was very discouraging; however, I altered my trap; and, not to trouble you with particulars, going one morning to see my traps, I found in one of them a large old he-goat; and, in one of the others, three kids, a male and two females.

As to the old one, I knew not what to do with him; he was so fierce I durst not go into the pit to him; that is to say, to bring him away alive, which was what I wanted; I could have killed him, but that was not my business, nor would it answer my end; so I e'en let him out, and he ran away as if he had been frightened out of his wits; but I did not then know what I afterwards learned, that hunger would tame a lion: if I had let him stay there three or four days without food, and then have carried him some water to drink, and then a little corn, he would have been as tame as one of the kids; for they are mighty sagacious, tractable creatures, where they are well used.

However, for the present I let him go, knowing no better at that time; then I went to the three kids, and taking them one by one, I tied them with strings together; and with some difficulty brought them all home.

It was a good while before they would feed; but throwing them some sweet corn, it tempted them, and they began to be tame; and now I found that if I expected to supply myself with goat's flesh, when I had no powder or shot left, breeding some up tame was my only way, when perhaps I might have them about my house like a flock of sheep. But then it presently occurred to me that I must keep the tame from the wild, or else they would always run wild when they grew up; and the only way for this was to have some inclosed piece of ground, well fenced either with hedge or pale, to keep them in so effectually that those within might not break out, or those without break in.

This was a great undertaking for one pair of hands; yet as I saw there was an absolute necessity of doing it, my first piece of work was to find out a proper piece of ground; namely, where there was likely to be herbage for them to eat, water for them to drink, and cover to keep them from the sun.

Those who understand such inclosures, will think I had very little contrivance, when I pitched upon a place very proper for all these, being a plain open piece of meadow-land, or savanna (as our people call it in the western colonies), which had two or three little rills of fresh water in it, and at one end was very woody; I say they will smile at my forecast, when I shall tell them I began my inclosing of this piece of ground in such a manner, that my hedge, or pale, must have been at least two miles about; nor was the madness of it so great as to the compass; for if it was ten miles about, I was like to have time enough to do it in; but I did not consider that my goats would be as wild in so much compass, as if they had had the whole island; and I should have so much room to chase them in that I should never catch them.

My hedge was begun and carried on, I believe, about fifty yards, when this thought occurred to me; so I presently

stopped short, and for the first beginning I resolved to inclose a piece of about 150 yards in length, and 100 yards in breadth, which, as it would maintain as many as I should have in any reasonable time, so, as my flock increased, I could add more ground to my inclosure.

This was acting with some prudence, and I went to work with courage. I was about three months hedging in the first piece; and till I had done it, I tethered the three kids in the best part of it, and used them to feed as near me as possible, to make them familiar; and very often I would go and carry them some ears of barley, or a handful of rice, and feed them out of my hand; so that after my inclosure was finished, and I let them loose, they would follow me up and down, bleating after me for a handful of corn.

This answered my end, and in about a year and a half I had a flock of about twelve goats, kids and all; and in two years more I had three-and-forty, besides several I took and killed for my food; and after that I inclosed five several pieces of ground to feed them in, with little pens to drive them into, to take them as I wanted them; and gates out of one piece of ground into another.

But this was not all; for now I not only had goat's flesh to feed on when I pleased, but milk, too, a thing which indeed in my beginning I did not so much as think of and which, when it came into my thoughts, was really an agreeable surprise; for now I set up my dairy, and had sometimes a gallon or two of milk in a day. And as Nature, who gives supplies of food to every creature, dictates even naturally how to make use of it, so I, that had never milked a cow, much less a goat, or seen butter or cheese made, very readily and handily, though after a great many essays and miscarriages, made me both butter and cheese at last, and never wanted it afterwards.

How mercifully can our great Creator treat his creatures, even in those conditions in which they seemed to be overwhelmed in destruction! How can he sweeten the bitterest providences, and give us cause to praise him for dungeons and prisons! What a table was here spread for me in a wilderness, where I saw nothing at first but to perish for hunger!

It would have made a stoic smile, to have seen me and my little family sit down to dinner: there was my majesty, the prince and lord of the whole island; I had the lives of all my subjects at absolute command; I could hang, draw, give liberty, and take it away, and no rebels among all my subjects!

Then to see how like a king I dined, too, all alone, attended by my servants! Poll, as if he had been my favorite, was the only person permitted to talk to me; my dog, which was now grown old and crazy, and found no species to multiply his kind upon, sat always at my right hand; and two cats, one on one side the table, and one on the other, expecting now and then a bit from my hand as a mark of special favor.

But these were not the two cats which I brought on shore at first, for they were both of them dead, and had been interred near my habitation by my own hands; but one of them having multiplied by I know not what kind of creature, these were two which I preserved tame, whereas the rest ran wild into the woods, and became indeed troublesome to me at last; for they would often come into my house, and plunder me too, till at last I was obliged to shoot them, and did kill a great many. At length they left me with this attendance, and in this plentiful manner I lived; neither could I be said to want anything but society, and of that, in some time after this, I was like to have too much.

I was something impatient, as I have observed, to have the use of my boat, though very loth to run any more hazard: and therefore sometimes I sat contriving ways to get her about the island, and at other times I sat myself down contented enough without her. But I had a strange uneasiness in my mind to go down to the point of the island, where, as I have said, in my last ramble, I went up the hill to see how the shore lay and how the current set, that I might see what I had to do: this inclination increased upon me every day; and at length I resolved to travel thither by land, and following the edge of the shore, I did so: but had any one in England been to meet such a man as I was, it must either have frighted them or raised a great deal of laughter; and, as I frequently stood still to look at myself, I could not but smile at the notion of my traveling through Yorkshire with such an equipage, and in such a dress. I had a great high shapeless cap, made of goat's-

skin, with a flap hanging down behind, as well to keep the sun from me, as to shoot the rain off from running into my neck; nothing being so hurtful in these climates as the rain upon the flesh under the clothes. I had a short jacket of goat's-skin, the skirts coming down to about the middle of my thighs, and a pair of open-kneed breeches of the same; the breeches were made of the skin of an old he-goat, whose hair hung down such a length on either side, that, like pantaloons, it reached to the middle of my legs. Stockings and shoes I had none, but I made me a pair of something. I scarce know what to call them, like buskins, to flap over my legs, and lace on either side like spatterdashes; but of a most barbarous shape, as indeed were all the rest of my clothes.

I had on a broad belt of goat's-skin dried, which I drew together with two thongs of the same, instead of buckles; and in a kind of frog on either side of this, instead of a sword and dagger, hung a little saw and hatchet; one on one side, one on the other: I had another belt not so broad, and fastened in the same manner, which hung over my shoulder; and at the end of it, under my left arm, hung two pouches, both made of goat's-skin too; in one of which hung my powder, in the other my shot: at my back I carried my basket, on my shoulder my gun, and over my head a great clumsy ugly goat's-skin umbrella, but which, after all, was the most necessary thing I had about me, next to my gun: as for my face, the color of it was really not so Mulatto-like as one might expect from a man not at all careful of it, and living within nine or ten degrees of the equinox. My beard I had once suffered to grow till it was about a quarter of a yard long, but as I had both scissors and razors sufficient, I had cut it pretty short, except what grew on my upper lip, which I had trimmed into a large pair of Mahometan whiskers, such as I had seen worn by some Turks whom I saw at Sallee: for the Moors did not wear such though the Turks did. Of these mustachios, or whiskers, I will not say they were long enough to hang my hat upon them; but they were of length and shape monstrous enough, and such as in England would have passed for frightful.

But all this is by-the-by; for, as to my figure, I had so few to observe me that it was no manner of consequence, so I say no more to that part: in this kind of figure I went my new journey, and was out five or six days. I travelled first along the sea-shore, directly to the place where I first brought my boat to an anchor to get up upon the rocks, and having no boat now to take care of, I went over the land a nearer way to the same height that I was upon before; when looking forward to the point of the rock I was obliged to double with my boat, as I said above, I was surprised to see the sea all smooth and quiet; no rippling, no motion, no current, any more there than in other places.

I was at a strange loss to understand this, and resolved to spend some time in the observing of it, to see if nothing from the sets of the tide had occasioned it; but I was presently convinced how it was; namely, that the tide of ebb setting from the west, and joining with a current of waters from some great river on the shore, must be the occasion of this current; and that, accordingly as the wind blew more forcibly from the west, or from the north, this current came nearer or went farther from the shore; for, waiting thereabouts till evening, I went up to the rock again, and then the tide of ebb being made, I plainly saw the current again as before, only that it ran farther off, being near half a league from the shore: whereas in my case it set close upon the shore, and hurried me and my canoe along with it, which at another time it would not have done.

This observation convinced me that I had nothing to do but to observe the ebbing and the flowing of the tide, and I might very easily bring my boat about the island again. But when I began to think about putting it in practice I had such terror upon my spirits at the remembrance of the danger I had been in, that I could not think of it again with any patience; but, on the contrary, I took up another resolution, which was more safe, though more laborious; and this was, that I would build, or rather make me another periagua, or canoe, and so have one for one side of the island, and one for the other.

You are to understand that now I had, as I may call it, two plantations in the island; one, my little fortification or tent, with the wall about it under the rock, with the cave behind me, which by this

time I had enlarged into several apartments or caves, one within another. One of these, which was the driest and largest, and had a door yet beyond my wall or fortification, that is to say, beyond where my wall joined to the rock, was all filled up with large earthen pots, of which I have given an account, and with fourteen or fifteen great baskets, which would hold five or six bushels each, where I laid up my stores of provision, especially my corn, some in the ear cut off short from the straw, and the other rubbed out with my hands.

As for my wall, made as before, with long stakes or piles, those piles grew all like trees, and were by this time grown so big, and spread so very much, that there was not the least appearance, to any one's view, of any habitation behind them.

Near this dwelling of mine, but a little farther within the land, and upon lower ground, lay my two pieces of corn-ground, which I kept duly cultivated and sowed, and which duly yielded me their harvest in its season; and whenever I had occasion for more corn, I had more land adjoining as fit as that.

Besides this, I had my country-seat, and I had now a tolerable plantation there also; for, first, I had my little bower, as I called it, which I kept in repair; that is to say, I kept the hedge which circled it in constantly fitted up to its usual height, the ladder standing always in the inside: I kept the trees, which at first were no more than my stakes, but were now grown very firm and tall,—I kept them always so cut, that they might spread and grow thick and wild, and make the more agreeable shade, which they did effectually to my mind. In the middle of this I had my tent always standing, being a piece of sail spread over poles set up for that purpose, and which never wanted any repair or renewing; and under this I had made me a squab or couch, with the skins of the creatures I had killed, and with other soft things, and a blanket laid on them, such as belonged to our sea-bedding, which I had saved, and a great watch-coat to cover me; and here, whenever I had occasion to be absent from my chief seat, I took up my country habitation.

Adjoining to this I had my inclosures for my cattle, that is to say, my goats; and as I had taken an inconceivable deal of pains to fence and inclose this ground, I was so uneasy to see it kept entire, lest the goats should break through, that I never left off, till with infinite labor I had stuck the outside of the hedge so full of small stakes, and so near to one another, that it was rather a pale than a hedge, and there was scarce room to put a hand through between them, which afterwards, when those stakes grew, as they all did in the next rainy season, made the inclosure strong like a wall, indeed stronger than any wall.

This will testify for me that I was not idle, and that I spared no pains to bring to pass whatever appeared necessary for my comfortable support; for I considered the keeping up a breed of tame creatures thus at my hand would be a living magazine of flesh, milk, butter, and cheese for me, as long as I lived in the place, if it were to be forty years; and that keeping them in my reach depended entirely upon my perfecting my inclosures to such a degree that I might be sure of keeping them together; which, by this method, indeed, I so effectually secured that, when these little stakes began to grow, I had planted them so very thick I was forced to pull some of them up again.

In this place also I had my grapes growing, which I principally depended on for my winter store of raisins, and which I never failed to preserve very carefully as the best and most agreeable dainty of my whole diet; and indeed they were not only agreeable, but physical, wholesome, nourishing, and refreshing to the last degree.

As this was also about half way between my other habitation and the place where I had laid up my boat, I generally stayed and lay here in my way thither; for I used frequently to visit my boat, and I kept all things about or belonging to her in very good order. Sometimes I went out in her to divert myself, but no more hazardous voyages would I go, nor scarce ever above a stone's cast or two from the shore, I was so apprehensive of being hurried out of my knowledge again by the currents, or winds, or any other accident. But now I come to a new scene of my life.

It happened one day about noon, going towards my boat, I was exceedingly surprised with the print of a man's naked foot on the shore, which was very plain to be seen in the sand. I stood like one thunderstruck, or as if I had seen an

apparition. I listened, I looked round me; I could hear nothing, nor see anything; I went up to a rising ground to look farther. I went up the shore, and down the shore, but it was all one; I could see no other impression but that one. I went to it again, to see if there were any more, and to observe if it might not be my fancy, but there was no room for that, for there was exactly the very print of a foot, toes, heel, and every part of a foot: how it came thither I knew not, nor could in the least imagine. But after innumerable fluttering thoughts, like a man perfectly confused, and out of myself, I came home to my fortification, not feeling, as we say, the ground I went on, but terrified to the last degree, looking behind me at every two or three steps, mistaking every bush and tree, and fancying every stump at a distance to be a man. Nor is it possible to describe how many various shapes an affrighted imagination represented things to me in; how many wild ideas were formed every moment in my fancy, and what strange unaccountable whimsies came into my thoughts by the way.

When I came to my castle, for so I think I called it ever after this, I fled into it like one pursued; whether I went over by the ladder, as first contrived, or went in at the hole in the rock, which I called a door, I cannot remember; no, nor could I remember the next morning; for never frighted hare fled to cover, or fox to earth, with more terror of mind than I to this retreat.

I had no sleep that night; the farther I was from the occasion of my fright the greater my apprehensions were; which is something contrary to the nature of such things, and especially to the usual practice of all creatures in fear. But I was so embarrassed with my own frightful ideas of the thing, that I formed nothing but dismal imaginations to myself, even though I was now a great way off it.

At last I concluded that it must be some more dangerous creature; namely, that it must be some of the savages of the main-land over against me, who had wandered out to sea in their canoes, and, either driven by the currents or by contrary winds, had made the island, and had been on shore, but were going away again to sea, being as loth, perhaps, to have stayed in this desolate island as I would have been to have had them.

While these reflections were rolling upon my mind, I was very thankful in my thought that I was so happy as not to be thereabouts at that time, or that they did not see my boat, by which they would have concluded that some inhabitants had been in the place, and perhaps have searched farther for me. Then terrible thoughts racked my imaginations about their having found my boat, and that there were people here; and that, if so, I should certainly have them come again in great numbers, and devour me; that if it should happen so that they should not find me, yet they would find my inclosure, destroy all my corn, carry away all my flock of tame goats, and I should perish at last for mere want.

Thus my fear banished all my religious hope; all that former confidence in God which was founded upon such wonderful experience as I had had of his goodness, now vanished; as if he that had fed me by miracle hitherto, could not preserve by his power the provision which he had made for me by his goodness. I reproached myself with my easiness, that would not sow any more corn one year than would just serve me till the next season, as if no accident could intervene to prevent my enjoying the crop that was upon the ground. And this I thought so just a reproof, that I resolved for the future to have two or three years' corn beforehand, so that whatever might come, I might not perish for want of bread.

These thoughts took me up many hours, days, nay, I may say, weeks and months; and one particular effect of my cogitations on this occasion I cannot omit; namely, one morning early, lying in bed and filled with thoughts about my danger from the appearance of savages, I found it discomposed me very much; upon which those words of the Scripture came into my thoughts, "Call upon me in the day of trouble, and I will deliver thee, and thou shalt glorify me."

In the middle of these cogitations, apprehensions, and reflections, it came into my thoughts one day, that all this might be a mere chimera of my own, and that this foot might be the print of my own foot when I came on shore from my boat. This cheered me up a little too, and I began to persuade myself it was all a delusion; that it was nothing else but my own foot; and why might not I come that way from the boat as well as

I was going that way to the boat? Again, I considered also that I could by no means tell for certain where I had trod, and where I had not; and that, if at last this was only the print of my own foot, I had played the part of those fools who strive to make stories of spectres and apparitions, and then are themselves frighted at them more than anybody else.

Now I began to take courage, and to peep abroad again; for I had not stirred out of my castle for three days and nights, so that I began to starve for provision; for I had little or nothing within doors but some barley cakes and water. Then I knew that my goats wanted to be milked too, which usually was my evening diversion; and the poor creatures were in great pain and inconvenience for want of it; and indeed it almost spoiled some of them, and almost dried up their milk.

Heartening myself, therefore, with the belief that this was nothing but the print of one of my own feet (and so I might be truly said to start at my own shadow), I began to go abroad again, and went to my country-house to milk my flock; but to see with what fear I went forward, how often I looked behind me, how I was ready, every now and then, to lay down my basket, and run for my life; it would have made any one have thought I was haunted with an evil conscience, or that I had been lately most terribly frighted; and so indeed I had.

However, as I went down thus two or three days, and having seen nothing, I began to be a little bolder, and to think there was really nothing in it but my imagination; but I could not persuade myself fully of this till I should go down to the shore again, and see this print of a foot, and measure it by my own, and see if there was any similitude of fitness, that I might be assured it was my own foot. But when I came to the place first, it appeared evidently to me, that when I laid up my boat, I could not possibly be on shore anywhere thereabouts. Secondly, when I came to measure the mark with my own foot, I found my foot not so large by a great deal. Both these things filled my head with new imaginations, and gave me the vapors again to the highest degree, so that I shook with cold like one in an ague, and I went home again, filled with the belief that some man or men had been on shore there; or, in short, that the island was inhabited, and I might be surprised before I was aware; and what course to take for my security I knew not.

This confusion of my thoughts kept me waking all night, but in the morning I fell asleep, and having by the amusement of my mind been, as it were, tired, and my spirits exhausted, I slept very soundly, and awaked much better composed than I had ever been before. And now I began to think sedately; and, upon the utmost debate with myself, I concluded that this island, which was so exceeding pleasant, fruitful, and no farther from the main-land than as I had seen, was not so entirely abandoned as I might imagine. That although there were no stated inhabitants who lived on the spot, yet that there might sometimes come boats off from the shore, who either with design, or perhaps never but when they were driven by cross winds, might come to this place.

That I had lived here fifteen years now and had not met with the least shadow or figure of any people before; and that, if at any time they should be driven here, it was probable they went away again as soon as ever they could, seeing they had never thought fit to fix there upon any occasion to this time.

That the most I could suggest any danger from was from any such casual accidental landing of straggling people from the main, who, as it was likely, if they were driven hither, were here against their wills; so they made no stay here, but went off again with all possible speed, seldom staying one night on shore lest they should not have the help of the tides and daylight back again. And that, therefore, I had nothing to do but to consider of some safe retreat, in case I should see any savages land upon the spot.

Now I began sorely to repent that I had dug my cave so large as to bring a door through again, which door, as I said, came out beyond where my fortification joined to the rock. Upon maturely considering this, therefore, I resolved to draw me a second fortification, in the manner of a semicircle, at a distance from my wall, just where I planted a double row of trees about twelve years before, of which I made mention; these trees having been planted so thick before, there wanted but a few piles to be driven between them,

that they should be thicker and stronger, and my wall would be finished.

So that I had now a double wall, and my outer wall was thickened with pieces of timber, old cables, and everything I could think of to make it strong; having in it seven holes about as big as I might put my arm out at. In the inside of this I thickened my wall to about ten feet thick, continually bringing earth out of my cave, and laying it at the foot of the wall, and walking upon it; and through the seven holes I contrived to plant muskets, of which I took notice that I got seven on shore out of the ship; these, I say, I planted like my cannon, and fitted them into frames that held them like a carriage, that so I could fire all the seven guns in two minutes' time: this wall I was many a weary month in finishing, and yet never thought myself safe till it was done.

When this was done, I stuck all the ground without my wall, for a great way every way, as full with stakes or sticks of the osier-like wood, which I found so apt to grow, as they could well stand; insomuch that I believe I might set in near twenty thousand of them, leaving a pretty large space between them and my wall, that I might have room to see an enemy, and they might have no shelter from the young trees, if they attempted to approach my outer wall.

Thus in two years' time I had a thick grove, and in five or six years' time I had a wood before my dwelling, grown so monstrous thick and strong that it was indeed perfectly impassable; and no man of what kind soever would ever imagine that there was anything beyond it, much less a habitation. As for the way I proposed myself to go in and out (for I left no avenue), it was by setting two ladders, one to a part of the rock which was low, and then broke in, and left room to place another ladder upon that; so, when the two ladders were taken down, no man living could come down to me without mischiefing himself; and if they had come down, they were still on the outside of my outer wall.

Thus I took all the measures human prudence could suggest for my own preservation; and it will be seen at length, that they were not altogether without just reason, though I foresaw nothing at that time more than my mere fear suggested.

While this was doing I was not altogether careless of my other affairs; for I had a great concern upon me for my little herd of goats: they were not only a present supply to me upon every occasion, and began to be sufficient for me without the expense of powder and shot, but also abated the fatigue of my hunting after the wild ones; and I was loth to lose the advantage of them, and to have them all to nurse up over again.

To this purpose, after long consideration, I could think but of two ways to preserve them; one was to find another convenient place to dig a cave under ground, and to drive them into it every night; and the other was to inclose two or three little bits of land, remote from one another, and as much concealed as I could, where I might keep about half a dozen young goats in each place; so that if any disaster happened to the flock in general, I might be able to raise them again with little trouble and time; and this, though it would require a great deal of time and labor, I thought was the most rational design.

Accordingly I spent some time to find out the most retired parts of the island, and I pitched upon one, which was as private, indeed, as my heart could wish; for it was a little damp piece of ground in the middle of the hollow and thick woods, where, as is observed, I almost lost myself once before, endeavoring to come back that way from the eastern part of the island. Here I found a clear piece of land, near three acres, so surrounded with woods that it was almost an inclosure by nature; at least it did not want near so much labor to make it so as the other pieces of ground I had worked so hard.

I immediately went to work with this piece of ground, and in less than a month's time I had so fenced it round that my flock or herd, call it which you please, which were not so wild now as at first they might be supposed to be, were well enough secured in it. So, without any farther delay, I removed ten she-goats and two he-goats to this piece; and when there, I continued to perfect the fence till I made it as secure as the other, which, however, I did at more leisure, and it took me up more time by a great deal.

All this labor I was at the expense of purely from my apprehensions on the account of the print of a man's foot which I had seen; for as yet I never saw any

human creature come near the island, and I had now lived two years under these uneasinesses, which indeed made my life much less comfortable than it was before, as may well be imagined by any who know what it is to live in the constant snare of the fear of man.

But to go on; after I had thus secured one part of my little living stock, I went about the whole island searching for another private place to make such another deposit; when wandering more to the west point of the island than I had ever done yet, and looking out to sea, I thought I saw a boat upon the sea at a great distance. I had found a perspective glass or two in one of the seamen's chests, which I saved out of our ship; but I had it not about me; and this was so remote that I could not tell what to make of it, though I looked at it till my eyes were not able to look any longer. Whether it was a boat or not I do not know; but as I descended from the hill I could see no more of it, so I gave it over, only I resolved to go no more without a perspective glass in my pocket.

When I was come down the hill, to the end of the island, where indeed I had never been before, I was presently convinced that the seeing the print of a man's foot was not such a strange thing in the island as I imagined; and, but that it was a special Providence that I was cast upon the side of the island where the savages never came, I should easily have known that nothing was more frequent than for the canoes from the main, when they happened to be a little too far out at sea, to shoot over to that side of the island for harbor; likewise, as they often met and fought in their canoes, the victors, having taken any prisoners, would bring them over to this shore, where, according to their dreadful customs, being all cannibals, they would kill and eat them; of which hereafter.

When I was come down the hill to the shore, as I said above, being the S. W. point of the island, I was perfectly confounded and amazed; nor is it possible for me to express the horror of my mind at seeing the shore spread with skulls, hands, feet, and other bones of human bodies; and particularly I observed a place where there had been a fire made, and a circle dug in the earth, like a cock-pit, where it is supposed the savage wretches had sat down to their inhuman feastings upon the bodies of their fellow-creatures.

I was so astonished with the sight of these things that I entertained no notions of any danger to myself from it for a long while; all my apprehensions were buried in the thoughts of such a pitch of inhuman, hellish brutality, and the horror of the degeneracy of human nature; which, though I had heard of often, yet I never had so near a view of before; in short, I turned away my face from the horrid spectacle, my stomach grew sick, and I was just at the point of fainting, when nature discharged the disorder from my stomach, and, having vomited with an uncommon violence, I was a little relieved, but could not bear to stay in the place a moment; so I got me up the hill again with all the speed I could, and walked on towards my own habitation.

When I came a little out of that part of the island I stood still awhile as amazed; and then, recovering myself, I looked up with the utmost affection of my soul, and, with a flood of tears in my eyes, gave God thanks that had cast my first lot in a part of the world where I was distinguished from such dreadful creatures as these; and though I had esteemed my present condition very miserable, had yet given me so many comforts in it, that I had still more to give thanks for than to complain of; and this above all, that I had, even in this miserable condition, been comforted with the knowledge of himself, and the hope of his blessing, which was a felicity more than sufficiently equivalent to all the misery which I had suffered or could suffer.

In this frame of thankfulness I went home to my castle and began to be much easier now, as to the safety of my circumstances, than ever I was before; for I observed that these wretches never came to this island in search of what they could get; perhaps not seeking, nor wanting, or not expecting anything here; and having often, no doubt, been up in the covered woody part of it without finding anything to their purpose. I knew I had been here now almost eighteen years, and never saw the least footsteps of a human creature there before; and might be here eighteen years more as entirely concealed as I was now, if I did not discover myself to them, which I had no manner of occasion to do, it being my only business to keep myself entirely concealed where I was, unless I

found a better sort of creatures than cannibals to make myself known to.

Yet I entertained such an abhorrence of the savage wretches that I have been speaking of, and of the wretched inhuman custom of their devouring and eating one another up, that I continued pensive and sad, and kept close within my own circle for almost two years after this: when I say my own circle, I mean by it my three plantations, namely, my castle, my country-seat, which I called my bower, and my inclosure in the woods; nor did I look after this for any other use than as an inclosure for my goats; for the aversion which nature gave me to these hellish wretches was such, that I was as fearful of seeing them as of seeing the devil himself; nor did I so much as go to look after my boat in all this time, but began rather to think of never making any more attempts to bring the other boat round the island to me, lest I should meet with some of these creatures at sea, in which, if I had happened to have fallen into their hands, I knew what would have been my lot.

. . . . . .

We must leave the words of Robinson Crusoe, and condense the rest of his adventures into a page.

Some months later another wreck was cast up, and from this he obtained a quantity of new stores. Two years afterward he was again alarmed by the arrival of another party of savages. They brought two prisoners. While they were cutting one up, the other ran away in Crusoe's direction. Three of the cannibals gave chase. Crusoe rescued the fugitive, who became his devoted servant. This incident taking place on a Friday, Crusoe called the black man Friday. He taught him many words of English, and the man became very useful and a welcome companion.

CRUSOE FINDS TWO MORE COMPANIONS, INCLUDING FRIDAY'S FATHER

One day Friday came running to his master in great alarm. A party of savages had arrived, and Friday was sure they had come for him. Comforting him as well as he was able, Crusoe armed himself and Friday and sallied out from his castle.

When they came in sight of the savages, the latter were seen eating a prisoner, while another captive was lying bound upon the sand. This captive was a white man. Crusoe and Friday fired upon the party, killing some and scaring the others. While Crusoe was attending to the white man Friday found a third prisoner lying in the bottom of one of the canoes. This captive proved to be his father.

As soon as he was able to give an account of himself, the white man, a Spaniard, proved to be one of a band of seventeen who had been shipwrecked and cast among the savages of the nation to which Friday belonged. They were treated well. But shortly afterward their friends went to war with a rival tribe, were beaten, and several of them, including the Spaniard and Friday's father, were taken prisoners. These two set out in a canoe to bring the other Spaniards to the island.

After their departure an English ship came in sight. From this vessel a number of men landed near Crusoe's habitation. They brought three prisoners. At dusk, while the men were asleep, Crusoe approached the captives and found that they were the officers of the ship. There had been a mutiny on board.

Crusoe released the three men, and after some exciting episodes the captain was restored to his ship. In this, after leaving the survivors of the mutineers on the island, Crusoe, taking Friday with him, left the island on December 19, 1686, the same day of the month in which he made his escape from Sallee.

In this vessel Crusoe arrived in England on June 11, 1687, after an absence of thirty-five years. Soon after, he went to Lisbon. He found out from letters that so well had his estate in the Brazils been managed that he was master of more than $25,000 and of an estate worth about $5,000 a year.

Returning to England, Crusoe married and settled down on a farm in Bedfordshire. But the old roving spirit came upon him again. After his wife's death he started out once more, revisiting his island, now a fairly thriving colony. He had many other adventures in China and Russian Tartary. Eventually he reached London again on January 10, 1705, after another absence of over ten years.

Defoe really wrote three books about Robinson Crusoe, not only telling his life, but giving his thoughts on many things. The story we have just read is told in the first and most interesting of these books.

THE NEXT STORY OF FAMOUS BOOKS IS ON PAGE 947.

The Bettmann Archive

French fur traders guiding their birch-bark canoe through the dangerous rapids of a river.

FRENCH CANADA BEFORE THE CONQUEST

FROM 1534 TO 1763

ONE hot summer day in the year 1534 a small ship sailed into a wide bay on the northeast coast of North America. The ship was French, and its master was Jacques Cartier, of the port of St. Malo in the province of Brittany. He and his ship's company had sailed a long voyage since they left the shores of France. They had passed the familiar fishing grounds off the coast of Labrador and made their way across the strange waters of the Gulf of St. Lawrence. They did not know of the great river which flowed into the gulf, and so they sailed southward until they found themselves in a large bay. The day was so warm that Cartier gave to the bay a name which it still bears — the Bay of Chaleur, or heat.

On July 24 he went ashore near the place where the harbor of Gaspé now stands. There he planted a large wooden cross with the words written on it "Long live the King of France." While a few friendly Indians watched, he claimed the new country he had found for the King of France, and he and his companions knelt around the cross to pray. This was the beginning of the story of French exploration and settlement in North America.

There had, of course, been earlier explorations off the eastern coast of what is now Canada. Centuries earlier, the Vikings, sailing across the dangerous waters of the northern Atlantic in small open skiffs, had become familiar with this northern coastline, probably down as far as New England.

In recent years, a few rusty fragments of iron weapons were found under a rock in the wilderness south of Hudson Bay. The weapons are known to have belonged to Vikings of the days of the great Norse exploration. No one is quite sure how they came to be placed under a rock in northern Ontario. They may, however, mark the place where some Norse warrior, traveling with his companions far inland into the heart of North America by way of Hudson Bay, died by the wayside and was buried with his sword and shield.

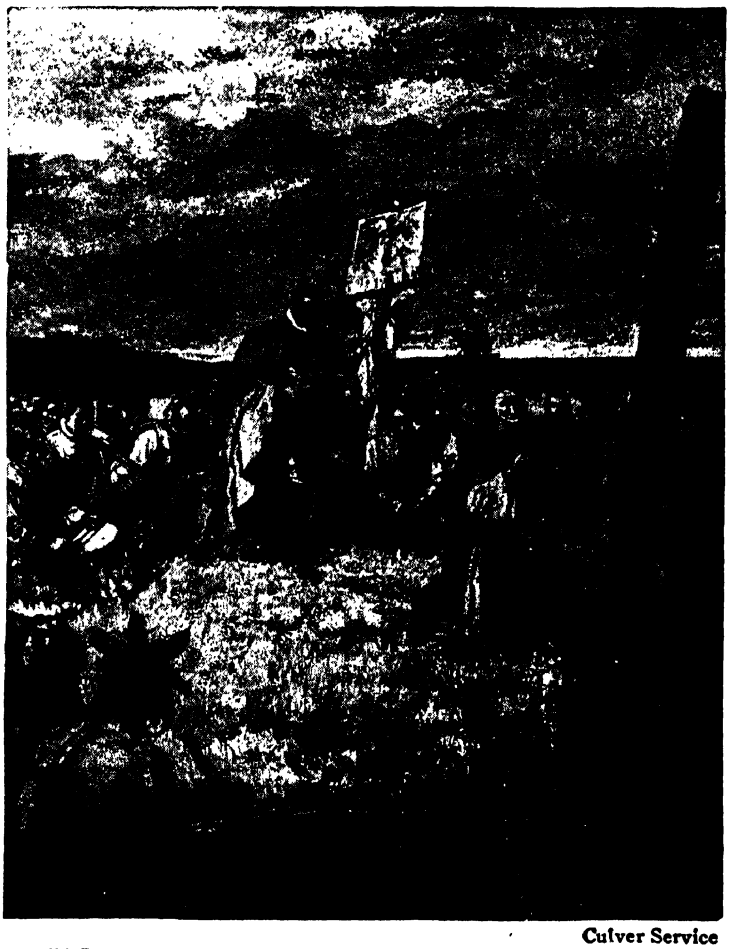
The Norsemen left a tradition for daring adventure, but the stories of their voyages were no more than legends. The practical discovery of America began with the voyages of Columbus, who first saw the West Indies in 1492. Within five years of that date, John and Sebastian Cabot, sailing from England, explored the coasts of Newfoundland and Labrador. The coastal waters through which

the Cabots sailed were rich in codfish, and before many years had passed, the fishermen of western Europe were coming each summer to the Newfoundland fishing banks. Cartier, when he set out in 1534, carried as crew a company of these fishermen who had already become familiar with the coastal waters of North America.

Cartier, like all the European explorers who came westward across the Atlantic in his day, was really looking for a short route to China. It was natural, therefore, that he should come again after his first exploration. In 1535 he found the entrance to the great river that leads into the heart of Canada, and he called it the St. Lawrence after the saint on whose festival day he discovered it.

The Indians whom he met on the shores of the river told him that there were wealthy kingdoms in the interior. He sailed westward, up the broad river, hoping to come upon the riches of this land, and hoping too that the river would open out into a western sea by which he could make his way at last to China. All he found, however, were a few poor Indian settlements. On the spot where Montreal now stands he climbed the mountain and looked westward over the thick forests. To his dismay he saw the river was broken by strong rapids that blocked his further progress. He was forced to spend the winter at an Indian village where Quebec now stands. In 1536 he sailed back to France, taking an Indian chief, Donnacona, and some of his companions, to tell about the new world.

It was a hundred years later before the French really tried to make use of the discoveries of Cartier. He, however, had shown the way into the interior of Canada, and he had traded with the Indians, exchanging knives and iron ware for furs.



Culver Service

In 1534 Jacques Cartier made his first voyage to the New World, landing on the Gaspé shore. There he planted the cross and the banner of France.

The early history of Canada is the story of fishermen and fur traders. There was a good market in Europe for the codfish of the eastern coastal waters. Soon fishermen began to come ashore in order to dry their catch of fish. Racks, or flakes, were built, on which the fish were spread in the sun before being packed away for shipment to Europe. Here, in these fishing stations, the fishermen came in contact with the Indians, who brought them their furs to sell in exchange for goods brought from France or England. The Indians had no iron, and they were eager to buy the knives, pots, kettles, axes and ornaments which the fishermen offered them. In return, they gave furs taken from animals they had killed in the forests. The best of these was the beaver skin, light, warm and beautiful. In the cities of Europe, the beaver was made into fine garments. It was also found to be good for making hats, and a beaver hat became a prized possession.

The French first tried to make settlements in Canada because they wanted to or-

ganize the fur trade. Attempts at settlement were made in Cartier's day, but without success. The climate was hard and there was little food. Many trials ended in tragedy before the first colony of French settlers that survived was founded in 1604. This was at Port Royal, on the Bay of Fundy, in what is now the province of Nova Scotia. Here a little company of Frenchmen, whose leader was Pierre de Monts, founded a settlement, erected living quarters built around a central courtyard and began to cultivate gardens. This was the beginning of French settlement on the Atlantic seaboard. The settlers called the region Acadia.

One of the men who helped in founding Port Royal was a young soldier and explorer named Samuel de Champlain. In 1608 it was he who began the real New France at Quebec on the St. Lawrence River. He thought that by going up the river to build a trading post, he would be nearer the source of supply, and he perhaps thought also that he could find a way to the western sea from this base. With a little company of men, he sailed up the river, and built a wooden dwelling-place like that at Port Royal.

Samuel de Champlain.

From 1608 to 1660 the French settlements in the St. Lawrence Valley suffered from enormous difficulties, which very nearly destroyed the whole venture. Champlain's company which had been given a monopoly of the fur trade, failed to bring to Canada enough settlers who would have made the colony secure and prosperous. During those years France was frequently at war with England, and at one time both Port Royal and Quebec fell into the hands of the English. Meanwhile, the fur trade was proving difficult to control. The Indians brought their furs down the St. Lawrence River system, and they were constantly attacked by their enemies, the fierce Iroquois, who lived in what is now the northern part of New York. The Indians with whom Champlain traded were the Hurons and the Algonkins. He found that they were at war with their southern neighbors of the Iroquois confederation. The Iroquois, supplied with weapons by the Dutch and English traders in the Hudson Valley, came down the waterways that flow from the south into the St. Lawrence and fell upon the Hurons on their way to the French posts. So strong were they that at the height of the Indian war, the supply of furs at Quebec was almost cut off.

These years, however, were not without progress, for many important discoveries were made. The fur traders and the missionaries together made known to the white man all the main river routes of the St. Lawrence system. Champlain himself, who was a brave and adventurous explorer, found his way up the Ottawa River, across the river route into Georgian Bay, and southward across Lake Ontario into what is now the state of New York. Some of his followers went to live with the Indians, and one of them, Etienne Brûlé, traveled widely, from the shores of Lake Superior, which he saw at its eastern end, to the Susquehanna River which he seems to have followed to its source. Another Frenchman, Jean Nicolet, paddled with a band of Indians halfway down the length of Lake Michigan and explored what is now Wisconsin.

Equally important and daring was the work of the missionaries. These men, wishing to convert the Indians to the Christian religion, visited their villages in the interior. In a country which they called Huronia, between Lake Ontario and Lake Huron, they found a number of villages of Huron Indians. Here they established mission stations, built stockades, houses and small churches. They brought in a few farm animals, such as pigs and cows, carrying them by canoe over the difficult river route from Quebec. The task of paddling squirming, squealing pigs, or worse still, a big awkward cow, down a rapid river would take great patience and real canoeing skill. The largest of these mission stations, Sainte Marie, has recently been uncovered where it has lain in ruins for 300 years, and it is possible to see how much the French missionaries built among their Huron converts.

The work of exploration done in these early days by trader and missionary was the result of patient toil in the face of great difficulties and dangers. Travel was hard and uncomfortable in the birchbark canoes of the Indians. The mosquitoes, which swarmed in thick clouds on the northern rivers, nearly drove the explorers out of their senses. Food was often scarce, and travelers sometimes went for days without eating. The Indians lived with few comforts and often in conditions of great uncleanliness. Life among

them was always a hardship for the white traveler. In spite of these difficulties, however, the French found the important routes into the interior of the country, and also laid the foundation of the fur trade.

These promising beginnings, made on the foundations which Champlain built, were destroyed by the fierce Indian wars of the ten years between 1640 and 1650. During this period, the Iroquois fell upon the trade routes and the settlements of the Hurons with fury and determination. The French tried to protect the friendly Hurons who still tried to bring furs eastward. In 1642 the French founded a western trading post at Montreal where the Ottawa River flows into the St. Lawrence. The Iroquois, however, struck at the Hurons farther west. By 1650 all their villages in the country known as Huronia had been destroyed, and the Hurons themselves had been killed or carried into captivity. The Jesuit missions were destroyed too, and the faithful priests who had gone to teach religion among the Indians were put to death by the Iroquois. The names of two of these men, Brébeuf and Lalemant, have become famous for the courage with which they faced their cruel fate. A shrine in their honor now stands at the site of the village of Ste. Marie, in the province of Ontario.

NEW FRANCE IS MADE A ROYAL COLONY

There were reasons, other than the fury of the Iroquois, for the weakness of New France in these early days. The trading company, called the Company of a Hundred Associates, paid little attention to the colony, and made no effort to bring out settlers. Finally, in 1663, the charter of the company was canceled, and New France became a royal colony, governed directly by the king's officials.

The change to royal government was a healthy one for New France. The colony was now governed by a governor, a bishop and an intendant, all appointed by the king. The governor took charge of defending the colony, the bishop was head of the Church and the intendant carried out the ordinary business of the colony.

MILITARY PROTECTION IS GIVEN THE SETTLERS

The first work to be done by the new government was to protect the colony against the Indians. A famous French regiment was brought out to New France, forts were built along the waterways which the raiding parties used, and the Iroquois were driven back into their own country. At first the French soldiers in their uniforms of bright red and blue seemed strange in the wild forests of the St. Lawrence Valley; but they soon learned the ways of the woodsmen, and their fine training and good weapons made it possible for them to withstand many times their number of Iroquois.

TALON, THE INTENDANT, OR BUSINESS MANAGER OF THE COLONY

The first intendant of the new royal colony was a wise and industrious man named Jean Talon. He knew that a great deal of careful planning would have to be done if the colony were ever to grow into a prosperous settlement. More people were needed, and Talon arranged for settlers to be brought out from France. The most famous of these newcomers were groups of girls who were recruited in France to go to the New World and become wives of the men settled there. Some of these girls, who were called "daughters of the King," arrived in Quebec on a summer day each year for several years. As they came off the ship, the men of the colony stood eagerly on shore, each wondering which of the pretty strangers would become his wife.

ADVENTUROUS YOUNG MEN GO TO LIVE AMONG THE INDIANS

Talon brought out new kinds of farm animals and new plants and shrubs from France, and helped the farmers to clear their fields and build their houses on new lands along the river. He tried also to control the fur trade by issuing licenses to those who were permitted to buy furs from the Indians. It was difficult, however, to keep track of the traders. Many young men of the colony went off to live among the Indians. They were called *coureurs de bois,* or wood runners, and they soon learned all the skill of the Indians, with whom they lived on very good terms. If they could not sell their furs at Montreal or Quebec, they could always send them to the English or Dutch on the Hudson. Talon and the other officials of the colony would have liked to keep these young men in the settlements, and to make the Indians bring their furs to the trading posts. This, however, turned out to be impossible, and soon there were scores of *coureurs de bois* following the Indians to the hunting-grounds, and bringing their own cargo of furs down the river to market in the summertime.

During this period, the colony also was served by a famous bishop and a famous governor. The bishop was Laval (François

de Laval-Montmorency), who did much to help build churches and schools in New France, and to encourage missionary work among the Indians.

The governor was Count Louis de Frontenac. He was an energetic and vigorous man who came to New France in 1672. He quickly set about completing the defenses of the colony. Posts were established in the interior, one of which was called Fort Frontenac and bring in settlers, to organize the defense of the seigneuries, and to watch over the interests of the farmers, or *habitants,* as they were called. In return the *seigneur* received from the farmers certain small payments, some of which were in the form of goods. The *habitants* also were obliged to use the *seigneur's* mill and his oven, paying a small fee.

The community which grew up along the St. Lawrence Valley and down the Richelieu

From the Public Archives of Canada

When New France became a royal colony, carefully chosen groups of young women were sent over to marry the bachelors among the settlers. The painter Charles W. Jefferys shows us a group of these brides landing at Quebec.

was built where the city of Kingston now stands. By carrying his line of protecting forts westward to Lake Ontario, Frontenac safeguarded the whole length of the St. Lawrence River against Iroquois attack. He also made treaties with Indian tribes, encouraged explorers to open up new canoe routes in the interior, and encouraged the settlers to improve their own means of defense. Frontenac was an active man, who never hesitated to take hard canoe trips into the Indian country. He had two periods as governor. Even during the second of these, when Frontenac was seventy-six years old, he personally led his men against their Indian enemies.

In the settled areas along the St. Lawrence a thriving farming country soon began to grow. The land was laid out in long strips leading back from the river, which was the chief highway. Large grants of land were made to important men in the colonies, who were called *seigneurs.* It was their duty to was one of peasant farmers, living for the most part from what they grew or made themselves, to which they added the fish and game of the streams and forests. They cleared the land laboriously, tree by tree; they plowed with oxen; they reaped their grain by hand and winnowed it in simple home-made machines. Their cloth was woven in their own kitchens from yarn which they themselves spun, and their log houses had only the modest furnishings which they themselves could build. For those who found the life of the farm and the parish too unexciting, there was always the fur-trading country. Each year the more adventurous of the young men went off in the big canoes up the St. Lawrence and the Ottawa. Many of them found that the fur trade of the interior, for all its hardships and its dangers, offered a way of life more enthralling than that of the farm.

It was these *coureurs de bois* who pushed

the boundaries of New France westward until, at its height, it reached from the Gulf of Mexico to Hudson Bay. The fur traders were drawn ever farther into the interior in search of better sources of supply. They were encouraged by Talon and Frontenac, who believed that forts should be built to hold the country which they opened. And they were equalled in both courage and curiosity by the missionaries, who often were the first white men to find their way up some strange river or into some silent and majestic lake.

The record of these explorations is an amazing one. In the twenty-five years after New France became a royal colony, the whole St. Lawrence waterway system had been opened, the Gulf of Mexico had been reached from Quebec, and interior routes to Hudson Bay had also been found. In 1672 Father Charles Albanel traveled over a very difficult route by way of the Saguenay River and over the height of land to Hudson Bay. Later, Pierre d'Iberville found another route to Hudson Bay through northern Ontario.

Two of the most adventurous *coureurs de bois* in all Canadian history, Pierre Radisson and a man called Groseilliers, had gone beyond Lake Huron to Lake Michigan and Lake Superior. Daniel du Lhut and Jacques de Noyon reached the western shores of Lake Superior during this period, and in 1673 a trader and a missionary together, Louis Joliet and Father Jacques Marquette, traveled through Lake Michigan and across the watershed to the Mississippi, which they followed nearly to its mouth. The full journey from New France to the Gulf of Mexico was made by Renè-Robert Cavelier de la Salle in 1682.

From these explorations the French in Canada gained an idea of the vast size of the continent. They learned that they could travel easily into the interior of the continent by means of a marvelous system of waterways, and that a great unclaimed fur-trading empire lay open for them to claim. Their leaders in Canada, particularly men like Frontenac and La Salle, soon began to dream of a great French empire that would include the whole interior of North America. It would have as its main lines of communication the great river systems of the St. Lawrence, the Ohio and the Mississippi. Eventually it would reach out to the western sea, which they knew existed somewhere toward the setting sun. It was in search of this sea that explorers from New France, Pierre La Vérendrye and his sons, traveled far out to the flat prairies in the 1740's, beyond the fur-trading posts they had built in what today is southern Manitoba.

The French, however, were not the only ones who found the fur trade of North America profitable; nor were they the only ones

From an old print

Father Jacques Marquette, a Jesuit missionary, and Louis Joliet, a fur trader, set out in canoes to find the Mississippi River. They explored this great stream for 300 miles. The whole voyage was nearly 3,000 miles.

whose explorers pressed inland up main rivers. The British, too, were founding an empire on the continent, and by 1700 thriving British colonies had been planted along the whole coastline, from Maine to Carolina. Up the great Hudson River and thence along the Mohawk toward Lake Erie, there lay a natural route to the interior for the English fur traders. Competition for the Indian furs became more and more brisk, and English and French alike began to build fortified posts to defend the trading routes.

This map shows territory claimed by France, England and Spain in 1756, three years before Quebec fell.

To the north, also, the English had begun to penetrate the continent. In 1668, a group of English traders, helped by the two French *coureurs de bois,* Radisson and Groseilliers, sent an expedition to Hudson Bay. So rich was the cargo of furs which the traders brought back that in 1670 a company was formed to carry on the trade into Hudson Bay. It was called The Governor and Company of Adventurers of England trading into Hudson's Bay, and it was granted a monopoly of trade and rights of government in the area where the rivers ran into Hudson Bay.

French and English thus became rivals for the fur trade and they became rivals also for the control of the continent. The French planned to build forts into the interior and down the Mississippi River, thus making a line of communication between New France and the colony they founded in Louisiana. This threatened to hem the English colonies in between the Atlantic shore and the Mississippi. The Hudson's Bay Company, on the other hand, was building a fur-trading empire that shut off the sources of supply on which the French depended.

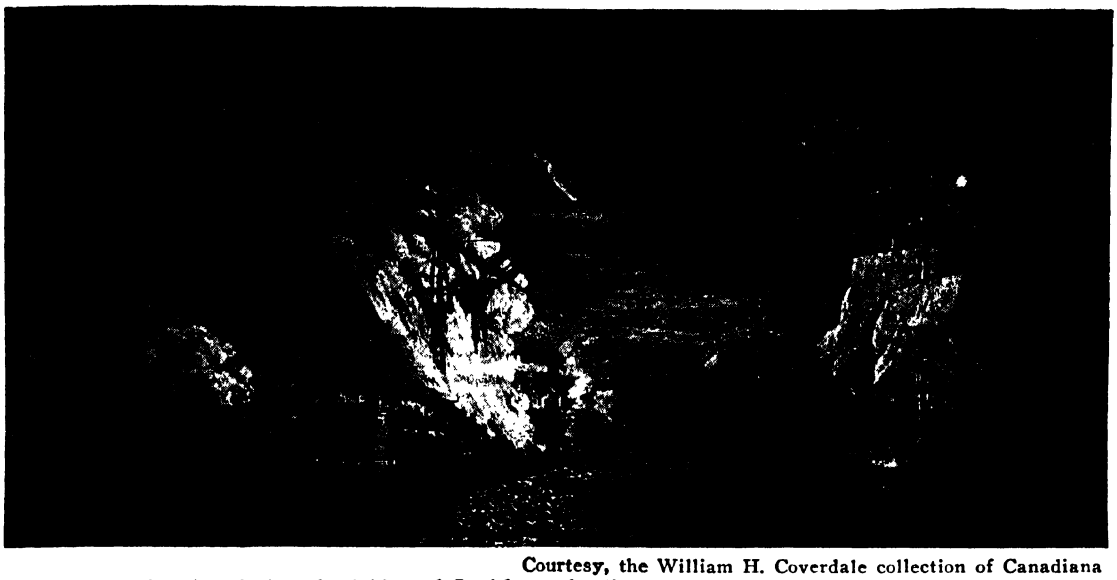
The conflict between English and French in North America lasted, off and on, for 150 years and ended in victory for the English. There were various points at which the two sides came in contact, where most of the fighting took place. Acadia, where the French had planted a colony, lay close to the English colonies in New England, and the sea routes from New England to England were endangered by this French outpost. The Lake Champlain country, where the Hudson River system and the St. Lawrence-Richelieu system almost met, was another area of conflict, and forts on both sides, such as Ticonderoga and Crown Point, guarded the waterways. On Lake Ontario and in the valley of the Ohio there were other places where the opposing forces met, and in the far north, on Hudson Bay, there was a brief but bitter struggle for control.

The conflict which took place in these areas was not continuous, but sharp fighting kept flaring up along the frontier, and every once in a while the smoldering rivalry flamed into open war. Both sides used their Indian allies. The Micmacs in Nova Scotia, the Hurons and Algonkins in the St. Lawrence Valley supported the French. The fierce Iroquois of the region south of Lake Ontario fought on the side of the English.

Often the fighting took the form of Indian warfare. Raiding parties would set out on long journeys, they would steal up on the outposts of their rivals, destroy the buildings and kill or carry off the traders or settlers whom they found there. The Indians on both sides were cruel and savage fighters, and many terrible acts took place in the bitter frontier battles.

THE WORLD-WIDE STRUGGLE BETWEEN FRANCE AND ENGLAND

Often the warfare became general, and then considerable fleets and armies would be used. The period was one during which England and France were rivals, not only in North America, but in Europe, the West Indies and India as well, and sometimes the fighting in America would be set off by conflict elsewhere. Both the French settlement at Port Royal and the fortress at Quebec fell to the English shortly after they were founded, but were later returned to the French. In 1689 the battle was joined again on a grand scale. French expeditions, under



Courtesy, the William H. Coverdale collection of Canadiana
French ships burning during the taking of Louisbourg by the English fleet under Admiral Boscawen in 1758.

a courageous and talented young Canadian named D'Iberville, captured the English posts on Hudson Bay, and for a time it seemed that the English menace from the north might be removed. In Acadia, the English took Port Royal and managed to control the whole of this area. An English expedition against Quebec failed, and the English were driven back in northern New York by vigorous attacks from Frontenac and his men.

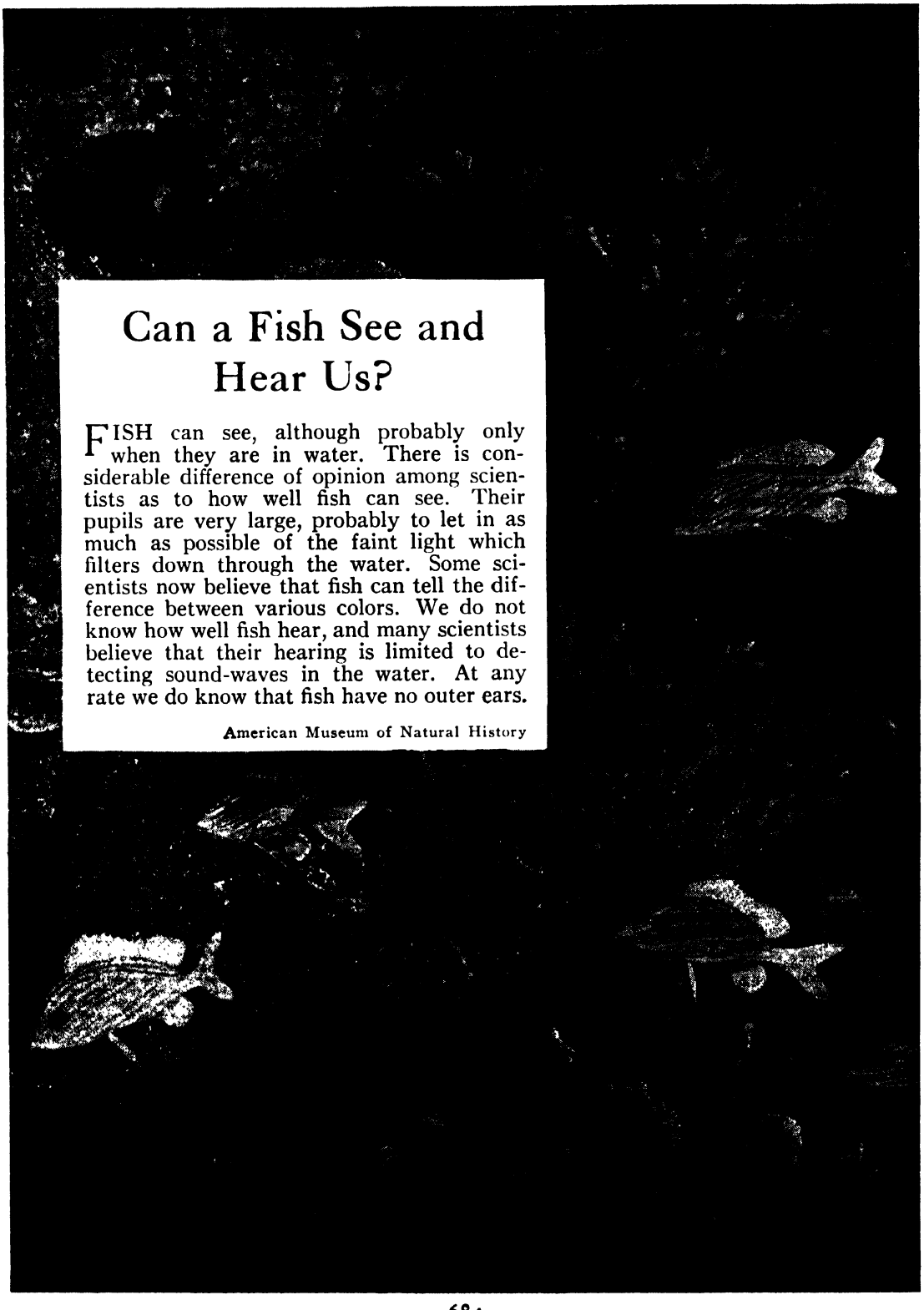
This part of the war was brought to an end in 1713 by the Treaty of Utrecht. The English regained Hudson Bay. Acadia was also surrendered to England and was named Nova Scotia, New Scotland. However, the peace treaty did not settle the reasons for conflict. The French still had possessions in the mouth of the St. Lawrence, one of which, Louisbourg, they began to fortify. In the forests and on the rivers of the interior, the fur traders still fought one another for control of the trading routes.

The uneasy peace lasted until 1756. Then another general conflict broke out. We call it the French and Indian War. Canadians call it the Seven Years' War. There had been fighting even during the years of peace; and one unhappy result had been the decision of the authorities in Nova Scotia to drive out the French Acadian settlers, lest they join with the Indians to make war on the English. The story of the Acadians, who were called together one day and told to board ships at once, has been made famous by Longfellow in his poem EVANGELINE.

At first the Seven Years' War went badly for the English. The French were led by an able general, the Marquis of Montcalm, and they held strong positions at Louisbourg, Quebec, and along the Richelieu and Ohio valleys. Soon, however, the greater strength and numbers of the English began to tell. In 1758 Louisbourg fell, so that the English could now sail up the river to Quebec. The following year a strong English army, led by a young and clever general, James Wolfe, appeared before Quebec. After weeks of waiting, Wolfe found a way up the steep bank of the river to the heights behind the fortress, and there, on the Plains of Abraham, the French defenders were beaten and the city taken.

Quebec had been the center of French resistance in America. After it fell the rest of the country soon came into English hands. In 1763, by the Treaty of Paris, New France became an English colony, and French rule ceased in the valley of the St. Lawrence. The French had shown themselves brave and clever frontiersmen, but their position in North America was dangerous and vulnerable. Once the English were able to cut off the supplies which came to them across the Atlantic from France, their strength gradually weakened until finally they were forced to surrender. Their settlers, however, remained to build a community in the St. Lawrence Valley under English rule. French Canada today is the living memorial to the founders of New France.

THE NEXT STORY OF CANADA IS ON PAGE 940.



Can a Fish See and Hear Us?

FISH can see, although probably only when they are in water. There is considerable difference of opinion among scientists as to how well fish can see. Their pupils are very large, probably to let in as much as possible of the faint light which filters down through the water. Some scientists now believe that fish can tell the difference between various colors. We do not know how well fish hear, and many scientists believe that their hearing is limited to detecting sound-waves in the water. At any rate we do know that fish have no outer ears.

American Museum of Natural History

WHAT IS PAIN AND WHY DOES IT HURT?

You know what pain is if you have ever had a toothache, if you have ever cut yourself or run a sliver into your finger. We know that nerves run all through our bodies —to our skin and to our internal organs. When some part of your body is damaged or diseased, the nerves which run from that part to the brain become excited. This excitement is registered in the brain as the sensation of pain, and is felt in the damaged part of the body as pain.

Pain is a valuable thing, for it warns us that something is wrong. If, for instance, you did not feel pain when you put your hand by accident on a hot stove, you might leave the hand there until you suffered a very severe burn. The moment you feel the pain, however, you withdraw your hand.

WHERE DOES THE WATER GO AT LOW TIDE?

The tides are like great waves that travel over the surface of the oceans. As the earth spins around each twenty-four hours, the moon and the sun pull upon the oceans. Some of the water which formed part of the last high tide in any port, moves on under the pull of the moon, as the crest of the tide travels on. Since there is just so much water in the ocean, it is clear that the water which travels on in the crest of the tide moves away from the place where it was before. This causes a low tide in that place.

HOW DO WE KNOW THE HEIGHT OF A MOUNTAIN?

There is one rather easy way by which you can measure the height of a mountain the next time you go mountain-climbing.

You must take with you a barometer, an instrument used to measure the weight or the pressure of the atmosphere. The higher you go, the less air there is above you, and the less its weight. The column of mercury in the barometer rises when the pressure of the air increases, and falls when the pressure becomes less. At sea level the pressure of the atmosphere is about 15 pounds to the square inch and the mercury in the barometer stands somewhere near 30 inches. With every 1,000 feet you climb, however, the barometer falls about one inch. For every inch that your barometer falls, then, you can figure that you have climbed about 1,000 feet. From this you can also figure out the number of feet that a fall in the barometer of fractions of an inch would indicate.

WHAT DO WE MEAN BY THE WORD "ALLERGY"?

When we say that a person has an allergy to a certain food, to the pollen of certain grasses or to the dust from the fur or skin of certain animals, we mean that he shows certain symptoms of physical distress. Hives, asthma and hay fever are the results of allergies. This distress or illness is the result of his coming in contact with certain substances, called foreign proteins, which are contained in the food, grasses or dust. These foreign proteins can not be absorbed by some people's bodies, and act like poison in them. Sometimes it is difficult to find the substance to which a person is allergic.

WHAT DO WE MEAN BY HAY FEVER?

Perhaps you have seen a hay-fever sufferer, in the summer, sneezing violently and showing every sign of a serious cold. Hay fever is not a cold, but is caused by the pollen of some plant, carried by the wind against the oversensitive membranes of eye, nose and throat.

Hay fever belongs to the family of allergic diseases, in which a person becomes ill because he is especially sensitive to certain foods or other substances.

WHAT IS THERE INSIDE THE JUMPING BEAN?

The secret of the jumping bean lies inside it. There, all coiled up in its tight little house, lives the caterpillar or larva of a special kind of gray moth. Sometimes the caterpillar wants to stretch itself, and then it uncoils like a spring. This sudden motion pushes against the inside of the bean, which jumps and tumbles and rolls and jerks, this way and that.

Jumping beans come from a shrub which grows in swamps in Mexico and the southern United States. In two of the bean's three sections there are small black seeds; the third part often contains the caterpillar.

Before the pods carrying the beans appear, the shrub bears flowers. The gray moth visits the flowers and in each one of them lays an egg. As the flower turns into the pod, the egg inside it grows into the caterpillar which makes the bean jump.

WHY DOES OIL NOT MIX WITH WATER?

When we mix water with alcohol, the molecules of water and the molecules of alcohol are evenly distributed throughout the whole

The Bettmann Archive

Archimedes working out a problem in the sand. He was interested in mathematics as well as other sciences.

solution. In other words, one of these liquids dissolves in the other, and the molecules are evenly mixed. Such a mixture of liquids is properly called a solution.

When we try, however, to mix oil with water, we find they do not mix unless we shake them violently. Even then, they will separate after a time. The oil does not dissolve in the water because the oil particles do not divide into their separate molecules, but remain in much larger particles or globules which stick together. A mixture of this kind is called an emulsion.

WHAT DOES THE WORD "EUREKA" MEAN?

This famous word means "I have found it." The story goes that it was used by one of the greatest philosophers of antiquity, Archimedes, who lived in the city of Syracuse in Sicily. Archimedes had been working on the problem of specific gravity, and when he found the answer to his problem, he ran into the street shouting *"Eureka!"* For the details of this story see Index.

WHY DOES A PIN GET HOT IF RUBBED AGAINST A STONE?

All rubbing, or friction, causes heat. The friction of the pinpoint rubbing against the roughness of a stone causes heat. Since the pin is made of metal, which conducts heat well, the heat runs up the pin easily and quickly.

WHY DOES OIL FLOAT ON THE SURFACE OF WATER?

Oil floats on the surface of water because it does not dissolve in the water, as alcohol does, and because it is lighter than the water. For the same reason cream, which is lighter than the rest of the milk, rises to the top of the bottle.

IS THERE ANY COLOR IN THE SEA?

In the sea, as well as on land, life decks itself in rainbow colors. There we find meadows of green and blue and red algae. Blue flying-fish, rosy sea-anemones, red coral and iridescent mackerel add to the wonderful

beauty of the undersea world. In fact, there is hardly a color on land that can not be matched in the sea.

At great depths in the ocean, however, the colors disappear. At 700 feet only a strange shade of blue is left. Half a mile down all is complete darkness in the sea.

WHAT MAKES US SNEEZE?

The nose and the other passages through which we breathe are lined with very delicate mucous membrane. When this membrane becomes irritated, we sneeze in order to get rid of the irritation. Sometimes a person sneezes because there is dust in his nasal passages, or because he has inhaled a little pepper. Any foreign matter tickles or disturbs the nerve endings in the mucous membrane.

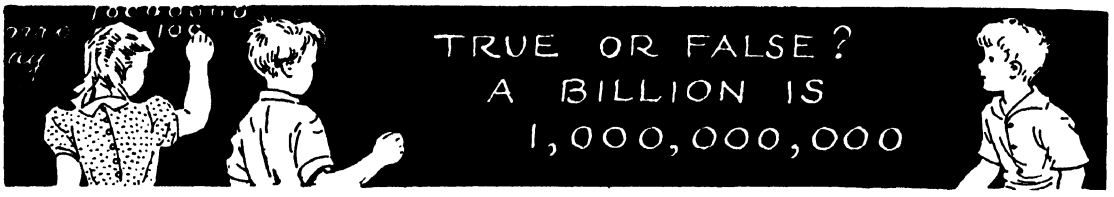
Sometimes you will sneeze if you look directly at the sun or at any other very bright light. If you have a cold, or hay fever, the mucous membrane in your nose becomes swollen, and this also results in irritation which may cause you to sneeze.

Sneezing is a reflex action—this means that we can not sneeze just when we want to. In other words, sneezing is not under the control of the will, but is involuntary, like the winking of our eyes when something comes close to them suddenly.

WHO WERE THE PEOPLE KNOWN AS MOUND-BUILDERS

The mound-builders lived before the dawn of history, and were probably the ancestors of the American Indians. The peculiar mounds of earth which they built as temples, altars and burial mounds are found scattered throughout various sections of the United States. Thousands of them are found in the valleys of the Mississippi and the Ohio. In Ohio alone there are over 10,000 of these mounds. Some are in the shapes of animals—totems—which were worshiped by the people who built them. The Serpent Mound in Ohio is 1,348 feet long, with a body 30 feet across and 5 feet high. Many of the small mounds covered human remains, buried with weapons and ornaments and utensils of copper and stone. The largest mound discovered so far is in West Virginia, the Grave Creek Mound. It is about 70 feet high and 900 feet around. A large number of mounds in Wisconsin have the shapes of serpents, birds and mammals—buffalo, elk, moose, deer, wolves and panthers—found in North America.

The mounds were built for several different purposes. Some were forts, to be used for defense; some were altars; and others were burial places. Still other mounds were simply the foundations for houses or religious structures. This illustration shows a religious ceremony centering around a small mound, with symbolic shell and reversed arrows, while the chief huts of the village are burning. Arrowheads, hunting knives and sharp bone needles found in and near the mounds show that their builders slew wild animals, ate the flesh and used the pelts.



HOW MUCH IS A BILLION?

The nations of the world have differing ideas as to how much a billion actually is. In the United States and Canada, and in France too, a billion is one thousand millions, written as a one with nine zeros after it—1,000,000,000. In France this number is sometimes called a *milliard,* a term which is always applied to it in Germany. In England and Germany, on the other hand, a billion is one million millions, written as a one with no less than twelve zeros after it—1,000,000,000,000.

WHY DO OUR TEARS TASTE OF SALT?

Tears are made to wash the eyes. If you took just the right quantity of pure table salt, and dissolved it in perfectly pure water, you would have something almost exactly the same as tears.

Perfectly pure water is found to injure delicate living things, like the front of the eyeball, and it is not natural to the body. The natural kind of water in which every part of the body lives its life is salt water. If you dissolve the right amount of salt in water, you have what is called "normal salt solution," meaning that it exactly suits the body. This solution is the same as tears.

WHY DOES QUICKSILVER ROLL UP INTO LITTLE BALLS?

The molecules of mercury, or quicksilver, have a very powerful attraction for one another. We see this same attraction when water forms in drops, but while water will form in drops on some surfaces, it will not on others. If we put a drop of water on a piece of blotting-paper, the attraction of the surface of the paper for the molecules of water is greater than their attraction for one another; and so the drop of water is broken up, and the water wets the paper. But though a drop of mercury is a true liquid, it will not wet the paper. Even if it is split up, it simply splits up into smaller balls or drops. This is because the molecules of the mercury have a greater attraction for each other than they have for the paper.

WHAT HAPPENS WHEN A PERSON DROWNS?

Human lungs are not made to take oxygen from water; and so, when a drowning person breathes in water instead of air, his supply of oxygen is cut off. At the same time the amount of carbon dioxide rapidly accumulates in the body and poisons it, finally stopping the heart. When a person feels that he is sinking in deep water, because he can not swim or is disabled, he struggles to come to the surface. There he tries to fill his lungs by taking deep breaths. In doing so, however, some water usually is drawn into the larynx (the breathing passage in the throat) and he also swallows a considerable amount of water. As his struggles increase, the lungs and stomach are filled with water, thus weighting his body and drawing it down.

A person can often be revived, even though he may have been submerged for quite a little time. This is because his breathing organs continue to work for five or six minutes after he has lost consciousness, and the heart continues to beat for four to six minutes more. In reviving a drowned person, the water is gently pressed out of his lungs, as he lies face down, by rhythmic pressure on the back of his chest. How to do this is taught in life-saving courses; and it is important knowledge to have if you go swimming very often or enjoy other water sports.

It is often said that a drowning person rises to the surface three times, but that is not true. If he throws his arms above his head, he may sink like a diver and not come up at all.

WHY DOES WATER ALWAYS SEEM SHALLOWER THAN IT IS?

When we turn on the water in the bathtub, and our cake of soap falls into the water and sinks to the bottom, a curious illusion occurs. If we plunge our hand into the water to seize the soap, we find that *it is not where it seems to be.* It seems quite close to the surface, but our hand has to go much lower than our eyes direct in order to reach it. The eye is completely deceived into believ-

ing that the water is much shallower than it really is. Pebbles and fish in a pool always appear to be nearer to us than they really are.

The reason is that the rays of light reaching us from the object at the bottom of the water do not come straight to us, as they would if there were no water between us and the object. The light from the object travels straight *as long as it is in the water,* but on emerging from the water into the air it is bent downward toward the surface of the water. This bending is called refraction, and it occurs whenever light passes from one transparent medium into another of different density—as, for example, from water to air, or from air to glass. The eye judges the position of an object by the direction of the light which comes to it, and therefore we imagine that the object has its position on the line taken by the ray after leaving the water. That, of course, places the apparent location of the object higher than the bottom of the water.

WHAT IS MEANT BY THE SAYING THAT "ALL FLESH IS GRASS"?

In the Bible this striking phrase is used as a figure of speech—"the grass withereth, the flower fadeth," and so on; but the phrase is used in more than a poetic sense.

The whole of the animal kingdom feeds on substances which have already had a living existence as plants. This is true even of the carnivorous, or flesh-eating, animals, because, although they feed directly and mainly on the flesh of other animals, they indirectly eat herbs because their victims live on plant life. Thus it is literally true that "all flesh is grass."

The common opinion that flesh food is superior to plant food in strength-giving qualities is an error. Many of the strongest animals live entirely on vegetables. It is necessary to name only the buffalo, the elephant, the horse and the gorilla to remind ourselves that enormous physical power can be maintained solely by a vegetable diet. As a matter of fact, there is no element of the frame of man, or of any of the animals, which is not also found in plant life.

WHAT DOES THE EXPRESSION HORSE-POWER MEAN?

Power is the rate at which energy is being spent, or the rate at which work is being done. Though it is expressed in terms of horse-power, it bears no exact relation to animal horse-power. What we term horse-power, however, is so called because it originated from the results of experiments carried out by James Watt more than a century ago with strong dray-horses. He wished to find out the rate at which a horse, under average conditions, does its work, and he fixed, as a round figure, 550 foot-pounds of work a second, or 33,000 foot-pounds a minute—that is to say, work equivalent to that needed to raise a weight of 550 pounds one foot high in one second. Watt took this as the value of one horse-power, although he realized that it was more than an average horse can do over a full day's work. Of course, a horse, if stirred by a whip, can exert a much greater power, but only for a very short time.

The expression horse-power is qualified in several ways. What is called "indicated horse-power" is the horse-power exerted on the piston of an engine. Some of this power is absorbed in driving the engine, and the balance remaining for doing the work of driving machinery is known as actual, effective or, more usually, brake horse-power, and is the actual power given out by the engine or motor. Electrical horse-power is the equivalent of mechanical horse-power; one electrical horse-power is equal to 746 watts. The watt was named for the great inventor who experimented with horses. It is the amount of power brought by a current of one ampere flowing under a pressure of one volt.

WHAT IS THE HOLE IN THE NIB OF A PEN FOR?

Ease and rapidity in making the up and down strokes in writing require, in addition to firmness, a certain degree of flexibility in the point of the pen. Therefore all pen nibs have a slit running to the point from a little hole cut in the middle of the nib where it begins to taper. The flexibility is sometimes increased by other slits cut in the nib. If a nib had no slit, its point would stick in the paper and cause the ink to splutter. The curvature of the nib permits it to hold a fair amount of ink, and the film that forms across the hole prevents the ink from running down and making a blot.

Sixteen processes are necessary to make an ordinary steel nib. The slitting is one of the last operations, and takes place after the point has been ground. It is interesting to recall that metal pens were first made from steel tubing filed into shape, the edges of the tube meeting to form the slit.

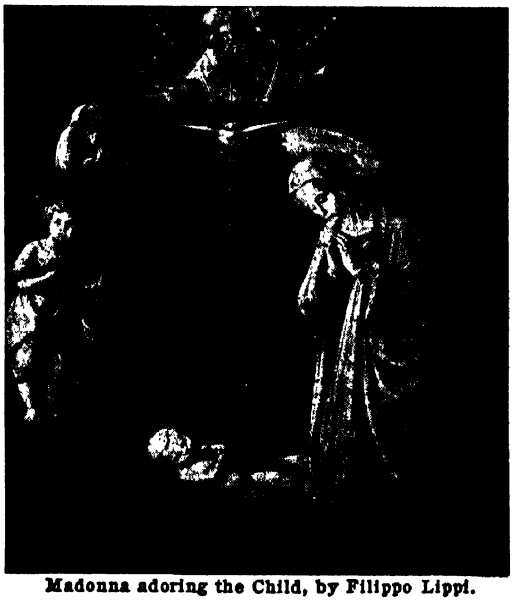
THE NEXT WONDER QUESTIONS ARE ON PAGE 875.

PICTURES BY FOUR ARTISTS OF FLORENCE

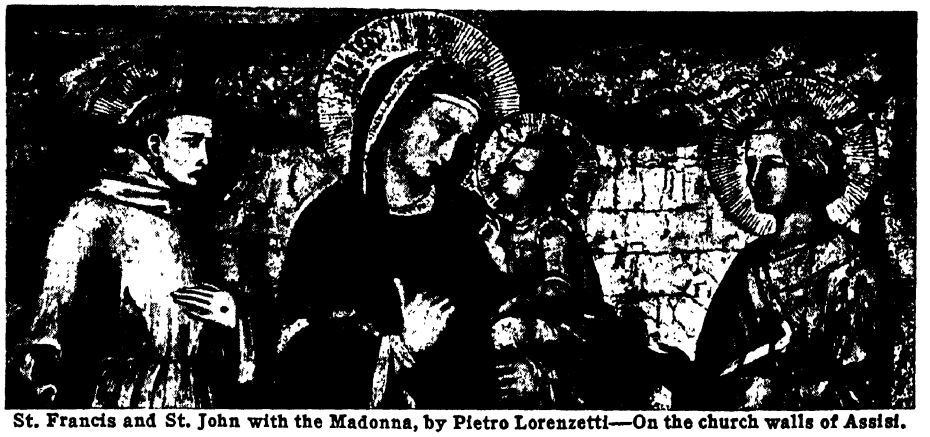
Botticelli's Madonna and Child.

Lorenzo di Credi's Madonna and Child.

The Visitation, by Domenico Ghirlandaio.



Madonna adoring the Child, by Filippo Lippi.



St. Francis and St. John with the Madonna, by Pietro Lorenzetti—On the church walls of Assisi.

THE WONDER MEN OF FLORENCE

THERE is a little town in Tuscany called Siena, a tranquil, if a dirty place, sitting in the sun. Lovers of beautiful things have a warm feeling for Siena; here in the thirteenth century were shown the first tender manifestations of that spiritual force called the Renaissance, the awakening of art after its long sleep.

The Renaissance in art was due to the workings of the Gothic movement north of the Alps. A very great beauty-sense lay behind this movement, as mysterious as beauty always is. It was something intensely airy and alive, with wild-flying wings, and very different from the heavy brooding of the Romanesque movement.

This lightness, this airiness, captured men's hearts and found its expression not only in buildings which flung up their lines like wheeling birds, but in statuary and colored shapes. From southern France the joy in lovely forms and natural beauty spread like a heavenly contagion. This feeling seems to have reached Duccio di Buoninsegna, the Sienese who was the first Italian painter that shows genius, and his fellow-townsmen had it to such an extent that when he had finished his great altar picture, they turned out in a body and carried it triumphantly to the cathedral. Bells rang from the steeples; the town had a holiday in honor of the beautiful thing.

This event, not the only one of its kind in the history of Italian art, throws a light on the peculiar workings of the Renaissance. For several hundred years ordinary citizens cared intensely about art. We can realize into what a far country we have traveled, how great is the gulf separating our cold selves from those ardent medieval people, if we try to imagine some of our communities making a triumphal procession for no other reason than that someone had painted a picture.

Duccio lived from about 1255 to 1340. Although he was a child of the Gothic period, his painting was a strange mixture of the new sense of beauty and the lifeless Byzantine grandeur which hung about Christian art in Italy like a gorgeous, stifling pall. Duccio tried to begin to understand and express what a living line meant. Byzantine lines were all dead. The Sienese artist must have known that a living figure has a certain vibration; he almost found it; he was obviously groping for it all his life, and in doing so he founded a style in which a delicate, pale emotion, a struggling for vitality, can be felt. Duccio's followers founded a school within a school; the Sienese within the Tuscan.

We are coming to a period in the story of art when men's names and dates crowd thick on the pages; and, as there is nothing quite so meaningless as a long string of words in an unfamiliar tongue, we will look at the painters in groups. If we can learn the characteristics of the various schools, we shall have gained enough knowledge to walk into a great art gallery or turn over a book on art, and say, without looking at the name on a picture, "that must be Sienese; that is Florentine, and that Venetian."

THE STRANGE COUNTRY IN THE ROOMS OF A GALLERY OF PRIMITIVES

The great men of the periods we shall unconsciously learn in learning the schools; then we shall be in the happy position of knowing the language of a strange country.

For, there is no doubt about it, any gallery owning a collection of *primitives* is, on the first dozen visits or so, a strange country to most of us. To thousands of people it is never anything else. They go there as a duty. They have been told by enthusiastic people that the gallery contains certain beautiful pictures, but they themselves find them simply ugly; they walk away, and afterward avoid the gallery. Thus one of the richest treasures of our inheritance becomes meaningless.

This is partly because eyes are untrained and partly because beauty is a relative term. All artists strive to express the beautiful, and some succeed better than others. Each man's work is important in itself as an expression of his individual sense of beauty, and also important in the part it plays in the world-movement of all the arts toward the expression of absolute beauty.

SOME POINTS TO REMEMBER IN STUDYING PICTURES

The paintings of the Sienese show a sense of beauty that is historic rather than individual. The painters knew little of technique or perspective, or often of ordinary drawing. They worked in water-color on linen stretched on wood, the fabric having been first dressed with glue. They used a great deal of gold, laying it on the canvas in leaf and afterward burnishing it, according to the dying-out Byzantine tradition. Their art was elementary, and they are truly called primitives. For their work marks the *first* step away from the real Byzantine, and that, in the history of art, was a step toward the realization of ultimate beauty.

In trying to understand pictures which according to the judgment of centuries of thinkers are great, we have to take into account more than drawing and color and subject. A point of great importance in the study of the early Italians is the period of the various artists. For this reason we should try to look at a Renaissance picture from the standpoint of the painter himself, and forget that we are onlookers of a far later day.

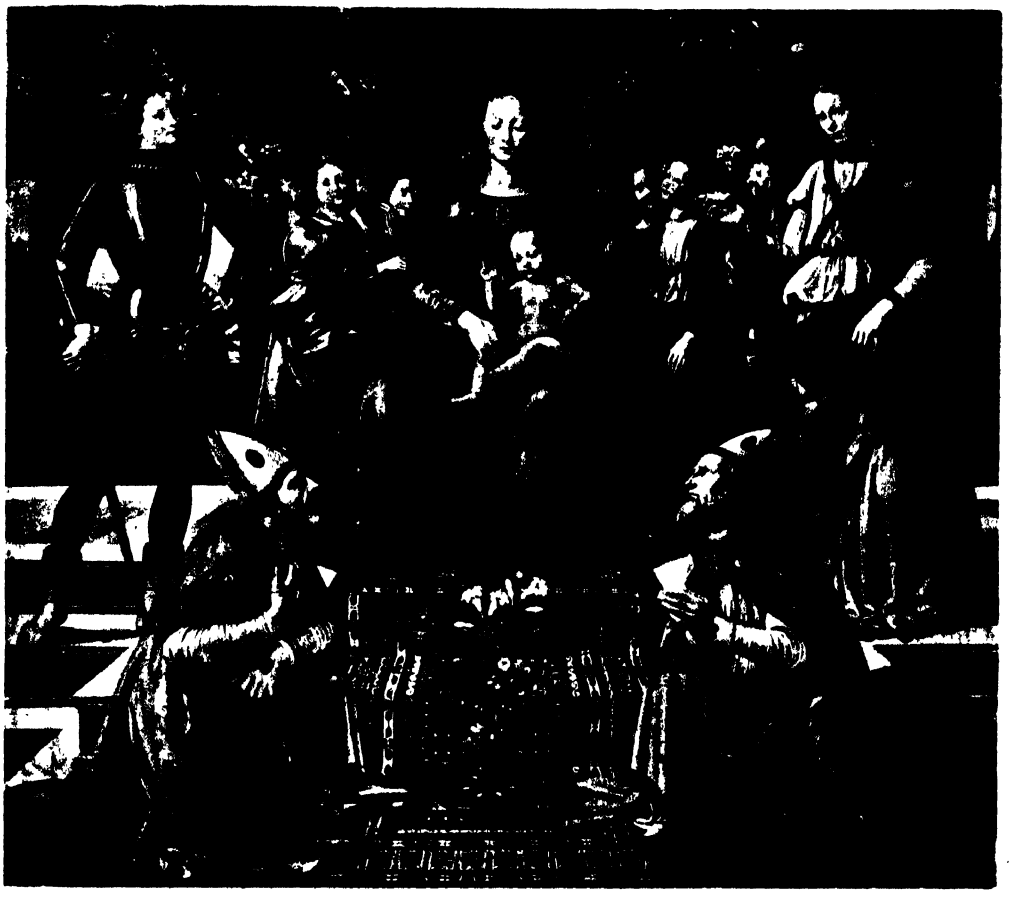
For instance, painters of early Italian religious pictures had been used to seeing, every time they went to church, wall-paintings or mosaics of biblical subjects. These decorations had been made by order of the Church, certain subjects to fill certain panels, the type of person in the picture settled once and for all, it seemed, by the Council of Nicæa.

THE NEW JOY PREACHED BY ST. FRANCIS, WHO LOVED THE BIRDS

There was no room for individual treatment. Imagine, therefore, when these rules were relaxed, the intense joy the early artists had in painting a saint without doing it to pattern. Imagine how they would look on the work as a labor of love and not as an order to make a picture, when they could give more thought to their own ideas. We should try to remember this when we see the quaint, wry-necked saints of the Sienese school, or Duccio's very badly drawn Madonna with a worse-drawn toy Child in her lap.

We should remember that artists are always influenced by what they are thinking about. The Sienese school grew up just after Dante had written his wonderful allegory, and the visions of the poet had been set free to creep into other men's thoughts. And that dear saint, Francis of Assisi, had been going to and fro, preaching and teaching. The spiritual life of thirteenth-century northern Italy is closely bound to that good man. He was in literature and religion what the Gothic spirit was in architecture and statuary—something alive and tender, unbound by tradition. To ourselves, now, the book called The Little Flowers of St. Francis is very precious. What must it have been to have lived in the very place where the memory was warm of the saint who spoke of his little sisters the Birds and his big brother the Sun?

THE DAWN OF ITALY'S GOLDEN AGE



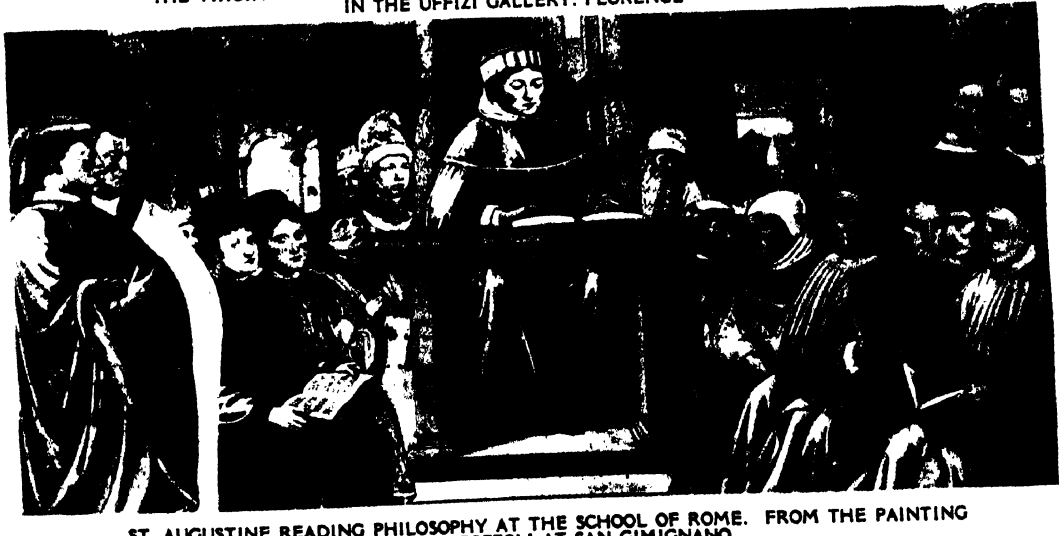
THE VIRGIN WITH THE INFANT CHRIST, BY GHIRLANDAIO, IN THE UFFIZI GALLERY, FLORENCE

AN ALLEGORICAL PICTURE OF SPRING, BY BOTTICELLI, IN THE ACADEMY, FLORENCE

THE FLIGHT INTO EGYPT. FROM A PAINTING BY GIOTTO, IN THE ARENA CHAPEL AT PADUA

THE NATIVITY. FROM THE PAINTING BY FRA ANGELICO, IN THE SAN MARCO MUSEUM, FLORENCE

THE VIRGIN WITH THE INFANT JESUS. FROM THE PAINTING BY BOTTICELLI IN THE UFFIZI GALLERY. FLORENCE



ST. AUGUSTINE READING PHILOSOPHY AT THE SCHOOL OF ROME. FROM THE PAINTING BY BENOZZO GOZZOLI AT SAN GIMIGNANO

ONE OF THE THREE WISE MEN, BY BENOZZO GOZZOLI

THE ANGEL OF THE ANNUNCIATION, BY MEMMI

PORTRAIT OF A LADY, BY PIERO DELLA FRANCESCA

SAINT FRANCIS, BY TADDEO BARTOLO

THE BETRAYAL BY JUDAS. FROM THE PAINTING BY CIMABUE, IN THE CHURCH OF ST. FRANCIS AT ASSISI

THE VIRGIN, BY LORENZO DI CREDI

THE DEATH OF SAINT FRANCIS, BY GIOTTO, IN THE CHURCH OF SANTA CROCE, FLORENCE

The new joy preached by St. Francis was the secret of the greatness and the weakness of the Sienese artists. Their best work is warm with an individual feeling, a struggle to make a personal, living thing out of lines and colors and tones. They did not think and plan sufficiently, but allowed a beautiful emotion to take the place of mental effort. Their greatest artists were Duccio, Simone Martini, known as Memmi, Ambrogio and Pietro Lorenzetti and Bartolo. After the fourteenth century the art of Siena died out for want of strength and vigor.

Side by side with the Sienese school grew another, the Florentine. A number of pictures showing something of the Sienese spirit have been attributed to Cimabue, the early Florentine, and many charming stories cluster around this captivating figure. But art historians believe that many pictures said to be Cimabue's work were painted by someone else—probably by Duccio or his followers—as the Florentine was a worker in mosaics and followed the Byzantine lines of tradition.

The Madonna and Child painted six hundred years ago by Duccio.

Florentine art was a very great movement—an intellectual force producing a number of the most wonderful artists of the world, among them two giants—Leonardo da Vinci and Michelangelo. The first of these notable Florentines was Giotto. He may quite possibly have been influenced by Duccio in the neighboring town, but he showed in his work the clear precision which was to mark the Florentine school and separate it from the gentle and poetic Sienese.

There are many legends about Giotto, one being that Cimabue found him a shepherd boy in the mountains drawing sheep on the rocks; another that he was apprenticed to a wool-merchant and spent his time watching artists at work. Be his origin what it may, Giotto himself is beyond argument a forceful genius with a mind open to all that was beautiful.

He had a keen dramatic sense, and could seize upon the most vivid actions and attitudes in the people he was painting. Intensely as he cared about his work, he never allowed sympathy to overweigh judgment. For instance, while portraying the grief and horror of some persons at the sudden death of a friend, in one of his great pictures, The Knight of Celano, he still kept his attention clear for the innumerable details of character, dress and personal appointments which, if treated in the right proportion, make for strength in a picture. Giotto took the second step along the road to the realization of the Italian ideal of beauty: he turned completely from the chilling Byzantine traditions which still lingered among the Sienese. When we look at his work, we see many faults of drawing, but we see that he battled with the problem of making a projection of color and shape on a flat surface look as much a solid human being as if it had been sculptured in the round. Giotto's coloring was always clear and pale—another move away from the heavy Byzantine tone of richness.

To understand the work of this pioneer among artists it is necessary to look, not only at his pictures, but at his frescoes in Padua and Assisi, and especially in Florence, remembering that a fresco is painted on the wall itself in water-color, before the plaster is dry. A great many Italian artists painted in fresco, and this kind of painting forms a most important part of the study of their work. Some people are very much disappointed when they go to Italy and see the frescoes of Giotto for the first time, because the paintings are faded and at first sight appear a little unconvincing.

But such people have not learned the lesson we have been learning—of looking at an artist's work from the point of view of the painter and the period. Keeping that in our minds, we are not so likely to

make a wrong judgment, because we shall not expect the brilliance of a modern oil-painting when we are looking at plaster pictures which have been exposed to light and heat for a thousand years, and which were painted by a man who, though a great genius, could not draw properly.

THE IMMORTAL GIOTTO WHO "TOOK HILLS AT A STRIDE"

Most of Giotto's frescoes are subjects from the life of St. Francis, cycles of beautiful stories. They adorn churches in Florence, Assisi, Padua and Rome. There are important panel pictures from his brush, too. One of Giotto's paintings is in the Louvre, another in the Munich gallery. The Metropolitan Museum has a picture which is attributed to Giotto and others are in private galleries.

Giotto died in 1337, but his spirit lived on over a hundred years. It took many generations of painters to reach the point where his progress had stopped. Giotto had taken hills at a stride. His followers plodded on, content merely to try to "catch up." They imitated and copied his style and work, and developed little or nothing on their own account. They were a numerous company and are known in art history as the Giotteschi.

The chief among them and the next best to the master was Andrea Orcagna. Another, Taddeo Gaddi, Giotto's favorite pupil and his godson, rather caricatured his master's style, exaggerating the long noses and faces and almond eyes which Giotto had introduced in place of the staring, round-faced Byzantine personations. But he was humble and knew his limitations. Sometimes he signed his work, "Taddeo, a disciple of Giotto, the good master."

FRA ANGELICO, THE GENTLE PAINTER WHO WEPT OVER HIS WORK

After Orcagna and Gaddi perhaps the best of the Giotteschi was Giovanni da Milano; then came Cennino Cennini, Andrea da Firenze, Antonio Veneziano, Spinella Aretino, Lorenzo Monaco. One of these men, Cennini, is chiefly remembered for a book on painting that he wrote, describing, among other things, Giotto's technique, and incidentally throwing a light on Tuscan habits and customs of the thirteenth century.

The greatest artist produced by the school of Giotto was the famous monk Fra Angelico of Fiesole, who lived from 1387 to 1455. He was a gentle and saintly painter, who felt intensely the inward meaning of all the subjects he portrayed and would frequently weep over his work. Fra Angelico's work lacks the strength of Giotto's, but it has a devoutness almost unrivaled. He accomplished an amazing amount of work, but comparatively little of it has survived. One of the treasures of the National Gallery in London is the predella for his altar picture Christ in Glory, painted for the Church of St. Domenico in Fiesole, the hill-top village above Florence. This panel picture is an inspiring and lovely thing—one of the rare flowers of the Renaissance.

Perhaps Fra Angelico used a little too much gold, because he thought that nothing short of gold was rich enough for portraits of Christ and the saints. In this way his work reminds us of the Sienese. But his careful composition and construction of figures is far indeed from the vagueness of the primitives.

Fra Angelico's favorite subject was the Annunciation; another theme he often painted was the Last Judgment. He was perhaps most happy in his pictures of Paradise. Earthly loves and hates hardly existed for him; all his affections soared outward to the heavenly land.

THE EXQUISITE PAINTER OF MAGICAL AND BEAUTIFUL EVENTS

Fra Angelico's pupil Benozzo Gozzoli was an idealist of another kind, loving to picture earthly as well as heavenly things. He has been called the most exquisite story-teller of the Renaissance, a painter of frescoes in which magical and beautiful events are shown. There was a slight tendency in master and pupil to make art visionary and apart from real life. Fra Angelico was first a saint and then a painter and Gozzoli was more an illustrator than either. His frescoes in the Riccardi Palace in Florence and elsewhere are like "the golden dreams of a child."

While Benozzo was but a child, a man was working who in his short life—he died in 1428 at the age of twenty-seven—brought a very different influence to bear on Florentine art. This was Masaccio. Masaccio's work was like a powerful, salt-nipped wind blowing through a languorous garden. He was very vigorous and realistic, indicating by his work that art should explain life, that life is not an affair of dreams, and that nature is the mistress

of all masters. In Italian art Masaccio was the next strong force after Giotto; and like him, he influenced a century of followers.

Masaccio's greatest work was the decoration in fresco of the Brancacci Chapel of the Carmine monks in Florence. The subjects are various—the Fall of Man, the Expulsion from Paradise, and then onward, skipping the rest of the Bible to the Acts of the Apostles. This work makes an epoch in art. It is one of the stages by which progress can be counted. One of the pictures best showing Masaccio's strength is the Expulsion from Paradise.

BOTTICELLI, WHO WOULD SACRIFICE JUDGMENT FOR HIS LOVE OF LINE

Artists of varying qualities were influenced by Masaccio. There was Fra Filippo Lippi, whose work showed a curious mixture of Fra Angelico's saintliness and Masaccio's realism. One of Fra Filippo's pupils was Botticelli, who has perhaps been loved a little more than he deserves.

Botticelli was uneven in his work, allowing himself to be swayed by his passion for a lovely line; and in order to achieve this he sometimes sacrificed both judgment and reason. At his best, as in the Allegory of Spring in the Florence Academy, he is a very fine product of the Tuscan school, but his best does not often happen. Like all the Italians, he painted many Madonnas and kindred subjects, and numerous artists after him worked in his manner. Botticelli's line sometimes suggests the *tremolo* in music. He was born about 1446 and died in 1510.

THE GREAT VARIETY OF THE PICTURES OF PIERO DI COSIMO

Piero di Cosimo, whose work is not at first sight as attractive as Botticelli's, was in some ways a stronger artist. He painted all kinds of subjects, classical and biblical; he also painted exquisite portraits, of which La Bella Simonetta—a beautiful Genoese girl whom Botticelli also painted—is the most famous. There was a mingled delicacy and strength and distinction in Cosimo's work that marked it out even in a century of great artists. His use of color was agreeable and his landscape distinguished. In composition he was somewhat fantastic. The paintings of Cosimo are an excellent study to lead up to the work of the great Leonardo da Vinci, who was his contemporary.

Two more Florentines call for mention—Domenico Ghirlandaio and Lorenzo di Credi. Ghirlandaio, much the stronger artist of the two, was living at the same time as Botticelli, and shared with him many of the commissions upon which artists depended then, as now. Ghirlandaio had a strong instinct for large compositions, and he painted in vivid and clear color. He had an extraordinary capacity for work, and is said to have declared that he would like to paint all the walls of Florence in fresco. Naturally he fell short of this achievement, but in the forty years of his life he accomplished a great deal. He was content to paint subjects as subjects, people as people; he had no spiritual insight, and thus his work is marked by none of the idealism that distinguishes other men of his century. As decoration it is very fine, however.

LORENZO DI CREDI TOUCHED BY THE SPIRIT OF THE GREAT LEONARDO

Lorenzo di Credi was the fellow-student of the great Leonardo da Vinci. We can see, when we have learned to judge this illustrious company of Florentines, that Lorenzo was a good second best. Like most of the men of his time, he ardently admired Leonardo and studied his style. Perhaps it may be said that a ghost of the other's greatness hides in Di Credi's work. Careful in drawing, he gave too much study to the working out of detail; and his painting shows more grace than force or originality. In the European galleries there are various fine examples of his work—usually the Madonna and the child—and he is represented in the Metropolitan Museum, the Boston Art Museum and other collections in America.

Another artist who lived in this amazing fifteenth century was Piero dei Franceschi, the Umbrian. His work was strangely cold and aloof; he preferred strength to beauty. Luca Signorelli was his pupil, and he had a strong feeling for composition for its own sake, regardless of individual figures.

After a little patience in sorting out these names and getting used to the idea of Italian art, we shall see how the work of the Florentine painters grew. It was a truly miraculous development, the mystical unskilled Sienese and the adventurous intellectual Florentines following one after another, until Leonardo came, and Michelangelo.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 823.

A meeting in London of great leaders in science in the eighteenth century.

MEN OF SCIENCE

III. THE GIANTS OF THE 1700's

IF we could have strolled along Nightingale Lane in London two hundred years ago we might frequently have observed a tall, thin man in old-fashioned clothes which varied hardly at all in fashion or material from year to year. Of all the strollers he was probably the least interesting in appearance. He never looked at the passers-by, and he seemed greatly confused and ill at ease when obliged to speak to anyone.

We would have been surprised to learn that this slightly shabby individual was nephew of the Duke of Devonshire and grandson of the Duke of Kent and that there was more than a million pounds (almost $5,000,000) deposited to his credit in the Bank of England. We might be even more surprised to learn that this timid man was one of the most famous chemists in Europe, Henry Cavendish, the man who discovered that water is a compound of two gases. For two thousand years it had been thought to be an element.

Henry Cavendish (1731-1810) was born in Nice, France, of English parents. Nearly all his life was spent in London, where he had two houses. He lived in one and kept his library in the other. Once a week he dined with certain members of the Royal Society (a scientific association), but he avoided all other company, especially that of his own family—and all women. Even the women servants in his house were ordered to keep out of his sight.

When Cavendish was only twenty-four, Joseph Black of Scotland had discovered that bubbles of carbon dioxide (which he called fixed air) were given off when acids were poured on chalk. Cavendish tried pouring different acids on metals. He found that when he poured sulphuric acid on zinc, or hydrochloric acid on tin, a gas bubbled up which burned with a pale blue flame. He called it inflammable air, but we now know this to be the lightest of all substances, hydrogen.

In 1783 Cavendish made a series of experiments establishing the fact that there is no very noticeable variation in the proportion of oxygen in the air at different times or at different places. The idea for his great discovery of the composition of water came from an experiment by John Waltire, a friend of Joseph Priestley. Putting a mixture of oxygen and hydrogen in a glass tube, Cavendish exploded the mixture with an electric spark. The gas mixture diminished in volume, and drops of water appeared on the tube.

Later he discovered the composition of nitric acid. He made a number of important discoveries in electricity, but he cared so little for public notice that he did not publish the notes of his work; in fact they were

not published until sixty-nine years after his death, and by that time other scientists had independently made the same discoveries. Cavendish's last great work was a series of experiments to find the specific gravity of the earth.

We have already said that it was a Scot, Joseph Black (1728-1799), who discovered carbon dioxide. Black was a chemist who taught at the University of Glasgow, and later in Edinburgh. Though at first he had been a believer in the phlogiston theory, he came to see that there is no such thing as a substance with negative weight. (Phlogiston was a "substance with minus weight," believed in by serious scholars for many years.) Black was the first to point out the difference between heat and temperature. He had the honor of belonging to the French Academy of Sciences as a foreign member.

Brown Brothers
Henry Cavendish.

Gabriel Fahrenheit (1686-1736) was a German physicist who was elected to the Royal Society of London. Fahrenheit's big contribution to science was the mercury thermometer which bears his name.

In 1774, two years before the American Declaration of Independence, an English Presbyterian preacher made a revolutionary discovery in chemistry; he heated red oxide of mercury with a burning glass and found that a very remarkable gas was given off. One August day he focused sunlight on the red powder. Presently he saw bubbles rise through the water trough, bubbles of a transparent, colorless, odorless something which looked exactly like ordinary air. But when he tested this gas he found that candles would remain lighted in it with a remarkably vigorous flame; mice lived more than twice as long as in a similar amount of ordinary air, and a red-hot iron wire blazed furiously. The substance, of course, was oxygen, but the discoverer, Joseph Priestley (1733-1804) called it dephlogisticated air, meaning air with the phlogiston taken out.

Born in a tiny village in Yorkshire, Priestley received a rather good education in languages (French, German, Italian, Arabic, Chaldee and Syriac), but he received no formal instruction in science. In his early years his salary as pastor of a small chapel was so small that he had to teach school and also give private lessons in order to support his family. Priestley's most important work in science was done when he was minister of the Mill Hill Chapel at Leeds, in northern England, and when he was librarian for Lord Shelburne, a liberal scholar and statesman.

Although Priestley was unpopular on account of his views in both religion and politics (he was an ardent supporter of both the American and the French revolutions), he made friends of some of the greatest thinkers of the time. With James Watt (famous for his work on the steam engine) and Erasmus Darwin (grandfather of Charles Darwin) he founded a scientific club called the Lunar Society, because it met at the full moon so that the members could walk home in the moonlight. Some people called it the Lunatic Society.

On July 14, 1791, friends of Priestley's arranged a dinner to celebrate the fall of the Bastille in Paris. Hearing of this, an infuriated mob burned Priestley's chapel, tore down his house and destroyed his property and many of his valuable papers. (There were not many in England who had any sympathy for the French revolutionists.) Three years later, Priestley emigrated to America where he was met at the pier by Governor George Clinton of New York. He became the friend of Thomas Jefferson and George Washington.

Among other discoveries made by Priestley were the deadly poison, carbon monoxide, also ammonia, nitrous oxide (laughing gas), nitric oxide and sulphurous acid. He was the first person to prepare and drink soda water and he discovered the fact that plants in sunlight take in carbon dioxide and give off oxygen.

Strangely enough, Priestley never realized just how important the discovery of oxygen was, and he fought for the phlogiston theory to the last.

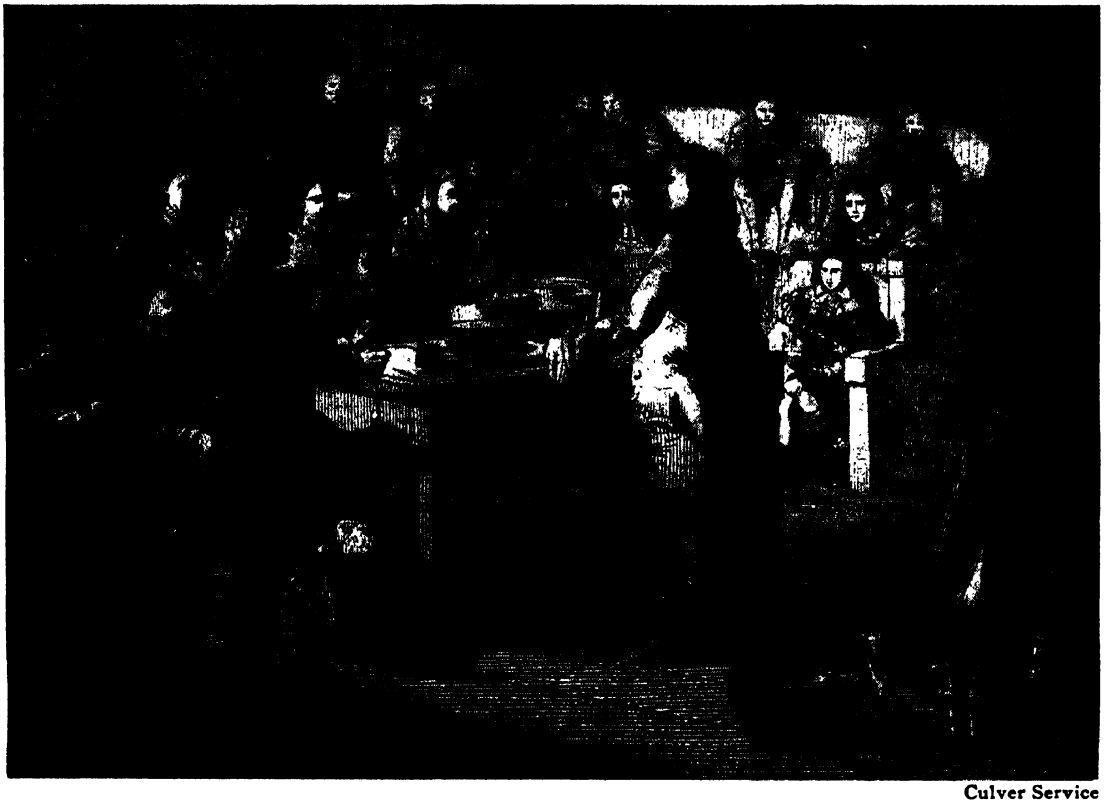
We mentioned the discovery of oxygen as Priestley's. Actually a poor Swedish druggist, Wilhelm Scheele (1742-1786), had prepared oxygen at least two years before

Priestley did. However, Scheele did not publish his results until 1777 so that the scientific world learned of the new "fire-air" from Priestley.

Scheele was apprenticed to an apothecary (druggist) when he was fifteen and spent most of his life in poverty as a druggist's clerk and later as the proprietor of a small-town pharmacy. In spite of the hard work necessary to make a living he found time for an enormous number of experiments. Scheele discovered the yellow-green gas, chlorine, which we now use to purify water; and he was the first to investigate the various acids found in plants and vegetables—tartaric acid, malic acid, citric acid, prussic acid. He discovered uric acid and proved that what we now call lactic acid causes milk to sour.

Antoine Laurent Lavoisier (1743-1794) has been called the father of modern chemistry. Lavoisier enjoyed as a youth all the advantages denied to Priestley and Scheele. His wealthy father sent him to the College Mazarin in his birthplace, Paris, where he studied mathematics, astronomy, chemistry and botany under some of the leading scientists of the day. No one ever worked harder than this tall, handsome young Frenchman. He was so busy with researches on chemistry, hypnotism, the prevention of fires, the lighting of cities, the aurora borealis and other subjects that he went on a diet of milk and bread to save time. Besides his other activities, he spent six hours a day working at his laboratory furnace and once a week he spent the entire day in his laboratory. Once he started to write a play, in addition to all his other activities, but he never finished the play.

When Lavoisier was only twenty-five he was elected to the French Academy of Sciences. The next year he became a tax farmer (a member of the organization which collected the taxes). Many tax farmers were greedy and dishonest, and the whole system was violently hated by the poor. All the evidence we have proves that Lavoisier never did anything in the least dishonest and that he was genuinely interested in improving the lot of the poor. But it turned out to be a sad thing for science that he ever joined the tax farmers, as we shall tell you. One good thing resulted—he found a charming young



Culver Service

An experiment by Joseph Black, Scottish chemist who discovered carbon dioxide. Notice the crude equipment.

wife, the daughter of another tax farmer, who became his lifelong companion and helper.

We have already seen how oxygen, carbon dioxide and many other gases were discovered before Lavoisier studied them. Another French chemist, Jean Rey, had suggested long before that the gain in weight when objects burn in air was due to air "mixing" with the product. Black and Cavendish had carefully weighed the materials they experimented with and the products of the chemical change, which we call burning.

MATTER DOES NOT DISAPPEAR, BUT ONLY CHANGES FORM, DURING CHEMICAL ACTION

But it was Lavoisier who made it plain that no matter that can be weighed disappears during any chemical change, and that if you weigh the products of any chemical change, you have exactly the same weight of matter that you started with. This is the corner-stone of the whole modern science of chemistry. Lavoisier also showed that burning and respiration are both forms of oxidation, one fast and the other slow, and that the whole phlogiston theory, or the idea of a substance with a weight less than nothing was unnecessary. Oxidation means forming a compound with oxygen.

Another ancient notion which was disproved by Lavoisier was the theory that water could be changed into earth by repeated boiling. He proved that diamond and charcoal are both forms of the same chemical element, carbon.

Before Lavoisier's time the study of chemistry had been held back by a strange jargon of weird terms inherited partly from the ancients and the alchemists. It was not always easy for one chemist to know just what the other was talking about. Together with three friends Lavoisier set to work in 1782 to work out a simplified language for chemistry. Our chemical language of today is due largely to the work of these four. The words oxygen and hydrogen are inventions of Lavoisier's. A Frenchman, Louis Bernard Guyton de Morveau (1737-1816), was one of those who suggested to Lavoisier a simplified language of chemistry.

Few scientists have had a happier life than Lavoisier. He was recognized throughout the world as one of the greatest scholars alive. He was happy in his married life and in his friends. He was well-off financially; and he was equally at home in the laboratory and in the company of the wits and social lions of Paris when Paris was (more than ever before or since) the gay capital of Europe. But as the French Revolution proceeded Lavoisier's connection with the tax farmers put him under suspicion. One of the most bloodthirsty leaders in the revolutionary period we call the Reign of Terror was Marat, who had been belittled

Pharmacy of Frederick William I of Prussia.

by Lavoisier years before as a very poor chemist. This same Marat now attacked Lavoisier and helped to bring about his death by the guillotine in 1794, a month after Priestley had left England for America.

Another French scientist of the period was Claude Louis Berthollet (1748-1822). He discovered the law of mass action, which helps us to understand how much of different compounds will be formed under varying conditions. He discovered the bleaching power of chlorine.

Jacques Charles (1746-1823) was a Frenchman who discovered a great law that is known as Charles' Law. This states that all gases expand at the same rate as their absolute temperature increases.

As you know, matter is anything that takes up space. During the eighteenth century, most scientists believed that heat was a form of matter. Even Lavoisier thought that heat was a weightless "caloric" fluid

which could get into things and make them hotter. For example, when a piece of iron got hot, it was because some "caloric" fluid entered it; and when the iron cooled off again, it was because the "caloric" fluid flowed out of it.

One of the first to attack this entire idea of a heat substance was Sir Benjamin Thompson, Count Rumford (1753-1814). This man was born plain Benjamin Thompson in Massachusetts. He was knighted by King George III of England in 1784. This made him Sir Benjamin Thompson. Later, in 1791, the Elector of Bavaria made him a count of the Holy Roman Empire, Count Rumford. These honors were bestowed upon him for his services as a soldier statesman and ambassador, not for his services to science. It is interesting to note that although he fought against the Thirteen Colonies during the Revolutionary War, his world-wide reputation prompted President Adams to invite him to return to the United States in 1799, with the position of head of the Military Academy and Inspector General of the United States Artillery. Rumford did not accept this offer.

While he was commander-in-chief of the Bavarian army, Count Rumford established a foundry in Munich to manufacture cannon. Here he noticed that during the process of boring, the metal of the cannon grew very hot. This was surprising, because there was no apparent source of heat. If, as scientists believed, heat was a substance, where did it come from in this case? So far as anyone could see, no heat was being added. A tool was merely being rubbed against the metal of the cannon, yet it became hot. (If you have ever drilled into wood, you have noticed the same thing. As you drill, the bit gets hotter and hotter.)

Count Rumford now ordered the entire apparatus, cannon and drilling tool, to be put into a box of cold water. Then the drilling process was begun again. To everyone's amazement the water began to boil after two and one-half hours of drilling. And without

Statue of Joseph Priestley, and two of his inventions.

The burning glass believed to have been used in the discovery of oxygen. It has two lenses in a heavy metal frame, which can be pivoted so as to catch the sun's rays from any angle.

Dickinson College from New York Herald Tribune

In the air gun, air is compressed into the iron ball attached to the barrel. Pressing the trigger releases enough air to fire a small bullet. Here, the gun leans against the compressor.

fire! Where did all the heat come from? The gun metal, the drill, the water, all started cold; and now the water was boiling. Count Rumford concluded that heat can not possibly be a material substance, since matter can not be created out of nothing. He said that heat must be some sort of motion.

Today we know this to be correct. We know that heat is energy. It is caused by the motion of the molecules of which the substance is made. Anything which makes the molecules move faster makes the substance hotter. Anything which slows their movement makes the substance colder.

By the end of the eighteenth century chemistry as a science was more like the modern science, and less like the mysterious proceedings of Paracelsus and the alchemists. Lavoisier and his three collaborators had introduced the modern system of names in chemistry, banishing queer terms like liver of sulphur, butter of arsenic, dephlogisticated air and flowers of zinc.

IN ANY GIVEN CHEMICAL COMPOUND THE ELEMENTS ARE ALWAYS IN THE SAME PROPORTION

The great French chemist, Joseph Louis Proust (1754-1826), was building on the work of Lavoisier to establish the fact that chemical compounds have a *constant* composition. This means, for example, that water always consists of the same proportions of oxygen and hydrogen. It doesn't have more oxygen at one time and less at another.

At the age of twelve John Dalton (1766-1844) became a school teacher—for a salary of about five shillings a week. Some of his pupils were much older than he. It was not so much love of teaching as poverty that made John a schoolmaster. He was one of the six children of a poor English Quaker, who made little by his work as a weaver. Teaching boys and girls older and taller than one's self has its disadvantages, as when one of Dalton's pupils challenged him to fight. Dalton decided not to fight and locked the boy up in his room. No one was hurt, but the boy's classmates broke the windows to show Dalton what they thought of him.

Dalton's chief pleasure in his early days was the study of weather and the atmosphere. Starting when he was twenty-one he kept a diary for fifty-seven years in which he recorded more than 200,000 meteorological (weather) observations. Ordinary air fascinated him What was it? A chemical compound? Or a mixture of the gases nitrogen, oxygen, carbon dioxide and water vapor? Why, when the Frenchman, Gay-Lussac, ascended in a balloon to a height of 21,375 feet over Paris, had he found the composition of the air to be practically the same as on the ground? Why didn't the heavy carbon dioxide all sink to the surface of the earth and the lighter water vapor rise to the top of the atmosphere? Why did water absorb very different amounts of the different gases in the air?

DALTON GIVES SCIENCE A LOGICAL THEORY OF ATOMS, BASED ON EXPERIMENTS

Finally Dalton decided air was a mixture, not a compound. This being true, Dalton believed the behavior of the gases might be explained if one thought of them as being composed of tiny particles. In other words, of atoms. The changes which substances went through from solid to liquid to gas and back again could be explained as a rearrangement of the atoms of each element. In 1808 Dalton published his famous atomic theory. It held that all matter is composed of tiny atoms, and that all the atoms of a particular element (oxygen, for example, or gold) are similar and of the *same weight*. The atoms of gold and lead are comparatively heavy, those of hydrogen very light.

Many scientists before Dalton had thought that matter is composed of atoms. Leucippus and Democritus among the Greeks; and later Galileo, Boyle, Isaac Newton, Gassendi and others thought well of the idea. But Dalton was the first to give the world a clear and logical theory, based on *experimental evidence*. Dalton was not a good experimenter himself, but he made wonderful use of the experiments of his fellow-scientists.

Publication of his atomic theory brought Dalton great fame, but many chemists refused to accept it. Even Humphry Davy was hostile. Yet within a few years the theory was generally accepted, even by those who had laughed at the idea at first.

Dalton never married. He was so colorblind that when he was dressed in his red robes of a Doctor of Laws he did not know that he was breaking one of the rules of the Quakers. (It was forbidden to wear red.) So he went cheerfully up to be introduced to the King since, as he confessed, red looked exactly the same to him as green. In spite of world-wide fame, Dalton remained poor, earning his living by teaching. When a French scientist came to Manchester to pay his respects, he expected to find Dalton installed in a great university. Instead, after a long search, he found the English scholar coaching a small boy in arithmetic.

Dalton represented the atoms of different elements by mysterious little signs: ○ for oxygen, ⊙ for hydrogen, ● for carbon, ◑ for nitrogen. Carbon monoxide was indicated by ○●, carbon dioxide by ○●○ and water by ⊙○. (He thought that only one atom of hydrogen joined with an atom of oxygen in forming water. Later it was learned that two atoms of hydrogen combine with one of oxygen in forming water.) Other chemists had even queerer symbols.

Jöns Jakob Berzelius (1779-1848) gave us the system we now use. The first letter or the first two letters of the Greek or Latin name of the element generally, though not always, forms the symbol. The symbol stands for the element's name, also for its atomic weight. Cu stands for copper (*cuprum*) and for its atomic weight, 63.57.

In "writing" a compound, we write the elements that make the compound, giving the number of atoms of each element in a single molecule. Instead of Dalton's ○●○ we now write CO_2 for the compound carbon dioxide. Vitamin A is $C_{20}H_{29}OH$. Imagine representing this formula with Dalton's little circles!

Benjamin Thompson (Count Rumford).

Just as Davy objected to Dalton's atomic theory, Dalton was shocked by Berzelius' plan to use letters as chemical symbols. "Berzelius' symbols are horrifying," he wrote.

Berzelius determined the *relative* (comparative) atomic weights of a large number of elements with great accuracy. He did not discover how much a single atom of any element weighed, but he made excellent estimates as to how much the atoms and molecules of some 2,000 substances weighed *as compared with oxygen.*

One of the great men of science of the eighteenth century was Humphry Davy (1778-1829). By the time he was twenty, Davy had become a laboratory assistant at Dr. Beddoes' Pneumatic Institution, a sort of hospital founded for the purpose of treating illness by using new gases which the chemists were discovering in that period. Here Davy experimented with a very peculiar gas called nitrous oxide. When people inhaled this gas, it exhilarated them, and made them do all sorts of peculiar things. Often they broke into laughter and so the gas came to be called laughing gas. Since this gas also made people unconscious and insensible to pain, it was used as an anesthetic to relieve pain in minor surgery.

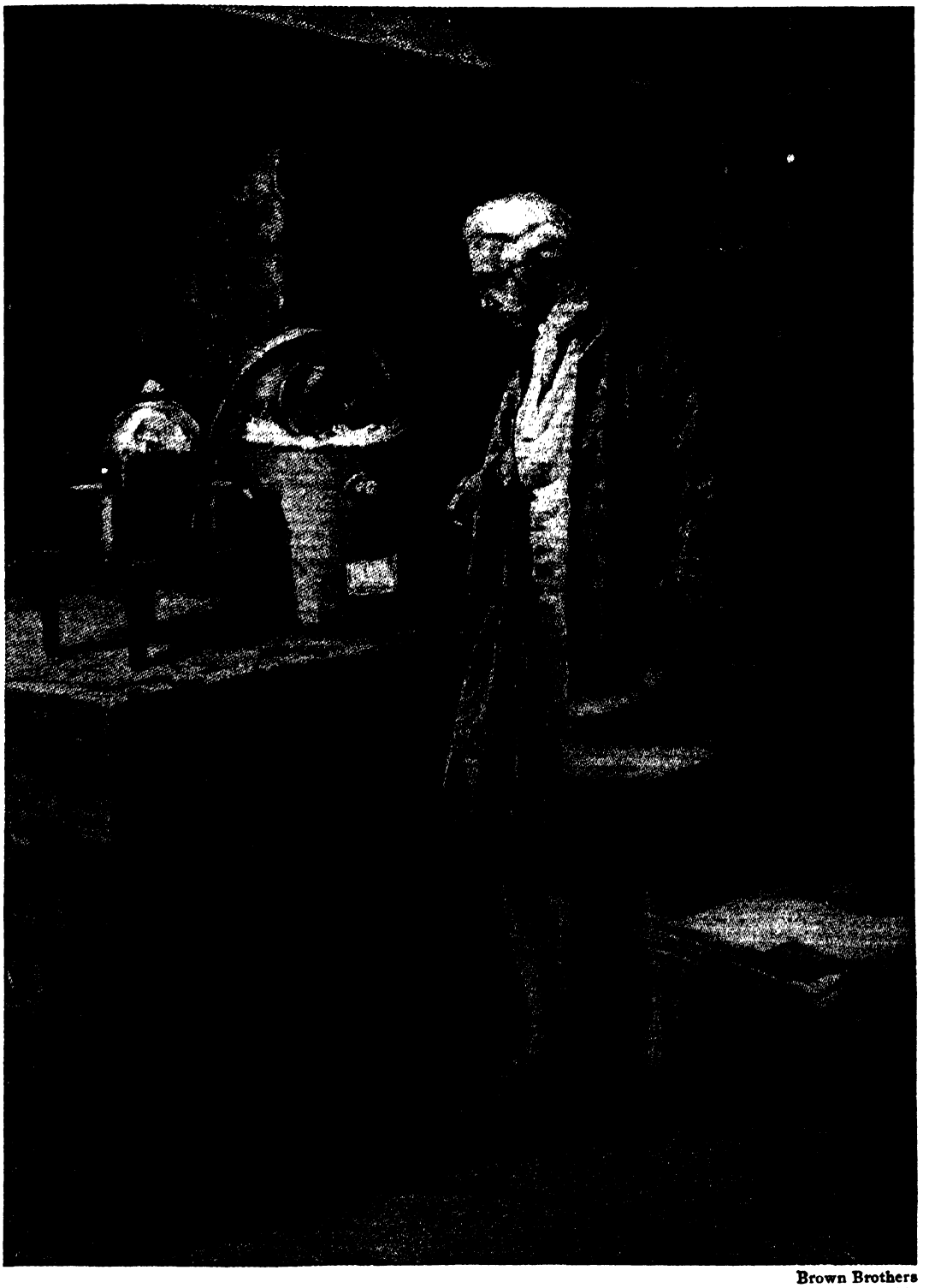
While he was at this institution, Davy performed an experiment which brought his work to the attention of Count Rumford. Davy devised an apparatus which rubbed two pieces of ice together until enough heat was given off to melt the ice. Rumford liked this experiment since it supported his ideas, for if ice is water without heat-fluid (as people then believed) how could rubbing two pieces of ice cause them to give off a substance which they do not contain? Therefore heat must be a motion in the ice, rather than a "caloric" fluid.

In 1801, Rumford offered Davy the post as director of the chemistry laboratory at the Royal Institution. Here Davy lectured to the public on science. His lectures were a tremendous success. All in all, Davy did his work so well that his name and his discoveries became known far and wide.

Although Davy was a chemist, the amazing electrical discoveries of the day interested him strongly. Volta had made a battery which produced electricity (see Electricity in Volume 11). The English scientists Nicholson and Carlisle put the wires leading from a voltaic battery into water and noticed bubbles arising near the wires. The bubbles turned out to be pure oxygen and pure hydrogen. In other words, the electric current had decomposed the water into the two gases of which it was made.

Would the same thing happen if one put the electric wires into other substances? Davy tried. In 1807 he put the wires from his battery into melted potash, and found that "small globules having a high metallic luster similar in visible character to quicksilver appeared." These small globules were actually pure metallic potassium never before seen by man. Using this same method of electrolysis, Davy discovered a host of other new metals—sodium, calcium, magnesium, strontium, barium—all newcomers to

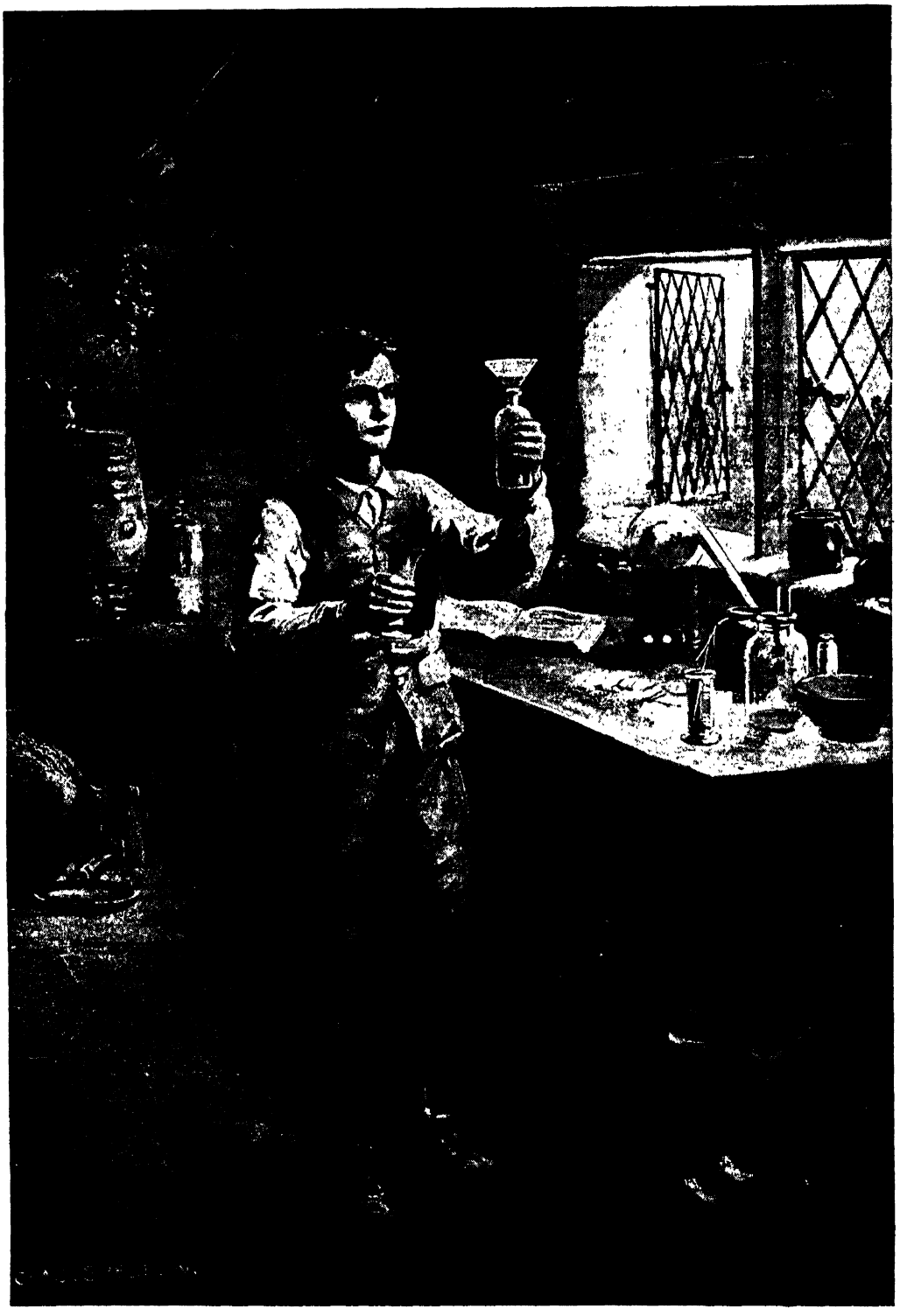
LAVOISIER, FOUNDER OF MODERN CHEMISTRY



Brown Brothers

Antoine Lavoisier, French scientist, gave chemists far better tools than they had ever before had. Many of his experiments were made on this huge furnace in his laboratory.

THE BOYHOOD OF SIR HUMPHRY DAVY



Humphry Davy was apprenticed to a chemist in a little country village, and here we see him in the chemist's shop, using his spare time to study and experiment. It was Davy who invented the miner's safety lamp.

man's knowledge in the field of chemical elements.

TO SOLVE THE PROBLEM OF COAL-MINE EXPLOSIONS, DAVY INVENTS A SAFETY LAMP

Davy's fame became still greater, and in 1812 he was knighted. Soon thereafter he was asked to solve a problem of great importance to England. Hundreds of miners were being killed yearly by explosions in the coal mines. These explosions were caused by the fact that a gas known as coal damp (methane) accumulated in pockets in the mines. Since the miners carried oil lamps for lighting their work, the flame of a lamp was liable to set off a violent explosion whenever a miner stepped into a gas pocket.

Could Sir Humphry Davy solve the problem and prevent these explosions? In 1815 he came up with a simple solution. He invented a safety lamp for miners. Instead of using an ordinary glass chimney open at the top, Davy enclosed the flame of the lamp within a wire cage. When you first think of it, there seem to be plenty of openings in such a screen through which a flame could get at the coal-gas. But this is not really so. The wire mesh is such a good conductor of heat that it conducts the heat away from the flame before the flame can get out of the lamp to reach the gas. Thus explosions from this cause seldom happen.

Progress in the science of living things (biology) was not so great during the 1700's as in chemistry and physics. But the foundations were laid for tremendous advances that came after 1800.

Aristotle in the fourth century before Christ had attempted to make a logical classification of animals. The first really great advance in the classification of living things was the work of the Englishman, John Ray (1627-1705), who did most of his work on plants, but who also made a classification of animals. His work was overshadowed by that of the Swedish naturalist, Linnaeus, whose accomplishments are related in a later chapter.

An English country parson, the Reverend Stephen Hales (1677-1761), was the first scientist to measure the pressure of blood in blood vessels. He noticed that different circumstances could change the blood pressure in the same individual and that the pressure in the arteries was different from that in the veins. Hales was also the first person to measure the amount of water taken in and given off by plants, and to observe the rate at which water rises in plant stems.

A tremendous debate between scientists in different countries took place in the eighteenth century as to whether living things arose spontaneously—or whether all the living things we observe are the offspring of descendants of previous living things. A hundred years earlier, Francesco Redi (1626-1679) had shown that no matter how rotten it may become, decaying meat never turns into maggots. He proved that the maggots are the offspring of flies and that if one keeps the flies away from the meat, no maggots will ever appear.

SPALLANZANI PROVES THAT BACTERIA DO NOT DEVELOP IN STERILE LIQUIDS

After Leeuwenhoek (of whom you read elsewhere) discovered bacteria, several scientists claimed they had proved that bacteria arose by spontaneous generation. That is, if one left soup or broth standing, part of the liquid would simply turn itself into living bacteria. This was disproved by the Italian Abbé Lazaro Spallanzani (1729-1799), who boiled broth in flasks, and sealed the flasks while boiling them. He found that no bacteria developed if he boiled the broth long enough under these conditions.

Curiously enough, the whole question of spontaneous generation was brought up again a hundred years after Spallanzani (about two hundred years after Redi) to be finally settled by the beautiful experiments of Pasteur and Tyndall (whose stories are told elsewhere. See Index.)

A relative of Spallanzani's was Laura Bassi, professor of physics at the University of Bologna, one of the few women to occupy such a distinguished post in those days. Even women scientists were very rare.

ELECTRICITY STIRS THE IMAGINATIONS OF SCIENTISTS IN THE 1700's

During the eighteenth century a number of scientists were fascinated by that mysterious force which William Gilbert in the preceding century had named electricity.

The story of the Men Who Found Electricity is told in Volume Eleven; but we must mention here also a few of those who belonged to the 1700's, for the present story would be incomplete without at least their names.

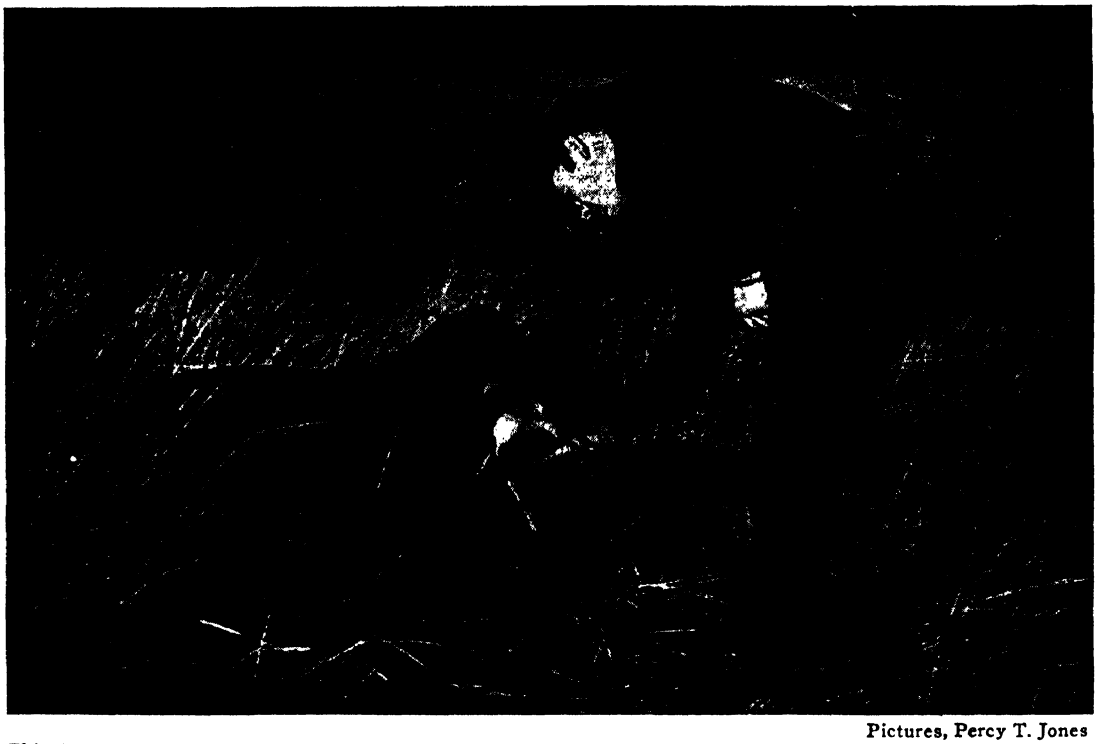
Benjamin Franklin, Charles Augustin Coulomb, Luigi Galvani and Alessandro Volta were the outstanding "electricity men" in the 1700's, as you will see in the story that begins on page 3980.

By THOMAS GORDON LAWRENCE.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 977.

DOGS THAT WORK AND HUNT FOR MAN

The tireless, agile sheepdog has tended flocks since Biblical times. One dog is capable of herding hundreds of sheep, guiding them to new pastures, rounding up those who stray from their fellows, and standing watch. There are several breeds that do this work, including the Collie, the Old English Sheepdog and the Welsh Corgi.



Pictures, Percy T. Jones

This dog, a champion Golden Retriever, is delivering a wild duck which his master shot over the water. Retrievers swim after their prey and are taught to carry it gently to avoid tearing or puncturing the flesh. Events called Field Trials, in which hunting dogs compete for prizes, are held by sportsmen during the hunting seasons.

FRIENDLY DOGS

IT was an important event for the human race when one of the wild men of old went into the wilderness, captured a creature with twice as many legs as his own and twice the speed he could command, tamed it and trained it, and so started an everlasting partnership between mankind and the animal kingdom. Geologists tell us that this happy friendship began in the Stone Age, about 5000 B.C.

Man lived by tracking, trapping and killing. In the dog he found a fresh addition to his powers. The friendly dog became new ears, new nose, new eyes to him and so doubled and tripled the forces which discovered and led him to his quarry. We know also that the dog early became a draft animal, hauling its master's property even before the wheel was invented.

Which was the first dog? Experts differ as to the origin of our four-footed friend of to-day. Many think that the dog sprang from the wolf and jackal. Others believe that there has always been a dog. Certainly dogs are usually friendly with other dogs, while they look upon wolves, jackals and foxes as their enemies. Moreover, the pupil of a dog's eye is round, that of the wolf is oblique and the jackal's eye is vertical.

Whatever their origin, the first dogs are now the ancestors of more than 200 breeds which the ingenuity of man has developed with all kinds of coats, shapes and sizes. It seems difficult to believe that the tiny, blunt-nosed, short-legged, full-coated Pekingese comes from the same family as the tall, stately, smooth-haired Great Dane. As long ago as 3700 B.C. the Egyptians, it is said, knew twenty-one different breeds. Two, if not more, of the breeds we know to-day, the Afghan Hound and the Saluki, were used by the Egyptians for hunting. The ancient people of the Nile Valley often regarded the dog as a god, mourning its death and burying it as a mummy in special cemeteries.

The American Kennel Club, the leading dog organization in the United States, recognizes 108 breeds and divides them into six groups as shown below. The Canadian Kennel Club is the leading dog organization in Canada, and these two clubs recognize each other's breeds.

Constance Bannister, photographer, courtesy, Woman's Day

SPORTING DOGS

Griffons (wire-haired pointing)
Pointers
Pointers (German short-hair)
Retrievers (Chesapeake Bay)
Retrievers (curly-coated)
Retrievers (flat-coated)
Retrievers (Golden)
Retrievers (Labrador)
Setters (English)
Setters (Gordon)
Setters (Irish)
Spaniels (American Water)
Spaniels (Brittany)
Spaniels (Clumber)
Spaniels (Cocker-American, English)
Spaniels (English Springer)
Spaniels (Field)
Spaniels (Irish Water)
Spaniels (Sussex)
Spaniels (Welsh Springer)

SPORTING DOGS (HOUNDS)

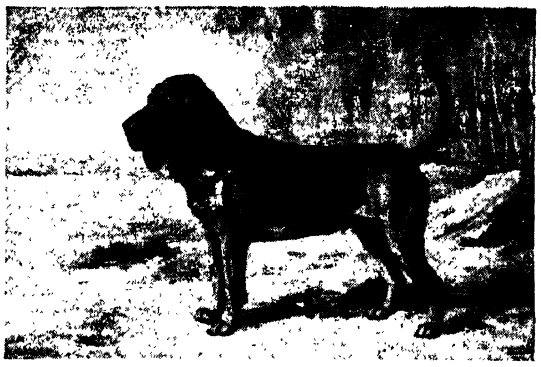
Afghan Hounds
Basset Hounds
Beagles
Bloodhounds
Borzoi (known also as Russian Wolfhound)
Dachshunde
Deerhounds (Scottish)
Foxhounds (American)
Foxhounds (English)
Greyhounds
Harriers
Norwegian Elkhounds
Otterhounds
Salukis
Whippets
Wolfhounds (Irish)

WORKING DOGS

Alaskan Malemutes
Belgian Sheepdogs
Bernese Mountain Dog

Dr. Samuel Milbank

This Labrador Retriever has won many prizes for his great beauty and hunting ability.



Giralda Farms

The Bloodhound, which is used to track criminals and missing persons, does not usually attack.

WORKING DOGS (continued)

Bouviers De Flandres
Boxers
Briards
Bull-Mastiffs
Collies (rough-coated and smooth-coated)
Doberman Pinschers
Eskimos
German Shepherd Dogs
Great Danes
Great Pyrenees
Komondorock
Kuvasz
Mastiffs
Newfoundlands
Old English Sheep-Dogs
Pulis
Rottweilers
Samoyedes
Schnauzers (Giant)
Shetland Sheepdogs
Siberian Huskies
St. Bernards
Welsh Corgis (Cardigan and Pembroke)

TERRIERS

Airedale Terriers
Bedlington Terriers
Border Terriers
Bullterriers
Bullterriers (colored)
Cairn Terriers
Dandie Dinmont Terriers
Fox Terriers (smooth-haired, wire-haired)
Irish Terriers
Kerry Blue Terriers
Lakeland Terriers
Lhasa Terriers
Manchester Terriers
Norwich Terriers
Schnauzers (miniature)
Schnauzers (standard)
Scottish Terriers
Sealyham Terriers
Skye Terriers
Staffordshire Terriers
Welsh Terriers
West Highland White Terriers

TOY DOGS

Affenpinschers
Chihuahuas
English Toy Spaniels
Griffons (Brussels)
Italian Greyhounds
Japanese Spaniels
Maltese
Mexican Hairless
Papillons
Pekingese
Pinschers (miniature)
Pomeranians
Pugs
Toy Manchester Terriers
Toy Poodles
Yorkshire Terriers

NON-SPORTING DOGS

Boston Terriers
Bulldogs
Chow Chows
Dalmatians
French Bulldogs
Keeshonden
Poodles
Schipperkes

Some breeds, like the Dachshund, may have two or three varieties of coats: short-hair, wire-hair and long-hair. Others come in two or three sizes; the Schnauzer, for example, may be giant, standard or miniature. One breed may offer several colors, like the American Cocker Spaniel that comes in the solid colors of black, red, liver and buff, or in the parti-colors of black and tan, black and white or brown and white. In some cases, the Kennel Club separates the varieties into two or more distinct breeds, as you can see from the listing above. However, the varieties of a breed rarely differ in shape.

There are few breeds of dogs that originated on this continent. Only the Chesapeake Bay Retriever, the American Water Spaniel and the perky Boston Terrier had their beginnings in the United States, though the American Foxhound might have been developed from English and French hounds imported to North America in the eighteenth century. Of course, the earliest settlers brought their dogs with them, and from Colonial days Canada and the United States have imported the best specimens of the foreign breeds.

Ever since their friendship began, dog has served man in many different ways. The first use—hunting—was a necessity until primitive people learned to raise their own food. To-day the hunting breeds, the Pointers, Setters, Spaniels, Retrievers and Hounds, bring much enjoyment to the sportsman. Dogs like the Pointer, Irish Setter and Cocker Spaniel hunt pheasants, quail, woodcock and

A KENNELFUL OF DOGS — THE TERRIERS

Wildoaks Kennels

WIRE HAIRED FOX TERRIER

Edgerstoune Kennels

WEST HIGHLANDWHITE TERRIER

Wissahoo Kennels

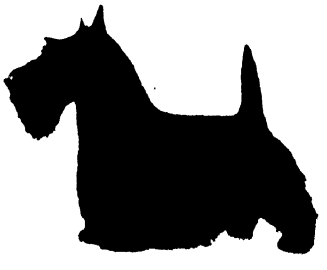
SMOOTH FOX TERRIER

Croglin Kennels

SEALYHAM TERRIER

Coolvin Hill Kennels

BULLTERRIER

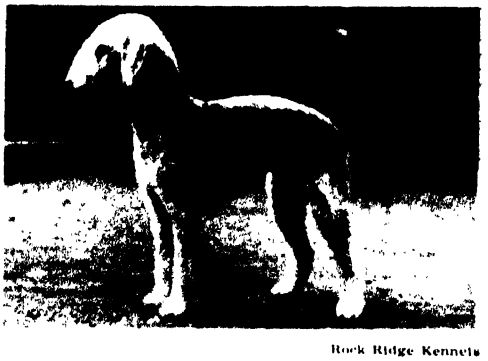


Belgalf Kennels

SCOTTISH TERRIER

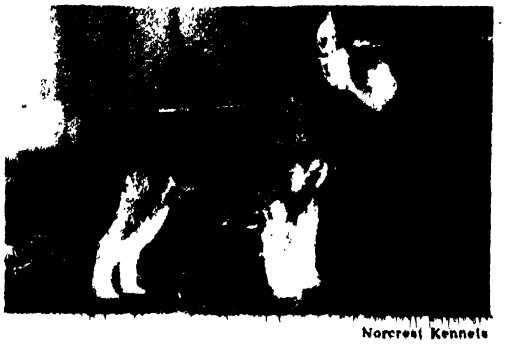
S. M. Stewart

AIREDALE TERRIER



Rock Ridge Kennels

BEDLINGTON TERRIER



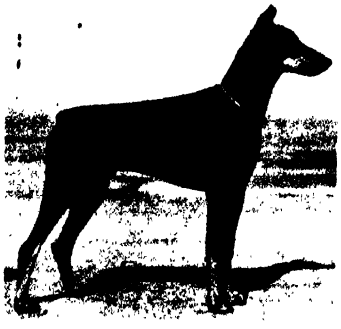
Norcrest Kennels

MINIATURE SCHNAUZER

Mrs. H. L. Platt

CAIRN TERRIER

WORKING DOGS



Randahof Kennels

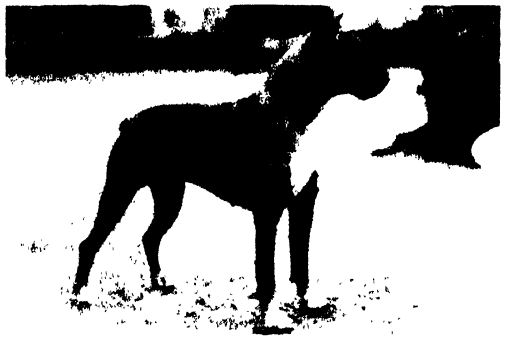
DOBERMAN PINSCHER

Merriedip Kennels

OLD ENGLISH SHEEPDOG

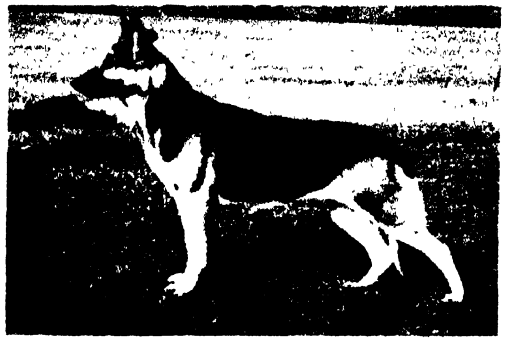
R. P. Stevens

GREAT DANE



Mrs. Lillian Palmedo

BOXER

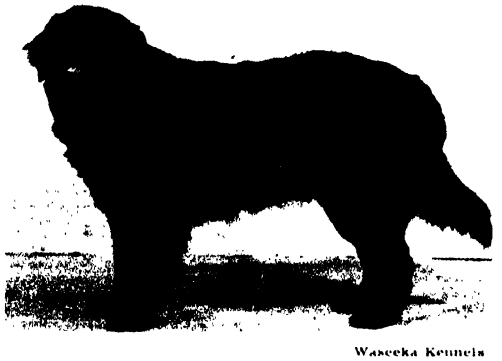


Giralda Farms

GERMAN SHEPHERD

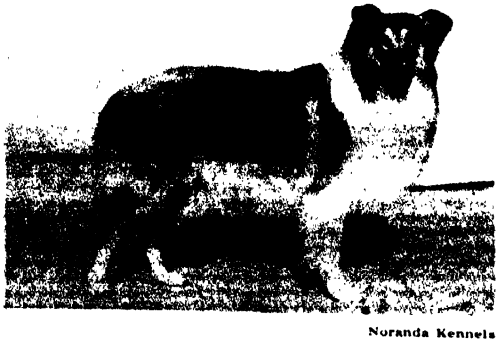
Rt. Rev. R. F. Keegan

SAMOYEDE



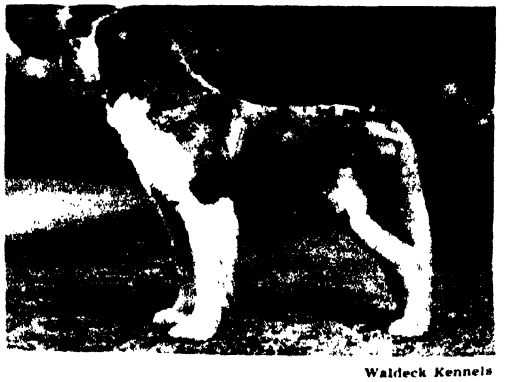
Waseeka Kennels

NEWFOUNDLAND



Noranda Kennels

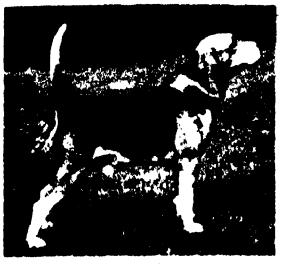
COLLIE



Waldeck Kennels

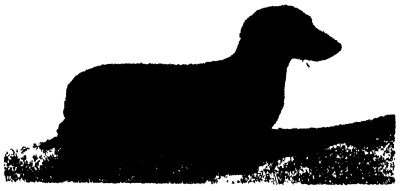
ST. BERNARD

SPORTING-HOUNDS



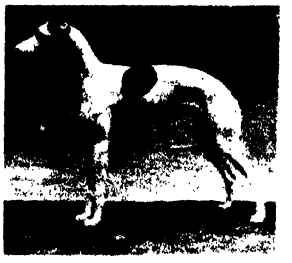
Liseter Beagles

BEAGLE



Mrs. G. F. Gillies

DACHSHUND



Marlormere Kennels

WHIPPET

Marion F. Florsheim

AFGHAN HOUND

L. J. Murr

BORZOI (RUSSIAN WOLFHOUND)

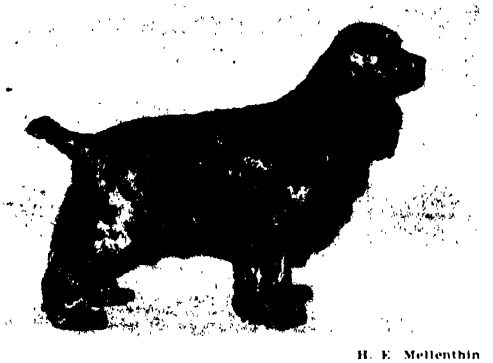
SPORTING DOGS

Giralda Farms

POINTER

Mrs. Cheever Porter

IRISH SETTER



H. E. Mellenthin

COCKER SPANIEL

Greenfair Kennels

ENGLISH SPRINGER SPANIEL

TOY DOGS

Wm. O. Bagshaw

MINIATURE PINSCHER

Mrs. V. Matta

POMERANIAN

Burlingame Kennels

BRUSSELS GRIFFON

NON-SPORTING

Mrs. Don Smith

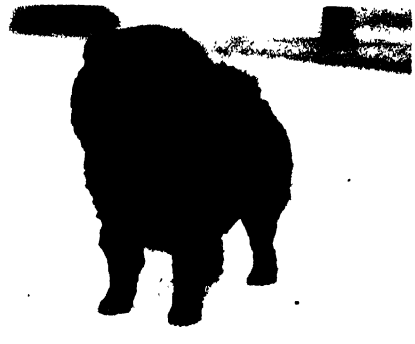
BOSTON TERRIER

Kelso Kennels

SCHIPPERKE

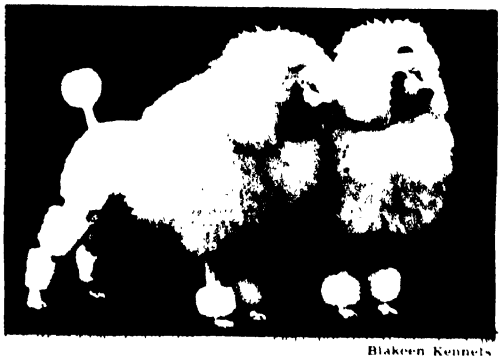
H. J. McCroden

BULLDOG



Tallyho Kennels

CHOW CHOW



Blakeen Kennels

POODLES

Mrs. L. W. Bonney

DALMATIAN

other game birds. The Retrievers are used generally for duck-hunting, swimming after the fallen prey and fetching it to the hunter. The Hounds--Beagles, Bassets, Harriers and Foxhounds—course (run) after rabbits, other rodents and foxes, either singly or in packs. Though most breeds hunt by scent, the fleetest members of the canine kingdom, the Greyhound family, hunt chiefly by sight. Greyhound racing in many countries rates second only to horse racing in the popular fancy.

The Working Dogs offer their contribution to man in guarding, drafting and herding. The German Shepherd, the Doberman Pinscher, the Boxer and other large breeds in this group have aided police throughout the world in tracking down criminals and attacking if necessary. In this connection, we must not forget the Bloodhound which, though it does not usually attack, is perhaps the best tracker of all.

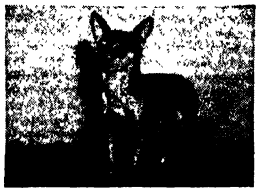
The great polar explorations might never have occurred when they did had it not been for the Eskimo Dogs, the Siberian Huskies and other breeds of the frozen lands. Even in our times, when the airplane has replaced former methods of transportation in polar exploration, Admiral Byrd used these dogs to reach points inaccessible to man's wings. In Belgium and Holland dogs haul milk and other products.

DOGS THAT SAVE HUMAN LIVES

Many a human owes his life to the shaggy St. Bernard of the Alps and to the water-loving Newfoundland whose record for saving drowning people is unsurpassed. The honors for protecting human life do not belong entirely to the big dogs, however; even the little Pomeranian can warn his master of fire, and has done so.

If you are wearing any wool, just think for a moment that you can probably thank a faithful, intelligent dog for guarding the sheep from which the wool was taken. From the days of Abraham, when one dog was said to have been capable of herding 4,000 sheep, breeds like the handsome Collie and Old English Sheepdog have labored in the service of man in herding, as well as his sheep, his cattle and hogs.

In World War I the Allies and Central Powers were quick to recognize the value of dogs in war work. Such breeds as the German Shepherd protected war factories against intruders, and served in the trenches as messengers and sentries and in first aid



Mrs. H. P. Donnell

C' marlow Kennels

The Mexican Chihuahua, smallest of all dogs. A full grown one can weigh as little as two pounds. Right, a Pekingese, once held sacred in China.

for the wounded. The famous movie dog, Rin-tin-tin, was found by an American officer in a German trench. World War II again found dogs in the useful work they performed before, and the United States developed an organization called Dogs For Defense which directed the training of larger breeds for war purposes.

This was the first time a large dog corps was ever brought together under one head. The dogs were trained to work with soldier sentries guarding stores of supplies, to attack an enemy without barking and to haul supplies and small field guns. A dog's superfine hearing enables him to give warning of an attack intended as a surprise, and as a messenger he can penetrate a barrage through which no human soldier could live. Owners enrolled thousands of dogs for war work.

In another part of our book we tell you of the wonderful service rendered to the blind by the amazing dogs of The Seeing Eye.

Our four-footed friends have had many strange uses. Do you know that dogs have been employed to turn spits and waterwheels, and to smuggle stolen goods under false skins fitted over their own? In the East, dogs like the Chow Chow have been a popular article of food.

The Terriers love to chase vermin and small game like the badger, otter, and even the fox. Nearly all of the breeds of this group originated in Great Britain and Ireland. In work or play the Terriers are always tireless, curious and engagingly intelligent. They make lively companions.

Smallest of all breeds is the Chihuahua, whose native home is Mexico. He is a member of the Toy Group, the breeds of which possess more courage and intelligence than their diminutive size would indicate. A very curious Toy dog, the Mexican Hairless, has no hair whatever except for tiny tufts on his head and tail. Toy dogs are excellent pets for apartment dwellers because they require little exercise.

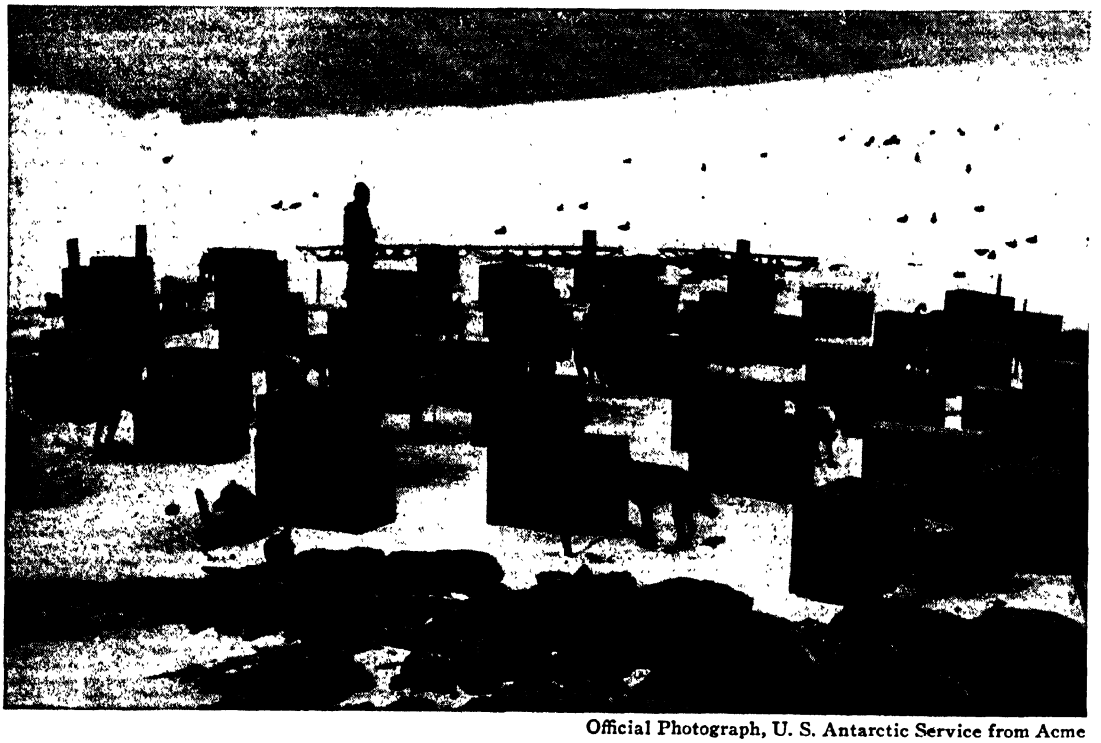
The last group of breeds, the Non-Sport-

ing, finds the Dalmatian, popularly known as the Coach Dog or Plum Pudding Dog; America's product, the Boston Terrier; and the French and English Bulldogs. In the Toy Group are tiny Poodles; among the Non-Sporting dogs are two more sizes of this famous breed renowned as a trick and circus dog: the standard size and the miniature. The hair of the Poodles may be clipped in a wide variety of styles.

Still another member of the Non-Sporting Group, the Schipperke from Belgium, shares the distinction with only one other breed, the Old English Sheepdog, of being completely tailless. These two breeds are rarely born tailless; usually their tails are cut by veterinarians a few days after birth. Nature —not man—has played a strange trick on the Basenji, a rare breed brought to America only a few years ago: the Basenji cannot bark!

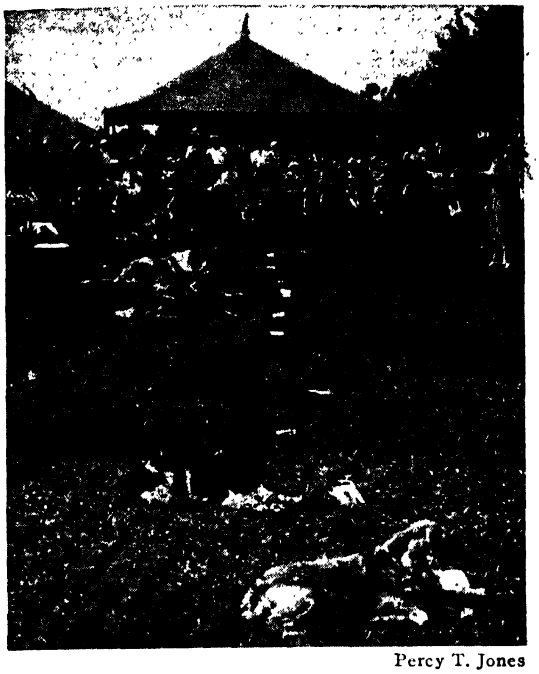
Those of us who own dogs know that their greatest contribution to our lives is companionship. However, many dog lovers enjoy the added pleasure of matching their pets against others in beauty, hunting ability and intelligence. A man who knows and loves dogs, especially one who breeds them, or buys and sells them, is called a dog-fancier. Dog shows in which fanciers try to win ribbons, cups and special honors are held at the rate of one a day. The group classification is followed, making the show an elimination contest. First each breed is judged separately. Then the winning dog of each breed competes with the winners of other breeds in their group. For example, the winning Setters, Spaniels, Retrievers and Pointers are judged in the Sporting Dog Class to determine the Best Sporting Dog. When the groups have been judged the six winners enter the "Best in Show" class to determine the best dog of all in the show. A dog becomes a champion by defeating other dogs in his breed at several shows, not necessarily by winning a group or "Best in Show" award.

If you ever attend a dog show, make sure you see the Obedience Classes. In these classes dog owners who have trained their pets to "heel," to "stay," to "fetch," to jump, to lie down for long periods, to "speak," and to track, compete with each other to see who has the best-trained dog. Instead of "champion" the winners of Obedience Classes receive the titles of Companion Dog, Companion Dog Excellent, and Utility Dog. To compete in the Obedience Classes



Official Photograph, U. S. Antarctic Service from Acme

This camp of kennels was known as Dogtown and housed the Huskies of Rear-Admiral Byrd's Antarctic Expeditions. The dogs were used to pull sleds over frozen lands where airplanes could not find a landing place.



Percy T. Jones

Contestants in the Obedience Class of a dog show.

your dog need not be a prize winner, but he must be pure-bred.

Another part of the dog show you will enjoy is the Children's Class. In this case, the dogs are not judged. Only the ability with which the children show their dogs is counted, and the child who handles his dog most capably receives first prize.

Hunting dogs compete in special events called Field Trials. The field or countryside where a trial is held is stocked with game, either by nature, or by man if no game abounds. Bird dogs range over the fields and when they find birds they "point" the quarry to their masters. (They stop and point the nose toward the game.) The bird is flushed (driven) from its cover and shot. A dog may or may not be required to retrieve the fallen bird to the hunter. In Trials for Hounds the prey is usually a rabbit. Hounds may hunt singly, in couples or in packs. The Retriever breeds, used mostly for duck-hunting, are taught to swim after a fallen duck after it has been shot and bring it back to the hunters. Hunting dogs are judged on their ability to find game, their steadiness and, often, on the speed with which they retrieve.

Most dog shows and field trials are held under the direction and rules of the American Kennel Club. Founded in 1884 the American Kennel Club is really an association of clubs devoted to the individual breeds, such as the American Spaniel Club, and of the clubs that hold dog shows. Each of these breed and show-giving clubs has a delegate who attends American Kennel Club meetings where matters of interest to dog owners are decided. The American Kennel Club also keeps a record of pure bred dogs, called the Stud Book, in which more than 1,500,000 dogs are now registered. The Club issues licenses to qualified persons, permitting them to be judges at dog shows and field trials. There are now more than 1,200 licensed judges.

A SOCIETY THAT PROTECTS DOGS AND THE GOOD WORK IT DOES

Another organization which deserves special note is the Society for Prevention of Cruelty to Animals. This is really a general name for a number of organizations in almost every civilized country of the world. Their work is explained by the name. They send members to schools to teach children how to care for their pets. They secure the passage of laws against brutality to animals and in general watch out for the welfare of dumb animals.

Few of us realize the economic importance of our canine (dog) friends. The dog population of the United States alone has been estimated at twelve to fifteen millions. Big meat-packing and cereal-making companies employ many thousands of people to prepare special foods for dogs, which you can secure at your local chain or grocery store. Other products for dogs—equipment, toys and medicine—form not only large industries in themselves but also contribute much advertising revenue. Governments collect taxes on dogs in the form of licenses. There are several magazines devoted entirely to canine matters, and some of the larger newspapers carry weekly columns of dog news and information on the care of dogs. Veterinarians (A veterinarian is a person who treats diseases of animals by medicine or surgery.), though they treat other animals, depend largely upon dogs for their livelihood.

There is something to admire and love in every dog. Each one has its faults and commits its follies, but when did one ever betray its master or mistress? When did the affections of one ever grow cold? We have done much for and with dogs, but they brought in with them from the wilds a nature whose savagery was redeemed by a vein of pure gold.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 767.

Culver Service

Sir Thomas More and his daughter Margaret in the Tower of London, where he was imprisoned and later beheaded.

FROM CHAUCER TO SHAKESPEARE

GEOFFREY CHAUCER died in 1400, and in the century and a half after his death many important changes took place in the English language, the habits of living of the English people and their general outlook on life. It is therefore no wonder that the writings of Chaucer and of Shakespeare (1564-1616) are so different. If Chaucer and Shakespeare had been able to meet somewhere, sometime, they would probably have felt a general interest and sympathy toward each other; but in speech, dress, habits and manners they would have been so different as to seem strange and foreign.

In the first place, Chaucer would have seemed to Shakespeare to be very much a Frenchman. England, as you know, had been invaded and conquered by the French-speaking Normans in the eleventh century; and the effects of that important event took a long time to wear off. It was only in the last fifteen years of Chaucer's life that English took the place of French as the language used in the schools of England. The first generation of grown people who were educated in the language of their own country came along, therefore, some time after Chaucer's death.

During the fifteenth century, however, England was steadily growing more English. Let us take a look at the legal and official documents of the time. In 1375 all such documents which were not written in Latin were in French; in 1400 a few documents were set down in English; by 1425 English was becoming common and by 1450 it had really won out over French. In 1422 the brewers of London started using English in the official reports and minutes of their guild because, as they said, they had noticed that the King now used English for official business.

Foreign wars and civil wars troubled the land during most of the century; so literature had small chance to develop. The various dialects of English were still spoken in the different sections of the island, so that a man from the north could hardly understand what a man from the south was saying. This also held back the making of books. Thus no great writers carried on the work Chaucer had so nobly begun. There

were a few disciples, notably John Lydgate (1370?-1450?), a monk of Bury St. Edmunds, who translated and adapted many foreign works into English verse, and who praised and imitated Chaucer. His chief works are the TROY BOOK and THE FALL OF PRINCES, each more than 30,000 lines long. Thomas Occleve or Hoccleve (1368?-1450?), a clerk in a government office in London, wrote a long treatise in rime on THE GOVERNMENT OF PRINCES, dedicated to the prince who later became King Henry V. He also left a poem called LA MALE RÈGLE DE T. HOCCLEVE, which, in spite of its French title, is in English. It tells with sorrow about the various sins and vanities of the author's youth. None of them seems very bad to a modern reader.

THE BEST OF CHAUCER'S FOLLOWERS WERE SCOTTISH POETS

The best of the followers of Chaucer, however, were not English, but Scottish. First of these is the king of Scotland, James I (1394-1437), whose KINGIS QUAIR (The King's Quire or Book) was written in Chaucer's favorite seven-line stanza; after this the stanza was known as "rime royal" because a king had written in it.

Robert Henryson (1425?-1500?), a Scottish schoolmaster, wrote THE TESTAMENT OF THE CRESSEID, a continuation of Chaucer's TROILUS AND CRISEYDE, in which he shows the heroine reduced to beggary and disease as a punishment for her unfaithfulness to Troilus. This poem is sometimes said to be the only sequel to a great piece of writing which does not fall too far below the level of the first one.

William Dunbar (1460?-1520?), the liveliest of the Scottish poets of the century, is remembered today chiefly because of his LAMENT FOR THE MAKARIS, a somber list of the poets who lived and died in the past. It has a pathetic refrain in Latin, *Timor mortis conturbat me* ("the fear of death distresses me"). It begins as follows:

I that in heill was and gladness
Am trublit now with great sickness
And feblit with infirmitie:—
Timor Mortis conturbat me.

Our plesance here is all vain glory,
This fals world is but transitory,
The flesh is bruckle, the Feynd is slee:—
Timor Mortis conturbat me.

Gawin Douglas (1475?-1522?) is of importance because he was the first poet to translate Virgil's AENEID into any English dialect; his translation is vigorous and effective and influenced important later translations. Sir David Lyndsay (1490?-1555), last of the Scottish group, was an ambassador and man of affairs. His main literary talent was in satire, and a long poem in dramatic form, A SATIRE OF THE THREE ESTATES, is his chief claim to fame. It attacks abuses common in the various classes of society.

MANY BALLADS CAME DOWN TO US FROM THE FIFTEENTH CENTURY

The most interesting poetry of the fifteenth century, however, is not the work of professional poets, but the popular (people's) ballads, handed down by memory from one singer or reciter to another and changing and developing as they went. We do not know whether the ballads were originally made by poets with some literary ability, or whether they "just grew," as people sitting around a campfire might compose a song, with ideas and verses contributed by everybody present. At any rate, the popular ballads were songs, and many of them have chorus lines, or refrains, which suggest that the audience chimed in from time to time. Most of the ballads have survived in many different versions, and no one single version can be called the "true" or "original" ballad. These poems are usually said to have been composed largely in the fifteenth century because the language, or the style, or some event referred to in them can be placed in that period. The written copies came much later, mostly in the seventeenth century.

The popular ballad is usually a poem which tells a story, with feelings appropriate to the occasion but not peculiar to the speaker or poet. Often the emotion is expressed principally by the chorus or refrain lines. The metre is most commonly alternate four-foot and three-foot lines, making up stanzas of four lines The second and fourth lines rime and sometimes the first and third rime also. Frequently the metre is irregular and the rimes are inexact.

This battell begane in Chyviat
An owar before the none
And when even-songe bell was rang,
The battell was not half done.

This battle began in Cheviot
An hour before the noon,
And when even-song bell was rung
The battle was not half done.

Some of the ballads are marvelous examples of story-telling, with swift, vivid action

and dramatic suspense. Often they are in dialog form, with questions and answers gradually and excitingly revealing the story. Thus, in EDWARD, the speakers are a young man and his mother; she asks Edward why his sword drops blood, and he at first answers that he has killed his hawk, then his steed, and finally admits that he has killed his father. As his mother asks what he will do for his wife and children now that he must go away into exile, he replies that he will never see them again; and when she asks what he will leave her, his mother, he replies "The curse of hell. . . . Sic counseils (such counsel or advice) ye gave to me O," revealing for the first time that his mother prompted him to do the murder. And here the ballad abruptly ends, at its dramatic climax.

THE STORY OF ROBIN HOOD WAS FIRST TOLD BY THE BALLAD-MAKERS

The ballads can be roughly divided according to subject matter. A large group of them deal with legendary heroes—the most famous is Robin Hood. Our Robin Hood stories were almost all originally ballads; and the character, with his merry men in the green wood, was so beloved that a longer poem, a sort of popular epic, called A GEST OF ROBYN HODE was made up on the basis of the ballads. The earliest reference to a Robin Hood ballad occurs in PIERS PLOWMAN, so there must have been some of these ballads in circulation as early as 1375. But the great popularity of Robin and Little John, and their enemy the Sheriff of Nottingham, is first marked in the fifteenth century. Although he was by far the best loved, Robin Hood was not the only outlaw to serve as hero for the ballad-makers.

Some of the ballads deal with actual historical events, especially battles. There are two different ballads, for instance, on the Battle of Otterburn, which was fought on August 19, 1388. One is usually called THE BATTLE OF OTTERBURN and the other is THE HUNTING OF THE CHEVIOT. The stanza above is from THE HUNTING OF THE CHEVIOT. Sir Philip Sidney was referring to one of these when he said, in his DEFENSE OF POETRY, "I never heard the old song of Percy and Douglas, that I found not my heart moved more than with a trumpet."

In THE GAY GOSHAWK and other ballads, true love finds a way to overcome difficulties or defeat cruel parents who try to oppose the match; in this one the girl takes a sleeping potion which makes her seem dead and she is carried to the church in Scotland for burial, where she revives and finds her lover waiting to marry her. In BARBARA ALLAN the young man sends for Barbara on his deathbed, and tells her he is dying for love of her; she reminds him that he neglected her when the healths were drunk round at the tavern. He turns to the wall and dies, and on her way home the church bell reproaches her, calling "Woe to Barbara Allan!" The last stanza is beautiful and touching:

> O mother, mother, make my bed!
> O make it soft and narrow!
> Since my love died for me today,
> I'll die for him tomorrow.

Not all of the ballads are sad. Some of them, like GET UP AND BAR THE DOOR tell the story of a simple contest between husband and wife. Still others are stories of tricks played by one person on another.

Many of the ballads deal with supernatural events. THE WIFE OF USHER'S WELL tells of a wealthy widow whose three sons were all lost at sea. She angrily wishes that the storms may never cease until her three boys return to her in flesh and blood; they do return, wearing hats made of birch that grew on no tree of this earth, but at the gates of Paradise. At the crowing of the cock they leave, with a farewell:

> Fare ye well, my mother dear!
> Farewell to barn and byre!
> And fare ye well, the bonny lass
> That kindles my mother's fire!

These poems, composed by no author whose name is known, handed along by word of mouth from generation to generation, form a great inheritance for us. Many of them are still sung today in out-of-the-way places. Great writers, who have had the riches of ancient and modern literature at their command, have found something in the old ballads which they considered precious. The characters in Shakespeare's plays sing or recite snatches from the ballads; Scott loved the ballads of the Scottish border and collected and published many of them.

When a poet writes a narrative poem imitating the style of the popular ballad, his piece is called an "art ballad." The most famous example of this kind of English literature is Coleridge's RIME OF THE ANCIENT MARINER. Even in the fifteenth century, however, a poet whose name is lost to

us wrote a little masterpiece in this style. It is called THE NUT-BROWN MAID. It presents the familiar medieval theme of the testing of a woman's constancy (as in Chaucer's CLERK'S TALE), and at the end the maiden finds out that her lover is not an outlaw, as he pretended to be, but an earl's son, and she, by being willing to suffer any hardship or disgrace for him, has won him.

An early woodcut illustrating the ballad about the Dragon of Wantley.

Not all of the poetry of the century after Chaucer's death celebrated the pleasures and sadnesses of this world. It was an age that was much concerned with religion; and there are many religious poems from the period. Carols, or songs of religious praise and devotion, were not at first confined to Christmas, but since carols were more or less joyful religious songs, and Christmas is the great time for religious pleasure and gaiety, that season later came to be the time for carols. One fifteenth century carol called CAN I NOT SING BUT HOY! resembles a ballad. It tells of a shepherd named Jolly Wat, who lay down on a hill, with his dog tied to his girdle, when he was awakened by singing of the GLORIA IN EXCELSIS. He left his dog to guard his sheep and set off for Bethlehem, where he found the Child.

Jesus, I offer to thee here my pipe,
My skirt, my tarbox and my scrip,
Home to my fellows now will I skip,
And also look unto my sheep!
(Chorus) Ut hoy!
For in his pipe he made so much joy!
Can I not sing but Hoy!
The jolly shepherd made so much joy!

Another carol is intended to be sung in the great hall of a house before the Christmas games start:

Let no man come into this hall,
Groom, page, nor yet marshal,
But that some sport he bring withal!
For now is the time of Christmas!

If that he say he cannot sing,
Some other sport then let him bring,
That it may please at this feasting!
For now is the time of Christmas!

If he say he can naught do,
Then for my love ask him no mo,
But to the stocks then let him go!
For now is the time of Christmas!

In the fifteenth century very little English prose was written which had any artistic purpose or intention. The tradition of English prose was carried on in some devotional books and religious works written for the use of pious women who could not read Latin; but these do not seem to have had very wide circulation. At most they kept the art of writing English prose alive. Two religious women themselves left writings in English which are of interest. One of them, Dame Juliana Berners, wrote the first-known English book on fishing. Her treatises on "hawking, hunting and fishing with an angle" were later called THE BOOK OF ST. ALBANS. She was prioress of a convent.

MARGERY KEMPE, WHO WROTE ABOUT HER RELIGIOUS EXPERIENCES

The other lady was Margery Kempe of Lynn, Norfolk, whose autobiography was put into modern English and published not long ago. It is a strange book, the record of an intensely religious, but emotionally unbalanced, person whose religious enthusiasm so carried her away that she was a nuisance to the clergy, the congregation and her neighbors. She made pilgrimages to the Holy Land, to Rome and to Santiago de Compostella in Spain; and she traveled in Scandinavia and Germany. But her book pays little attention to what she saw at these places; she seems to have been interested only in her own inner emotional and religious experiences.

Margery Kempe could not read or write. Her book was written for her by a friend and finished by a Lynn priest. Her father had been mayor of Lynn and her husband was one of the four chamberlains of Lynn

in 1394-95, a year after her marriage.

At the opposite extreme from Margery Kempe's strange record we have a series of letters, known as the PASTON LETTERS, between members of the Paston family of Norfolk over three generations from 1422 to 1509. The letters are in no way literary, and to a modern reader most of them seem scarcely personal, though they were written by members of the same family to each other. They deal with practical affairs, with money and lawsuits and purchases in town; and they show vividly what life was like for middle-class people in those days. They prove that even in the most unsettled times the ordinary tasks and concerns of life go on.

The most important event affecting English prose in the fifteenth century was the introduction of printing into England. Printing from moveable types had been invented about the middle of the century in Germany. The first English printer, William Caxton (1422-1491), learned the art on the Continent. He was a mercer (a dealer in cloth and other wares) and he spent twenty years in the Low Countries, with which much of the English cloth trade was then carried on. He rose to be governor of the English merchants at Bruges; and he became known at the court of the Duke and Duchess of Burgundy.

Culver Service
Lady Juliana Berners, writer on sports.

Now the Duchess of Burgundy was the sister of the English king. One day Caxton showed to her some translations he had made from French into English of a book about the siege of Troy. He had stopped his translating because he thought himself unfit for the task; but the Duchess liked his work and commanded him to go on and finish it. This he did in 1471 in the city of Cologne, and it was in that city that he learned the new art of printing. He determined to reproduce his translation by printing, because, as he said, so many noble lords wanted copies of it. In this way his book, called the RECUYELL (Collection) OF THE HISTORIES OF TROY, came to be the first book printed in English (1475).

Toward the end of 1476 Caxton returned to England and set up his press in Westminster, which was then a town some little distance from London. He proceeded to issue from his press a stream of pamphlets, books and similar pieces. In 1478 he printed Chaucer's CANTERBURY TALES and his translation of Boethius, and in 1483 the BOOK OF FAME (HOUSE OF FAME) and TROILUS AND CRISEIDE.

Caxton printed translations by himself and other men, histories, religious books, popular romances, poetry—everything, in fact, which had up to this time been copied laboriously by hand. As early as 1480 Caxton had a rival printer in England to compete with, but the interest and importance of William Caxton does not end with his being the first English printer. He was also a man of letters in his own right, a critic and translator, and a propagandist for what he considered good literature.

He was particularly interested in the kind of English he should use. In one of his prefaces he says that certain gentlemen had blamed him for using "over-curious terms which could not be understood of common people and desired me to use old and homely terms." He always described himself as a "simple person"; no doubt he was, but he was also a man of great imagination and perseverance. His work was carried on after his death by men who were better printers, Wynkyn de Worde (?-1534?) and Richard Pynson (?-1530?) but they quite rightly regarded Caxton as their guide and master.

Perhaps the most popular of all the books Caxton printed was a compilation of stories of chivalry by Sir Thomas Malory called MORTE D'ARTHUR. The title means The Death of Arthur, but the book includes far more than that; it is a collection of the stories about King Arthur and his Knights of the Round Table, with countless adventures of Arthur himself, of Lancelot, of the Quest for the Holy Grail, of Galahad, Gareth, Tristan and King Mark, and many others. This book is the source from which Tennyson's IDYLLS OF THE KING, the Arthurian poems of Edwin Arlington Robinson and almost all other modern treatments

of the Round Table stories are taken. The book is without doubt the one great masterpiece of fifteenth century prose.

CAXTON'S REASON FOR PRINTING THE STORIES OF KING ARTHUR

Caxton's reason for printing the book was, he says, a patriotic one. Various noblemen and gentlemen came to him, demanding why he had not printed a book about the great feats of King Arthur, for of all the famous Nine Worthies of the world (Hector, Alexander and Julius Caesar among the pagans, Joshua, David and Judas Maccabeus among the Jews, and Arthur, Charlemagne and Godfrey of Bouillon among the Christians) only one, Arthur, was born in Britain. Caxton had already printed a book about Godfrey of Bouillon. Since there were in existence many books about King Arthur in French and other languages, it was a disgrace that there was no great English book about him.

Caxton answered that many people doubted whether Arthur had really existed. The gentleman argued that there were many proofs of it—the Round Table at Winchester, Arthur's tomb at Glastonbury Abbey, Sir Gawain's skull at Dover Castle, besides references to him in old histories. These arguments convinced Caxton (even if they would not convince a modern historian) and he printed Sir Thomas Malory's book, recommending it to the reader for its moral value; "for herein may be seen noble chivalry, courtesy, humanity, friendliness, hardiness, love, friendship, cowardice, murder, hate, virtue and sin. Do after the good and leave the evil, and it shall bring you to good fame and renown. And for to pass the time this book shall be pleasant to read in, but to give faith and believe that all is true that is contained herein, ye be at your liberty."

SIR THOMAS MALORY, WHO GATHERED THE ARTHUR LEGENDS

Not much is known about Sir Thomas Malory, and it is not quite certain which of several knights of that name the author was. But we do know that he compiled his book from many sources, both French and English; that his manuscripts were perhaps ten times as long as the book he finally finished, though to a modern reader his book seems large; that in cutting down and selecting and arranging, if he did not tell a clear and single story he at least gave us a wide and ample picture. The world he portrays is full of forests and castles, of streams and bridges, of knights and dwarfs, and giants and beautiful queens and wicked enchantresses. The action consists mainly of knights meeting and running at each other with spears fixed until both horsemen are overthrown, when they rise and fight with swords until one of them yields himself or is slain. There is a good deal of mystery, because a knight is often disguised by wearing another knight's armor, and because possible enchantment always makes the outcome uncertain. The great attractiveness of the story is the constant and varied illustration it gives of noble and gentle behavior—courtesy in the original meaning of the word. Caxton was right in thinking that it would do the reader good, and no doubt part of Sir Thomas Malory's motive in making the book was to remind his fellow-countrymen of virtues formerly practiced but now no longer to be seen, for in the middle of the fifteenth century chivalry of the kind shown by Lancelot and Galahad was as old-fashioned as the formal manners of George Washington's time are today.

Malory's MORTE D'ARTHUR is still the great treasure house for stories of chivalry in English. The reader who has read many modern treatments of these stories can go back and find them still fresh and lovely at the source.

THE MORALITY PLAY WAS GIVEN ON A FIXED STAGE

In the fifteenth century the cycle plays given by the guilds continued; and during this century a new form, the "morality" or moral play, began to be seen. The earliest of these plays which survives illustrates the type. It is called THE CASTLE OF PERSEVERANCE, and the manuscript of it contains a drawing of the way it was staged. In the center of a green or open place was built a small building to look like a castle, with room on the ground floor of it for a bed. Surrounding the castle was a ditch or moat, or else a fence, behind which the spectators stood. Around the circle were five scaffolds or platforms. The characters in the play are supposed to represent qualities or ideas, not specific people. World, Flesh, Covetousness are some examples. Belial, the Devil, represents Sin, even though a stage direction says that the actor who plays Belial has gunpowder burning in pipes in his hands, his ears and his tail when he goes off to battle. The morality plays usually dealt with the coming of death, or the judgment of man, or the fight between the vices and

the virtues for man's soul. In THE CASTLE OF PERSEVERANCE there is a prologue to be spoken by two veillators (flag-bearers) a week before the performance, giving the date and place where the play will be given, a plot of the play, and an earnest request to everybody to come and to be on time. (The modern "movie trailers" serve the same purpose.)

THE ENGLISH DRAMA ENTERS A NEW PERIOD OF GROWTH

The drama had thus changed from the civic affair given by the guilds of a particular town, on wagons wheeled from one group of spectators to another, as in the fourteenth century, to something done by a traveling company, on a fixed stage. This was a start in the direction of the professional drama of Shakespeare's time. Moreover, the morality play provided for some originality of plot and theme on the part of the playwright; the characters were no longer Bible figures. And the seriousness of the subjects presented also had its influence on later drama.

The masterpiece of all the moralities is the play called EVERYMAN. In it the hero, Everyman, is summoned by death and has to go to his judgment. He tries to get his various friends (like Fellowship, Kindred and Goods) to go with him, but they all refuse. Only Good Deeds will go with him, and then only after Everyman undergoes confession and penance. Everyman finally descends with Good Deeds into the grave, and is called by an angel to heaven. The epilogue is given by Doctor, who points out the lesson to be learned from the play.

ROUGH COMEDY CREEPS INTO THE MORALITY PLAYS

Toward the end of the century the moral play began to degenerate, and an example from the last quarter of the century, called MANKIND, shows the creeping in again of horseplay and comedy as in the case of the guild plays. The vices are named Nought, New-Guise and Nowadays, representing the vanity of worldly life, and the main devil, called Tytivillus, makes his entrance only after the audience has been told that a collection will be taken up first. "Give us red royals (coins worth about ten shillings) if you will see his abominable presence!" cries Nowadays, but New-Guise, who realizes that perhaps everybody in the audience is not that rich, says, "You that can't pay the one, pay the t'other!" Mercy alone has to carry the ball for the side of goodness.

When Henry Tudor defeated Richard III at the Battle of Bosworth Field in 1485, the old civil war between the houses of York and Lancaster was at an end. Henry VII, as he became, and his queen united the claims of the two factions. A new era in English life was begun, and it was under this king and his son, Henry VIII, and his granddaughter, Queen Elizabeth, that England experienced her Renaissance. (See the article on Renaissance.)

John Skelton (1460-1529) is the first real personality among the poets of the new age. He was probably tutor to Prince Henry; and although he was a parson, his poems are for the most part lively, violent, satirical works, in short lines and with a rough accent. He attacks the vices of the court and gives vivid pictures of events and behavior.

THE FIRST PLAY WRITTEN PURELY FOR ENTERTAINMENT

The first play in which the characters were neither taken from the BIBLE nor named after abstract qualities, as in the moral play, was written in the reign of Henry VII, about 1497. It remained lost until the twentieth century, when a copy was found and republished. It is called FULGENS AND LUCRECE and was written by Henry Medwall, a chaplain to the Archbishop of Canterbury. It is about a Roman senator and his daughter, and two comic servants provide relief from the more serious debates which take place in the play. Medwall wrote it as an entertainment to be presented during dinner at the Archbishop's palace, and at one place there is a pause in the action while another course is served. The remarkable thing about this play is that it was written just for entertainment, without any serious purpose.

KING HENRY VIII ENCOURAGES LEARNING AND THE ARTS

Under Henry VIII, the real brilliance of the English Renaissance began to be visible. The King himself was, in his younger days, not only an athlete and a dashing figure of a king, but also a scholar interested in the new learning, a poet and a musician. He encouraged the great movement that was sweeping his court and he patronized the educators and writers who made it.

The chief ornament of Henry's court was Sir Thomas More (1478-1535), who became Lord Chancellor of England after Cardinal Wolsey, in 1529. More was beheaded for treason in 1535 because he would not betray his religious convictions. He was recog-

nized as a saint by the Catholic Church in 1935. He was a learned lawyer, a merry and witty man, a master of Latin and of English prose, and a liberal and enlightened thinker. His chief literary fame has come from a work he wrote in Latin, UTOPIA (1516), a picture of an imaginary and ideal country. He wrote also in English, most notably A DIALOGUE OF COMFORT AGAINST TRIBULATION (1533). He was a friend of the great Dutch scholar Erasmus and encouraged him to write his IN PRAISE OF FOLLY. From More's circle of relatives and friends, from the members of his own household, in fact, came several new important developments in English drama.

John Heywood (1497-1578) was the husband of Sir Thomas More's niece; he was the master of a singing school at court, and his contribution to the drama was the development of a kind of simple comedy called the interlude. The interlude is usually based on a debate, and it makes up in wit and merriment what it may lack in action. In his PLAY OF THE WEATHER various characters, including a lady, a gentleman, a laundress and a boy, all appear before Jupiter and complain about the weather. But their complaints tend to cancel each other out, for everyone has his own idea of what the best weather is, so Jupiter decides the argument by saying that the weather will continue to be just what it has always been.

THE FOUR P'S is a play in which four characters, a Pedler, a Pardoner, a Palmer and a Potecary (apothecary or druggist) hold a contest to see who can tell the biggest lie. The Palmer finally wins the lying contest by saying that although he has known 500,000 women in his life, he has never seen one of them lose her temper. The others immediately agree that there could be no more outrageous lie than this. These plays, with others which Heywood wrote, are pure entertainment; they use characters from real life and they are boisterous and lively. By the time Heywood died Shakespeare was already a boy in Stratford.

It must be remembered that as new forms in drama and poetry appeared, they did not entirely drive out the older fashions. The craft-guild plays which had been so popular in the fourteenth century continued to be played until Shakespeare's lifetime, and the morality plays and interludes survived for some time after new kinds of drama were being written. The same thing was true of poetry and prose. The Renaissance was in many ways not a sharp break with the past. Old ways of thinking and feeling continued to exist along with the new. And of course the popular ballads, and similar expressions of folk instinct in the drama—the sword dance, the morris dance and popular "mummers' plays" of St. George and the dragon—continued in the country for many centuries. So in the age of Shakespeare there was no real danger that playing and singing would move too far away from their real source, the people, no matter how refined and civilized they became.

Culver Service

Some mummers wore masks made to look like the heads of animals.

By HALLETT SMITH.

THE NEXT STORY OF LITERATURE IS ON PAGE 832.

Culver Service

Mummers acted such plays as St. George and the dragon, accompanying them with dancing, jokes and rough clowning.

OLD FAITHFUL GEYSER

Courtesy, Northern Pacific Railway

Visitors to Yellowstone Park always go to see Old Faithful, which lifts its white plume of water and steam 170 feet in the air at intervals of about sixty-five minutes. The eruptions last for four minutes.

YELLOWSTONE PARK, WONDERLAND OF THE WEST

THE Yellowstone National Park lies almost entirely in Wyoming, but small portions of its northern and western sides extend across the state boundaries into Montana and Idaho. It was set aside as a national park in 1872, during the administration of President Grant, and it has been added to several times since, so that its present area is about 3,472 square miles.

Although many other national parks have been created since Yellowstone was founded, it is still the most famous one, and it has probably the greatest variety of natural wonders to be found in any area of similar size. It has about three thousand geysers and hot springs, brilliantly colored mud volcanoes, petrified forests, and the exquisitely beautiful Grand Canyon of the Yellowstone River, besides many trout-filled streams and lakes, cascades and waterfalls, and a vast natural forest. It is one of the largest wildlife sanctuaries in the world, and if you follow its trails you may see deer, elk and antelope, and even mountain sheep, coyotes and moose, all of them quite unafraid because they have never learned to fear the destructive powers of human beings.

Bears are very common in the park, especially brown, cinnamon and black bears, all of which belong to the same species. Even the great grizzly bears are to be found there. The brown bears and their relatives are extremely friendly and full of curiosity. Visitors to the park are inclined to encourage this friendliness, but to do so is dangerous and against the park regulations. They are, after all, wild animals, and exceedingly strong ones, and visitors are forbidden to feed, tease or even touch them. Campers in the park have to be very careful to keep their supplies locked up, for the greedy, inquisitive bears love to delve into them and sample everything that looks eatable.

A large herd of bison, or buffalo, is kept on the range in the extreme eastern end of the park, and can only be seen by following the trails, on foot or on horseback, but a small herd is kept at Antelope Creek, near Tower Falls, for visitors to see. There are more than two hundred species of birds, from the eagles that nest in the mountain crags to the swans and pelicans of Yellowstone Lake.

Courtesy, Northern Pacific Railway

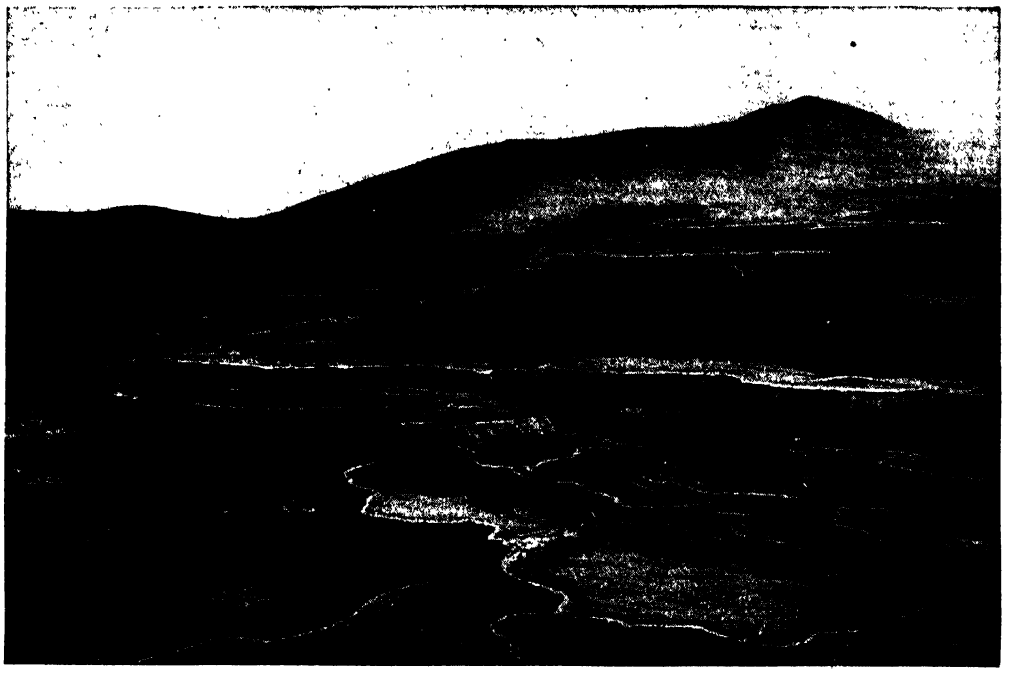
This black bear cub is quite used to being admired and poses very complacently for the camera.

Besides paths and trails that lead to the wilder and more remote sections of the park, there are about three hundred miles of good motor roads that go through the more spectacular scenic areas. The most exciting route to take in order to see the wonders of the park is the Grand Loop Highway. To take this route, you enter the park at the Northeast Gateway at Gardiner, Montana. From the entrance arch of basaltic rock the road leads through five miles of peaks and canyons to Mammoth Hot Springs. Here are located the administrative headquarters of the park, the main post office, general store, a hotel and tourist cabins. It is a strangely beautiful spot, for the many hot springs have built up terraces of travertine, or car-

bonate of lime, dazzlingly white, or colored, like the pools, by microscopic plants called "algæ," in shades varying from a delicate peach through brown to dark green. There is so much of this mineral substance in the water that articles placed in the pools soon become coated with it.

Among the sights of special interest are the Liberty Cap, a cone forty feet high, built up by the deposits of a now extinct spring; terrace in the world. Many of its springs appear to be boiling furiously, though their temperature does not reach the boiling point. The agitation is caused by carbonic acid gas forcing its way up through the water.

Mammoth Hot Springs is an unforgettable sight, but it is only one of the marvels of this strange region. About twenty miles farther along the highway we come to the Norris Geyser Basin, passing on the way



Here is a picture of the Mammoth Hot Springs in Yellowstone Park. Notice how the pools, filled with water which almost boils, rise above one another in terraces. The water of the springs is a deep blue in the centre, and where it flows over the edge of the basins a thousand colors show, rainbow-hued, in the sunlight. Articles left in the water for a short time will be covered with a deposit of carbonate of lime. Over the terraces hangs a mist of steam, and beyond are the everlasting hills. The thin crusts at the edge of the basins are crumbling and treacherous, the sudden puffs of vapor blinding.

the pyramid-shaped Cheops Mound and Orange Spring Mound, now being slowly built up; Minerva Terrace, with its grotto; and Angel Terrace, with its numerous dead trees preserved by their coating of travertine from the surrounding springs. The Devil's Kitchen is the fissure of a hot spring, long dead, and visitors are allowed to go down into it. Most of the caves and grottoes are not safe to enter because of the carbonic acid gas with which they are filled.

Blue Springs and Canary Spring, to the north of Angel Terrace, are particularly lovely, and from either of them you can get a wonderful view of the many-colored pools and terraces. We must not forget to speak of Jupiter Terrace, the largest hot spring

Beaver Lake where the road skirts the towering Obsidian Cliff, a peak made of black volcanic glass. The road around the base of the cliff was very difficult to build. It had to be cut in the volcanic glass and blasting powder could not be used. The problem was solved by building fires around the blocks of obsidian, and, when the glass expanded with the heat, dashing cold water on them. This shattered the rocks into small pieces.

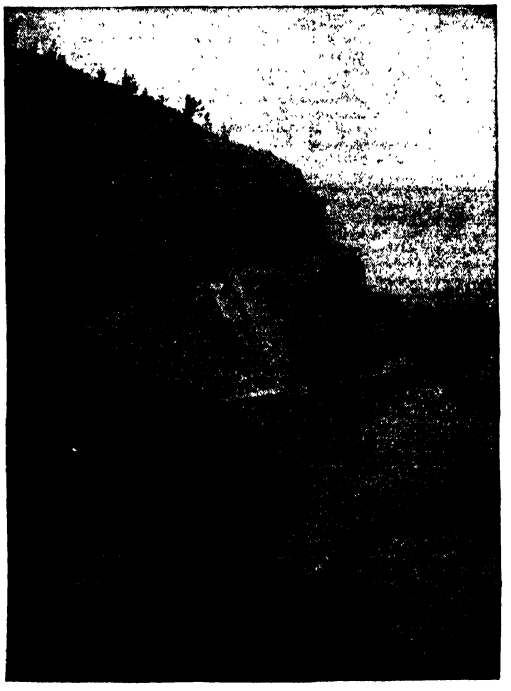
Norris Geyser Basin is one of the six principal areas in the park which contain geysers. The others are the Lower, Midway, Upper, Heart Lake and Shoshone basins. Geysers are found where the great heat of the earth's centre reaches up nearly to the surface. Water from the surface trickles down through

cracks in the rocks and soil, and sometimes underground springs seep upward. This water becomes intensely hot and forms steam, which expands and forces its way up through the cooler water above. When this happens, people watching the pool on the surface of the earth see it begin to bubble and give off clouds of steam, and they know that the geyser is getting ready to erupt.

If the tube, or path of the geyser through the earth were perfectly straight, nothing more would happen, but these tubes are crooked and narrow, and the heat-expanded water cannot circulate easily. The water lower down gets hotter and hotter, until the cooler water in the tube can no longer hold it down. Then the water bubbles over, releases the superheated water below, and the whole mass is carried upward, sometimes many feet into the air. When the geyser is cleared, the water cools off on the surface of the earth, and gradually seeps back into the earth again, where the whole process is repeated.

Naturally, each geyser has a differently constructed tube, and this makes each one behave differently from all the others. Often one particular geyser will change its behavior, and sometimes will stop erupting altogether. The Black Growler in the Norris Basin, which gives off only steam, has shifted its opening several times, and the great Monarch Geyser, which, many years ago, played once an hour and sometimes sent up black mud instead of clear water, no longer erupts at all. We can still see its crater, surrounded by brilliantly colored rocks. Congress Pool, not far away, is at different times a placid, blue pool, a boiling pool, a steam vent and a mud geyser.

This high pillar of stone is called Eagle Nest Rock. By a fortunate chance an immense eagle was just alighting when the picture was being made. Note the many different layers of rock in the high pinnacle which overhangs Gardiner Canyon.



This beautiful road built into the side of the cliff is in the Golden Gate Canyon on the way from Mammoth Hot Springs to the Norris Geyser Basin. The roadbed on the side of the cliff is of concrete. It is a remarkable engineering achievement.

The Lower, Midway and Upper Geyser basins adjoin one another about twenty-five miles farther south on the highway. The first wonder that we come to in the Lower Basin is the Fountain Paint Pot. This is a ridge of small basins which heave and bubble with pasty clay of every imaginable color—rich cream, vivid orange, brilliant blues, violets and purples. There are many other sights to see here, but the most fascinating are Firehole Lake and the Great Fountain Geyser. If we stand at the extreme eastern end of Firehole Lake and look down into its transparent depths we shall see what look like blue flames under the water. This is an illusion caused by the light striking the

Courtesy, U. S. Travel Bureau

The great bison seems indifferent, but the elk watch the camera intently. Note the long antlers of the males. In early spring the antlers break off, and new ones grow, reaching their full length by the end of August.

bubbles that arise from a spring at the bottom of the lake. Great Fountain Geyser is one of the most beautiful in the park.

In the Midway Basin we see Excelsior Geyser Crater. Many years ago Excelsior erupted to a height of three hundred feet, but now it is quiet, a boiling lake of heavenly blue with crusted walls of pearl-like white. Upper Geyser Basin has many exquisitely lovely pools, tinted with all the colors of the rainbow. Morning Glory Pool, which looks exactly like its name, is the most famous, but Sunset Lake, Rainbow and Emerald Pools and Three Sisters Spring are almost equally beautiful. Here is Old Faithful, the favorite geyser of most visitors. It is not the most beautiful or the highest or the most powerful of the geysers, but it is sufficiently lovely, and, true to its name, it has never disappointed the thousands—perhaps millions—of people who have come to watch it erupt since the first exploring party was thrilled by its graceful column many years ago.

The Beehive, so named because of its symmetrical cone, sometimes seems to be extinct and at other times plays quite regularly. The Giantess is the most awe-inspiring of all the geysers, but it erupts only about once a year. When it does erupt it is a frightening spectacle. The great pool boils furiously and the earth around it shakes and rumbles. First a mass of water is thrown upward a few feet, accompanied by loud, groaning sounds, as if a real giantess were suffering intense pain. Then, suddenly, the whole pool seems to rise into the air, higher and higher, till it reaches a height of two hundred feet or more. There is a roaring sound; clouds of steam roll away across the hills; and streams of water rush off to join the Firehole River. The eruption continues from twelve to thirty-six hours.

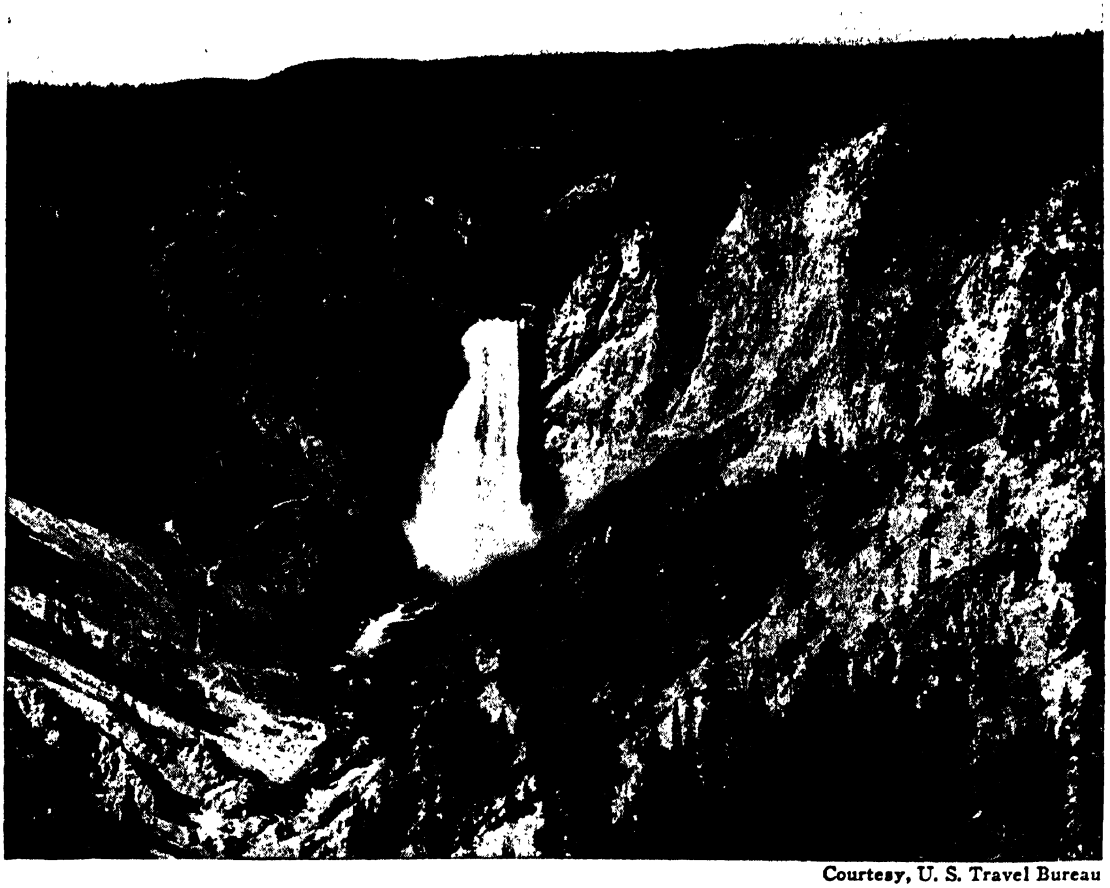
After leaving the Upper Geyser Basin the road turns eastward and climbs to the top of the Continental Divide, 8,366 feet above sea level. Here there is a small lily-covered lake, called Isa, the waters of which flow out in two directions, one toward the Pacific and the other toward the Atlantic. Farther on we come to Yellowstone Lake, an irregularly shaped body of water 139 square miles in area. Here is the famous Fishing Bridge, and nearby are a natural history museum and the United States Fish Hatchery. From the lake the river flows in a winding north-

western course toward the Grand Canyon of the Yellowstone. If we follow the river we shall come, first to the Upper Fall, which has a drop of 109 feet, and then to the Lower Fall. This fall is 308 feet high, nearly twice as high as Niagara.

Extending from the falls for a distance of twenty miles, the river flows through the Grand Canyon of the Yellowstone, perhaps the most beautiful sight in the park. Deep and narrow, its rock walls are carved in curious shapes and flame with brilliant reds and yellows, orange, violet and deep purple, against the dark green of the pines that clothe the surrounding hills.

There is much more to see in the park than we could possibly explore in less than a week. There are beautiful little lakes in the hills; the Tower Falls are almost as wonderful as those of the Yellowstone, and not far away are the petrified forests. For miles and miles along Lamar River are stumps and trunks of trees that have turned to stone. Specimen Ridge, which rises sharply out of the valley floor, is made up of beds of these forests, one above the other.

Before the White Man came to the Yellowstone, and for a long time afterward, the Indians would not go near the region of geysers and bubbling clay cauldrons and roaring falls. They believed it to be the haunt of evil spirits, and when we see the strange sights and hear the unearthly sounds that pervade the region we can easily understand why they felt about it as they did. To-day, however, people wander through this enchanted land, camping in the out-of-doors or stopping at comfortable inns, and enjoy its marvels in safety and confidence. For those who wish to learn more about the wonders about them, there are interesting museums where fascinating collections may be seen, and lectures, nature walks and campfire talks are conducted by ranger naturalists.



Courtesy, U. S. Travel Bureau

The Great Falls of the Yellowstone, where the turbulent river rushes over the cliff and drops three hundred and eight feet to the brilliantly colored floor of the canyon. This is one of the most thrilling sights in the park.

POEMS OF HOME

Illustrated by Erika Weihs

My Old Kentucky Home

By STEPHEN COLLINS FOSTER
(1826-1864)

THE sun shines bright on my old Kentucky home,
'Tis summer, the darkeys are gay;
The corn-top's ripe, and the meadow's in the bloom,
While the birds make music all the day.
The young folks roll on the little cabin floor,
All merry, all happy and bright;
By-and-by hard times come a-knocking at the door:—
Then my old Kentucky home, good-night!

Weep no more, my lady,
O, weep no more to-day!
We will sing one song for the old Kentucky home,
For the old Kentucky home, far away.

They hunt no more for the possum and the coon,
On the meadow, the hill, and the shore;
They sing no more by the glimmer of the moon,
On the bench by the old cabin door.
The day goes by like a shadow o'er the heart,
With sorrow, where all was delight;
The time has come when the darkeys have to part:—
Then my old Kentucky home, good-night!

Weep no more, my lady,
O, weep no more to-day!
We will sing one song for the old Kentucky home,
For the old Kentucky home, far away.

The head must bow, and the back will have to bend,
Wherever the darkey may go;
A few more days and the troubles all will end,
In the field where the sugar-canes grow.
A few more days for to tote the weary load,—
No matter, 'twill never be light;
A few more days till we totter on the road:—
Then my old Kentucky home, good-night!

Weep no more, my lady,
O, weep no more to-day!
We will sing one song for the old Kentucky home,
For the old Kentucky home, far away.

An Old Woman of the Roads*

By PADRAIC COLUM (1881-)

OH, to have a little house!
To own the hearth and stool and all!
The heaped-up sods upon the fire,
The pile of turf against the wall!

To have a clock with weights and chains,
And pendulum swinging up and down!
A dresser filled with shining delph,
Speckled and white and blue and brown!

I could be busy all the day
Clearing and sweeping hearth and floor,
And fixing on their shelf again
My white and blue and speckled store!

I could be quiet there at night
Beside the fire and by myself,
Sure of a bed and loth to leave
The ticking clock and shining delph!

Och! but I'm weary of mist and dark,
And roads where there's never a house nor bush!
And tired I am of bog and road,
And the crying wind and the lonesome hush!

And I am praying to God on high,
And I am praying Him night and day,
For a little house—a house of my own—
Out of the wind's and the rain's way.

*From Poems by Padraic Colum. Reprinted by permission of the publishers, The Macmillan Company.

A Canadian Boat Song

By AN UNKNOWN POET

LISTEN to me, as when ye heard our father
Sing long ago the song of other shores—
Listen to me, and then in chorus gather
All your deep voices as ye pull your oars:
Fair these broad meads—these hoary woods are grand;
But we are exiles from our fathers' land.

From the lone shieling of the misty island
Mountains divide us, and the waste of seas—
Yet still the blood is strong, the heart is Highland,
And we in dreams behold the Hebrides;
Fair these broad meads—these hoary woods are grand;
But we are exiles from our fathers' land.

We ne'er shall tread the fancy-haunted valley,
Where 'tween the dark hills creeps the small clear stream,
In arms around the patriarch banner rally,
Nor see the moon on royal tombstones gleam:
Fair these broad meads—these hoary woods are grand;
But we are exiles from our fathers' land.

When the bold kindred, in the time long-vanished,
Conquered the soil and fortified the keep;
No seer foretold the children would be banished,
That a degenerate lord might boast his sheep:
Fair these broad meads—these hoary woods are grand;
But we are exiles from our fathers' land.

Come foreign rage—let Discord burst in slaughter!
O then for clansmen true, and stern claymore—
The hearts that would have given their blood like water,
Beat heavily beyond the Atlantic roar:
Fair these broad meads—these hoary woods are grand;
But we are exiles from our fathers' land.

The Hills of Skye*

By WILLIAM MCLENNAN (1856-1904)

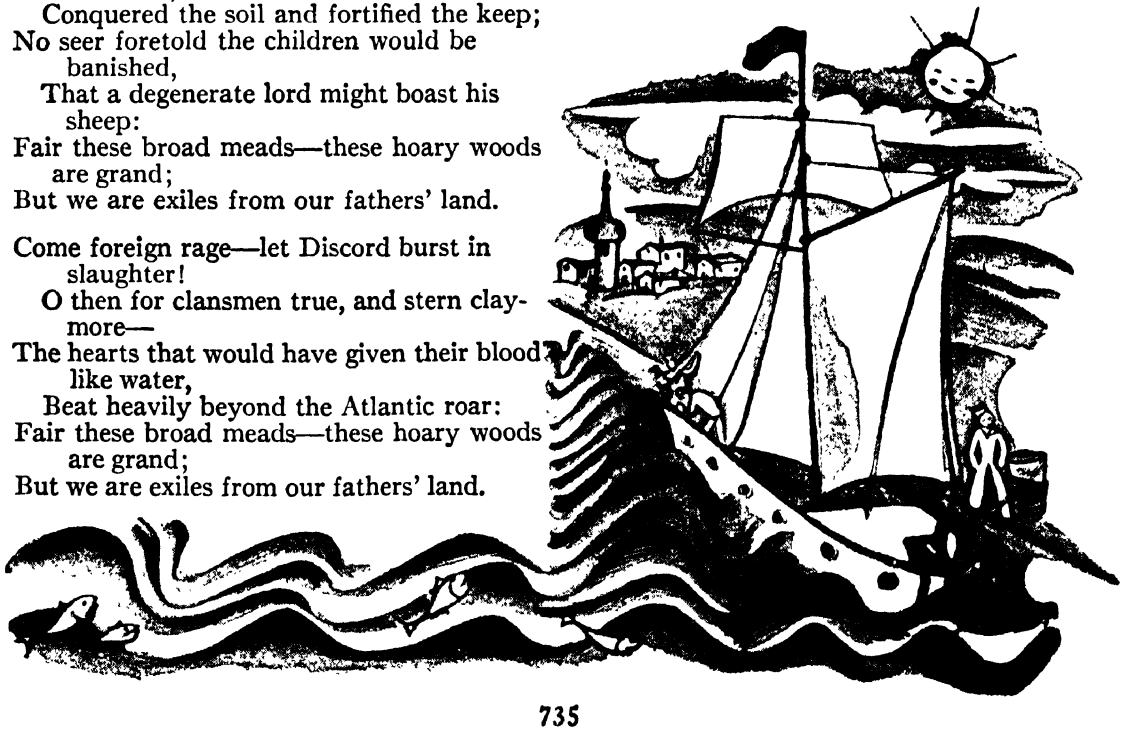
THERE'S a ship lies off Dunvegan
An' she longs to spread her wings
An' through a' the day she beckons
An' through a' the nicht she sings:—
"Come awa', awa', my darling,
Come awa' wi' me and fly
To a land that's fairer, kinder
Than the moors and hills o' Skye."

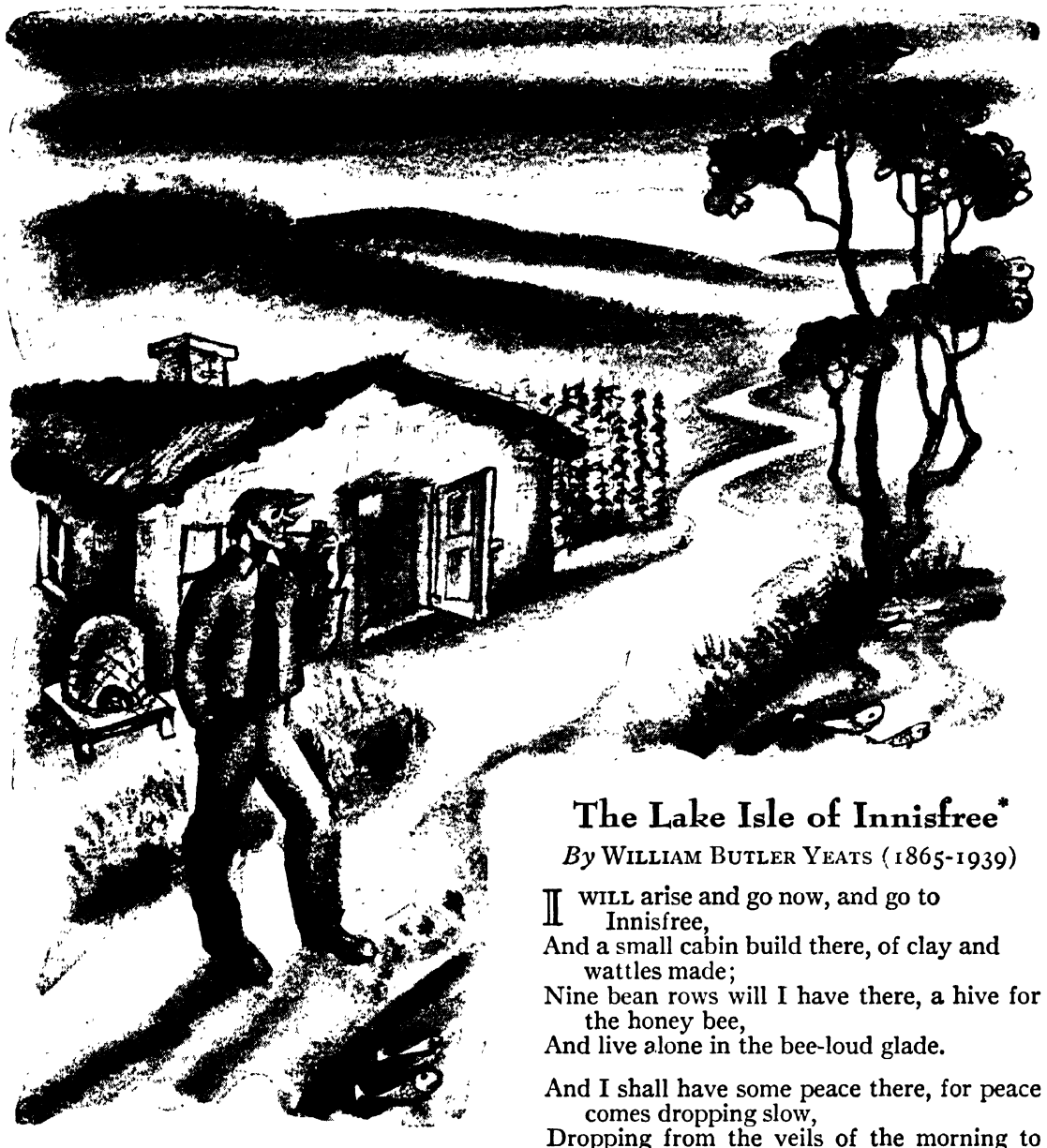
O my heart! my weary heart!
There's ne'er a day goes by
But it turns hame to Dunvegan
By the storm-beat hills o' Skye.

I hae wandered miles fu' many,
I hae marked fu' many a change,
I hae won me gear in plenty
In this land sae fair but strange:
Yet at times a spell is on me,
I'm a boy once more to rin
On the hills aboon Dunvegan,
An' the kind sea shuts me in.

O my heart! my weary heart!
There's ne'er a day goes by
But it turns home to Dunvegan
By the storm-beat hills o' Skye.

*Reprinted by permission of the publishers, Harper & Brothers.





Hame, Hame, Hame

By ALLAN CUNNINGHAM (1784-1842)

HAME, hame, hame, O hame
fain wad I be—
O hame, hame, hame, to my ain countree!

When the flower is i' the bud and the leaf is on the tree,
The lark shall sing me hame in my ain countree;
Hame, hame, hame, O hame fain wad I be—
O hame, hame, hame, to my ain countree!

The Lake Isle of Innisfree*

By WILLIAM BUTLER YEATS (1865-1939)

I WILL arise and go now, and go to Innisfree,
And a small cabin build there, of clay and wattles made;
Nine bean rows will I have there, a hive for the honey bee,
And live alone in the bee-loud glade.

And I shall have some peace there, for peace comes dropping slow,
Dropping from the veils of the morning to where the cricket sings;
There midnight's all a glimmer, and noon a purple glow,
And evening full of the linnet's wings.

I will arise and go now, for always night and day
I hear lake water lapping with low sounds by the shore;
While I stand on the roadway, or on the pavements gray,
I hear it in the deep heart's core.

*From Collected Poems by William Butler Yeats. Reprinted by permission of the publishers, The Macmillan Co.

Home No More Home To Me*

By ROBERT LOUIS STEVENSON (1850-1894)

HOME no more home to me, whither must I wander?
Hunger my driver, I go where I must.
Cold blows the winter wind over hill and heather;
Thick drives the rain, and my roof is in the dust.
Loved of wise men was the shade of my roof-tree.
The true word of welcome was spoken in the door:
Dear days of old, with the faces in the firelight,
Kind folks of old, you come again no more.

Home was home then, my dear, full of kindly faces;
Home was home then, my dear, happy for the child.
Fire and the windows bright glittered on the moorland;
Song, tuneful song, built a palace in the wild.
Now, when day dawns on the brow of the moorland,
Lone stands the house, and the chimney-stone is cold.
Lone let it stand now the friends are all departed,
The kind hearts, the true hearts, that loved the place of old.

Spring shall come, come again, calling up the moor-fowl;
Spring shall bring the sun and rain, bring the bees and flowers;
Red shall the heather bloom over hill and valley,
Soft flow the stream through the evening hours;
Fair the day shine as it shone on my childhood,
Fair the day shine on the house with open door;
Birds come and cry there and twitter in the chimney,
But I go for ever and come again no more.

My House**

By LOUIS UNTERMEYER (188_-

MAY nothing evil cross this door,
And may ill-fortune never pry
About these windows; may the roar
And rains go by.

Strengthened by faith, these rafters will
Withstand the battering of the storm;
This hearth, though all the world grow chill,
Will keep us warm.

Peace shall walk softly through these rooms,
Touching our lips with holy wine,
While every casual corner blooms
Into a shrine.

Laughter shall drown the raucous shout;
And, though these sheltering walls are thin,
May they be strong to keep hate out
And hold love in.

*From Complete Poems of Robert Louis Stevenson, copyright, 1905, 1923, Charles Scribner's Sons.
**From This Singing World, by Louis Untermeyer; copyright, 1923, Harcourt Brace & Company, Inc.

I Remember, I Remember

By THOMAS HOOD (1799-1845)

I REMEMBER, I remember
The house where I was born,
The little window where the sun
Came peeping in at morn;
He never came a wink too soon
Nor brought too long a day;
But now, I often wish the night
Had borne my breath away.

I remember, I remember
The roses, red and white,
The violets, and the lily-cups—
Those flowers made of light!
The lilacs where the robin built,
And where my brother set
The laburnum on his birthday,—
The tree is living yet!

I remember, I remember
Where I was used to swing,
And thought the air must rush as fresh
To swallows on the wing;
My spirit flew in feathers then
That is so heavy now;
The summer pools could hardly cool
The fever on my brow.

I remember, I remember
The fir-trees dark and high;
I used to think their slender tops
Were close against the sky:
It was a childish ignorance,
But now 'tis little joy
To know I'm farther off from Heaven
Than when I was a boy.

Home, Sweet Home

By JOHN HOWARD PAYNE (1792-1852)

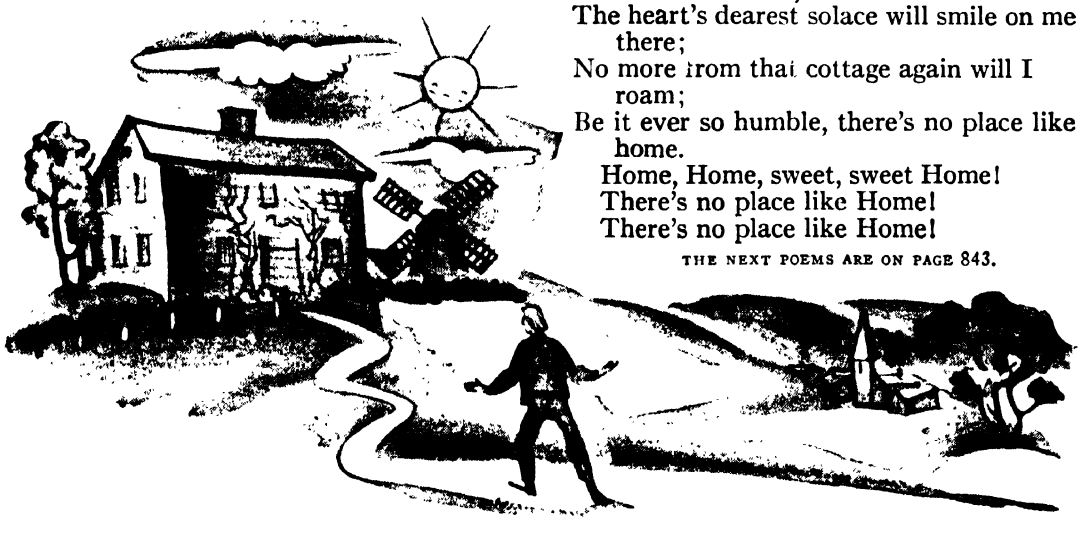
'MID pleasures and palaces though we may roam,
Be it ever so humble, there's no place like home;
A charm from the sky seems to hallow us there,
Which, seek through the world, is ne'er met with elsewhere.
Home, Home, sweet, sweet Home!
There's no place like Home!
There's no place like Home!

An exile from home, splendor dazzles in vain;
O, give me my lowly thatched cottage again!
The birds singing gayly, that came at my call,—
Give me them,—and the peace of mind, dearer than all!
Home, Home, sweet, sweet Home!
There's no place like Home!
There's no place like Home!

How sweet 'tis to sit 'neath a fond father's smile,
And the cares of a mother to soothe and beguile!
Let others delight 'mid new pleasures to roam,
But give me, oh, give me, the pleasures of home!
Home, Home, sweet, sweet Home!
There's no place like Home!
There's no place like Home!

To thee I'll return, overburdened with care;
The heart's dearest solace will smile on me there;
No more from that cottage again will I roam;
Be it ever so humble, there's no place like home.
Home, Home, sweet, sweet Home!
There's no place like Home!
There's no place like Home!

THE NEXT POEMS ARE ON PAGE 843.



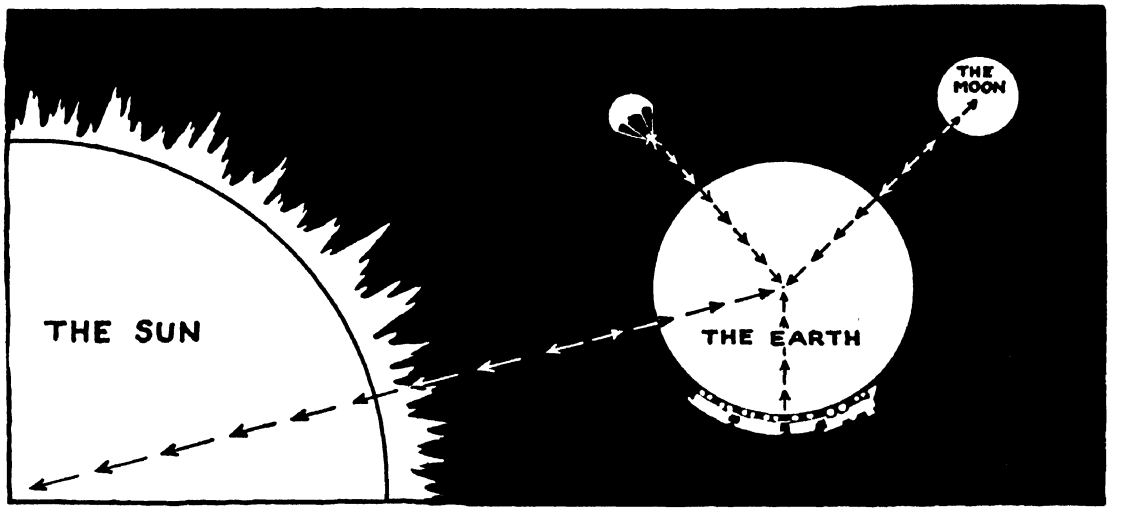
GRAVITATION

THE REASON WHY IT IS EASIER FOR YOU TO RUN DOWN A HILL THAN UP A HILL

TAKE a pencil in your fingers. Let it go. It will fall to the floor. Watch the leaves as they drop from the trees in autumn. They fall downward. A leaf may ride for a while on a current of air, but in the end it will fall.

Water runs downhill. A ball will roll downhill. An automobile will coast downhill, with the engine turned off; but you need the engine's power to send the car uphill. You may coast downhill on your bicycle; but you must use your human strength, or force, to pedal the bicycle uphill.

Everything on earth seems to be attracted toward the earth. And not just toward the surface. If you drop a stone over the edge



Gravitation is the force which balances the universe and holds it together. The sun, earth and moon each attract one another. The man in the parachute and the train on earth are both attracted to the center of the globe.

of a well, it will fall to the bottom, as if it were being pulled toward the center of the earth. And, in fact, the stone and the pencil and the autumn leaves and all other things on earth are being pulled toward the center of the globe by a force which we call gravitation. Through this force the earth is attracting all things that are on it; and all things on it are attracting the earth. Not only that, but every object on earth attracts every other object no matter how small they are or how far apart they are. This attraction is extremely small between ordinary bodies. Thus two masses of one gram each at a distance apart of one centimeter attract each other with a force of approximately $\frac{1}{15,000,000,000}$ gram. The masses of the sun and earth are so big that even at a distance of 93,000,000 miles they attract each other with a force of 4,000,000,000,000,000,000 tons. Greater bodies have greater attracting force than lesser bodies, as in a tug of war.

So far we have been talking about the mysterious force of gravitation as related to the earth and things on it. The same force works throughout the universe. The moon and earth attract each other; and they are attracted by the sun, and, with their feebler force, also attract the sun. All the other planets and bits of matter that wheel around the sun do so because of the attracting force of gravitation. Farther out in space, all the stars in the sky attract each other, even the most distant ones.

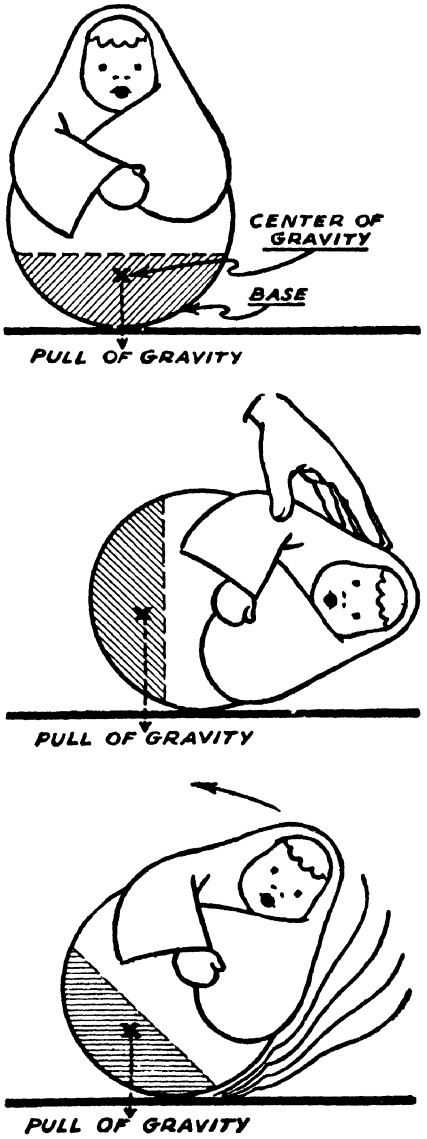
Thus we see that gravitation is the force by which the universe is balanced and held together. Gravitation acts according to a law which was discovered by Isaac Newton in the seventeenth century. The law may be stated in this way: Every body of matter in the universe attracts every other body along a straight line between them. The force of attraction between any two bodies varies directly according to the product of their masses, and inversely according to the square of the distance between them. In other words, the force is greater between large, heavy bodies than between small ones. It is greater between near objects than between things farther away. A rocket in space 210,000 miles from the earth but only 28,000 miles from the smaller, lighter moon would be equally attracted by both sides.

When a thing starts to fall, it falls faster and ever faster as it approaches the earth. If a stone is thrown from the top of the Empire State Building (1,248 feet high), it will travel 16 feet the first second. It will travel 48 feet in the next second, 80 feet in the third, 112 feet in the fourth, 144 feet in the fifth, and so on, until, during the tenth second, it hits the ground at the tremendous speed of 304 feet per second. As the stone approaches the earth, the earth's pull on it increases.

The airplane pilot is acting on this knowledge when he "bails out." He can safely fall for a few seconds without opening his parachute, for the rate of falling is not great at first. The rate, in fact, is the same as that of the stone from the Empire State Building —16 feet, 48, 80, 112 and so on—a gain in falling speed of 32 feet per second over the preceding second.

Until that great scientist Galileo disproved it, people thought that a heavy body will fall to the earth faster than a light body. The idea seemed logical enough. In those days ideas were not put to experimental tests as they are nowadays. Galileo applied some clever reasoning and showed that all bodies, light and heavy, must fall to the earth at the same rate. He reasoned as follows: if a light body is attached to a heavy body, then the sum of the two is still heavier, therefore the combined bodies should fall at a faster rate than the heavy body alone. But if a light body falls more slowly than a heavy body, it should have a slowing up effect on the heavy body. Now, the two statements contradict each other. Therefore the idea that a heavy body falls faster than a light body must be wrong. Galileo actually proved that all bodies fall with the same speed by dropping two bodies of unequal weights from the Leaning Tower of Pisa. They hit the earth at the same time. This famous demonstration was the beginning of experimental physics.

Of course the air will resist for a while the fall of such things as feathers and light bits of paper. But barring the resistance of the air, which can be noticed only in the case of very light things, all objects, regardless of their mass, fall toward earth at the same rate. This gain in speed is called the acceleration of gravitation. We shall come back to it later in the chapter and explain it more fully.



Concentration of weight near the base of the doll prevents it from tipping easily.

Can this great law of gravitation be changed or altered in its working? For instance, if we put something in between two other bodies, do we interfere with the gravitation between them; or does gravitation take no notice of obstacles? The answer to this is that the gravitation is exactly the same. Obstacles can not block it.

What would be the result of heat? If we take a thing that has a certain weight owing to the earth's pull for it, and its pull for the earth, and if we examine this thing, first when it has been made fifty times colder than ice by being plunged in liquid air, and then when it has been made white-hot, we find that the influence on the force of gravitation is nothing.

Are you defeating the force of gravitation when you hold an apple in your hand? No. You are opposing force with force. The same thing applies to airplanes. The force of gravitation is always acting, and the flyer, like the bird, has to balance this force by some force acting in the opposite direction. The bird gets this force by burning sugar in its muscles; the airplane gets it by burning gasoline in its engines.

We are told that Isaac Newton began working out the law of universal gravitation as he sat in his grandmother's garden and mused upon the way in which an apple fell from the tree to the ground. He wondered if the pulling force that always brings free-falling things downward, on earth, might not be a universal force. Johann Kepler had learned certain facts about the planets, showing that all the known planets move according to certain laws, their speeds depending on their distance from the sun, and so on. Newton studied Kepler's discoveries and after some discouragements, and errors in figuring due to the faulty measuring devices of the time, he was at last able to state his great law with confidence.

This was one of the greatest statements

any man had ever made. Though scientists of our time are revising somewhat our understanding of gravitation, Newton put forward enormously men's knowledge of the universe and its workings.

We know now why cream forms on top of milk, why the earth's core is the densest part of the sphere and the upper atmosphere the lightest part. We understand why a wooden canoe floats on water, and why cork floats and why a balloon will rise in the air, why a house built on rock is better than a house built on sand. Men knew all these facts, as facts, before Newton's time. Newton showed the reason. And now they were able to improve upon many machines. Great advances were made in astronomy. By observing the movements of certain stars, astronomers were able to predict invisible stars far out in space, and as telescopes were improved, these distant stars became visible, just where they were said to be. The planets Uranus and Pluto were predicted because of their gravitational effect on other bodies, long before they were seen.

One interesting example of a lesser body's pull on a greater body is seen on our coasts twice every day. The ocean tides are caused by the moon's pull, which is strong enough to draw up the water in a mighty heap on the side of the earth facing the moon. The article on Tides explains this more fully.

YOU WOULD WEIGH LESS AT THE EQUATOR THAN YOU WOULD AT THE NORTH POLE

The measure that we call weight is the strength of gravitational force on an object at the surface of the earth. You know that gravitational force becomes smaller, as the distance between two objects increases. The Equator is farther from the center of the earth than the Poles. Therefore a thing weighing a pound at the North Pole would weigh less than a pound at the Equator.

A child weighing sixty pounds on earth would weigh only ten pounds if transported to the moon; because the moon's gravitational force is only one-sixth that of the earth.

There is, as you can see now, a difference between mass and weight. Mass is the amount of stuff packed in an object; weight is the earth's pull upon it at any point on the surface. The mass of an object does not vary. The weight will vary a little from place to place, according to the distance from the center of the earth.

A body at the North or South Pole is nearer to the center of the earth than a body at the Equator. This is so because the earth is slightly flattened at the Poles. A body located near the Equator will therefore weigh less than a body near one of the Poles. If a body is raised a few miles above the earth's surface the decrease in its weight will be only a very small amount, for the reason that a few miles is a small distance compared to 4,000 miles—the radius of the earth. As a matter of fact a 100-pound boy at the top of a mountain four miles high will weigh 99.8 pounds.

A body weighs most at the surface of the earth. If you can imagine a body moved to the very center of the earth, it would weigh nothing, for it would be attracted equally in all directions.

THE FORCE OF THE EARTH'S GRAVITY COMES FROM A COMBINATION OF TWO OTHER FORCES

We come now to the word gravity. Sometimes this word is used as if it were another name for gravitation. However, it has a more precise meaning.

We have spoken of the acceleration of gravitation. The earth is always rotating, or turning on its axis, and this motion gives rise to another force, called centrifugal (center-fleeing) force. So a falling object is being pulled ever faster and faster toward the earth's center, and at the same time being pushed slightly away from the center. The result of these two forces on an object is known as the earth's gravity.

There is in every object a point around which the whole mass of the object can be balanced. This is called the center of gravity. In the case of a round object made of the same material throughout, the center of the object would be also the center of gravity. Now, suppose we take a square, thin board with the intention of finding its center of gravity, assuming, of course, that the board is made of the same material and is of the same thickness throughout. We want to fix a single thread to the board at one point so that when it hangs from the thread, the board will be evenly balanced. That point will, of course, be the center of gravity.

We all know what a diagonal is—the line joining opposite corners of such a board. If we draw the two diagonals, the point where they cross each other is the center of gravity. Suppose that, instead of a square board or a round object, we had one of a very irregular shape, and wished to find the point at which we could suspend it by a string so that it would swing evenly. Let us pick up the board, tie a string somewhere to its edge,

and let it hang steady. If we draw a line straight down the board continuing the line of the string, the center of gravity will be somewhere in that line. How do we know? When the board hangs steadily from the string, there must be, as in any other case of equilibrium, a balance of forces.

These forces, of course, are the earth's gravity pulling downward and the tension of the string pulling upward. As these two forces act equally and oppositely, the center of gravity must be somewhere in the line of them.

We often hear that a rowboat has been upest and someone has been drowned. There is a simple rule of safety which we all ought to know. It is that not more than one person at a time should stand up in a rowboat, and the lower that one crouches when he moves about, the less danger there will be.

We see that this is a problem in equilibrium, and the whole question of equilibrium depends upon the center of gravity. If the center of gravity of the boat were in its keel, as in the case of those little toys with half a bullet at their base, then the boat could not be so easily upset; it could be tilted or turned upside down, but it would right itself at once. This is a case, of course, of stable equilibrium, where any disturbance means the raising of the center of gravity. When we build what is called a lifeboat, we provide it, among other things, with a heavy keel, which means that the center of gravity is kept so low that, with the help of other arrangements, the boat, even when it is upset, has the power to right itself. But in an ordinary rowboat there is no heavy iron keel, and the greatest factors in determining where its center of gravity lies are the bodies of the occupants.

As soon as we stand up, the center of gravity of the boat is raised, and any disturbance is likely to lower it, which means that the boat goes over.

A ship's hold is filled with b[illegible]llast (freight, usually) which keeps its center of gravity low.

We must not leave the subject of gravitation without referring to what is perhaps the most important of all the questions it raises. If it is true that here is a force which acts forever, pulling every particle of matter in the universe toward every other particle, why does not all the matter in the universe collect into one great solid ball? Now, there are two possible answers to the question.

It might be that this process of gathering together all the matter in the universe is indeed going on, and has been going on since the universe was first made. But perhaps there has not yet been time enough for it to result in gathering everything together into a solid ball. This has in it the ideas of beginning and ending, as if the universe were a machine which had been wound up and set running, and must run down.

However, many modern scientists, following the work of Professor Albert Einstein, believe that there is a force in the universe opposing gravitation; and that the two forces work in a sort of rhythm. The result is like a great, slow contraction of the universe (gravitation working), followed by a great, slow expansion of the universe (the opposite force working). The theory is sometimes called the "space-time concept."

Ewing Galloway photograph

A carefully placed center of gravity in the Leaning Tower of Pisa prevents its falling. It has leaned for 800 years.

THE NEXT STORY OF SCIENCE IS ON PAGE 803.

HOW PLANTS WORK, MOVE AND FEEL

THE business of plants is mainly twofold: caring for self and caring for others. It is the first of these that we have to do with here. In the case of plants, caring for self means capturing raw materials, manufacturing these into carbon compounds—sugar and starch, fat and oil, and, above all, proteins (like the gluten of wheat); and using this self-made food for upkeep, for growth and for storage.

A great part of the work of green plants is devoted to increasing the amount of living matter; to growing.

The chief use of the root of land plants is to absorb water and salts from the soil. Of course, when the stem of the plant rises high, as in trees, the roots serve also as foundations, or anchors. Another use of roots is to form a storehouse for reserve food supplies. This is plainly seen in the case of edible roots, like carrots, parsnips and turnips.

The tip of a root is clear and delicate. It remains ever young and growing; it is always feeling its way farther into the soil. Its growing point is protected by a root-cap which saves the delicate, rapidly dividing cells from being punctured by sharp particles in the soil. A little way behind the growing part we see numerous root-hairs. They are the water-absorbers.

There are often many hundreds of root-hairs to a square inch, and they grow like delicate fingers into the gaps among the soil particles. They are outgrowths of the very living skin cells of the root, and their use is to absorb the soil-water which occurs in delicate films round the tiny particles. The wall of the finger-like processes that probe and bend in the gaps is very delicate, so that water passes readily through it into the denser cell contents. Moreover, toward the tip of the root-hair the cell wall is soft and gummy, so that a soil particle may almost be said to be glued to it.

For the most part what the plant gets from the soil passes in by the delicate root-hairs, and no one root-hair lasts very long. They shrivel away as the part of the root from

Harold M. Lambert, from Frederic Lewis

Helping the plants to grow. All plants need water.

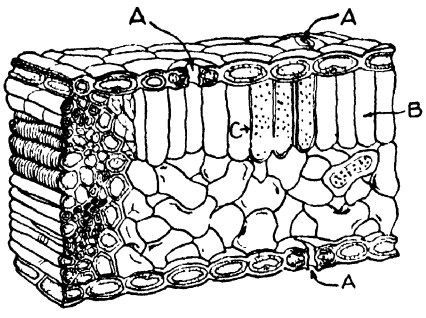
which they arise gets older, and new hairs are formed nearer the tip. It is important to understand that the growing of the root deeper into the ground is always just at the tip, below the youngest root-hairs; otherwise the growing would tear the root-hairs from their grip of the soil particles.

In the core of the young root there is a column of pipes, or vessels (wood and bast), surrounded by a slightly corky sheath. There is another corky sheath just below the outermost cells that form the root-hairs. Between these two slightly corky sheaths there is the rind, or cortex, of the root, a sort of intermediate reservoir for the absorbed water. But as the root gets older, the rind often becomes unimportant, or disappears altogether. What is most important is this, that the water captured by the root-hairs passes into the wood elements of the root's core and then into similar elements in the stem, until it finally reaches the leaves.

Some roots do strange things. The little brownish air-roots of the ivy are used for climbing purposes, binding the stem tightly to tree or wall. In some of the plants of tropical forests, which live off the ground, the roots absorb water vapor from the moist air. In the orchid which yields vanilla some of the roots serve as tendrils, and others dangle. They are able to absorb dew and rain, for they are surrounded by a sheath of large empty cells with openings to the outside.

In the bog moss more than half the cells are dead and empty, but are kept from collapsing by delicate spiral and circular bands. Twenty times the plant's own weight of water may be stored in these cells. Thus, when there is prolonged drought the bog moss is still able to flourish.

Now let us turn from the root to the leaf. The green leaf is the most important laboratory in the world, for all animal and human life depends on the nutritive material which it builds up.



A magnified cross section of a leaf, showing the wonderful arrangement of the various kinds of cells.

A - STOMATA
B - PALISADE CELLS
C - PALISADE CELLS WITH WALL REMOVED

A leaf is a sheet of living tissue, sometimes as thin as tissue paper, as in a young beech leaf; sometimes as thick as leather, as in a rubber plant. Some leaves are so small that we can hardly see them with the naked eye, while some palm leaves are six feet long.

No self-supporting higher plant can get on without leaves unless an expanse of green is attained in some other way—notably by having a large area of green stem. Thus in cactuses the leaves are turned into spines, and the whole stem is green.

To understand the work of leaves we must know a little about their architecture. Think of a leaf hardly thicker than this paper. The upper surface is covered by a layer of skin cells, and the outer walls of this are often thickened to protect the delicate, living units below. The skin cells often bear hairs, giving the leaf a woolly surface; or they may be, as it were, varnished with protective wax.

On the lower side of the leaf there is another skin (an epidermis), but every here and there on this surface there are numerous pores called stoma (one of these pores is called a stomata) which allow an exchange of gases between the leaf and the air. If the leaf is floating on the surface of a pond, as in the case of a water lily, there would be no use in having the openings on the lower surface which touches the water; the stoma are on the dry upper surface.

Between the two skins there is the middle green tissue of the leaf. Toward the upper surface the cells are arranged like bricks or posts, and often in two layers. They are called palisade cells. Toward the under surface there are more green cells, less closely fitted together, and the gaps between them communicate with the openings, or stoma. This is called the spongy tissue. The green color of the palisade layers and spongy layers is due to numerous green discs (chlorophyl corpuscles) in the living matter of the cells.

Finally, the leaf is supported by a framework or network of veins, which form the skeleton of the leaf. The veins are also of use as conducting pipes. Through them the water and salts from the roots reach the green cells of the leaf, and the materials manufactured by the leaf are carried downward to the stem and roots.

The all-important fact is the presence of the green cells in the middle tissue of the leaf, with thousands of chlorophyl discs turning their edges to the light. They are able, with the help of the energy of the sunlight, to split up the carbon dioxide of the atmosphere, freeing the oxygen and fixing the carbon in the form of carbon compounds. This building-up by the power of light is what is called photosynthesis.

Now let us see what happens when photosynthesis takes place. Water with mineral salts dissolved in it passes from the soil into the roots of the plant through the root-hairs. It is drawn upward into the leaves. The leaves also take in carbon dioxide from the atmosphere. The chlorophyl cells in the leaves, by the power of the sunlight, break up the carbon dioxide and manufacture the carbon (together with the materials they got from the soil) into sugar and starch and proteins and other food. The excess oxygen is sent out into the atmosphere.

The leaf also breathes. Every living creature must take in oxygen and give off carbon dioxide, for living can not go on without slow combustion (or oxidation). If we have in a room at night a lighted candle, a sleeping cat and a green plant, all three are taking in oxygen, burning away carbon compounds, and giving off carbon dioxide.

It is in the dark that we must study the breathing, or respiration, of plants, for in sunlight the breathing process is disguised or masked by the feeding process. The little openings (stoma) on the underside of the leaf are breathing pores, and it is also by these important apertures that water vapor is

given off to the atmosphere. The stoma open and close in an automatic way, so that, though too much water is not given off, there is yet enough to keep the up-current from the roots steadily going on.

Some of the simplest plants, which are single cells, so small as to be seen only under the microscope, swim about by means of living lashes, just as many of the simplest animals do. On the other hand, there are many animals, such as sponges and corals, which do not move except in their earliest days.

Yet, when we have allowed for the fact that some single-cell plants do move and the fact that some animals do remain still, the big fact stands out that plants are usually fixed, while animals are usually free.

Growth means increase in size; the amount of the living matter is added to, and there is a *redistribution of material.* The growing cells are very *tense,* for there is a pressure on the cell wall exerted from within by the watery living matter and the cell sap. The living matter just inside the cell wall controls the give-and-take between the cell sap and the cell wall, and thus controls the tenseness.

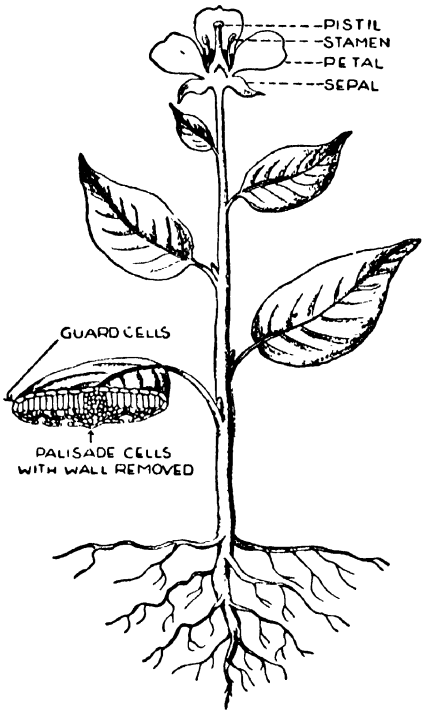
You know the limpness of a shoot that has been cut off from its water supply; it is like a punctured tire. It is losing water into the air and gaining none back; its cells lose their tenseness and the shoot withers. If we put the cut end into water before the withering has gone too far, the shoot may become stiff once more.

It is worth while to dwell a little on the tenseness of growing and active plant cells. The movements of both growing and full-grown parts depend on changes in tenseness.

When a seed sprouts, however it has been lying, the young shoot grows upward and the young root grows downward. It is their nature so to do. If the seedling starts rightly and is then turned upside down, it will soon have its root growing down once more and its stem growing up. Of course, it may come about that the root's tendency to seek moisture may be strong enough to counteract the tendency to grow toward the center of the earth. Very careful experiments have shown that the root's sensitiveness to gravity is situated at its very tip.

Roots are sensitive to moisture and grow toward it, altering the direction of their growth according to the conditions in the soil around them.

Plants grown in a window turn toward the light, and they would become lopsided if the flower-pot were not turned round once in a while. It seems a very sensible thing to do, to spread themselves so that they get all the light possible. The plant's response is automatic, and is due to inequalities of growth. The stem grows less rapidly on the more illumined side, for light has a delaying influence on growth. This is just the opposite of the influence of heat, which hastens growth. Now, if the growing part of a shoot in a window grows less rapidly on the side next to the light, the result must be a bending toward the window.



The parts of a typical flowering plant.

It is interesting to watch a growing shoot of ivy—to notice that it bends away from the light. Moreover, before it attaches itself, it gives off brownish aerial rootlets, and these are all toward the shaded side. This is plainly all the better for gripping a wall or a tree. The same is well seen in the fixing discs of the Virginia creeper. So it is not necessary that a shoot structure must grow toward the light; it is, indeed, occasionally the other way.

So plants answer back to gravity, to moisture and to light: and their answers are seen in movements of their growing parts. There are other influences to which plants are sensitive, such as electricity, chemicals and even air.

Another point of importance is that a change in the growth of a part of a plant may become fixed when the part becomes older and therefore stiff. Some peculiarity stamped on the growing portion may last

throughout life. It remains as a record of something the plant has experienced.

So far we have dealt with sensitiveness and movements in growing plants, or, we may say, in parts which are still young. Let us pass to sensitiveness and movements in full-grown parts.

Thus the beautiful three-bladed leaves of the clover and the wood-sorrel are spread out during the day, but folded downward at nightfall. This may protect them from over-cooling at night; but we do not know. Similarly, many flowers, like daisies, close up at dusk; and others, like the yellow sorrel, when the day is dull. The feathery leaves of the sensitive plant expand horizontally during the day, but fold up at evening. The opposite leaflets of each division of the compound leaf fold their upper surfaces together; the divisions of the compound leaf seem to huddle together instead of being like an expanded fan; and the leaf stalk sinks from a more or less erect position and hangs downward at a sharp angle. The same remarkable movements may be brought about in a minute by shaking the plant. The movements are due to changes in the tenseness of cells at the hinge of the leaf stalk or at the base of each division of the leaf.

A variety of leaf shapes. Groups marked A, B and C have a center axis; D, E and F are hand-shaped. The pattern is very much broken up in G; and H shows a "parallel" leaf.

If we pinch a leaflet at the tip of one of the divisions of the leaf we can follow the message. One pair of leaflets after another may be seen folding together, and finally the leaf as a whole droops down. There is evidently the handing-on of an influence from one part of the leaf to another part at a considerable distance, and it may be from one leaf to another. Possibly the message travels by long, delicate tubes filled with sap surrounded by a sheaf of living matter.

When a bee visits the cornflower and touches the sensitive hairs of the stamens, the curved stalks straighten and contract, drawing the anther tube downward. The effect is to brush out the pollen on to the bee's body, and the insect is thus ready to dust another flower which has its stigma expanded. In this case there is sensitiveness to touch and a real usefulness in the movement. This is only one of several flowers which show this peculiar sensitiveness, and which are pollinated in some such manner.

In the case of the crocus and the tulip, and of some other flowers, it is the heat and not the light of the sun that starts a movement. The marigold opens in the morning and closes in the evening even when kept in darkness. *An internal rhythm has been established.*

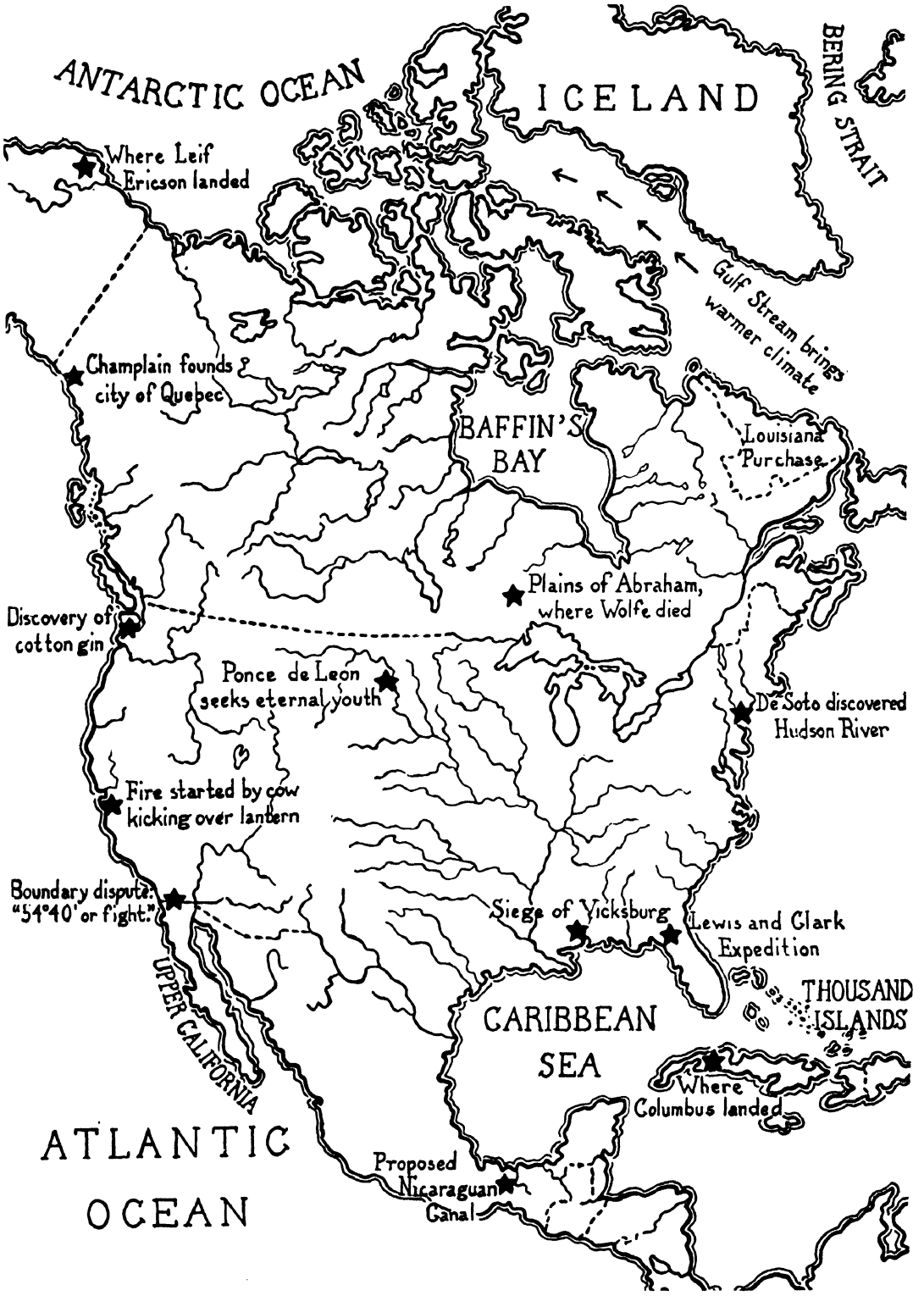
The Indian telegraph-plant, which grows in the basin of the Ganges, is interesting. Its leaf has a main leaflet which is stationary, and two small ones which describe circles with jerky movements.

The reddish leaves of the sundew have numerous spreading tentacles. Each tentacle bears at its tip a dew-like drop of sticky stuff which entangles the legs of small insects. When one tentacle is touched, a message travels down to other tentacles, which slowly curve inward. What looked like an outspread hand becomes a closed fist. Digestive juice is poured round the victim, which is then absorbed. After a while the tentacles expand again, ready for another meal.

Still more striking is the Venus's fly-trap of Carolina. If the fly-trap has been induced to shut on something it does not want, it opens again quickly; and when it has been cheated two or three times in rapid succession, the plant ceases for a time to respond.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 880.

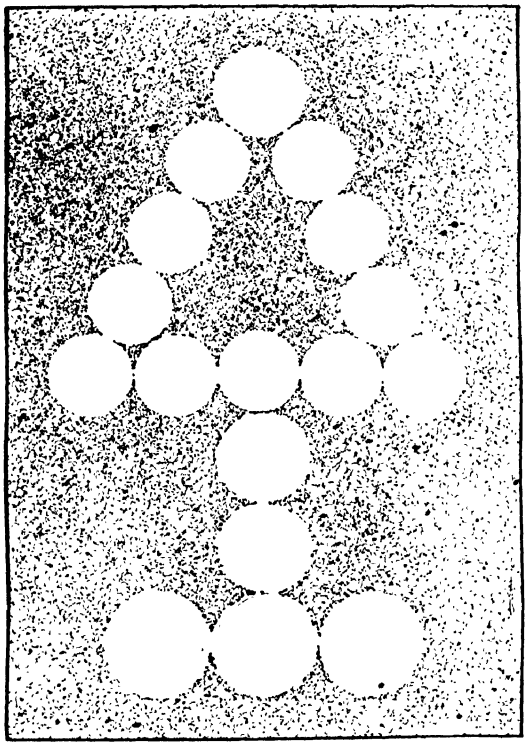
CAN YOU TELL WHAT IS WRONG?



Trace this map on a piece of thin paper. Can you correct all the errors? There are more than twenty.

A STIPPLED SILHOUETTE

ARTISTS sometimes shade certain areas of their drawings with a number of tiny dark points: this is called stippling or stipple work. You can produce some interesting stippling effects with nothing but an old toothbrush, a small piece of wire screening and a bottle of ink. With these you will be able to make a silhouette of an object against a background of stippling.



Design made from coins of three sizes.

The object in question is to lie perfectly flat against the paper. If you are making a silhouette of something like a leaf or a flower which does not naturally lie flat, you must fasten it to the paper with pins or rubber cement. When you have arranged the object properly on the paper, dip your toothbrush in the ink. Allow the surplus ink to drain off into the bottle. Now hold the screening up over the paper, keeping it parallel to the paper and about three inches away from it. Working from top to bottom and from one side to the other over the paper, rub the toothbrush bristles over the wire screening. This will cause the ink to be spattered over the whole surface of the paper. Allow the spatters of ink to dry. Then remove the object from the paper; you will find it reproduced in perfect outline, surrounded by a great number of little ink spatters. You may produce all kinds of interesting effects by using different kinds of inks and papers of different colors and surfaces.

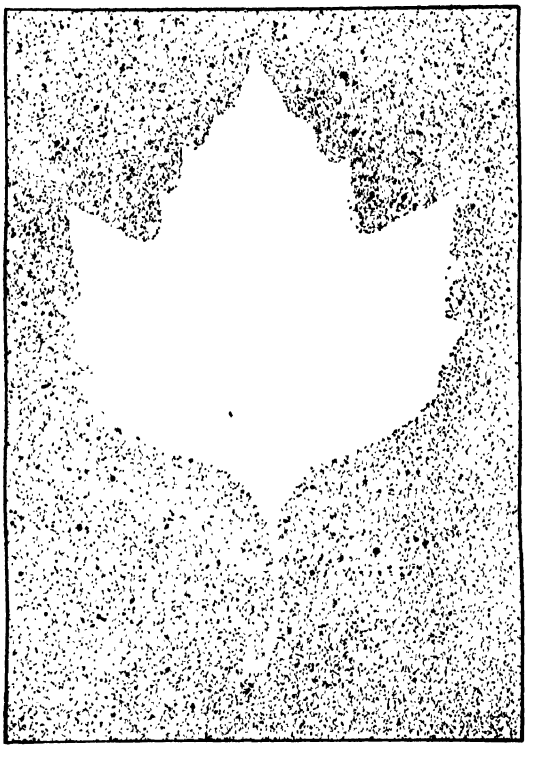


Illustration for Botany Notebook.

There are many things of which you may make silhouettes of this kind: flowers, leaves, coins arranged to form striking designs, and so on. You must remember, of course, that the object on the paper will be spattered as well as the paper itself, so that by the time the spattering is completed, this object will be covered with ink. Therefore you must never use this process with things that would be ruined by ink.

A TRICK YOU CAN PLAY WITH A BOOK

THIS is a trick of a really startling kind, which will puzzle even the wisest man if he does not know how it is done. You will seem to be not only a mind-reader, but a master-mind with figures.

You invite someone, the older and wiser the better, to take down any book he pleases from the bookshelves, to open it haphazard, and to choose a word in the first nine lines of any page, and not later than the ninth word in the line. He is then to notice the number of the page, and multiply it by 10. To the product he is to add 25 and the number of the line. The result thus obtained is in turn to be multiplied by 10, and the number at which the word stands to be added to the product.

He is then to hand you the book, with a slip of paper on which are written the figures last obtained. After thinking for a few moments you open the book and read out the word chosen.

To obtain this surprising result, all that you have to do is to subtract in your mind 250 from the amount given you on the slip of paper handed to you.

The last figure of the answer will give you the number at which the word stands in the line, the last but one the number of the line, and the remaining figures the number of the page.

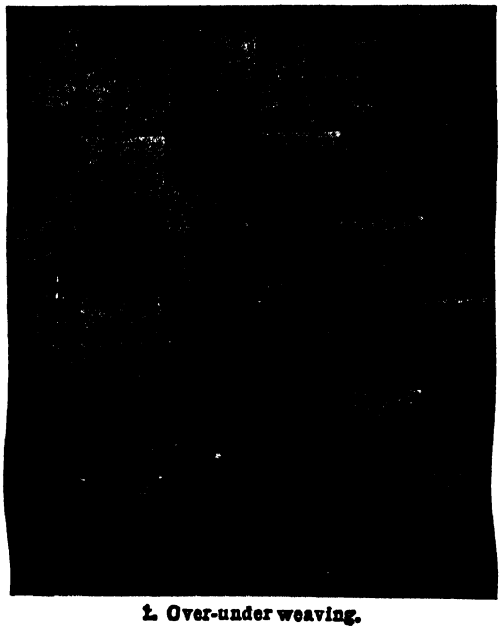
Suppose, for instance, that the person choosing the word had happened to choose the fifth word in the ninth line of the eighty-fourth page. In such case the process would be as follows:

$$\begin{aligned} 84 \times 10 &= 840 \\ 840 + 25 + 9 &= 874 \\ 874 \times 10 &= 8740 \\ 8740 + 5 &= 8745 \\ 8745 - 250 &= 8495 \end{aligned}$$

And 8495, dissected as explained, gives 84, 9, 5, being the three clues necessary to the discovery. Remember, it must be one of the first nine words in one of the first nine lines of the page.

MAY BASKETS MADE WITH PAPER STRIPS

ATTRACTIVE May baskets can be made by using paper strips of various colors. You will find that it is quite easy to make these really beautiful little baskets.



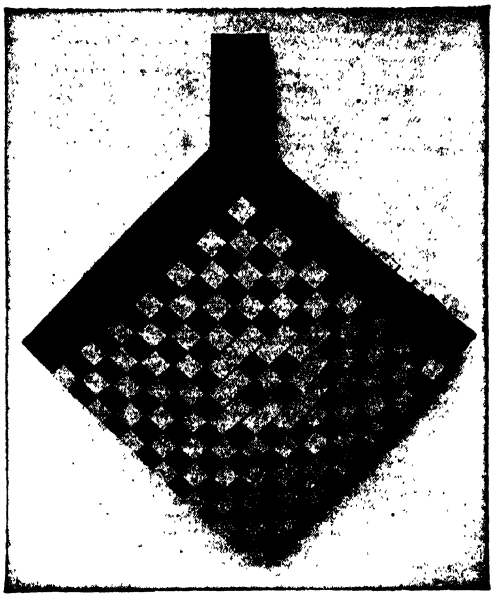
1. Over-under weaving.

The first thing to do is to secure a few sheets of tough paper and to cut strips ½ inch or more in width. These pieces should be about 12 or 14 inches long. The base of the basket is woven by the over-under method (see picture 1), allowing the ends to extend. When a base of the desired size is secured, push the strips closely together, and bend them upward at right angles to the bottom. Then take a long strip and weave in and out of these upstanding strips. The next thing to do is to crease the corners. Now finish this process by weaving far enough around the second time to tuck the end in securely.

The first strip woven in should be pushed down close to the bottom. After weaving in another strip, and as many more as are desired, be sure that you go outside of the spokes of which you went inside the last time around. When the desired number of rounds have been made, leave the two middle upstanding spokes on each side. Be sure to cut the others so that they extend above the weaving a length nearly twice the width of a strip. You may now bend each spoke down so that it weaves into the basket and the end disappears.

To strengthen the edge of the basket a second strip may be woven around, directly over the last one, before the spokes are turned down. To make the handle, braid the four remaining spokes so that they interlock. Then bind the handle with another strip that is wound around and around, and fasten the ends securely.

This May basket is now ready for the flowers which either your friend or your family will appreciate. If you wish to modify the use of the over-under method of weaving you should study its application as shown in picture 2. The design that you see in the middle is made by varying the weave to go over two or three as needed to secure the desired result. This variation can be repeated to form a pleasing symmetrical pattern. In fact, there is no end to the patterns that you will be able to make, once you have the principles of the method thoroughly in mind. You will be able to produce original and startling effects that will delight the fortunate ones who receive the basket.

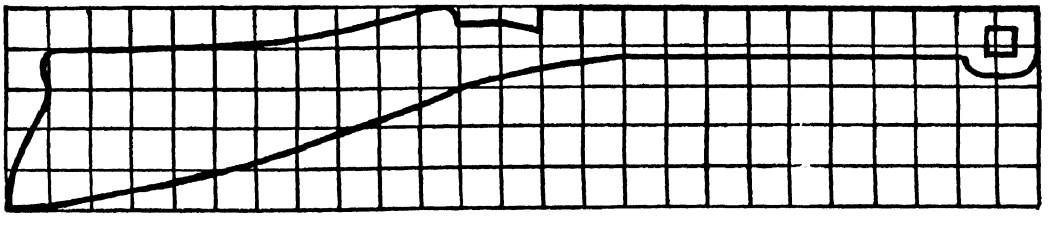


2. A varied design.

HOW TO MAKE A CROSSBOW

THE powerful crossbow was widely used throughout the Middle Ages. How would you like to make a weapon of this sort? We are going to show you how to make a simple crossbow that will really work.

The stock of the bow is to be cut by means of a jig-saw from a piece of hard wood an inch thick; we give you the pattern to be followed in figure 1. A hole ¾ of an inch square is to be cut at the end of the stock; the bow is to fit in this.



1. Plan of crossbow. Each square represents a square inch.

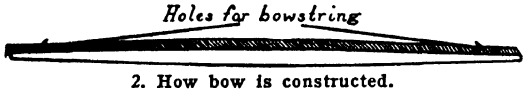
The bow is to be made of hazel or ash, or any wood that bends without breaking. The bow should be 2 feet long, ¾ of an inch thick in the middle, and it is to taper off at both ends (see Figure 2). When you have finished cutting the bow, bore two holes in it at each end (about an inch away from the end); the bowstring will pass through these holes.

Next, pass the bow through the hole in the stock. You may find that it will stick at first. Sandpaper it down at the middle until it passes through the hole. It should be held in position in such a manner that the stock will divide it into two equal parts. The bow should fit tightly in the stock. If it does not, apply some plastic wood or liquid cement to the portion of the bow that is to fit into the stock.

A groove is now to be cut along the top of the barrel of your crossbow; the arrow will rest in this groove. Place an old iron tube or rod (an old curtain rod will do) in

a fire and keep it there until it is nearly red-hot. Then take it out of the fire, handling it with a pot-holder; lay it along the barrel so that it will be exactly parallel to and equally distant from both sides of the barrel. The tube or rod will then burn the required groove. After the groove has been produced, rub it with sandpaper until its surface is absolutely smooth.

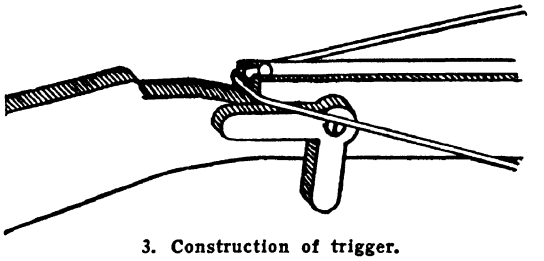
You are now to string the bow; any kind of stout cord will do for this purpose. When the bow has been strung, pull back the string until it is in the position indicated by figure 3. Next, make the trigger, as shown in figure 3. This is to be made of wood, from a quarter to a half-inch thick. It



2. How bow is constructed.

is to be fastened to the barrel by means of a screw, in such a manner that it will turn fairly easily. Note that the end of the trigger nearest the bowstring is to extend an inch or so beyond it.

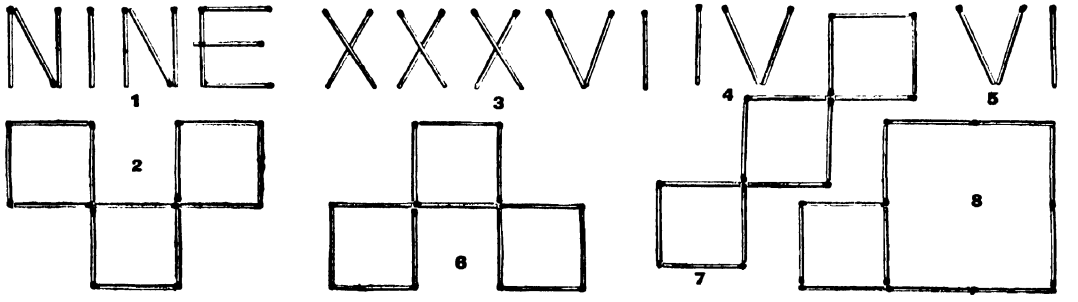
The bow is now ready to receive the arrow. For your arrow you may use any cylindrical stick that will fit into the groove. It is to be placed along the groove so that one end is at the trigger end of the barrel,



3. Construction of trigger.

as in figure 3. When you are ready to fire, pull the finger end of the trigger toward you. In doing so you raise the other end of the trigger. This in turn raises the string, until finally it clears the surface against which it has been resting. The bowstring now makes contact with the arrow and shoots it off into space with considerable force. With a little practice you will be able to shoot accurately at a target.

ANSWERS TO MATCH PROBLEMS ON PAGE 625



On page 625 appeared some problems to be attempted with matches or pins. The pictures above show how these problems are solved. It will be seen that a few of them are just "catches."

RECIPES FOR CANDY

MOLASSES CANDY

IT is great fun to make this popular candy. The ingredients necessary are: 2 cups of molasses, 3 tablespoonfuls of butter, ⅔ cup of sugar and 1 tablespoon of vinegar. First melt the butter; then add the molasses and sugar, stirring until the sugar is dissolved. Boil over a slow fire until it is brittle when tried in cold water. If you use a confectioner's thermometer, it should register about 255°. Just before removing from the fire, add the vinegar, which will make the candy foam up delightfully. Pour it into well buttered pans. When the candy is cool enough to handle, you may pull until it turns light

colored. Draw into sticks and cut into inch lengths. If you wish molasses nut candy, add 1 cup of chopped nut meats and a pinch of salt, just before taking the candy from the stove. If you use peanuts, be sure to remove the brown inner skin from the meats before you chop them.

FIVE-MINUTE PEPPERMINTS

THE materials needed are: 1 cup of white sugar, ¼ cup of boiling water, ⅛ teaspoon of cream of tartar, 6 drops of peppermint, and a bit of coloring paste.

First make the fondant. Put the sugar and water in a pan over the fire, stirring constantly until the sugar is thoroughly dissolved. Remove the spoon and do not stir again while it is boiling. When the syrup first boils, add the cream of tartar. This cuts the grain and helps to keep it creamy. Before it boils, carefully wipe the sides of the kettle with a cloth or brush dipped in hot water. Every particle of the sugar must be melted before the syrup begins to boil, and it is important that no sugar grains remain, as it will make the fondant gritty. Cover the pan, as the steam formed will help wash down the sides of the pan.

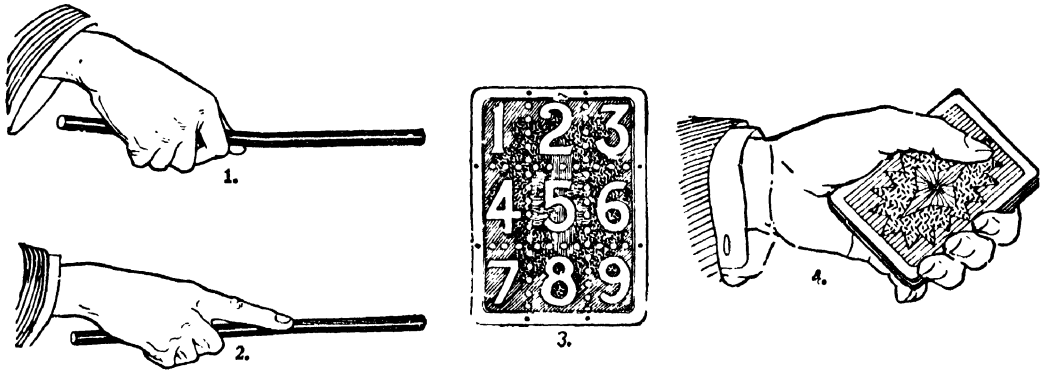
Let the syrup boil 5 minutes or until the thermometer reads 240° Fahrenheit. Never stir or shake the syrup while boiling. Remove from the fire, and when cool, beat until creamy. With a medicine dropper, add 6 drops of oil flavoring, and add the coloring matter, which may be purchased in small tubes for a few cents.

Drop in small round-shaped pieces from tip of spoon on waxed paper or marble slab. Do not disturb until the drops are hard and look dull on top. The coloring matter is not necessary. They are just as good white, but more attractive if colored pink or light green. For prettiest effect in serving the candies, color some and leave the others white.

THE MYSTERY OF TELEGRAPHING THOUGHT

WE have all been baffled at times by the wonderful way in which a lady sitting on a platform at one end of a hall has been able to tell what a gentleman at the other end has in his hand, and we have thought of this performance as something almost supernatural. As a matter of fact, this strange system of *thought-reading* is really very simple. What is involved is really an ingenious set of signals between the two performers in this magical duet, as we might call it. The boys or girls who would learn to play this *duet* must practice diligently until they are perfect in the parts that they must play in it.

Let us suppose that the duet is played by a boy and his sister. When the eventful night comes, the boy introduces the lady as his *medium*. Being a medium she naturally possesses a certain amount of the thought-reading faculty. To prove this, if the company, during her absence from the room, will touch or indicate any article therein, she will, on her return, declare which article it was. There are several ways by which the performer may impart the necessary in-



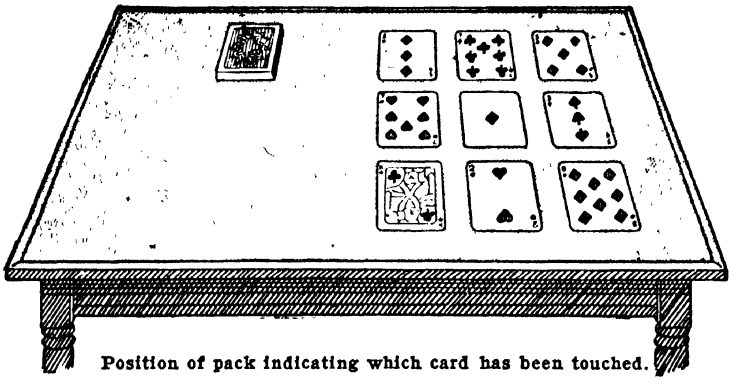
The methods of telegraphing thought with a magic wand and a pack of cards.

formation. One of the simplest is to arrange that when he asks for, say, the sixth time "Is it this?" the question is to be answered "Yes." For a second attempt it may be arranged that the eighth or ninth question shall furnish the clue.

Another plan is to agree that whenever the performer's question refers to a four-legged object, say, a chair or a table, the one next following shall be answered in the affirmative. The performer may repeat the trick without speaking at all, using a ruler or a paper-knife as a wand or pointer, merely touching or indicating various objects in succession. Where he points with a wand, as above, it may be agreed that, so long as the performer holds the wand as shown in picture 1, the medium is to answer No to all his questions; but if the forefinger is to be shifted so as to lie along the wand as in picture 2, the answer is to be Yes. The same principle may be carried a good deal further, as in the following mystifying trick. During the absence of the medium a pack of cards is first well shuffled; a great point should be made of this, because it has nothing whatever to do with the trick. Nine cards are then dealt face upward on the table in rows of three each. One of these is *touched* by one of the company. When the medium returns from the other room, she appears to be lost in thought; then she names the right card.

Here the row in which the card stands is indicated by the manner in which the performer holds the wand—for in this particular case the wand is not used merely to distract the audience's attention. If the performer holds the wand between the forefinger and the thumb only, the card is in the first row; if he encircles it with two fingers, it is in the second row; if he grasps it with his whole hand, it is in the third row. The number at which it stands in the row is revealed by the position of the left hand of the performer. If this hand grasps the lapel of his coat the card is No. 1; if the thumb is in the vest pocket, No. 2; if the hand hangs down by the side, No. 3. Very simple, isn't it?

Another method of telegraphing thought is by the position of the performer's thumb on the back of the unused cards. For this purpose you must imagine that the surface of the top card is divided into nine portions, numbered as is indicated in picture 3. The performer indicates the card that has been touched by holding the pack so that his thumb rests on that part answering to it in position. Supposing that it was held as shown in picture 4, the medium would know that the card was the middle one in the first row. This most ingenious trick may be repeated in a still more surprising way.



Position of pack indicating which card has been touched.

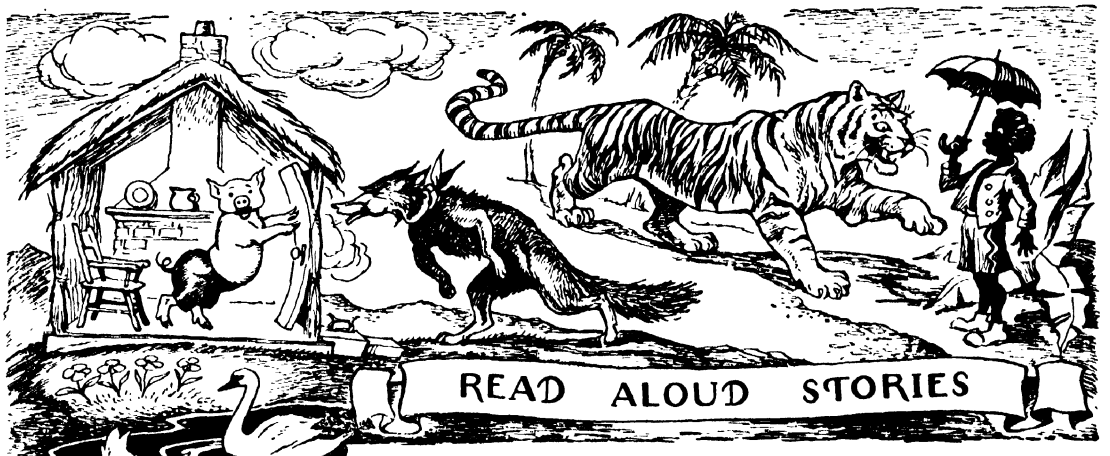
5.

Suppose that the nine cards are laid on the table as shown in picture 5. A similar group is imagined lying side by side with it, and the pack is left by the performer in that position which in the imaginary group corresponds with the card touched. Thus the pack laid as in picture 5 would indicate that the middle card in the top row is the one.

It is to be borne in mind that tricks like those which we have just described can be done well only when the two performers understand each other thoroughly. If signals are not caught the medium will have to guess, and a series of incorrect guesses will spoil your entire performance. After all, what you are trying to do is build up an atmosphere of mystery. Your audience must be convinced that it is looking at something quite mysterious and extraordinary. How could you possibly maintain an atmosphere of mystery if the medium appears to be taking part in a mere guessing game?

Remember then that you must practice well with your fellow-performer before trying these tricks in public. To maintain the interest of the audience and to create a feeling of suspense, the medium should sometimes appear to be in doubt before indicating the correct card or object.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 891.



PELLE'S NEW SUIT

By ELSA BESKOW

THERE was once a little Swedish boy whose name was Pelle. Now, Pelle had a lamb which was all his own and which he took care of all himself.

The lamb grew and Pelle grew. And the lamb's wool grew longer and longer, but Pelle's coat only grew shorter!

One day Pelle took a pair of shears and cut off all the lamb's wool. Then he took the wool to his grandmother and said: "Granny dear, please card this wool for me!"

"That I will, my dear," said his grandmother, "if you will pull the weeds in my carrot patch for me."

So Pelle pulled the weeds in Granny's carrot patch and Granny carded Pelle's wool.

Then Pelle went to his other grandmother and said:

"Grandmother dear, please spin this wool into yarn for me!"

"That will I gladly do, my dear," said his grandmother, "if while I am spinning it you will tend my cows for me."

And so Pelle tended Grandmother's cows and Grandmother spun Pelle's yarn.

Then Pelle went to a neighbor who was a painter and asked him for some paint with which to color his yarn.

"What a silly little boy you are!" laughed the painter. "My paint is not what you want to color your wool. But if you will row over to the store to get a bottle of turpentine for me you may buy yourself some dye out of the change from the shilling."

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So Pelle rowed over to the store and bought a bottle of turpentine for the painter, and bought for himself a large sack of blue dye out of the change from the shilling.

Then he dyed his wool himself until it was all, all blue.

And then Pelle went to his mother and said: "Mother dear, please weave this yarn into cloth for me."

"That will I gladly do," said his mother, "if you will take care of your little sister for me."

So Pelle took good care of his little sister, and Mother wove the wool into cloth.

Then Pelle went to the tailor: "Dear Mr. Tailor, please make a suit for me out of this cloth."

"Is that what you want, you little rascal?" said the tailor. "Indeed I will, if you will rake my hay and bring in my wood and feed my pigs for me."

So Pelle raked the tailor's hay and fed his pigs.

And then he carried in all the wood. And the tailor had Pelle's suit ready that very Saturday evening.

And on Sunday morning Pelle put on his new suit and went to his lamb and said: "Thank you very much for my new suit, little lamb."

"Ba-a-ah," said the lamb, and it sounded almost as if the lamb were laughing.

LITTLE BLACK SAMBO

By HELEN BANNERMAN

ONCE upon a time there was a little black boy, and his name was Little Black Sambo.

And his Mother was called Black Mumbo.

And his Father was called Black Jumbo.

And Black Mumbo made him a beautiful little Red Coat, and a pair of beautiful little Blue Trousers.

And Black Jumbo went to the Bazaar, and bought him a beautiful Green Umbrella, and a lovely little Pair of Purple Shoes with Crimson Soles and Crimson Linings.

And then wasn't Little Black Sambo Grand?

So he put on all his fine clothes, and went out for a walk in the Jungle. And by and by he met a Tiger. And the Tiger said to him, "Little Black Sambo, I'm going to eat you up!" And Little Black Sambo said, "Oh! Please, Mr. Tiger, don't eat me up and I'll give you my beautiful little Red Coat."

So the Tiger said, "Very well, I won't eat you this time, but you must give me your beautiful little Red Coat." So the Tiger got poor Little Black Sambo's beautiful little Red Coat, and went away saying, "Now I'm the grandest Tiger in the Jungle."

And Little Black Sambo went on, and by and by he met another Tiger, and it said to him, "Little Black Sambo, I'm going to eat you up!" And Little Black Sambo said, "Oh! Please Mr. Tiger, don't eat me up, and I'll give you my beautiful little Blue Trousers." So the Tiger got poor Little Black Sambo's beautiful little Blue Trousers, and went away saying, "Now I'm the grandest Tiger in the Jungle."

And Little Black Sambo went on, and by and by he met another Tiger, and it said to him, "Little Black Sambo, I'm going to eat you up!" And Little Black Sambo said, "Oh! Please Mr. Tiger, don't eat me up and I'll give you my beautiful little Purple Shoes with Crimson Soles and Crimson Linings."

But the Tiger said, "What use would your shoes be to me? I've got four feet, and you've got only two: you haven't got enough shoes

for me."

But Little Black Sambo said, "You could wear them on your ears."

"So I could," said the Tiger, "that's a very

good idea. Give them to me and I won't eat you this time."

So the Tiger got poor Little Black Sambo's beautiful little Purple Shoes with Crimson Soles and Crimson Linings, and went away saying, "Now I'm the grandest Tiger in the Jungle."

And by and by Little Black Sambo met another Tiger, and it said to him, "Little Black Sambo, I'm going to eat you up!" And Little Black Sambo said, "Oh! Please Mr. Tiger, don't eat me up, and I'll give you my beautiful green Umbrella." But the Tiger said, "How can I carry an umbrella when I need all my paws for walking with?"

"You could tie a knot on your tail, and carry it that way," said Little Black Sambo. "So I could," said the Tiger. "Give it to me, and I won't eat you this time." So he got poor Little Black Sambo's beautiful green Umbrella, and went away saying, "Now I'm the grandest Tiger in the Jungle."

And poor Little Black Sambo went away crying because the cruel Tigers had taken all his fine clothes.

Presently he heard a horrible noise that sounded like "Gr-r-r-r rrr," and it got louder and louder. "Oh! dear!" said Little Black Sambo, "there are all the Tigers coming back to eat me up! What shall I do?" So he ran quickly to a palm-tree, and peeped around it to see what the matter was.

And there he saw all the Tigers fighting, and disputing which of them was the grandest. And at last they all got so angry that they jumped up and took off all the fine clothes, and began to tear each other with their claws, and bite each other with their great big white teeth.

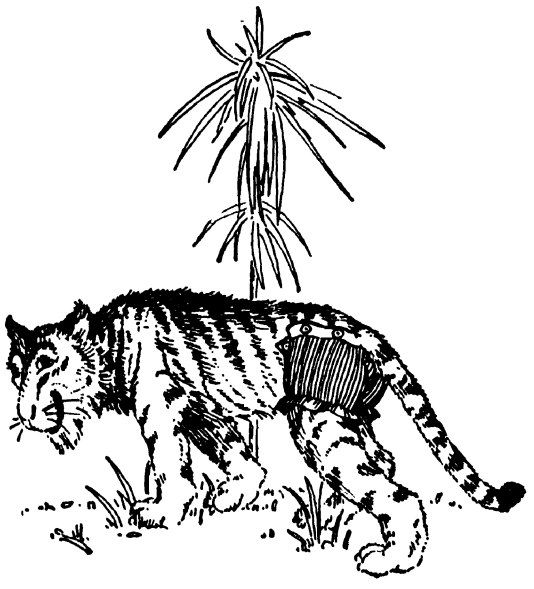
And they came, rolling and tumbling right to the foot of the very tree where Little Black Sambo was hiding, but he jumped quickly in behind the umbrella. And the Tigers all caught hold of each others' tails, as they wrangled and scrambled, and so they found themselves in a ring round the tree.

Then, while the Tigers were wrangling and scrambling, Little Black Sambo jumped up, and called out. "Oh! Tigers! why have you taken off all your nice clothes? Don't you want them any more?"

But the Tigers only answered, "Gr-r-r!"

Then Little Black Sambo said, "If you want them, say so, or I'll take them away." But the Tigers would not let go of each others' tails and so they could only say, "Grr-r-r-r-r-rrrr!"

So Little Black Sambo put on all his fine clothes again and walked off.



And the Tigers were very, very angry, but still they would not let go of each others' tails. And they were so angry that they ran around the tree, trying to eat each other up, and they ran faster and faster, till they were whirling round so fast you couldn't see their legs at all.

And they still ran faster and faster and faster, till they all just melted away, and there was nothing left but a great big pool of melted butter (or "ghi," as it is called in India,) round the foot of the tree.

Now Black Jumbo was just coming home from his work, with a great big brass pot in his arms, and when he saw what was left of all the Tigers he said, "Oh! what lovely melted butter! I'll take that home to Black Mumbo for her to cook with."

So he put it all into the great big brass pot, and took it home to Black Mumbo to cook with.

When Black Mumbo saw the melted butter, wasn't she pleased! "Now," said she, "we'll all have pancakes for supper!"

So she got flour and eggs and milk and sugar and butter, and she made a huge big plate of most lovely pancakes. And she fried them in the melted butter which the Tigers had made, and they were just as yellow and brown as little Tigers.

And then they all sat down to supper.

And Black Mumbo ate twenty-seven pancakes.

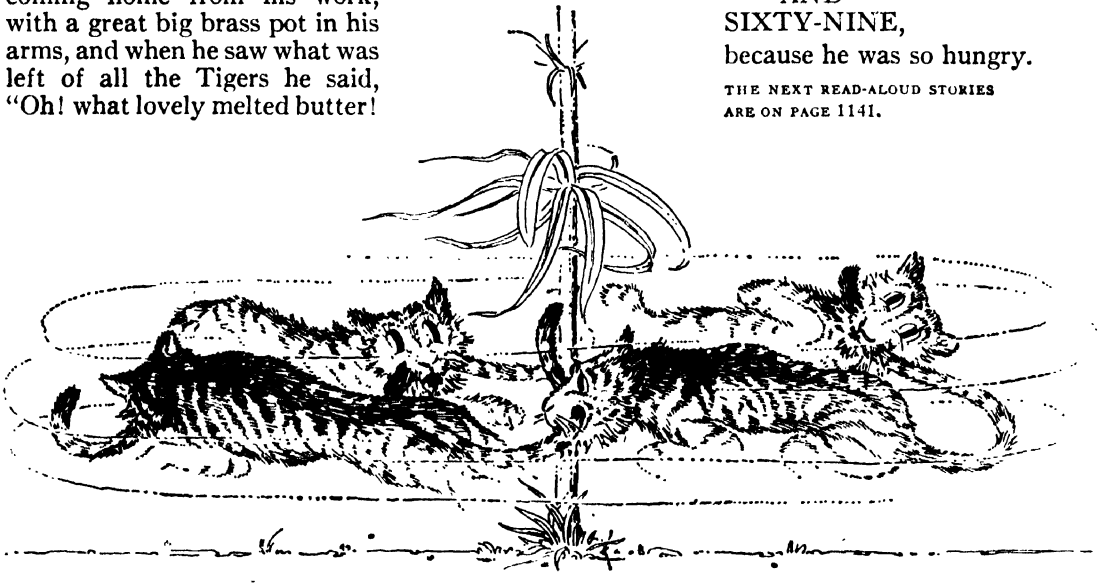
And Black Jumbo ate Fifty-Five.

And Little Black Sambo ate

A HUNDRED
AND
SIXTY-NINE,

because he was so hungry.

THE NEXT READ-ALOUD STORIES ARE ON PAGE 1141.



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MY SHADOW*

By ROBERT LOUIS STEVENSON

I have a little shadow that goes in and
out with me,
And what can be the use of him is more
than I can see.
He is very, very like me from the heels
up to the head;
And I see him jump before me when I
jump into my bed.

The funniest thing about him is the way
he likes to grow—
Not at all like proper children, which
is always very slow;
For he sometimes shoots up taller, like
an India-rubber ball,
And he sometimes gets so little that
there's none of him at all.

He hasn't got a notion of how children
ought to play,
And can only make a fool of me in every
sort of way.
He stays so close beside me, he's a
coward, you can see;
I'd think shame to stick to nursie as
that shadow sticks to me.

One morning, very early, before the sun
was up,
I rose and found the shining dew on
every buttercup;
But my lazy little shadow, like an
arrant sleepy-head,
Had stayed at home behind me, and was
fast asleep in bed.

THE SWING*

By ROBERT LOUIS STEVENSON

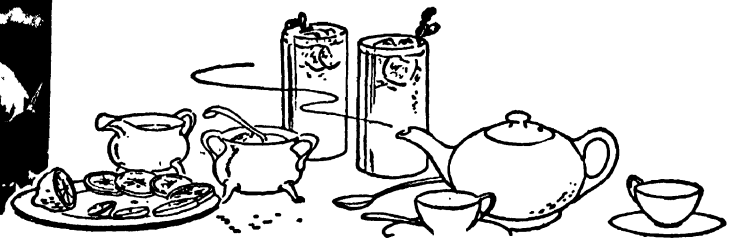
How do you like to go up in a swing?
Up in the sky so blue?
Oh, I do think it the pleasantest thing
Ever a child can do!

Up in the air and over the wall
Till I can see so wide,
Rivers and trees and cattle and all
Over the countryside.

Till I look down on the garden green
Down on the roof so brown.
Up in the air I go flying again—
Up in the air—and down!

*From The Complete Poems of Robert Louis Stevenson, copyright, 1905, 1923, by Charles Scribner's Sons. By permission of the publishers.

THE STORY IN A TEACUP



WE think little of the tiny leaf which floats in our cup of tea, yet the little leaf has had a world of adventure. It may have been grown in China, in India or Ceylon, or on the island of Formosa. It may have unfurled its soft green spear on the sunny slope of a high mountain, or deep in a tropical lowland. And when the leaf was picked, machinery crushed it and fermented it, baked it, packed it and sent it forth to bring comfort and pleasure to mankind.

Nobody can say with certainty when tea was first used, but it was known to the Chinese more than five hundred years before Christ was born. It is believed that tea was first used in China, not as a beverage, but as a medicine. More than a thousand years ago the custom of tea-drinking had become so popular that the first of a long series of taxes was imposed on the article. The tax did not discourage the tea-drinkers, for the custom continued to spread all over China and Japan. During the seventeenth century it was introduced into western Europe, and from there it was brought to America by the British settlers. As you will remember, the tax that the mother country put on tea was one of the grievances that finally helped to bring about the American Revolution.

Early in the nineteenth century the British East India Company began to encourage the cultivation of tea in India, and today a great deal of the tea that is imported by Great Britain and North America comes from India and Ceylon, though some of it comes from China, Formosa, Java and South Africa. The Russians, who are great tea-drinkers, get most of their tea from China.

The tea plant is really an evergreen tree, which, if allowed to grow, would be as tall as a maple tree; but in order to get many small, tender leaves, it is kept trimmed so that it forms a bush about four feet high. These bushes are grown in rows in gardens, and they are ready to be picked when they are about four years old. Then the pickers go along the rows with their baskets, picking only the bud and the first four leaves from each branch. Since new leaves are always

Gathering tea on a sunny slope of the Himalayas.

coming out, the picking goes on all during the growing season.

Each of these leaves has a name. In China the bud and the first tiny leaf are called gunpowder, and the other three leaves are called, in order of size, young hyson, hyson and imperial. In India and Ceylon the bud and first leaf are called broken, or flowery, orange pekoe (pronounced peck-o), and the other three leaves are called orange pekoe, pekoe and souchong. The smaller leaves are the tenderest, but there is such a difference in the tenderness of different bushes that the larger leaves on one bush may be more tender than the smaller leaves on another bush. The finest teas, as a rule, are those grown on the high mountain slopes. This is because in the hot lowlands the bushes grow so fast that the leaves become woody and do not have so much flavor.

When the tea is taken to the factory, the baskets are emptied out on to shallow trays, and a pound of tea covers an area a yard square. The trays are then carried to a heated room, through which a strong current of air is forced. This softens and withers the leaf, until it becomes quite soft and flaccid. The process usually occupies from eighteen to twenty hours. Special machines consisting of cylinders rotating in hot air are often used instead of the open trays.

Now the leaves are passed through a machine which curls them and presses the juice out upon their surface. After this the tea is spread out in darkened rooms or placed in drawers in layers, one or two inches thick, and then covered with damp curtains so arranged that they do not actually touch the leaves. The heat and moisture cause the tea to ferment, after which it goes through a sort of baking process for a little while to arrest fermentation and to dry out the leaves. It is this fermentation that changes the color of the leaves and gives us what is called black tea. Green and black teas may come from the same bush, but the green tea is not fermented, it is steamed and baked soon after it is gathered. There is a third type of tea in which the leaves are only partially fermented. This is called oolong, and most of it comes from Formosa.

The leaves must now be sorted into sizes

Each worker carefully plucks only the buds and first four leaves, and tosses them into the basket on her back.
Empire Tea Bureau

Thomas J. Lipton, Inc.

Carrying the plucked tea from field to factory by elephant train. Where the distance is very short, the boxes may be carried by overhead cables, a strange sight indeed on remote tea plantations.

and qualities. Sieves of various meshes are employed for the purpose. Then, after a second drying, the tea is ready for market. It is packed by machinery into chests lined with lead, and away it goes to the ship. Great care must be exercised in the choice of wood for the chests, because tea readily absorbs odors and thereby loses its own.

In China, even today, much of this process is carried out by hand, though in some places machinery has been introduced. Some years ago tea-culture was introduced into the United States, and excellent tea has been grown at Summerville, South Carolina, and other places where the climate and soil are suitable. The cost of labor is so much greater here than it is in the East that, so far, it has not been possible to produce tea in the United States on a commercial scale.

When a tea shipment arrives, samples are drawn from the cargo and sent to the tea merchants, who submit them to the tea-taster, so that they may have his opinion on the quality and value of the shipment. He has a tiny pot of tea made from each, and takes a sip from each brew. Those that he likes he commends, and the merchant buys them. (See the picture on page 766.)

Most of the tea we buy is already blended, packaged and ready to brew. The blending is done by the wholesale tea merchants under the direction of experts who know just

Empire Tea Bureau

Examining the day's harvest, which has just arrived at the factory. Any stalks must be removed.

which combinations of different kinds of tea give the best flavors. The water with which it is brewed has an important effect upon tea, and since the water varies in different parts of the country, most of the larger companies prepare their blends to suit the water in the district where the tea is to be sold.

When tea was first brought to England, it was such a novelty that people paid as high as fifty dollars a pound for it. As more tea came, prices became lower, and so great was the demand that the fastest ships were devoted to the tea trade. As soon as they got their cargo they raced home, and the ship which arrived first got the best price for the new season's crop. The tea trade had much to do with the development of the fast clipper ships, both in America and England. In 1866 three of these vessels left Foochow, on the coast of China, at the same time, made the voyage of fully 16,000 miles in ninety-nine days, and were docked in London within two hours of one another.

Before the Revolution the colonies were not permitted to trade direct with foreign countries: all of their products had to be taken to England to be sold, and any goods that they imported had to be brought from England. So it was with the tea that was used in the colonies. It was not until after the Revolution, in 1784, that the American tea trade was started, and American ships

Empire Tea Bureau

The "withering tats," special racks made of tightly drawn cloth, on which the fresh leaves are spread to soften and lose some of their moisture. Many Oriental words, such as "tats," come into the story of tea.

Screen Traveler, from Gendreau

In rolling machines, the leaf cells are broken up, the juices are freed, and the leaf is given a twist.

FROM ROLL-BREAKER TO FLANNEL SCREEN

Screen Traveler, from Gendreau

After the leaves are removed from the rolling machine (see the picture on the previous page), they are shaken apart on sifters, or roll-breakers. The leaves break into several pieces and fall into the containers below.

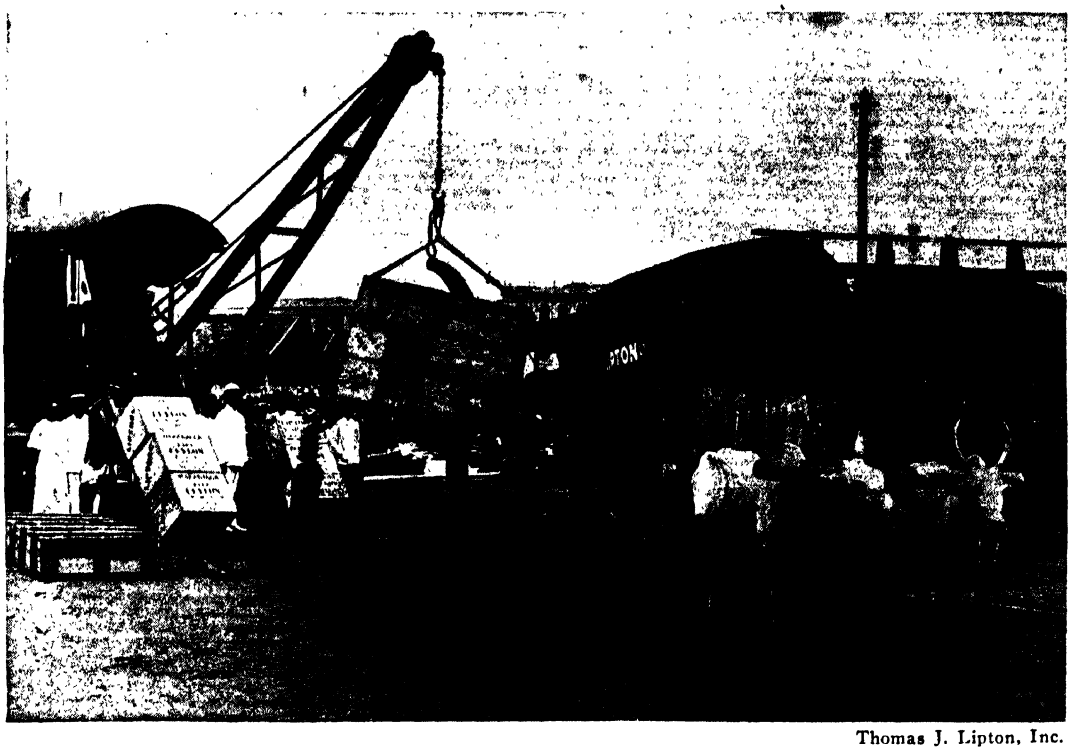
Screen Traveler, from Gendreau

The Javanese girls are throwing handfuls of broken tea leaves against flannel screens. When the screens are tipped forward, only the tender tips are left sticking to the cloth. Orange pekoe is made from the tips.

TEA READY FOR THE WORLD'S MARKETS

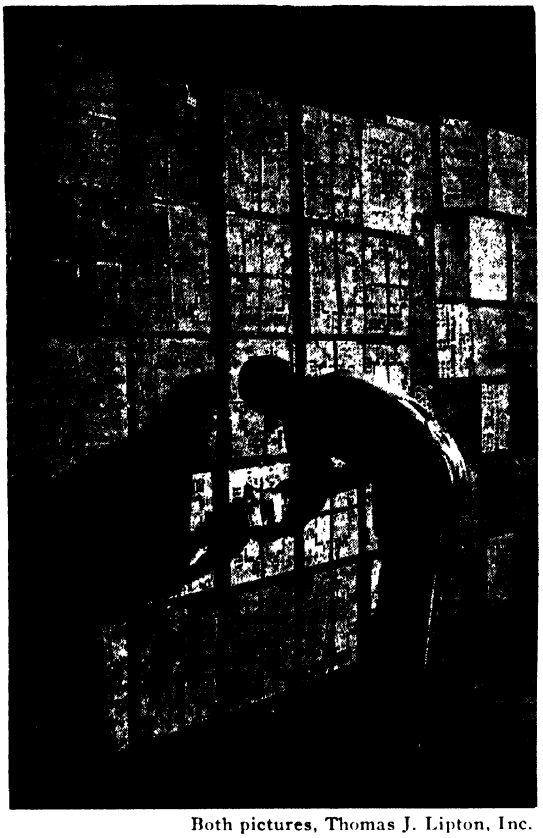
Screen Traveler, from Gendreau

Packing tea in Sumatra. The tea is carried in baskets to the big hoppers, through which it pours into the boxes placed beneath. When the boxes are filled, sealed and labeled, they are ready to be shipped far away.



Thomas J. Lipton, Inc.

Tea ready to be shipped from Ceylon to the other side of the globe. The thatched, two-wheeled cart, drawn by oxen, is in strange contrast to the modern, powerful crane that can do the work of many men.



Both pictures, Thomas J. Lipton, Inc.

In many countries, tea must remain in a warehouse until it is tested. Here a sample is being drawn.

made the long voyage around Cape Horn and across the Pacific to China and back, bringing tea and silk and spices. The trade grew so rapidly that within three years from its beginning, more than a million pounds of tea were being imported. Today tea is one of the cheapest of all beverages and the poorest person can afford it. There are, however, certain rare teas which sell for thirty or forty dollars a pound.

Besides China and Japan, the principal tea-drinkers are the people of the United Kingdom, the British Dominions, the United States and Russia. The United States is the second largest tea market in the world, and imports more than ninety million pounds of tea every year. Of this amount, about half comes from India and Ceylon, and much of the rest from the East Indies. China grows more tea than any other country, but consumes most of her tea at home. Of the tea consumed in the United States, about 75 per cent is black, 18 per cent green and 7 per cent oolong.

The mildly stimulating effect of tea is caused by caffeine, of which an average cup contains about three-quarters of a grain. Tannin, which tea also contains, gives it an astringent quality. Tannin, or tannic acid, is used to soothe painful burns, and tea itself can be used for this purpose.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 785.

Testing and blending is done by experts. They must have a naturally keen sense of taste, and are trained for years.

American Museum of Natural History

New York weasel, in its pure white winter pelage (coat). This winter fur is called ermine by the fur trade.

THE SHORT-LEGGED WEASEL FAMILY

THE weasel family, or mustelids, are small or medium-sized members of the carnivores, the flesh-eaters. They have short limbs and generally are slender in build. Their canine teeth are well developed and the molar or cheek teeth are broader across the crown than those of the cat, but the edges are still sharp; this shows that although the weasels are flesh-eaters they are not so dependent on meat for food as the cats are. Some members of this group have glands, called musk-glands, under the base of the tail, from which a strong-scented fluid can be ejected (shot out). Not only the skunk but also the martens, weasels, ferrets, and some of the badgers have these glands.

The weasel family, or Mustelidæ, includes the martens, weasels, ferrets, wolverines, badgers, skunks and otters. The range of the mustelids is widespread and representatives of this group are found on all of the continents except Australia. They are of special importance to the ladies, for it is from this group that we get a great portion of the valuable fur which many women wear. This is generally known as the fur of commerce.

The marten is one of the best known of these fur-bearers. This little animal is found only in the Northern Hemisphere and prefers heavily wooded districts. In color the American marten is yellowish brown, darker on the tail and legs and lighter on the head. There is a pale buff, orange or, rarely, a white patch on the throat. The marten is the most arboreal (tree-living) of the weasel tribe and is an expert climber, hunting for much of its food in the trees. So well can this marten climb that it is capable of catching the red squirrel among the branches. Besides the red squirrel, its food consists of mice, rabbits, chipmunks and other small mammals, birds, eggs, frogs and insects. It is also fond of certain berries and during the season eats quantities of them. The favorite den is a hollow, high up in a tree. The usual number of young is three or four.

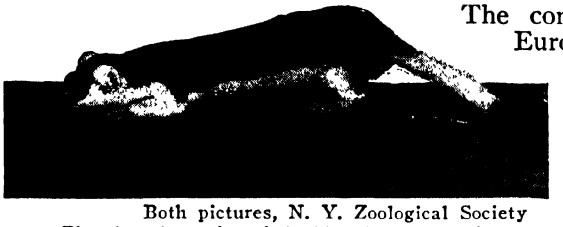
A close relative of the American marten is the pine marten of Europe, whose range includes much of northern Europe and Asia. At one time the pine marten was common in

Great Britain but is now restricted to the forests of the more remote districts. This animal is also known as the yellow-breasted marten on account of the orange patch on the breast.

The beech, white-breasted or stone marten has a more southern range in Europe and is found as far east as the Himalayas, in Asia.

The sable, whose soft, beautiful fur is greatly prized, is a true marten. It is closely related to the pine marten and has much the same habits. The sable is found in the forests of northern Asia, especially in eastern Siberia and Kamchatka. The skins that bring the highest prices are thick and soft and uniform in coloring, blackish above with a mixture of gray on the nose and face. Generally there is chestnut brown on the neck and orange on the throat, an attractive combination of warm colors. In some skins the underparts and breast are white. The sable is about twenty inches long from nose to root of tail. The tail is about seven inches long. A single sable skin has been known at times to cost more than $2,000. One interesting thing about the sable is that the hairs are fixed to the skin in such a way that the fur can be rubbed in either direction. Fine brushes for painters are made from the hairs of sable tails.

The fisher, or pennant marten.



Both pictures, N. Y. Zoological Society

The changing color of the New York weasel.

The yellow-throated marten is found from southern Siberia, south through the mountains of eastern Asia to Sumatra. This is a strikingly colored animal, the general color being dark brown or black. The chin and upper throat are white, while the remaining underparts are yellow or orange. In some specimens the bright color is found only on the throat and chest. This marten's habits are similar to those of other martens although it is more sociable and a number may be found running together. Much of its food consists of fruit and berries. The writer once observed three of these animals feeding from a tree in the mountains of western China. The martens suspended themselves from the branches by their hind legs and with their free front paws reached out, plucked the small fruit which this tree bore and gobbled it up eagerly.

The fisher, or pennant (pekan) marten, is a large marten found throughout the heavy forests of Canada, extending south into the mountain forests of the United States. It is a rare animal and has become extinct over much of its southern range. It is stoutly built, about three feet long, and varies in color from black to light brown. It is a bold fighter and will attack and kill bear cubs and porcupines.

The true weasels of North America may be divided into four groups: the least weasel, the short-tailed weasel, the long-tailed weasel and the bridled weasel. The least weasel is the smallest of all the carnivores, or flesh-eaters. The least weasel is found in North America; it also inhabits certain regions in northern Asia. The length of the head and body is about six inches, and the tail is about one and one-half inches.

The common weasel of Europe is a relative and is only slightly larger in over-all size. In the short-tailed group, the Bonaparte and the Arctic weasels are the best known. The Bonaparte occurs in the northern United States and Canada, and the latter, as the name implies, in the Arctic regions. It averages about eight inches in length of head and body, and the tail is about four inches long.

The long-tailed weasels are larger, head and body being from ten to twelve inches in length and the tail five to six inches. The New York weasel is a member of this group, as are the long-tailed weasels of western North America. This group is more southern in its distribution, being found throughout most of the United States and southern Canada. The European stoat is the European representative of this weasel. Other forms are found in continental Europe and Asia.

The bridled weasel is a large weasel whose head is blotched with white. It ranges from southwestern United States south into South America. There are several other forms of weasels found in central and southern Asia, including the Himalayan weasel, with dark underparts, and the striped weasel, which

owes its name to the stripe down its back.

Weasels are truly carnivorous, feeding on almost any warm-blooded prey they can master. The smaller forms feed to a great extent on insects. The farmer dislikes them because they rob the hen roosts; it is true that the weasels are very destructive at times, but their chief food is harmful rodents, and the good they do often outweighs the damage. In the northern parts of their range weasels turn white in winter, and it is this white coat that produces the ermine of the fur trade. The best ermine comes from Siberia. The males of most of the weasels are larger than the females.

The tyra, a bushy-tailed weasel found in Mexico and in South America. It sometimes gathers in large bands.

In Asia, from Siberia south to Sumatra and Java, there is a group of large weasels whose appearance reminds one of a light-colored mink. But their coats are not modified for life in the water, and their habits are more like those of the true weasels. The Chinese weasel is a member of this group. The fur of these animals is dyed and known in the fur trade as Japanese mink and kolinsky.

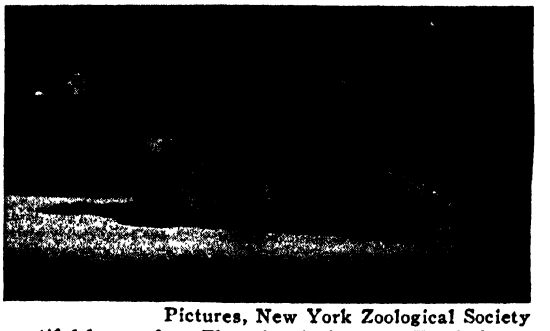
The range of the tiger weasel is from Rumania and Hungary eastward to The Gobi (the Mongolian desert). At one time thought to be related to the ferrets, the tiger weasel is now placed with the true weasels. In color the back is a mottling of yellowish white and brown.

The mink is a large, dark-brown animal, well known for its rich fur. Forms of mink are found in North America and Europe. Generally found about water, they are expert swimmers and divers and prey upon fish, frogs and other aquatic life. They also feed on mice, rabbits, muskrats and birds. The coat of the mink is especially adapted for life in the water.

Among the prairie-dog towns of the western United States, the black-footed ferret makes his home. About two feet long, pale buff in general color, darker on the back with a dark mask across the eyes, the black-footed ferret's only near relative is the masked polecat found in Central Asia. Never found away from the prairie-dog towns, it depends upon the prairie-dog to be its food and the prairie-dog burrows for its home. This ferret's Old World cousin lives much the same life but feeds on marmots and squirrels.

The European polecat, the creature from which the domesticated ferret originated, is found in western, northern and central Europe. In color the long guard hairs (the outer hairs) are dark brown or black, through which the buff undercoat shows. The polecat is rare in Great Britain because its liking for poultry and game birds has caused it to be exceedingly unpopular. Other forms of the polecat are the Siberian polecat of northern and western Asia and the Tibetan polecat found in the mountains of southern Asia. In the fur trade the pelt of the polecat is known as fitch.

The weasel group is represented in Africa by the poelcilogale, or African striped weasel, and the zorilla, also known as the striped polecat. The former has an elongated body,



Pictures, New York Zoological Society

The left-hand photograph shows the mink, famous for its beautiful brown fur. The mink is found in North America and Europe. On the right we see the black-footed ferret, an inhabitant of the western United States. It is the sworn enemy of the prairie dog, preying on it and taking possession of its burrows.

black in color with a white crown and four white or yellowish stripes running lengthwise down the back. The tail is white. The zorilla reminds one of the spotted skunk of North America in both size and color-pattern.

The tyra and grison occur from Mexico south throughout much of South America. The tyra is about three feet long and looks somewhat like the North American fisher.

Top and centre photos, N. Y. Zoological Soc.

The ratel, or honey-badger, found in India and in parts of Africa.

In general color the body is dark brown or black, although some specimens may be a lighter brown. The head and neck are lighter, often gray. There is generally a light spot on the chest. The tyra is found both in the forests and in the open country, and a number of the animals sometimes travel together, adults and young.

The grison is a smaller animal. The underparts are very dark brown, while the upper parts, from the forehead to the end of the tail, are gray. The tail is relatively short, only about half the length of the head and body.

The wolverine, or glutton or carcajou, is the largest of the animals of this group. It is found in the northern districts of Europe, Asia and North America. It is of a dark brown color with two paler stripes, which begin at the shoulders and pass along the sides to meet again at the tail. The wolverine is about three and one-half feet long and may weigh up to thirty pounds. It is despised by trappers, as it will steal the bait from traps set for more valuable animals and will also eat the marten or fox that may already be captured. The wolverine itself is difficult to trap. It also has the habit of stealing and hiding the traps.

The wolverine, a powerful and cunning member of the weasel family.

The ratel, or honey-badger, is found in India and throughout Africa. Its underparts are black, while the upper surface is gray from the forehead to part of the tail. This animal has long, strong foreclaws which it uses in digging. It feeds on small mammals, eggs and insects and is very fond of honey and bee grubs. In Africa it is a well-known fact that the ratel works in partnership with a small bird known as the honey-guide. The honey-guide, having discovered a bee's nest, gives a series of notes which are understood by the ratel. The animal follows the bird to the bee's nest and proceeds to dig it from the ground and make a feast on the honey and comb and grubs, while some of the grubs are eaten by the bird. Men, too, understand the actions of this helpful bird and have found many nests of the honey in this way. The ratel is as big as the American badger.

The American badger is gray in general color; it has black and white markings about the head. The total length of the creature is about thirty inches,

Courtesy, Fish and Wildlife Service

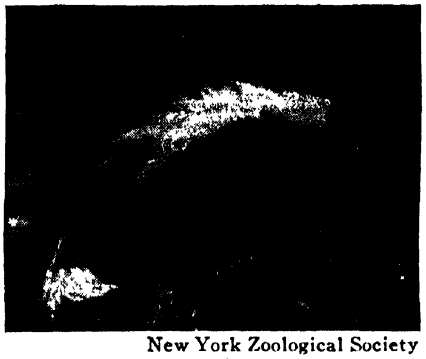
The American badger, found west of the Mississippi. It has a remarkably broad and fat body.

five inches of which is tail. This is a short-legged, heavy-set animal with strong digging claws on the forepaws. The badger is found chiefly west of the Mississippi River. East of that river, it inhabits the treeless lands in Wisconsin, Michigan, northern Illinois, Indiana and northwestern Ohio. At the present time it appears to be extending its range eastward. In the West it is found from southern Canada south into Mexico. It is active chiefly at night but sometimes goes

abroad by day. Its chief food is small rodents. The badger is a foe of the ground squirrels, and with the strong claws on its forepaws digs the ground squirrels from their burrows without difficulty.

The European badger is about the same size as the American badger and has much the same color of fur; but the European badger has a longer face and different head markings. It and its relatives are found over much of Europe and in western Asia. In Asia, there are close relatives, namely, the Chinese badger, the white-tailed badger and the Japanese badger.

In southern Asia, from southern Tibet and southern China, through Assam and the northern part of Burma, there is found a group of long-snouted, long-tailed badgers, known as sand-badgers or hog-badgers. In general the habits are similar to those of the other badgers.



New York Zoological Society
The skunk, which is famous for its odor.

The mydaus, or Malay badger, is a much smaller animal, being about fifteen inches long. Its wee tail is less than an inch long. The Malay badger is to be found only on the islands of Sumatra, Java and Borneo. In general color it is dark brown, but the crown of the head, a stripe down the centre of the back and the tip of the tail are white. This animal is known for its skunk-like habit of being able to eject an evil-smelling fluid for a considerable distance.

The helictis, or ferret-badger, is found in eastern Asia, from southern China south to Java. It is about fifteen inches long in head and body, and the tail is about eight inches. It is of a yellowish brown color with a white stripe extending from the top of the head, between the shoulders and halfway down the back. There are also white markings on the face and cheeks and tip of the tail.

The skunks are found only in America and are not likely to be confused with any other animal found in the Western Hemisphere, on account of both their coloring and their habits. Of the several forms of skunks found throughout this range, the common or striped skunk is best known to most people. This is a black animal with two white stripes down the back. These stripes vary in length and breadth, from a mere white spot on the back of the head to broad white stripes which cover most of the upper parts of the back. The less white the skunk has in color the more valuable is the skin for fur.

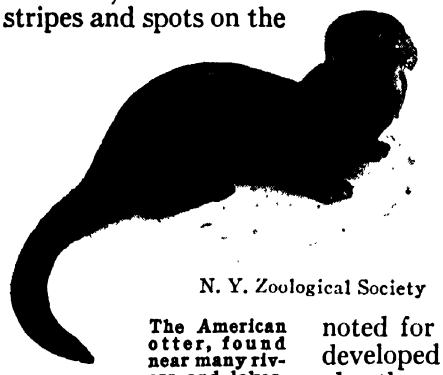
The skunk's great popularity, or perhaps it would be better to say unpopularity, is because of the fact that he possesses a pair of scent glands under the tail from which he can eject an evil-smelling fluid. The fluid is ejected in the form of a yellow mist and may be thrown to a distance of six or eight feet; if carried in a breeze it will travel much farther. The skunk will generally give a fair warning and may take a great deal of abuse before he will use this means of defense. But if he is cornered and thinks his life is in danger he will stamp his feet, raise his tail in a stiff upright position and, if this warning has not the desired effect on the enemy, he will use his last means of protection, the evil spray. Although the skunk may be facing the enemy as he fires, he can turn his body to any desired direction and no person or animal within a radius of six or eight feet is safe. Skunks of all kinds have, and occasionally use, this natural weapon. The common skunk is found from central Canada, south throughout the United States and northern Mexico.

Throughout Mexico and the southern part of Arizona and New Mexico, the hooded skunk makes its home. It is more slender in build than the common skunk and has a longer tail. From Arizona and New Mexico, south through Central America and into South America, the hog-nosed skunk ranges. It is a thicker-set, heavier animal than the common skunk. Though black in general color, as are all the skunks, the white of this animal extends from the crown of the head over the entire upper parts, including the entire tail. Therefore it is the whitest of the skunks. Another interesting fact concerning the hog-nosed skunk is that it appears to be immune to the poison of the fer-de-lance and other poisonous snakes. (That is, the bite of one of these snakes does not harm the hog-nosed skunk.)

Skunks are largely insect feeders, constantly searching for grubs which form much of their food. They are also fond of grasshoppers, locusts and other insects, as well as mice, birds and eggs when those are available.

The good they do in eating harmful insects and mice more than pays for their occasional inroads into the poultry yards. In the country they often frequent garbage dumps for delicacies. They are strictly terrestrial (living on land) and do not climb trees.

The little spotted skunk is found throughout much of the southern United States, south to Central America. On the Pacific coast it ranges north as far as British Columbia. It is a pretty little animal, black in color with numerous white stripes and spots on the back and sides. About twenty inches long, including the tail, it is more weasel-like in appearance and more adept in climbing than the common skunk. Over much of its range, and in the fur industry, the spotted skunk is known as the civet. This is an error. The true civet is a very different animal and is found only in the Old World. It does not belong to the Mustelidæ, or weasel family, but to the Viverridæ. See page 501.



N. Y. Zoological Society

The American otter, found near many rivers and lakes.

The otter, in one or another of its many forms, is found on all the continents except Australia. It is adapted for life in the water and is the most aquatic of any of the weasel tribe. Aquatic means living in water all or part of the time.

Formerly the otter ranged over the entire continent of North America, from the limit of trees in northern Canada and Alaska to northern Mexico, wherever the country was to its liking. Now, however, civilization has restricted some of its range and constant trapping has reduced the otter's numbers.

In length an adult otter is about forty inches long, the tail being about twelve inches. The weight is about twenty pounds. In color the otter is a rich brown above, paler below. Its food consists of fish, crayfish and shellfish; occasionally it may take a duck or other bird or small mammals, but such cases are rare. Where crayfish are common, they seem to form a large portion of the otter's food. Otters are great travelers, and for this reason they may appear for a brief time in localities where they have not been for years.

The den of the otter is generally in a bank by the side of a river or lake. The entrance is under the water, but there is often an exit on the top of the bank. Here in late April or early May the young are born. The litter generally numbers one to three. Otters become very tame and make delightful pets. In China tame otters are used to drive fish into the nets of their owners.

The European otter is a trifle smaller than the American form but otherwise, both in habit and appearance, is similar. It is still common in some sections of Great Britain and is often hunted with trained dogs. The European otter and its close relatives are to be found throughout most of Europe and Asia, as far south as, and including, India. In India we find two other smaller otters. One of these two is the smooth otter, which is characterized by short and smooth fur; the other Indian species is a clawless otter, which is sharply distinguished from other otters in that it is noted for the absence of claws, or very undeveloped ones. In South and West Africa also there is a clawless otter, but this animal is of large size, being one of the largest of the true otters. In the Malay region, the hairy-nosed otter is found. As the name implies, the muzzle is covered with hair. The spotted-neck otter is an African form with orange spotting on the neck.

The largest in the family is the Brazilian otter, found in the rivers and lakes of South America. The marine otter also is found in South America, where it inhabits the coastal shores, the bays and estuaries. It is rarely found far from salt water.

The sea otter is as much at home in the sea as the seal is, the strong flipper-like hind feet adapting it to such a life. The animal is about four feet long, about a foot of which is the tail. In color it is brownish black, many of the guard hairs being tipped with white. The pelt of the sea otter is considered the most valuable of furs, as much as $2,500 having been paid for a single skin. On account of its value this animal was much hunted and was on the verge of extinction. Strict laws protecting it have had the desired effect and the animal is now increasing in numbers.

The sea otter is found in the Pacific Ocean, from southern California north to Alaska and west to Kamchatka. As a rule a single young is born in a cave or among the rocks along the coast. The animals spend much of their time among the kelp beds found along the shore. Their chief food is shellfish, crustaceans, sea urchins and occasionally fish.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 865.

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