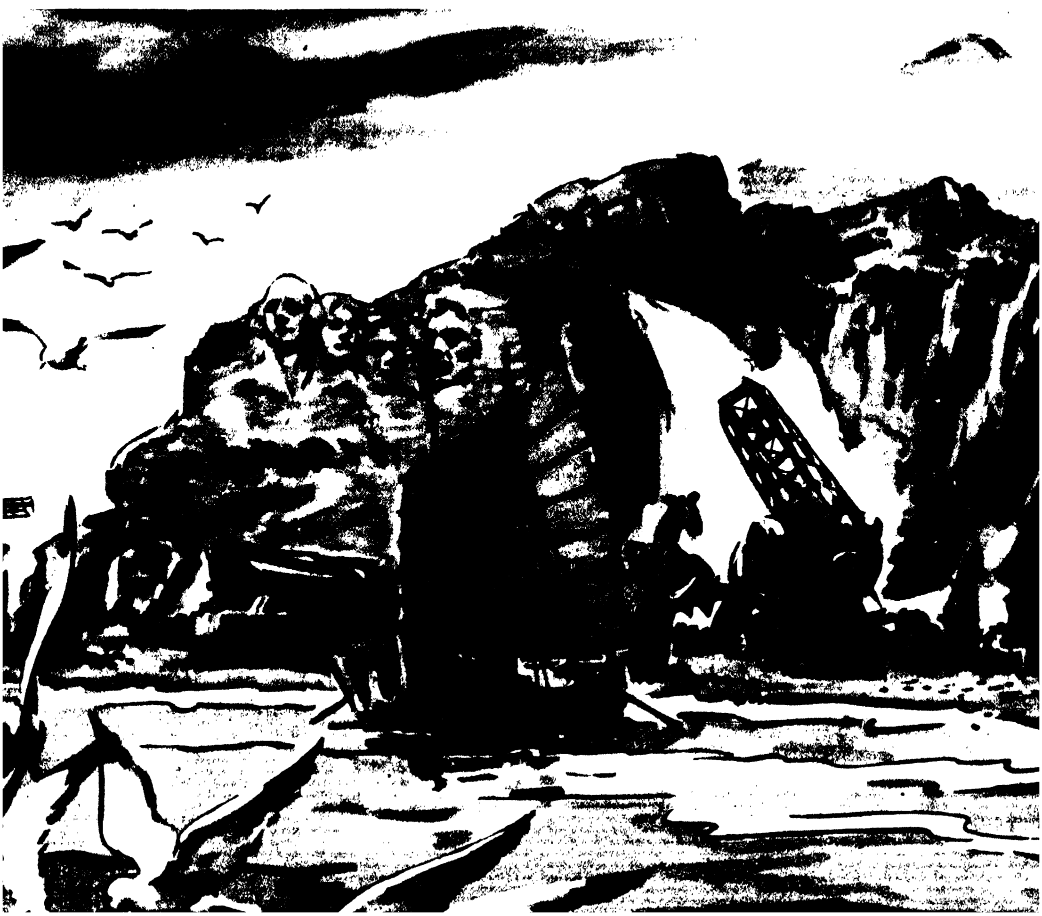
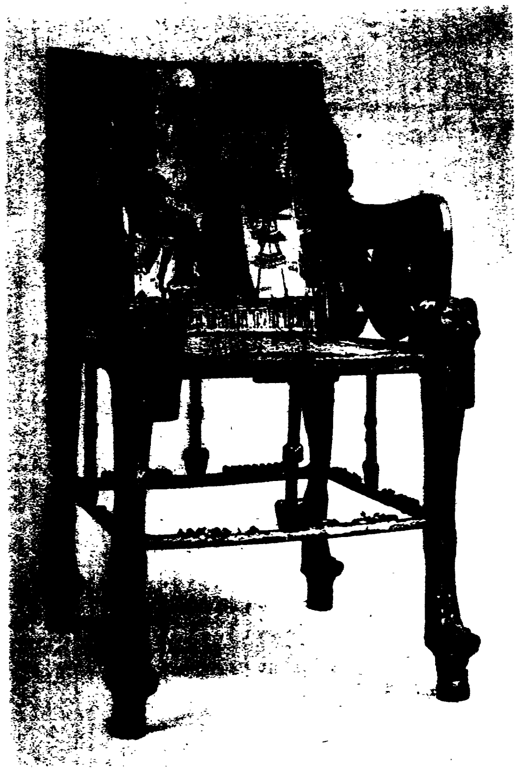


ANCIENT ART TREASURES FROM THE TOMB OF A BOY KING



WHAT king's name is better known than that of Tutankhamen, yet who can tell very much about his reign? As a mummy he is more famous than he was as ruler. What we know we have learned principally from his tomb, which was found by Lord Carnarvon and Howard Carter in 1922. It yielded an amazing store of treasure — chests and jars, chariots, couches, thrones, miniature boats, daggers and exquisite jewelry. The mummy of the king in a coffin of solid gold, itself a work of art, held costly personal adornments in which gold, jewels and finest enamel are combined. The very sandals are of gold. Slippers and fragments of clothing, as well as the mummy itself, show that the ruler was very young when he died, probably not more than eighteen. The figure of the king, at the left, bears upon the brow the vulture and the cobra, symbols of Upper and Lower Egypt. Head-dress, collar and insignia are in gilt. In the centre you see the coronation throne, overlaid with gold and richly adorned with colored inlay. At the right is one of the curious animals decorating a royal coach; teeth and tongue are of solid ivory.

VOLUME III

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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Contents of Volume III

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.

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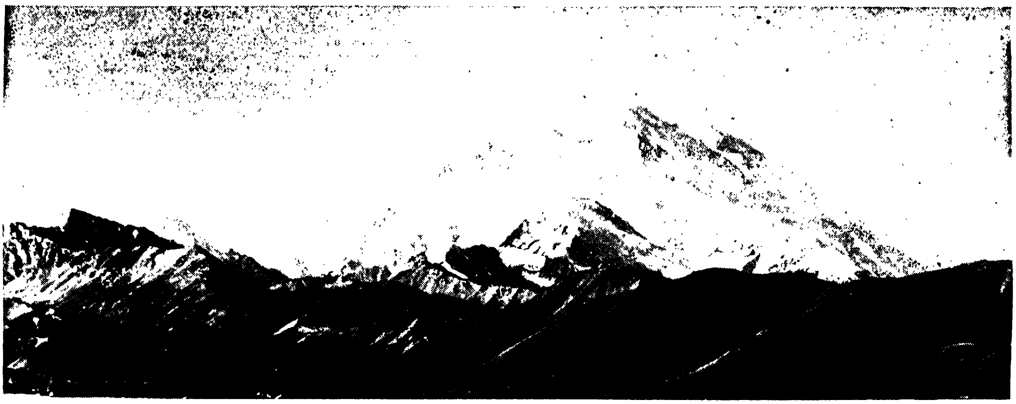


U. S. Department of the Interior

The beauty and grandeur of Mount McKinley—its head and shoulders always cloaked in a garment of ice and snow.

GLACIERS AND THE GREAT ICE AGE

GLACIERS, or rivers of ice, rank high among the earth's wonders that have captured man's imagination. They add mystery and majesty to the beauty of nature. High mountains without snow and ice caps never seem so impressive as snowy peaks. Glaciers, as we know them today in Canada and the United States, are only to be seen in the higher mountains of the West. They depend, of course, upon snowfall and continuous cold; hence the farther we go into the cold north the lower down on the hills the ice creeps, until, around the Pole and in Alaska and Greenland and Norway there are glaciers at sea level. This is also true as you go far southward, toward the South Pole.

Glaciers differ from permanent snow banks, which are far more numerous in our mountains. Glaciers move. A glacier is a sort of frozen river, slowly advancing from the basin where it collects, or *cirque* as it is called, and moving down a valley until it finally melts and runs away as water. Fall after fall of snow piles up on mountain slopes, and changes into ice as it is thawed and frozen again; and as more and more snow falls, the thickening blanket compresses the layers beneath.

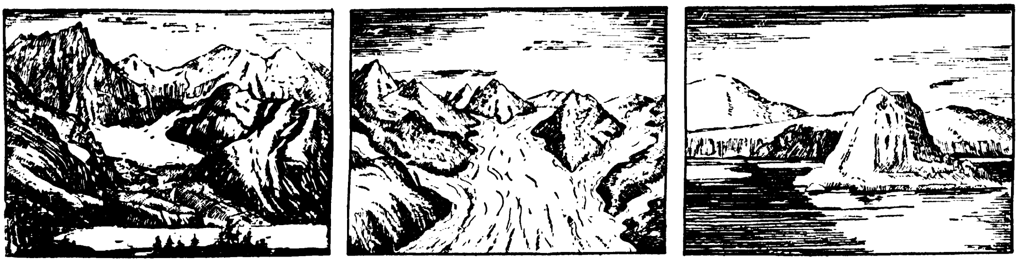
Let us imagine ourselves watching a new glacier being formed. It begins at a time of increased rainfall, or snowfall, and increased cold on a mountain. The summer is also colder than usual, so that less snow melts. As a result, so much snow piles up on our mountain that some of it is pushed downward by the weight of the snow and ice above. Year after year this goes on, the source being refilled by new snowfalls as rapidly as the nose advances. Eventually the front descends to a point where melting is as rapid as the ice advance, and that is the end of the glacier's advance.

The surface of a glacier is likely to be very irregular, as the creeping ice winds its way down over the irregularities of the valley floor. Steep places may cause cracks in the ice mass to open, and we have a frozen waterfall. These cracks are known as crevasses. Often they are covered over by a winter's snows, so that they can not be seen. Thus there is always the danger of falling down a crevasse, when walking over a glacier.

The original crack where the ice-field, or *névé*, ends and the glacier begins is marked by a large crevasse known as the *bergschrund*. Most of the terms used in speaking about glaciers are French or German, originating in Switzerland where glaciers were first studied.

There are several types of glaciers. Those nestling in small basins in the mountains are called cliff glaciers. Larger ones are known as valley glaciers. A glacier which comes out of the mountains and spreads out at the foot, often the result of the merging of several valley glaciers, is known as a piedmont glacier. Many of the Alaskan glaciers are of this type. Lastly, we have the great continental glaciers, or ice caps, such as the huge thick masses which mantle Greenland and the Antarctic continent.

At one time, not so many thousands of



Three types of glacier: the valley glacier, cutting a deep basin between hills; the piedmont, spreading out at the foot of mountains; the continental glacier, which entirely covers a land mass. An iceberg has broken off.

years ago, all of northern North America was covered by such an ice cap as that which now decks Greenland. This was during a part of a geological period known as the Pleistocene, a period which began about a million years ago. For some reason, which geologists have not been able to explain, ice began to accumulate at several centers in Canada. It grew thicker and advanced southward over the land. Eventually, huge masses of ice several thousands of feet thick extended as far south as New York City and the Ohio and Missouri rivers. In its advance, the ice stripped off much of the soil cover which had been formed by millions of years of rock decay; and it carried along huge boulders and rubble all the way to its terminus—the place where the ice melted.

Such deposits of material carried by glaciers are known as moraines, and the moraine at the end of a glacier is called a terminal moraine. Large amounts of rock and earth can be piled up as the glacial front remains stationary for a period of years in one place; and Long Island and Cape Cod represent just such "dumps" of rock, called debris.

Gradually, after many years, the air warmed again and the melting became more rapid than the ice advance. A halting, hesitant retreat was made by the glacier; and a series of recessional moraines were left during its brief halts on the way back to final disappearance from the continent.

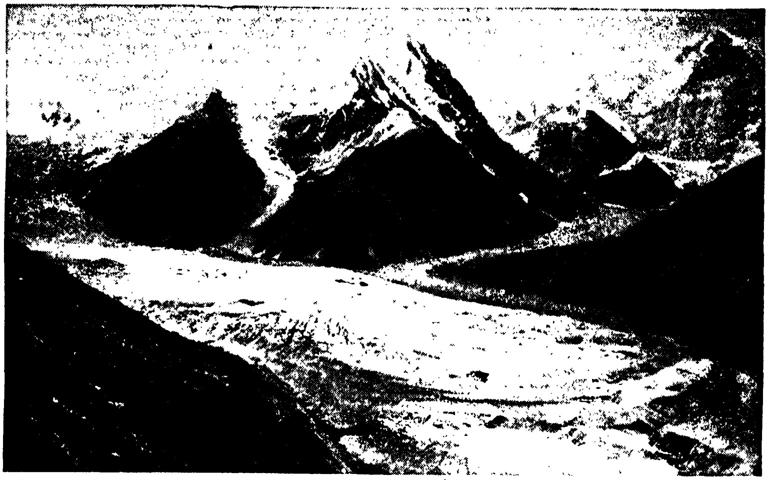
As the front receded it lay bare once more the underlying rocks; and very different was their appearance from the days before their covering. Stream-drainage patterns were blocked by great deposits of debris; pockets were filled with glacial clay and boulder mixtures, called till. The glacier had gouged out huge basins which became filled with water—the Great Lakes. And the poorly drained, lake-dotted sections of Canada remained as reminders of the ice sheet which once had covered all the land.

Many land forms are results of the glacial visits; elongated gravel hills, usually in clusters, like those of Boston Harbor, are known as drumlins. Mount Monadnock in New Hampshire has given its name to the hills which stuck their heads up above the thick ice sheet; they are known as monadnocks. Bare, rounded rocks are called *roches moutonée* or "sheep-backs." Best known of all, because they are the most widespread, are the scattered boulders known as glacial erratics; they were carried by the glacier but dropped by the melting ice before reaching a resting place with their fellows in some moraine.

Rocking stones in Bronx Park (New York City), in Fitchburg, Massachusetts, and many other places are glacial erratics, as is the famous Plymouth Rock. Scratches and grooves across the surface of bare rocks, well seen in New York's Central Park, are sure marks of glaciers; and by noting the direction in which the scratches run, we can determine the direction of the ice movement across Manhattan Island.

Geologists estimate that the glacier started its last retreat northward about 20,000 years ago, only a short time as geological time goes. What caused it to advance and to retreat is a problem. Perhaps it was a change in the intensity of the sun's radiation, perhaps a change in the earth's atmosphere, perhaps a slight elevation of the land. Many causes have been suggested; perhaps it was a combination of factors working together. Study of the ground moraine, the till and other deposits, especially in the Midwest, has shown us that there was not just a single glacier. During the Pleistocene there were four advances and recessions of the ice, and the period between the second and the third glaciation was longer than the time which has passed since the last retreat.

During that period, between the second and third glaciations, climate was warmer in these latitudes. Geologists have learned this by studying the deposits left by the glaciers, studying the amount of weathering in them, and noting the fossil remains. All over the world there are similar evidences, so whatever the cause, it was world-wide. Geologists have also found evidences of repeated glaciations in still earlier times. These evidences have been preserved in ancient sedimentary rocks.



American Museum of Natural History
A very strange glacier in Tibet—two frozen rivers, one clear, one muddy, side by side. The dark river may be the result of debris that was carried along before it froze.

This is a good place to pause and explain what we mean by the Pleistocene and other such terms in describing the world's history. Scientists have divided the earth's age into five parts, called eras. Each era stretches over so many years that we study most of them in sections, called periods. The later periods can best be studied in parts, called epochs. Here are the names of the eras, periods and epochs, beginning with the earliest:

1. *The Archeozoic Era.* The word comes from the Greek words meaning Oldest Life. Very simple life forms, such as algae, may have lived on earth during the later part of the era.
2. *The Proterozoic (Early Life) Era.* This is thought to have been a very long era.
3. *The Paleozoic (Ancient Life) Era.* This era is divided into periods which we call (beginning with the oldest) Cambrian, Ordovician, Silurian, Devonian and Carboniferous.
4. *The Mesozoic (Middle Life) Era.* This era has been divided into Triassic, Jurassic, Lower (Early) Cretaceous and Upper (Late) Cretaceous periods.
5. *The Cenozoic (New Life) Era.* This era is divided into Tertiary (Third) and Quarternary (Fourth) periods, names left over from a classification of the earth's eras which is now no longer used.

   The Tertiary is divided into Eocene, Oligocene, Miocene and Pliocene epochs.

   The Quarternary is divided into Pleistocene (Newest Life) and Holocene (Recent) epochs.

In the following chapters of the Department of the Earth, we shall tell more about these eras, except the first two, the Archeozoic and the Proterozoic. Little is known about them.

So then, you will understand that when we tell you about the great continental glaciers of the Pleistocene epoch, we are not going very far back as geologists count time. However, geologists have also learned much about the climate, the land, water and life of earlier periods and eras. From the rock deposits (the sedimentary rocks) they have worked out much of the earth's history from the earliest times, as far back as the Archeozoic era and up to the present. In the oldest rocks there apparently was no life which could leave any trace of itself impressed in the rocks. However, the rocks of that period have been thoroughly metamorphosed (changed) so that few traces would remain, if there had been life forms.

To the student of ancient life (the paleontologist), the next period, the Proterozoic, also offers few clues. In fact, we do not find a complete historical record of the earth anywhere in the world; but here and there we find a bit of rock with a part of a sequence and, by piecing them together, man has worked out a rough timetable. The vertical section from top to bottom of the Grand Canyon, for instance, is thought to represent perhaps one and a half billion years. Many thousands of feet of younger sediments have been removed to expose the present surface formations. The geological time chart shows how one period followed another. A change in the rock layers usually indicates the end of a period. A greater and more important break is thought to mark the division between eras. The convulsions of the earth's crust, for instance, that made the Appalachian Mountains have been placed at the end of the Paleozoic era. The Rocky Mountain uplift came at the close of the Mesozoic.

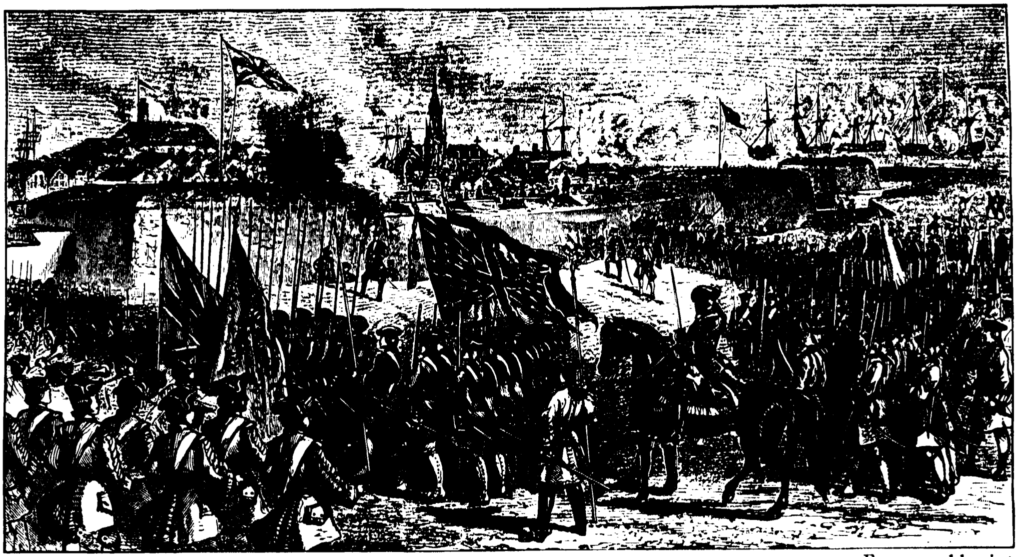
THE NEXT STORY OF THE EARTH IS ON PAGE 905.

TWO GREAT MEN—AMERICAN AND ENGLISH

When the French began to build forts on the Ohio River, a young surveyor named Washington was sent by the governor of Virginia to order them away. With a few companions he set off on the journey through the forest.

Both pictures from old prints

The death of General Wolfe at the Battle of Quebec, after he had been told of his victory. This picture is from the painting by Benjamin West. Montcalm, the French general, was also killed.



From an old print

William Pepperell and 4,000 men from New England in 1745 captured the strong French fort at Louisbourg, on Cape Breton Island. An English fleet gave the American colonists some help.

THE STRUGGLE FOR THE CONTINENT

WE have told how Spain, England, France, Holland and Sweden all tried to plant colonies in North America, how the Dutch conquered the Swedish settlements and how the English took over all of the territory of the Dutch. The Spanish possessions were in the far south and Spain kept them for a long time. They do not enter into this story, which is about the struggle between England and France for the rest of the continent, a struggle in which France lost every foot of land she owned on the mainland.

As you have learned, Englishmen planted many colonies along the Atlantic coast from Maine to Florida. Some of these colonies were divided and others were joined together, until at last thirteen remained. While the English settlements did not extend very far back from the coast, the royal charters under which these colonies were established had granted to several of them all the land beyond the mountains clear to the Pacific Ocean. In the meantime, the French in Quebec and Acadia (now called Nova Scotia) were exploring inland. They built forts and trading posts on the Great Lakes and down the Mississippi River, creating a barrier which would, if properly strengthened, prevent the English colonies from spreading westward into the Mississippi Valley and beyond.

There was a great difference between the kind of colonies that were established by the English and the kind that the French planted. Most of the settlers in the English colonies were people of the middle classes who brought their families with them and expected to spend their lives in the new land. In all of the colonies most of the people lived by farming, and most of the farmers owned their own land. In some of the colonies fishing was also a very important industry, and the people of New England built many small ships in which they carried dried fish and timber to other English colonies, or to the French and Spanish colonies, and even to Europe. For a long time the English government left the colonies very much alone. For this reason the people of the separate colonies got used to governing themselves and did not take kindly to interference in local affairs by the far-away "Home" government.

New France was settled in a different way. The settlers belonged mainly to two classes of French people, the seignorial class, or landed gentry as they would be called in England, and the peasant farmers, or *habitants*. There were not very many people of the middle classes from the towns as there were in the English colonies.

Both the French government and the companies that were given the right to develop New France were more interested in the fur trade than in the settlement of the land. They did not like the settlers to do anything which might interfere with the fur trade, which brought so much wealth to a few people back in France. Therefore they made all kinds of rules and regulations which the people of the colonies had to obey, and which left them very little liberty.

THE YOUNG MEN WHO WERE CHARMED BY LIFE IN THE WOODS

This state of affairs caused many of the younger men in New France to run away to the woods and live among the Indians where the rules could not follow them. These men were called *coureurs-de-bois,* or runners of the woods. They became independent fur-trappers, skilled in woodcraft and in the Indian type of warfare. Most of them married Indian women, and their children became more Indian than French in their way of life. This was another reason why the French colonies developed more slowly than did the English colonies.

The French knew better than the English, how to make friends with the Indians. The English settlers were always having trouble with the Indians and it is not always easy to decide who was to blame for some of these troubles. Probably one reason for the Indians' hatred of the English settlers was the very fact that the English were land-hungry and wherever they went they cleared the land for cultivation, thus destroying the forests that the Indians loved and in which they lived and hunted. The French, on the other hand, protected the forest lands in order to protect the fur trade.

THE PATIENT WORK OF THE JESUIT MISSIONARIES IN NEW FRANCE

One other reason for the good feeling between the French and the Indians was the great number of missionaries who came out from France and visited all the tribes. These missionaries were all members of Roman Catholic orders. Several orders sent missionaries to North America, but the most important were the members of the Society of Jesus, or the Jesuits, as they are often called. Father Marquette and Father Jogues were two of the best known. The Jesuit missionaries traveled thousands of miles through the forests and down the waterways of the continent, and they wrote accounts of all that they saw and did. These accounts, or "relations," as they are called, have been of great value to historians in later times. Many of the missionaries were tortured or even killed by the Indians, but more always came, and at last their efforts had some effect, except with the Five Nations, who did not like them because they were French.

The Five Nations were the only Indians who were friendly with the English and hostile to the French. You remember how Champlain's mistake cost the friendship of these warriors. The Five Nations, or the Iroquois Confederacy, was made up of the Mohawks, Oneidas, Onondagas, Cayugas and Senecas. In 1715, they were joined by the Tuscaroras, who had been driven out of North Carolina, and the confederacy became known as the Six Nations. An Irishman, Sir William Johnson, who lived in the Mohawk Valley, had such great influence with the Six Nations that in 1746 he was appointed Indian Commissioner for the colony of New York. He did much to keep the Six Nations loyal to the English, so that even years later, during the Revolution, they took the side of the Crown against the colonies.

THE ENGLISH COLONIES DREW CLOSER TOGETHER AGAINST THEIR COMMON FOES

As the power of the French and English grew stronger in North America during the seventeenth century, the two peoples began to clash in earnest. The various English colonies did not always agree among themselves; in fact they were continually quarreling over boundary lines and territorial rights, but they were firmly united in fear and hatred of the French and their Indian allies. The French, with equal reason, feared and hated the English and their allies, the Iroquois, and each side encouraged their Indian friends to raid the other side.

In Europe, Spain had grown weaker as England grew stronger, and had come to lean on France, the great rival of England. Near the end of the seventeenth century there began a series of European wars which lasted, off and on, until the fall of Napoleon in the nineteenth century. In these wars England and France were the chief contestants, though most of the other European countries were involved at various times, and the actual fighting was carried on in lands as far away as India and North America as well as in Europe. Before we go on we must tell you the names and dates of the wars that affected the colonies in North America.

The first was called the War of the Palatinate in Europe, and King William's War in America because England's Dutch king, William III, was on the throne at that time. The war lasted from 1689 to 1697. Next came the War of the Spanish Succession, called Queen Anne's War in America, and this lasted from 1702 to 1713. About thirty years later came the War of the Austrian Succession, which was called King George's War in America and lasted from 1744 to 1748. This was followed by the Seven Years War, called in America the French and Indian War. This lasted from 1756 to 1763, and it cost France all of her American possessions.

In the first of these wars—King William's War—the governor of New York led off by stirring up the Iroquois to make a fierce attack on the French village of Lachine, near Montreal. The French led their Indian allies in ruthless attacks on New England and New York, capturing Salmon Falls in New Hampshire and Schenectady in New York. The English colonists sent expeditions which captured Port Royal in Acadia, but failed to capture Montreal and Quebec. When peace was signed between England and France at the end of this war each nation restored what had been captured in the North American colonies. This angered the American settlers who felt that all of their fighting and suffering from Indian massacres had gone for nothing.

From an old print

A farmer named Dustin was working in his fields, with several of his children around him, when Indians attacked. He seized his gun and was able to keep them back while he and the children retreated.

The Indian raids were dreadful affairs no matter which side encouraged them. Some terrible stories were told of Indian raids on white settlements. One of many such tragedies was the frightful attack on a peaceful farm near Haverhill in Massachusetts. A farmer named Dustin and seven of his children were working in a field when they heard the terrible war whoop of the Indians. The farmer seized his gun and was able to keep the Indians back until he and the children reached a house. At the Dustin's own house the Indians killed the baby by throwing it against a tree, and took Mrs. Dustin, another woman and a boy away with them. Mrs. Dustin found out that the prisoners were to be tortured when the party, which was made up of nine Indian men and boys and three squaws, reached the end of their journey. One night when all of the Indians were asleep, Mrs. Dustin, the other woman and the boy very quietly got hold of tomahawks and killed ten of the Indians. Only one squaw and a boy escaped. Then Mrs. Dustin scalped the ten Indians and the three made their way back home, more than a hundred miles through the forest. The government paid Mrs. Dustin a large sum of money for the scalps. As you know, the Indians took the scalps of their dead enemies, and at this time the colonial governments had taken to paying bounties to friendly Indians for the scalps of enemy Indians.

QUEEN ANNE'S WAR IN WHICH SPAIN FOUGHT ON THE SIDE OF FRANCE

In Queen Anne's War, which started in 1702, the French and their Indian allies captured many towns. At Deerfield in Massachusetts, in 1704, about fifty people were killed and more than a hundred captured. If any of the captives could not keep up as they were being taken away, they were tomahawked and scalped. Later some of the Deerfield captives were ransomed, but others had been adopted into the Indian tribe and had grown to love the life of the wilderness so much that they refused to return to their families. In this war Spain fought on the French side and a Spanish and French fleet tried to take Charleston, South Carolina, but the brave people of Charleston forced them to go away. A party of Carolinians and Indians burned the Spanish city of St. Augustine but failed to capture it.

During this war the English again captured Port Royal in Acadia. At the end of the war the English kept all of Acadia and the country around Hudson Bay. Port Royal was renamed Annapolis Royal in honor of the Queen, and Acadia became Nova Scotia. France had now lost much territory, but was still powerful in America.

The thirty years of peace that followed were not entirely peaceful for the English colonies. The Indians kept on making attacks on the outlying settlements, and the colonists believed that the French authorities in Quebec encouraged them and furnished them with arms. When, in 1744, King George's War broke out, the colonists were quite ready for it.

THE CAPTURE, BY WILLIAM PEPPERELL, OF THE FRENCH FORTRESS OF LOUISBOURG

The French had built a strong fort at Louisbourg on Cape Breton Island. The French government had spent a great deal of money on it and it was thought that it was too strong to be captured. However, in 1745, a force of about 4,000 New Englanders under William Pepperell sailed to attack the fort. With some help from an English fleet they captured it and gained a large stock of powder and other ammunition. This was a very important event, for it showed how the English colonists could fight. Louisbourg, however, was given back to the French when the peace treaty was signed at Aix-la-Chapelle in 1748.

By this time the English colonists were beginning to think that they would soon need the land across the Allegheny Mountains. The English kings had granted to Virginia, Massachusetts, Connecticut and Carolina the land from sea to sea, and the grant of Pennsylvania extended beyond the mountains. New York also claimed some of the western lands. Though the waters of Lake Champlain flowed into the St. Lawrence River, the lake itself and the land around it were easier to reach from the English colonies than from the French colonies. The English wished to settle the land, but the French wished to keep it open and uninhabited for the sake of the fur trade. Settlers always make the wild animals scarcer.

BOTH FRENCH AND ENGLISH CLAIM THE VALLEY OF THE OHIO

In the valley of the Ohio River there was much game, but few Indians lived there. Pennsylvania claimed a part of the land. Virginia said that it was a part of the territory which she had been granted by James I. The French said that, since the Ohio flowed into the Mississippi, all of this land belonged to France because of the voyages of La Salle. In those days a nation which occupied the mouth of a river always claimed all the land from which water ran off into that river or any of its branches.

The French began in 1749 to send men all through the region to raise the French flag and to bury lead plates on which were the royal arms of France. The same year a number of wealthy Virginians formed the Ohio Company for the purpose of settling the land along the Ohio River. Lawrence Washington, the elder brother of George, was one of the managers, and in 1750 much of the land in what is now western Pennsylvania and West Virginia was surveyed.

The French began to build forts in the region. Where Pittsburgh now stands the Allegheny and the Monongahela rivers flow together and form the Ohio. This was an important spot to both the French and the English. A few English settled in the neighborhood, but did not build a strong fort, as it was claimed by both Pennsylvania and Virginia, and neither colony wished to spend money on a fort that might be given to the other. When Governor Dinwiddie of Virginia heard of these new French forts, he sent the young George Washington to

From an old print

General Braddock, who did not understand how to fight the Indians, was defeated, and fatally wounded.

warn the French that they must leave Virginia territory. On another page you may read of Washington's terrible journey through the forest.

The commanders of the French forts were most polite to the young messenger, but they said they could not think of leaving without orders from the government of New France in Montreal. Instead, they set about almost at once to build a strong fort where Pittsburgh is now, and called it Fort Duquesne. Governor Dinwiddie sent some Virginia troops to drive away the French in 1754. The commander became ill, and George Washington, who was second in command, took charge. Roads had to be cut through the woods in order to get cannon and wagons through, and sometimes the little army did not advance more than a mile or two a day.

When they had crossed the mountains and had reached a place called Great Meadows they surprised a small French scouting force and killed ten and took twenty-two prisoners. While waiting for reinforcements Washington built a rude entrenchment which he called Fort Necessity. When the reinforcements came, Washington's force amounted to 300 white men and 150 Indians led by a chief called Half-King. There were about 1,400 French at Fort Duquesne and 600 of them marched out and attacked the Virginians. The Virginians had very little powder, and when it was all gone they had to surrender, but they were permitted to march away and were not taken prisoners. Half-King did not think very highly of such war and said that the French acted like cowards and the English like fools.

Both France and England at once sent troops to America though war was not declared until 1756. General Edward Braddock with about a thousand English regular troops reached Virginia early in 1755. It was planned to attack the French in four places at once: at Fort Duquesne, on Lake Ontario, on Lake Champlain and on the border of Acadia, which was now an English possession. General Braddock was to take Fort Duquesne.

About 500 Virginians went with Braddock's troops when they started for Fort Duquesne, but Braddock had only contempt for such raw, untrained troops, and he also cared nothing for the help of the Indians. He was used to the orderly fighting on European battlefields, he knew nothing about fighting in the woods, and he thought his trained regulars better than any other kind of troops.

He was a brave man, but stupid, and this stupidity cost him his life.

THE DEFEAT OF BRADDOCK AND "THE KING'S REGULARS" AT FORT DUQUESNE

Benjamin Franklin, who met him at Alexandria, Virginia, tried to warn the General of the dangers he would meet, but Braddock answered that the French and Indians might frighten the raw militia, but that they could make no impression on the king's regulars. Some of the colonists grew angry and left. On July 9, 1755, near Fort Duquesne, a party of Canadians and Indians met Braddock's army and the fighting began. The regulars fought bravely, but they could not see anybody to shoot at, for the enemy fought Indian-fashion, from behind trees. The regulars stood in close formation in the narrow road, and their bright red coats made perfect targets. Braddock himself went up and down the lines encouraging and scolding his men, but he thought it cowardly to shoot from behind trees and logs as the Virginians were doing. Braddock was killed; and nearly two-thirds of his army were killed or wounded. George Washington had to lead away what was left of the little army.

THE FOUNDATION FOR LONGFELLOW'S SAD STORY OF EVANGELINE

This same year, 1755, the French inhabitants of Acadia were sent away from their homes. The poet Longfellow, in Evangeline, has told the story, but all that he tells is not quite true. All of the Acadians were not so good as he says, and the English were not so cruel. In those days governments traded lands back and forth without bothering to consult the people who lived in them. When the French government gave up Acadia to the English, neither side bothered much about the poor Acadians. Many of the Acadians did not like their land to belong to England, and plotted with the other French and the Indians. The English decided to send these people to the different English colonies where they could not make so much trouble. Most of the families were kept together, but a few were separated in the rush, and it is of one of these cases that the poet writes.

All of these battles were fought while England and France were supposed to be at peace, but in 1756 the French and Indian War began in earnest. The French sent a good general to Canada, the Marquis de Montcalm. He soon began to win victories for France, but he could not control his Indians. When they helped to capture a fort or an army, they thought they had the right to kill all the people they captured. When Fort William Henry on Lake George was taken by the French, Montcalm promised the English force that they should go home unharmed, and the Indian chiefs agreed, but after the English started, the Indians killed all the wounded and kept making attacks on the column until six or seven hundred had been killed. At another time Israel Putnam, whom we shall meet again in the Revolution, was captured, tied to a stake, and the flames were already curling about him when he was rescued by a French officer who was not afraid of the Indians.

THE ENGLISH GOVERNMENT DETERMINES TO DRIVE THE FRENCH OUT OF NORTH AMERICA

We cannot tell of all the battles and massacres which took place in the next few years. In nearly all of them the French won, and many English and many Americans were killed and scalped. But the French government did not support Montcalm as it should have done, and the tide began to turn. William Pitt, Earl of Chatham, was now in charge of the war in England, and he determined to drive the French out of North America. He was not willing, as other English statesmen had been, to take a little bit of territory here and another there, but he intended to take it all. So many soldiers were sent out, and the American colonists were encouraged to raise both men and money for the war.

In 1758 the British again captured Louisbourg. In this capture we see, for the first time in America, the soldier who was finally to end the war, General James Wolfe. Though Sir Jeffrey Amherst and Admiral Boscawen were in chief command, it was Wolfe who forced the French to abandon the Grand Battery and finally to surrender. With the surrender of Louisbourg, the St. Lawrence was open for the entrance of the British fleet, and all eyes next turned to Quebec as the prize for which the English must fight the next summer.

THE SIX NATIONS BEGIN TO LOSE THEIR ADMIRATION FOR THE ENGLISH

Victories were necessary if the English were to remain in the country. The Iroquois hated the French, as you know, but they were beginning to despise the English, who could not overcome the enemy of both. If the French kept on winning victories, soon the Six Nations would refuse to help the English any longer, for the Indians never liked to be on the losing side. They had seen the

English and Americans lose Fort Oswego and Fort William Henry and fail to capture Ticonderoga on Lake Champlain. Indians went to visit Montcalm, saying that they wished to see the man who trampled the English under his feet.

The capture of Louisbourg changed all this and English victories began to come rapidly. Fort Frontenac, built of stone by La Salle, where the St. Lawrence River flows out of Lake Ontario, was taken and then battered down by its own cannon. An immense stock of war material was taken across the lake or destroyed. The Six Nations decided that perhaps the English might win after all, and they became sure of it a few months later when Fort Duquesne also fell into English and American hands. The little settlement around the fort was named Pittsburgh, in honor of the great British statesman, and the next year Fort Pitt was built.

With the year 1759 more important English successes came. Fort Niagara, at the mouth of the Niagara River, fell, and shortly afterward Fort Ticonderoga was surrendered by the French. As rats desert a sinking ship, the Indian allies of the French grew less willing to help them, while on the other hand, the Six Nations forgot that they had even thought of ceasing to aid the English.

THE GREAT TASK OF GENERAL WOLFE—TO CAPTURE THE CITADEL OF QUEBEC

Quebec, however, still remained in French hands. Quebec was built high on a cliff, more than 200 feet above the St. Lawrence River at the point where it is joined by the St. Charles River. The French believed that the city could not be taken. General Wolfe, who was in very poor health, had gone back to England to try to get well. There he found that the government was depending upon him to take the fortress of Quebec. Though far from well, he returned to America. He sailed up the St. Lawrence in June, 1759, and during the whole month of July his fleet stayed near the city trying to figure out a way to take it. Wolfe became more seriously ill in August, but his mind was always on his task. He felt that he could not live long and begged the doctor to "patch me up enough for this business."

Attack in front was impossible, and below the city there was no hope of success. But Wolfe had himself rowed up the river, and his keen eyes finally spied a path up the face of the cliff, used perhaps by goats, or by reckless young men who wished to get quickly down to the water's edge. Few thought of climbing up the cliff. Moving his ships up and down the river without any reason that could be seen, he puzzled General Montcalm, who could not imagine what the British were trying to do. On the night of the 12th of September, Wolfe had a part of his men pretend to make a landing below the city to attract the attention of the French away from the real plan. The main part of his army was in the ships up above the city.

THE ENGLISH MAKE A SURPRISE LANDING ON THE SLEEPING CITY

At midnight 1,600 men in small boats stole down the stream in the shadow of the cliffs. Wolfe in his boat was repeating verses from Gray's Elegy in a Country Churchyard, which had recently been published in England. When he came to the line, "The paths of glory lead but to the grave," the young general said to one of his officers, "I would rather have written that poem than take Quebec."

Quietly the soldiers landed and began the steep climb up the cliff, gaining the top before the French sentry knew of their presence. Before six o'clock the 1,600 men were drawn up on the broad field at the top of the cliffs, called the Plains of Abraham. Three thousand more soon followed. Montcalm marched out of the city to meet the English as soon as he could, and a fierce battle followed.

On this broad plain the English had the advantage, just as the French had it in the woods at Fort Duquesne. Wolfe's soldiers were English regulars who were used to fighting in open spaces where they could see one another and the enemy and hear the orders of their officers. A large part of Montcalm's force was made up of Canadians. These men were splendid fighters in the woods, where they used Indian methods, but did not do so well in the open ground.

THE BATTLE OF QUEBEC COST THE LIVES OF BOTH BRAVE GENERALS

Wolfe was wounded twice but he kept on fighting until a bullet passed through his lungs and he fell. He was carried to the rear. As he lay dying he heard an officer say, "See how they run!" Wolfe tried to raise himself, saying, "Who run?" When told that the French were giving way everywhere, he sank back whispering, "God be praised, I die in peace." The famous painter, Benjamin West, who lived then, painted a picture of this scene which you may see on page 776.

The brave Marquis of Montcalm was

killed too. He was struck in the chest, but at first seemed not to feel the wound, until all at once he fell from his horse. When told that he was dying his answer was, "So much the better. I shall not live to see Quebec surrendered." He died that night, and a few days later the city opened its gates to the English. Now high above the St. Lawrence stands a tall monument erected in honor of two brave men who died, one at the moment of victory, the other in the bitterness of defeat.

THE END OF THE WAR FOUND ENGLAND EVERYWHERE VICTORIOUS

The next year an unsuccessful attempt was made by the French to retake Quebec. Soon Montreal also fell into the hands of the English. The colony of New France was conquered, and English officers ruled. The war continued in Europe, however, and in 1762 Spain joined in to help France. The British fleet was too strong for the allies, and took Cuba and the Philippine Islands from Spain. Peace was made the next year (February 10, 1763), and the map of North America was made over by the famous Treaty of Paris.

England took all New France and all the eastern half of the Mississippi Valley from France, but traded Cuba and the Philippines back to Spain in return for the Floridas. East Florida was almost the same then as the present state of Florida. West Florida was a strip of land along the Gulf of Mexico reaching to the Mississippi River. It included what is now the coast of Alabama, Mississippi and part of Louisiana. Since Spain had lost some of her valuable possessions because she had come to the aid of France, that country gave her the city of New Orleans on the east bank of the Mississippi, and all the territory claimed by France between the Mississippi River and the Rocky Mountains, reaching as far north as the head of the Missouri River. We shall meet with this territory again under the name of Louisiana. All or part of thirteen states have been formed from this territory, including the present state of Louisiana.

TWO LITTLE ISLANDS OFF NEWFOUNDLAND WERE ALL THAT WERE LEFT TO FRANCE

Two tiny islands, St. Pierre and Miquelon, off the coast of Newfoundland, were left to France. They are barren and rocky, and in peacetime are chiefly useful as harbors for the fishing fleet from France. They have remained French ever since, and in World War II they came into the news when the people who live on them voted to side with the Fighting French against Germany and her allies. To return to the treaty of 1763, some of the French islands in the West Indies, which had been captured by the British during the war, were returned to France.

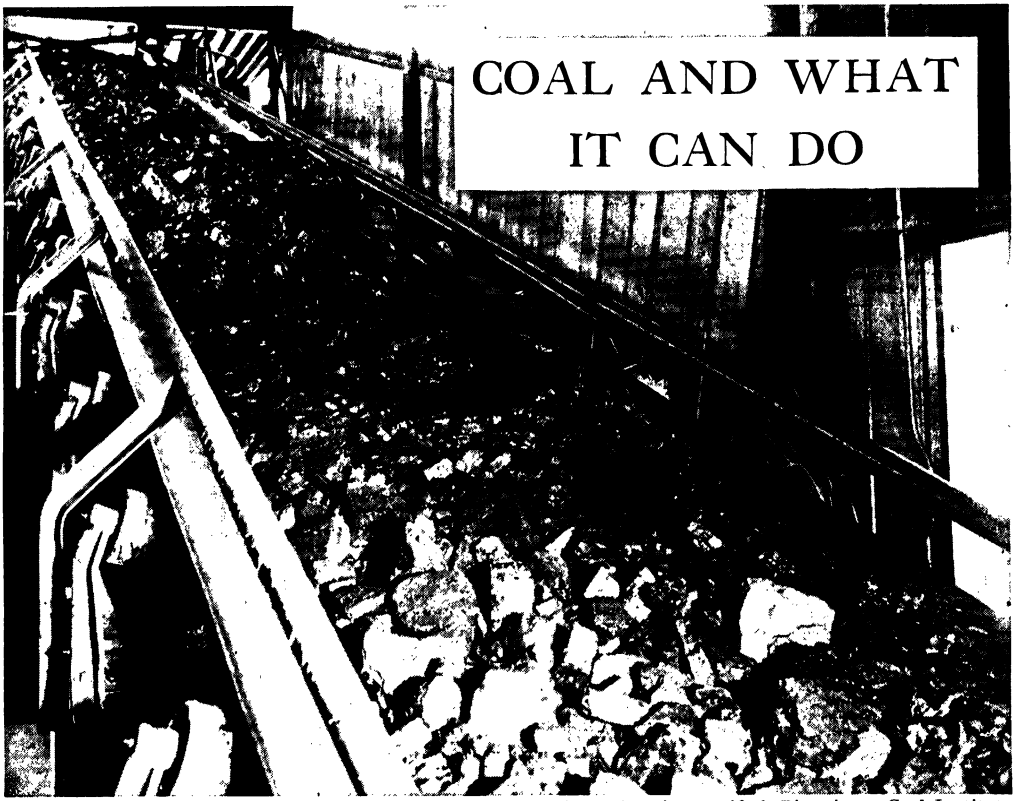
THE CONSPIRACY OF PONTIAC AND OTHER INDIAN UPRISINGS TROUBLE THE ENGLISH

The struggle for the continent of North America was over for the time being, so far as Europe was concerned. The great question for England to settle was what to do with her new possessions and her old ones. The war had cost much in men and money, and the unfriendly Indians were still a threat to the peace of the settlements. In the summer of 1763 the Indians of what was then the West made a final effort to drive the English away from their territory. This is called the Conspiracy of Pontiac after the chief who organized and led the uprising. Pontiac was a chief of the allied Ottawas, Ojibways and Pottawattomies, and in military and political genius he was far greater than any other Indian leader that we know of. The Indians had never learned to plan and carry out big campaigns over a wide territory; their warfare was more of the hit-and-run type. Pontiac succeeded in organizing an uprising in which twelve fortified posts were attacked and eight captured. The garrisons and many of the settlers were massacred and several English expeditions were defeated. In the end the uprising failed, but it came tragically near to succeeding. In 1766 Pontiac signed a treaty of peace with Sir William Johnson at Oswego in New York. Later this great Indian leader was murdered by a Kaskaskia Indian who had been bribed by a trader. The northern Indians thereupon went to war with the Illinois group of tribes from which the murderer came, and almost completely exterminated them.

It is not difficult to see why it was thought necessary to keep an army in the colonies to protect the frontier. The British government considered that the colonies had cost more than had been received from them, and that they would probably continue to be an expense. Could the colonies be made to pay a part of the cost of protection against the Indians? So far as the government was concerned the answer to this question was "yes," and Parliament set about levying taxes on the colonies.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 965.

COAL AND WHAT IT CAN DO



All photos, unless otherwise specified, Bituminous Coal Institute

This big belt conveyor is carrying the coal up to the preparation plant, where it will be graded and cleaned.

AMONG the most precious of man's natural resources is the black or brown mineral which we call coal. We burn it to keep ourselves warm during the winter; gas made from it cooks our food. Coal moves many of our railroad trains. We use it to generate electricity, the tireless servant of mankind. We employ coke, a product of coal, to smelt ores. We can transform coal into the gasoline which runs our motor cars. From coal, too, we obtain lovely colors, delicate perfumes, precious medicines, powerful explosives, fertilizers, textiles, insecticides (insect-killers) and a vast number of other products.

Coal represents the remains of trees and other plants which lived and died in swampy places millions and millions of years ago. The remains of these plants accumulated at the bottom of swamps until they formed a layer of half-rotted vegetation many feet deep. Then the level of the water rose and the swamp became a sea or inland lake. The layer of dead vegetation was covered over by many feet of mud. When the sea became a swamp again, other trees flourished and died; they, too, accumulated at the bottom of the water. The waters rose again; again the rotting vegetation at the bottom was covered over with mud. Later, in many places, the land was lifted up, and swamps and seas disappeared.

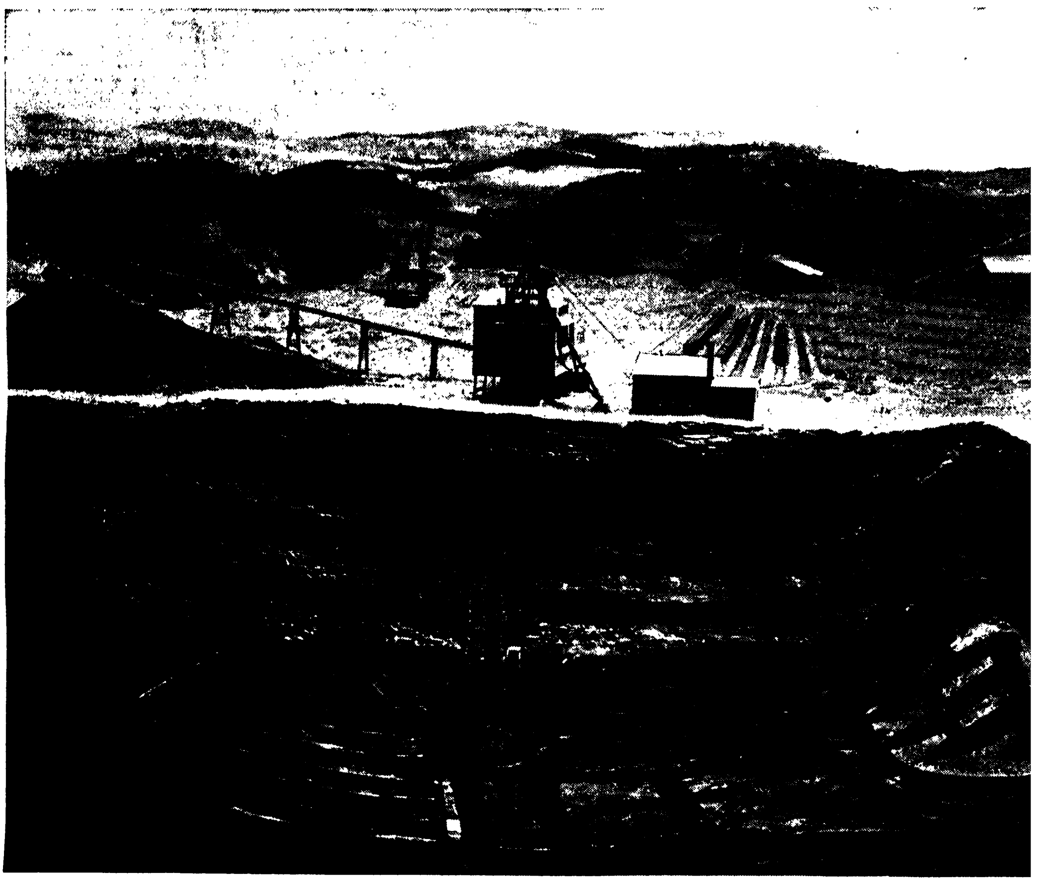
The layers of vegetation then lay deep in the earth under a huge mass of other materials. As a result they were subjected to great pressure and heat. In the course of the ages they were changed—very, very slowly, indeed—into coal beds, ranging in thickness from a few inches to many feet. The mud that had covered them became rock—mostly sandstone and shale.

In its present form coal consists chiefly of carbon, with varying amounts of hydrogen, oxygen, nitrogen and other chemical elements. There are a number of different varieties of coal, which represent different stages in its development from a decaying mass of vegetation to a mineral. The more pressure and heat this vegetation underwent, the higher the percentage of fixed carbon it contains; the more completely it has been changed. (We give the name of fixed carbon to the carbon that remains after coal has been heated and various other substances, including moisture, have been driven off.)

Peat represents the first stage in the formation of coal—the stage in which half-rotted vegetation collects at the bottom of swamps and bogs. Most experts say that peat is not really coal, but rather a substance which might develop into coal in the course of time. It is found in many parts of the world, including Ireland, Great Britain, the Netherlands and North America. It is used chiefly as a fuel. Before it can serve this purpose, it must first be pressed and thoroughly dried, because it contains a good deal of moisture. Peat has also been used in the manufacture of certain kinds of paper and textiles.

Coal which has reached only an early stage of development is apt to contain many traces of the wood from which it was formed. Therefore, it is called lignite, from *lignum,* the Latin word for wood. Since it is generally brownish in color, lignite is also known as brown coal. (Some American coal experts distinguish between lignite and brown coal; they give the name of brown coal to the softer variety.) A good deal of lignite is found in the United States and Canada; there are large deposits, too, in Soviet Russia, Austria, Germany, Australia, New Zealand and India. Lignite rarely contains

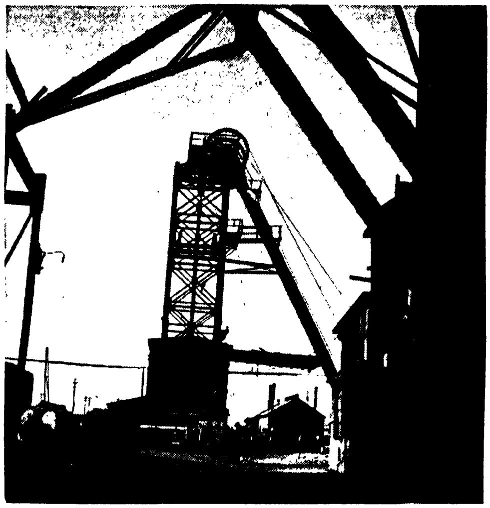
A diagram of a typical anthracite mine. The shaft (center) leads to the underground workings. Note the seams of coal and the many galleries, which form a maze of passageways. In the upper right-hand part of the picture we see a typical breaker, or preparation plant. (The preparation plant is called a tipple in bituminous coal



more than 50 per cent of fixed carbon; it is not so good a fuel for ordinary domestic heating as the other kinds of coal.

Bituminous coal represents a more advanced stage of development; it has up to 80 per cent of fixed carbon. It is by far the most plentiful and the most important of all the different kinds of coal. It is sometimes called soft coal, but not very accurately, since some bituminous coal is quite hard. In fact, the very name of this coal is misleading. The word "bitumen" is used to describe various inflammable mineral substances, including petroleum and asphalt, but it is not applied nowadays to coal. The name "bituminous coal" goes back to the early days of mining, when men did not understand the nature of coal.

Bituminous coal catches fire easily and burns with a long yellow flame; some vari-



National Film Board

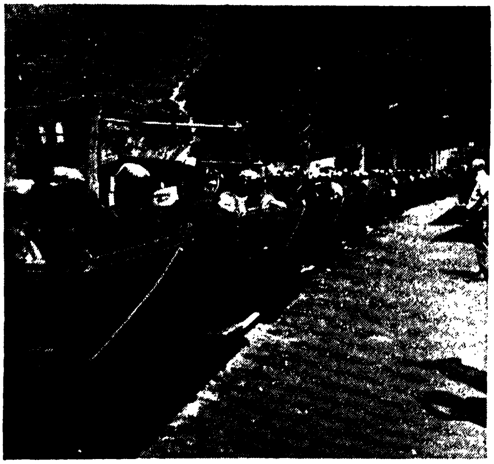
Scene at a mine in the busy town of New Aberdeen, Nova Scotia. In the center we see the entrance to one of the shafts leading to the mine workings.

mines.) As you see, the artist has removed the roofs from some of the "rooms" inside of the mine in order to show us the pillars that provide support.

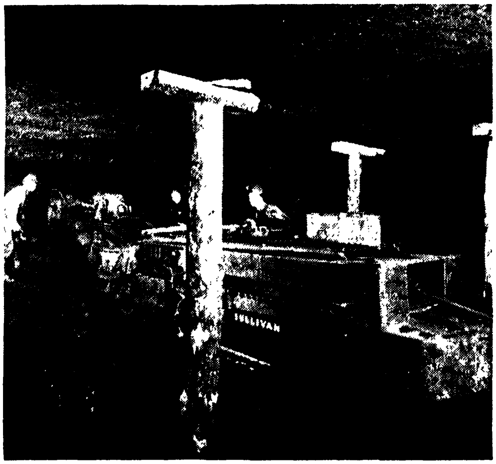
Open-pit mining. A mechanical shovel scoops up rock and dirt in order to get at the coal seam beneath.

eties produce a good deal of smoke. It is widely distributed throughout the world; the United States, China, Canada, Great Britain, Germany, India, Russia, Poland, Czechoslovakia, France and Austria have large deposits.

The most fully developed kind of coal is anthracite, which sometimes has as much as 90 per cent of fixed carbon. The name comes from the Greek word *anthrax,* meaning coal. Anthracite is hard and shiny. It kindles slowly, but burns longer than other kinds of coal. It produces a blue flame; it gives off



Miners riding to work at Algoma, West Virginia, in open cars, drawn by a powerful electric locomotive.



A cutting machine working away at the face of a coal seam. Note the pillars propping up the roof.

Drilling a hole in the face of a seam. When the drilling is completed, the miner will cram explosives in the hole. These will be set off by means of an electric current, and a large quantity of coal will be brought down.

no smoke and almost no odor. Most of the anthracite mined in the United States comes from Pennsylvania. There is also a great deal of anthracite in China, Great Britain, Canada, Spain and South America.

Lignite, bituminous coal and anthracite are the principal kinds of coal, but there are various other kinds. Sub-bituminous coal ranks between lignite and bituminous coal. Semi-bituminous coal and semi-anthracite represent two stages between bituminous coal and anthracite.

The history of man's use of coal goes back several thousand years. We find a number of references to the mineral in the Bible and in the work of ancient Greek and Latin writers. Coal served as a fuel in China long before the Christian Era. In England it was probably used before the Romans conquered the land in the first century A.D.; it was certainly in use in the early Middle Ages. It was burned so inefficiently in those days that it gave off heavy smoke and disagreeable odors, which many people thought were poisonous. Indeed, King Edward I (1239-1307) made the use of coal a criminal offense, punishable by death.

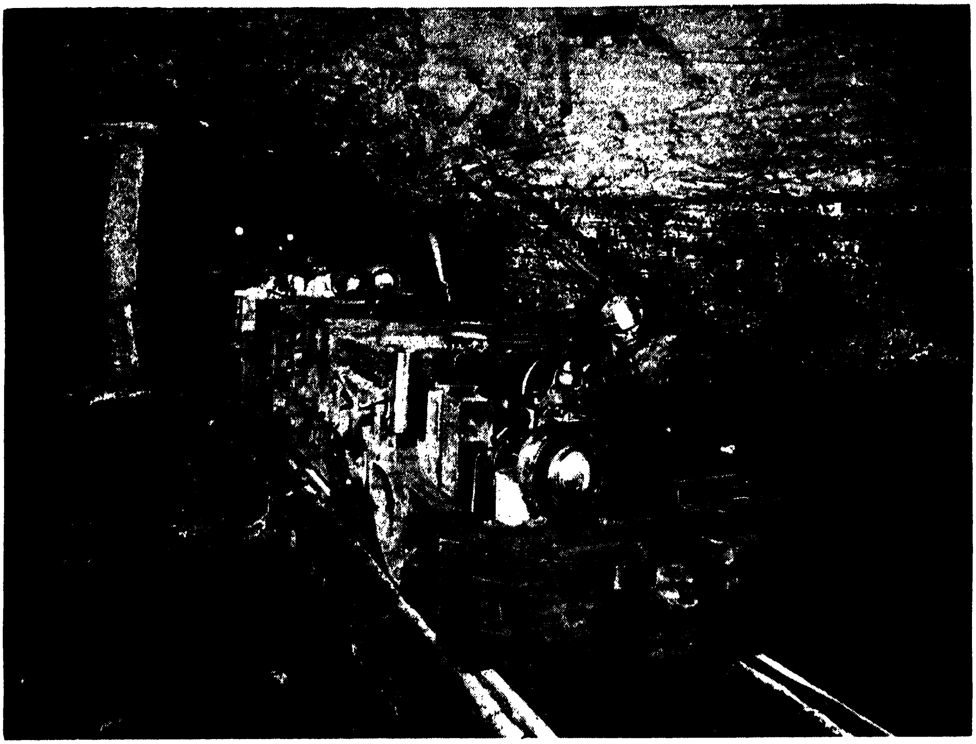
In time the prejudice against coal in England died away and coal mines were opened in various parts of the country. The earliest

After the coal has been brought down from the seam by means of explosives, a mechanical loader, mounted on a track, scoops up the coal and places it on a conveyor belt. From this belt it passes into waiting mine cars.

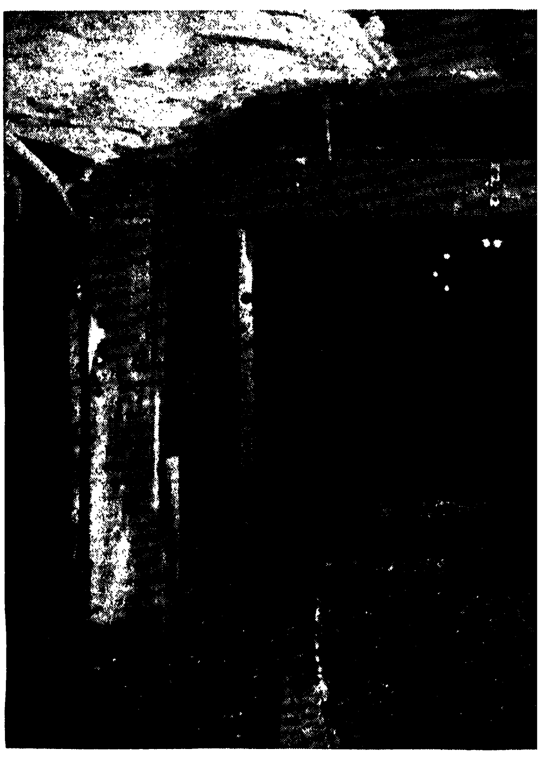
English mines were quarries. Men dug down to the coal seams and then extracted the coal from the open pits which were formed in this way. Later, English operators started underground workings, and these became very extensive in the course of the years.

The first coal mine in the American colonies was opened about the middle of the eighteenth century on the James River, not far from Richmond, Virginia. The mineral was not in much demand in colonial times, since the immense forests of those days yielded plenty of wood for burning. A certain amount of coal was used in the industries that flourished in the towns on the eastern coast; most of this coal came from England or Nova Scotia. The situation changed after the American Revolution. More mines were opened up and the new country became independent of foreign coal.

The rise of the railroads toward the middle of the nineteenth century marked a milestone in the history of the world's coal industry. Now the coal could be easily carried from mine to market. Besides, the railroads used large amounts of coal and became the best customers of the coal companies. As time went on, coal was used more and more as a fuel and it also began to serve as a raw material in industry. By the end of



A low-slung electric locomotive hauling coal cars. It draws its power from an overhead trolley wire.



the century it was by far the most important mineral. Nations short of coal were almost fatally handicapped.

For a time England was the foremost coal producer of the world, but toward the end of the nineteenth century the United States forged ahead. Today America is far in the lead. Great Britain still ranks high among coal-producing nations, which also include Soviet Russia, Germany, France, Poland, Czechoslovakia, South Africa, Belgium, Australia, Canada, India and the Netherlands.

The first people to use coal probably knocked chunks of it loose from seams that appeared on the surface of the earth—that outcropped, as miners would say. But comparatively few coal deposits are so conveniently located. In order to get coal, men must generally dig through the overlying layers of rock.

If the coal seams are fairly close to the surface, mine operators use the strip, or open pit, mining method. In order to get at the coal, they "strip" the land of the overburden—that is, the dirt and rock that lie above the coal seam. Explosives blast the overburden into fragments; it is then removed by huge mechanical shovels and set to one side in great ridges. (The biggest of these shovels can remove thirty-five tons of overburden in one bite.) The shovels then dig out the exposed coal seam; they load the coal into motor trucks, which carry it to freight cars or to preparation plants. Strip mining is practical only when the overburden does not extend more than seventy-five feet or so below the surface of the earth.

Most coal is extracted by means of deep, or underground, mining. There are three kinds of underground mines—shaft, slope and drift. In shaft mines, at least two vertical shafts are sunk into the earth, sometimes to a depth of several thousand feet; underground galleries lead from the shafts to the seams of coal. A slope mine is reached by a tunnel following a gradual downward slope; a drift mine, by a horizontal tunnel dug into the side of a hill.

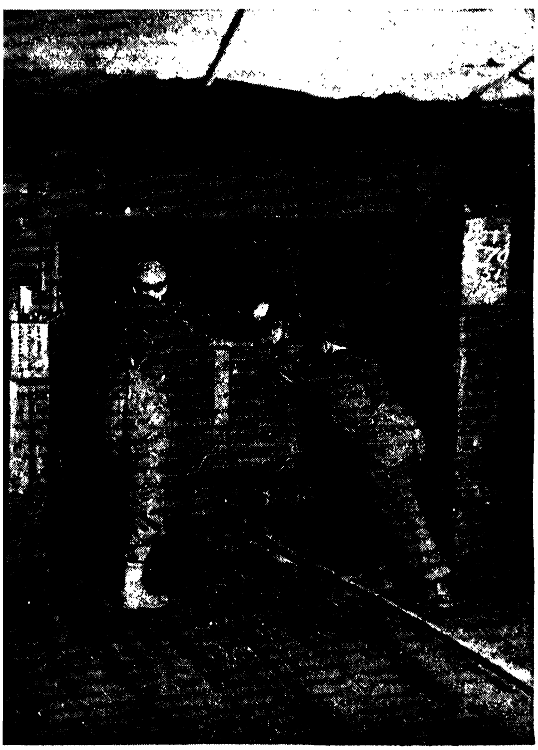
An underground mine is laid out like a big city. Corresponding to the principal city streets, there are the main haulage ways—galleries along which strings of cars haul men or coal. From these haulage ways lead smaller galleries, representing the city's side streets. On either side of the smaller galleries, in bituminous coal mines, we find the "rooms," from which the coal is extracted; they correspond to city lots. Rooms are called "breasts" in anthracite mines.

National Film Board

Canadian miner working with a compressed-air drill.

Underground mines have extensive transportation systems. In shaft mines big elevators, called cages, lower the men down the shaft to the underground galleries and bring them up again when their work is done for the day. The same cages also bring up coal from the workings. In most of our large mines there is also a miniature railway system for the transportation of men and coal. Low-slung electric locomotives haul open cars along heavy steel rails; they get their power either from overhead trolleys or from storage batteries. Trackless shuttle cars, run by storage batteries or compressed air, sometimes bring coal from the seams to the main haulage ways. In some mines cars are run by means of an endless cable, like that of a cable railway. In others there is a conveyor system; coal is carried from the workings to the mine mouth on moving belts of rubber.

There was a time when underground mining was a comparatively simple operation, requiring simple equipment. The miners dug at the coal with their picks, blasting the seams with explosives when necessary. Then they shoveled the coal into cars, and mules hauled the cars to the surface. There are



D. L. and W. Coal Co.

Pushing a coal car into a "cage" or elevator. Later, the cage will be drawn up to the surface.

Miners in the Willow Grove Mine of St. Clairsville, Ohio, discussing safety measures. Note the electric lamps attached to the miners' caps. Each lamp is connected by means of a cable to a battery carried on the belt.

still a few mines of this sort, but in today's large-scale mining operations, digging, loading and hauling are done by machines. The modern mine is like an up-to-date factory, where skilled operators handle ingenious tools.

The first step in extracting coal from a seam is undercutting. An electrically operated machine, called an undercutter, removes a layer about six inches in depth from the bottom (sometimes also from the top) of the seam; it penetrates to a distance of about six feet. A hole is now drilled in the face of the seam; explosives are pushed into the hole. The miners withdraw, and the explosives are set off by means of an electric current. The explosion brings down a large quantity of coal. The miners now bring into position a machine with a conveyor belt driven by electric power. Coal is loaded on the conveyor belt and then discharged into waiting cars.

In some of the most modern mines the shooting is done by compressed air. Some mines use machines which combine the operations of cutting and loading; no blasting is necessary. The machines rip into the coal seams and dump the coal into a conveyor, from which it is loaded into mine cars. There are several kinds of combination machines of this sort. The most recent, the Joy Continuous Miner, is over 25 feet long and 7½ feet wide. It tears the coal loose, carries it on a moving belt into coal cars and sprays water on it from 19 nozzles to wet down the coal dust. It can dig two tons of coal a minute.

Underground coal mining is a hazardous operation. Cave-ins become a threat as more and more coal is taken out of a seam. Underground water is often bothersome. The air in some mines may contain inflammable or poisonous gases, such as methane and carbon monoxide. The most dangerous of these is the inflammable gas methane, also known as marsh gas. It is a product of the gradual transformation of coal from dead plants to a mineral. It is particularly to be feared because it is odorless and gives no warning of its presence. In some mines, too, coal dust is dangerous; it makes the air less fit to breathe, and when it is highly concentrated it is a dangerous explosive.

Modern mine operators use a vast amount of equipment in order to reduce accidents and increase safety. Some of the measures which they have adopted go back many years; others were put into effect recently.

A spraying machine is blowing rock dust (lime rock, ground to a powder) over the roofs and walls of a coal-mine gallery. The rock dust dilutes the coal dust, which is a very dangerous explosive when it is highly concentrated.

Miners guard against cave-ins by leaving solid pillars of coal at intervals; they also prop up the roof and walls of the working room with heavy timbers. After the coal has been dug out of a seam, the pillars are generally removed and the roof is allowed to fall. This is called "room and pillar mining." In "long wall mining" the roof is supported, not by pillars, but by walls made of waste materials. Steel and reinforced concrete are also used to avert cave-ins; they serve particularly to support the roofs and walls of main haulage ways.

DRAINAGE SYSTEMS KEEP WATER OUT OF UNDERGROUND COAL MINES

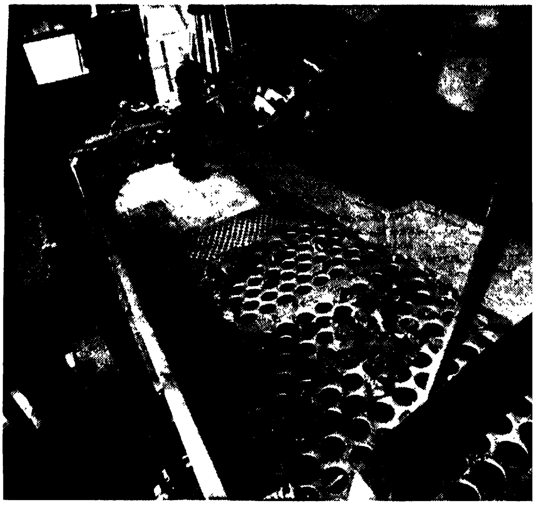
To keep water out of underground workings, extensive drainage systems are provided. In some mines, water runs off by way of a passage leading out from the bottom of a mine. In others, water is allowed to drain into a sump, or reservoir, at the bottom of the mine. From the sump it is pumped out to the surface.

Underground mines are well ventilated in order to provide ample oxygen and to control dangerous gases. Big electrically driven fans, located near the mine mouth, send fresh air circulating through the mine's many passageways, thus diluting or drawing out dangerous gases. Ventilation goes hand in hand with constant watchfulness. Supervisors, called fire bosses, inspect the working areas in order to see that the air is fit to breathe and that it does not contain dangerous amounts of explosive gases. They generally use what is known as a safety lamp. Its tiny flame, enclosed in wire gauze, changes color and warns miners if dangerous gases are present. To lessen the possibility of explosions, no devices causing sparks or open flames are permitted; smoking is banned.

In some mines, water sprays control the dust which is raised in the cutting process. In many mines, powerful spraying machines blow rock dust (lime rock, ground into a powder) over the roofs and walls of the underground tunnels. As a result, the rock dust, which is not inflammable, becomes so thoroughly mixed with the coal dust that there is no longer any danger of a coal-dust explosion..

The miner's clothing helps to guard him from accident. His head is protected by a cap with a hard crown. In front of this cap is set an electric lamp, connected by means of a cable to a battery carried on the belt. The miner wears heavy leather shoes, with steel pieces set under the toe caps. For certain jobs he is also provided with shatterproof goggles, mechanical and chemical respirators (breathing devices), face and eye shields, welding shields and safety belts and harnesses.

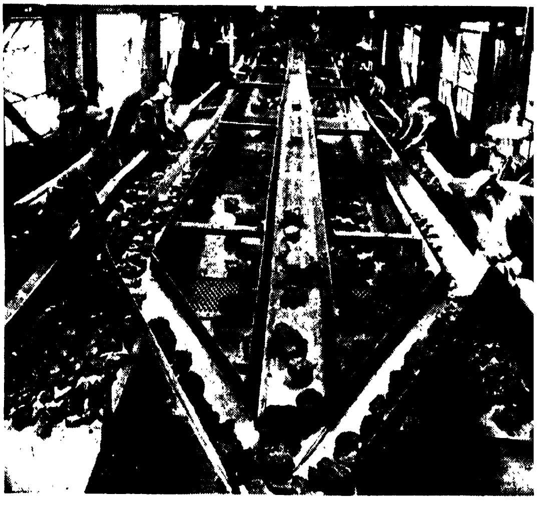
The coal which comes out of the mine is in chunks of many different sizes and is mixed with rocks and dirt. Before it is ready for the market, it must first pass through a preparation plant, located on the surface, near the mine mouth. Here the coal is sorted



Anthracite Institute

In this picture we see the coal being divided into different sizes by being passed over a "shaking screen," with holes that gradually increase in size.

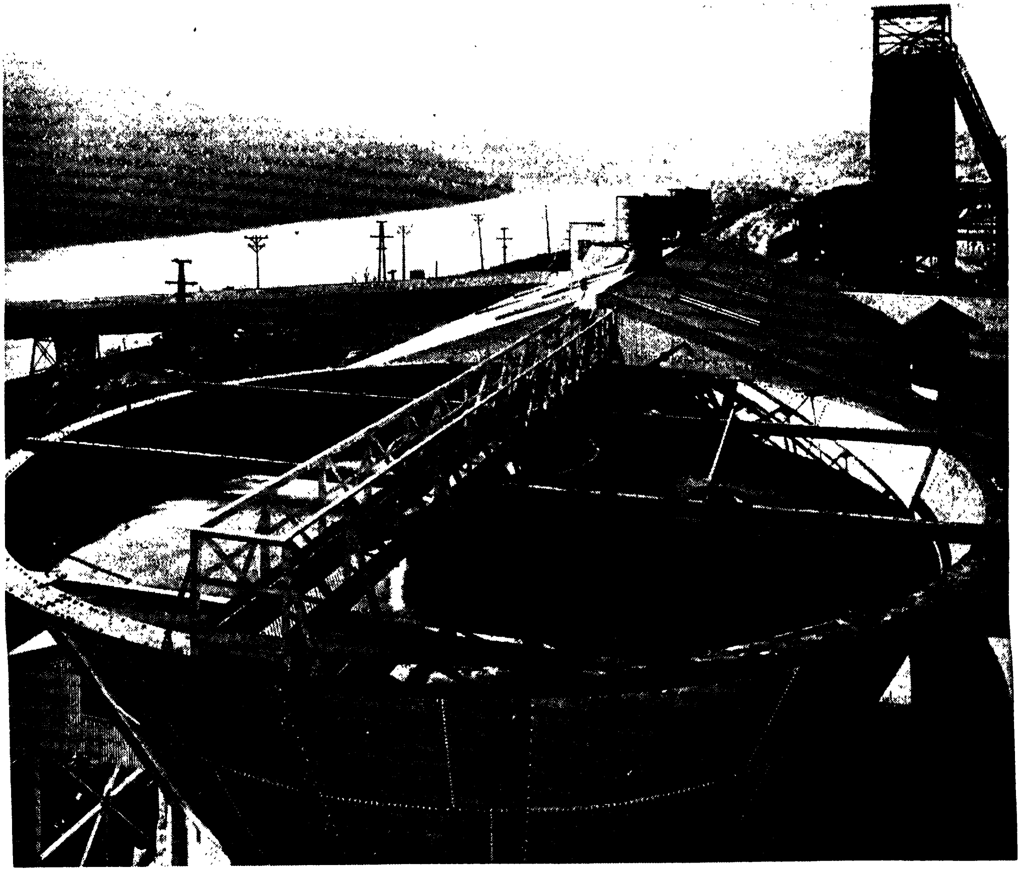
These men, in the tipple of a bituminous coal mine, are looking for pieces of slate or shale, which they quickly remove from the coal as it passes by.



out into different sizes and is cleaned. In bituminous mining the preparation plant is called a tipple; in anthracite mining, a breaker.

Mechanical conveyors carry the coal to the top of the tipple or breaker, where the work of separation and cleaning begins. Big chunks are broken up by rolls with sharp teeth. The coal now passes down a succession of screens. The holes in the first screen are small; they become increasingly larger in the following ones. The screens are tilted slightly; machines keep jiggling them to and fro. Gravity and the continuous forward and backward motion of the screens keep the coal moving; the different sizes drop through the screens into separate chutes.

The largest chunks of coal are passed on to the picking tables, where rocks and other refuse are removed by hand. The smaller sizes are cleaned in a tank through which water is constantly flowing. Since rocks and dirt are heavier than coal, they sink to the bottom of the tank and then pass out through refuse disposal gates. The coal is carried along with the flowing water over a kind of miniature dam. In some mines the coal is cleaned by blasts of air; in others, by a combination of water and sand. Sometimes the coal is sprayed with water or oil in order to lay the dust.



Coal comes from the mines mixed with rocks and dirt, which must be removed before the coal is ready for market. In this picture we see coal being cleaned in a big metal cone-shaped tank, filled with water. Since rocks and dirt are heavier than coal, they sink below and leave the tank through gates at the bottom.

When the coal has been graded and cleaned, some of it is set aside in order to supply power and heat for the mine or to serve near-by areas. Most of it passes into huge bins, set over railroad tracks. From

AN UP-TO-DATE METHOD OF LOADING COAL

National Film Board

Coal from a Canadian mine being loaded into a freight car by means of a machine provided with a conveyor belt. The conveyor belt is run and controlled by the machine, with motor, at which the operator stands.

After the coal has been cleaned and graded, it passes into huge bins, which are set over railroad tracks. From these bins the coal slides down sloping chutes into open freight cars waiting on the tracks below. Most of the coal that is mined in North America is carried to market in freight cars like those shown in the above picture.

these bins the coal slides down sloping chutes into open freight cars on the tracks below. The great bulk of the coal that is mined is carried to market in these freight cars. Freighters also transport a considerable quantity. In the United States the big ships which bring iron ore from the Lake Superior region to Lake Erie ports carry coal on the return trip.

There has been great progress in the methods of extracting and preparing coal since the early days. There has also been a remarkable improvement in the living conditions of the men who mine the coal. In former days a mining town was apt to be a dreary place. It generally consisted of unpainted, one-story wooden shacks, clustering around the mine mouth. The miners rented these houses from the mining company; they bought their food, clothing and other supplies from a company store. There were no paved streets, no sewers, no street lights, no city water in these coal towns. The miner enjoyed few of the comforts of life; he often had a hard time making both ends meet, for wages were generally small in those days.

Today things have changed greatly for the better, particularly in the mining communities of the United States and Canada. American and Canadian miners are now among the most highly paid workers in industry, and their increasing prosperity is reflected in the appearance of coal towns. Solid, comfortable houses are replacing the drab shacks of the past. Many miners now own their own homes. In the most progressive coal towns there are good schools, beautiful churches, up-to-date hospitals and fine moving-picture houses. The miner takes pride in his home, his family, his community. The company store still thrives; it now competes with independent groceries, butcher shops and clothing stores.

Coal serves mankind today in many different ways. It is still used chiefly as a fuel—the most important one of modern times, in spite of the increasing competition of petroleum and natural gas. It is widely used for home heating as well as for large-scale heating in apartments, hotels, schools, public buildings and central heating systems. It runs the dynamos of power-houses; most of our electric current is produced in this way. Coal is used to supply power for railroads and great manufacturing plants. Bituminous coal, anthracite and lignite all serve as fuels.

Sometimes chunks of coal are put up in paper package form, and the package is fed into the furnace, paper and all. Coal that is too fine for ordinary use makes a good fuel when it is pressed together, with pitch as a binding material, to form either briquettes (bricks) or pellets (little balls). Coal is widely used in industry in pulverized form—that is, ground up so as to form a fine powder. This powder, which burns as readily as fuel oil, is blown into the furnace by a blast of air. The gases that result from this type of heating may be used to run gas turbines.

MECHANICAL STOKERS AND OTHER DEVICES MAKE COAL HEATING EFFECTIVE

Various devices are employed to make coal heating as effective as possible. Mechanical stokers, operated by small electric motors, feed coal automatically into the furnace. Some devices remove the ashes from the firebox automatically and deposit them in covered receptacles.

Coal gives us the solid fuel known as coke. We make coke by heating bituminous coal in furnaces into which air is not admitted. Gases and vapors are driven off from the coal. The solid mass that remains, consisting of fixed carbon and ash, is coke.

Formerly coal was coked (that is, made into coke) in long rows of arched ovens. These were shaped somewhat like beehives, and so they received the name of beehive ovens. The vapors and gases that resulted from coking were allowed to pass off into the surrounding air, for people thought that they were useless.

COKING OVENS ARE SPECIALLY DESIGNED TO SAVE THE VALUABLE BY-PRODUCTS

Today we know that these by-products are valuable. To save them for future use, most bituminous coal is now coked in specially designed ovens known, appropriately enough, as by-product ovens. They are arranged in batteries, or groups, consisting of from ten to ninety ovens. Each oven is surrounded by vertical flues in which very hot gases are burned. Bituminous coal is loaded into the oven through the top; then the oven is sealed tight and intense heat is applied. The gases and vapors pass through large pipes to by-product preparation units. The coke, of course, remains in the ovens. A fair quantity of coal is still coked in beehive ovens.

Freight cars, loaded with coal of different sizes, in the switching yards of a large anthracite mine.

Anthracite Institute

A considerable part of the earnings of American railroads comes from the hauling of coal from the mines. For their part, the railroads are good customers of the coal companies, since a good many locomotives still burn coal.

FROM BITUMINOUS COAL TO COKE

This striking picture shows bituminous coal being converted into coke in a battery of by-product ovens. These ovens, as the name indicates, are specially designed to save the valuable by-products of the coking process.

Coke serves only to a limited extent for domestic heating. It is far more important as a fuel in the smelting of ores; it is the chief fuel used for that purpose today. (See the article on Iron and Steel.) Coke is also employed in the manufacture of water gas and of certain chemicals.

Coal, the most important solid fuel, is used to make both gas and liquid fuels. In our article on the Story of Gas, we tell you how coal and coke are converted into the manufactured gas that is used in our kitchen ranges and heating units, as well as in industry.

FUEL GAS FROM COAL BURNED IN ITS UNDERGROUND SEAMS

In recent years mining engineers have sought to produce fuel gas by burning coal in its underground seams. This method is called underground gasification. The Russians claim that they have been experimenting with it for some time. In the United States the first experiment in underground gasification took place in an Alabama mine in January 1947. Mining engineers claim that the process is very promising. It will make useful the coal in seams that could not be mined profitably, either because they are too thin or because they are too far away from railroads or freighters.

There are two important methods, both developed in Germany, for converting coal into fuel oil. One is known as the Bergius hydrogenation method. (Hydrogenation means combining with hydrogen.) In this process pulverized coal, suspended in oil, is heated to about 450° Centigrade (842° Fahrenheit). It is then made to react with hydrogen gas in the presence of a catalyst. (A catalyst is a substance which speeds up a chemical reaction without being changed itself.) The reaction produces fuel oils, gases and solid wax.

The other method of changing coal into liquid fuel is called the Fischer-Tropsch water-gas process. Steam is blown through hot coal or coke, and water gas—a mixture of carbon monoxide and hydrogen—is produced. The carbon monoxide and hydrogen are then made to react together in the presence of a catalyst. As in the case of the Bergius process, the end products are fuel oils, gases and wax.

Bituminous coal has been the chief source of fuel oils produced from coal. Lignite is also a good coal for this purpose.

It costs more to produce gasoline and Diesel oil from coal than from crude petroleum. Perhaps the cost of production will decrease in time. However that may be, it is comforting to know that coal can be made to yield liquid fuels. The known reserves of petroleum are comparatively limited; they may all be used up in a few hundred years. On the contrary, as we shall see, there is still plenty of coal in the ground. When man has used up all his petroleum supplies, there will still be plenty of liquid fuel available—liquid fuel made from coal.

When we talk of coal as a raw material, we have in mind particularly the gases and vapor that result from coking. We have seen that when coal is coked in by-product ovens, the by-products are piped from the ovens to special preparation units.

Here they are cooled by a water spray and they yield fuel gas, ammonia and coal tar. Some of the fuel gas serves to heat the by-product oven; the rest is piped to city mains for use in our homes and factories. The ammonia is treated with sulfuric acid and is transformed into ammonia sulfate, a valuable fertilizer. The coal tar is a thick, black liquid with a most disagreeable smell. It certainly does not look promising; yet it is one of the chemist's most precious raw materials.

When it is distilled, it yields a dozen or so crudes (raw materials), including pitch, benzene, toluene, naphthalene, anthracene, phenol and cresol. There is almost no limit to the ways in which these crudes serve mankind. Generally combined with other materials, they have already yielded more than 200,000 products.

THE NUMBERLESS PRODUCTS WHICH COME FROM COAL-TAR CRUDES

Coal-tar crudes give us picric acid, trinitrotoluol (TNT) and most of the other explosives used in industry and war. They yield dyes with all the colors of the rainbow, as well as a bewildering variety of perfumes and flavorings. They serve as a base for many plastic materials. (See the article on Plastics). They also give us paving materials, textiles, roofing paper, the timber preservative creosote, the food preservative benzoic acid, moth balls, photographic developers, paints, synthetic rubber, the sweetener saccharin and many other products.

Coal-tar crudes also help to guard the health of mankind. From them we obtain valuable vitamins—nicotinic acid, B complex, vitamin K. They provide us with powerful disinfectants and antiseptics. They also yield a great variety of drugs used in medicine; among others, the pain-killers aspirin and anacin; the sulfa drugs, which represent one of the greatest medical advances of the twentieth century; novocaine, which deadens our sense of pain; and atabrine, used to ward off or treat malaria.

Coal-tar crudes also provide strong allies in our ceaseless fight against animal and plant enemies. DDT, the insecticide, is derived from a coal-tar crude; so is ANTU, the deadly rat poison; so is 2,4-D, which has worked wonders in killing off weeds of lawn and garden.

Such, then, is the story of coal. How long will this wonder-working mineral be available to mankind? We saw that existing coal beds are the result of a natural process that started millions of years ago. The process is still going on in nature, but it is slow, indeed, compared with the rate at which we are using up our coal supplies. We must consider coal, therefore, as a resource which can not be replaced once it has been withdrawn from the earth.

It is fortunate that we still have tremendous reserves. For all its vast production, the United States still has plenty of coal underground; so have practically all the other countries which are now producing coal in quantity. China, which is not an important producer, has enormous deposits which have hardly been tapped as yet. New discoveries of coal fields will undoubtedly add to the world supply. The coal prospector is likely to strike rich finds in Siberia, Afghanistan, the Orange Free State, the province of Alberta in Canada and the vast southern region which we call Antarctica.

It has been estimated that there are still seven and a half trillion (7,500,000,000,000) tons of coal in the earth. If we continue to use coal at the present rate—about a billion and three-quarters tons a year—these reserves will last us for rather more than 4,000 years. This figure will have to be changed, of course, if the yearly production goes up or down in the future. It seems perfectly clear, however, that man will not have to worry about his coal supplies for a long time to come.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 858.

A modern coal-mining town in Virginia. Living conditions are excellent in towns like these. Many miners own their own homes. There are well-stocked stores, progressive schools, fine churches and up-to-date hospitals.

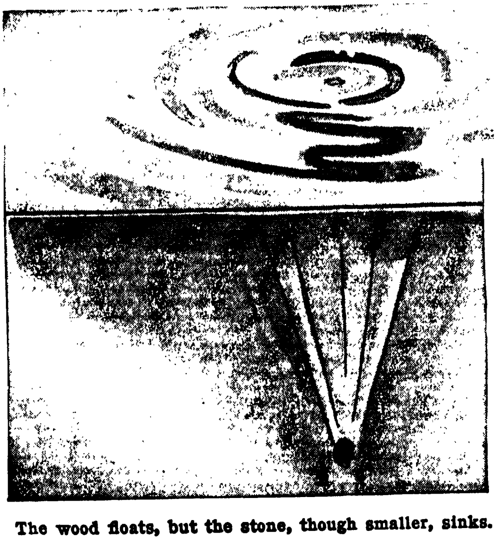
DENSITY and SPECIFIC GRAVITY

THROW a stone into a pond. It sinks. Throw a chip of wood. What happens? Yes, it will float. Why? Why does some soap float on the water in your bathtub, while other soap sinks?

Your first answer might be: "The stone is heavier than the wood, and the soap that sinks is heavier than the one that floats." But think—a very small pebble will sink, while a very large, heavy board or log will float; and a small scrap of one kind of soap will sink, while a large, much heavier bar will float.

To find the answer to our question, we must consider the density of the various materials we have been discussing.

What is density? It is the amount of matter packed into a thing in proportion to the space it occupies. The total amount of wood-stuff in a board is the board's mass. The space it occupies is its volume. The amount of mass in, say, every cubic inch gives the density of the board. Wood has a smaller density than stone. Stone is packed very tight with stone-stuff, while wood has many spaces. Some kinds of soap are purposely made with spaces between the soap particles. Other soap is more dense, more closely packed together with soap-stuff.



The wood floats, but the stone, though smaller, sinks.

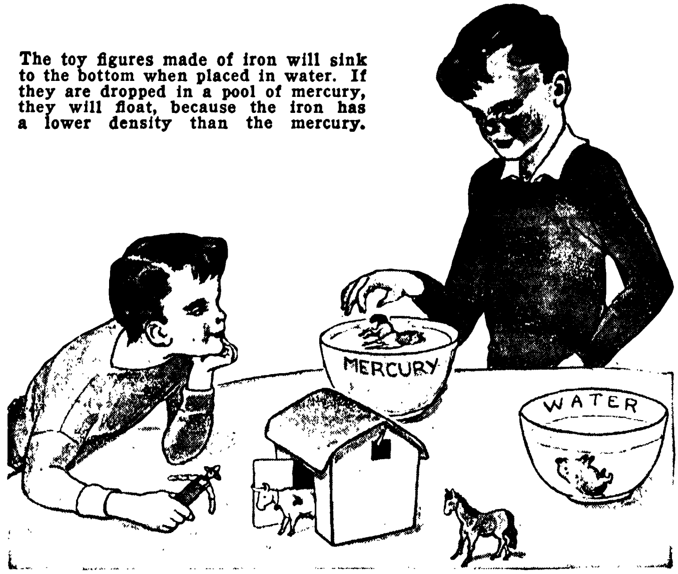
Density is mass per unit of volume. If we want to be very exact, we shall call this mass-density, not just density.

We have still not answered why the less dense objects will float on water while the more dense objects (the stone and the close-packed soap) must sink. The fact is that less dense things will float on more dense things. Water is more dense than ordinary board; but water is much less dense than stone.

We can give you many more examples. Cream floats on milk, because cream is less dense than the milk. A person who can not swim will sink if he falls into Lake Ontario, but a person falling into the Dead Sea could not possibly sink, for the Dead Sea, thick with salt, is denser than the human body; whereas the water of Lake Ontario is less dense than the human body.

In general, gases are less dense than liquids, and liquids are less dense than solids. Yet (as we have already seen) there are many exceptions. The most dramatic exception is that of mercury, a very dense liquid. You may know it as quicksilver, the heavy silver fluid in the tube of a thermometer. So dense is mercury that iron and steel machinery is sometimes made that will float on mercury.

Hot, or warm, water will float on cold water (as long as the temperature of the cooler water does not go down below four degrees Centigrade.) Some distance below the surface, the Gulf Stream is as cold as the surrounding ocean, while the upper layers are warm. Why do the warm layers float? Because increased heat means increased motion of molecules. This tends to counteract their attraction for one another. The molecules of cold water tend to herd together, which makes cold water more dense.



The toy figures made of iron will sink to the bottom when placed in water. If they are dropped in a pool of mercury, they will float, because the iron has a lower density than the mercury.

THE HIGHER THE ATOMIC WEIGHT OF A SUBSTANCE, THE GREATER ITS DENSITY

Density is determined by the structure of a substance (the air spaces in some soap, the tightly packed stone, and so on); density is also determined by the atoms of a substance, and this is most important. Atoms of greater atomic weight are denser than atoms of less atomic weight. In the following examples, we give you the approximate atomic weights of various elements—for instance, 56 for iron. A more exact figure is 55.85. Atomic weights, as you have already learned, are relative, using $\frac{1}{16}$ of the atomic weight of oxygen as 1. Thus hydrogen has atomic weight 1.008.

Iron (weight 56) will float on mercury (weight 200).

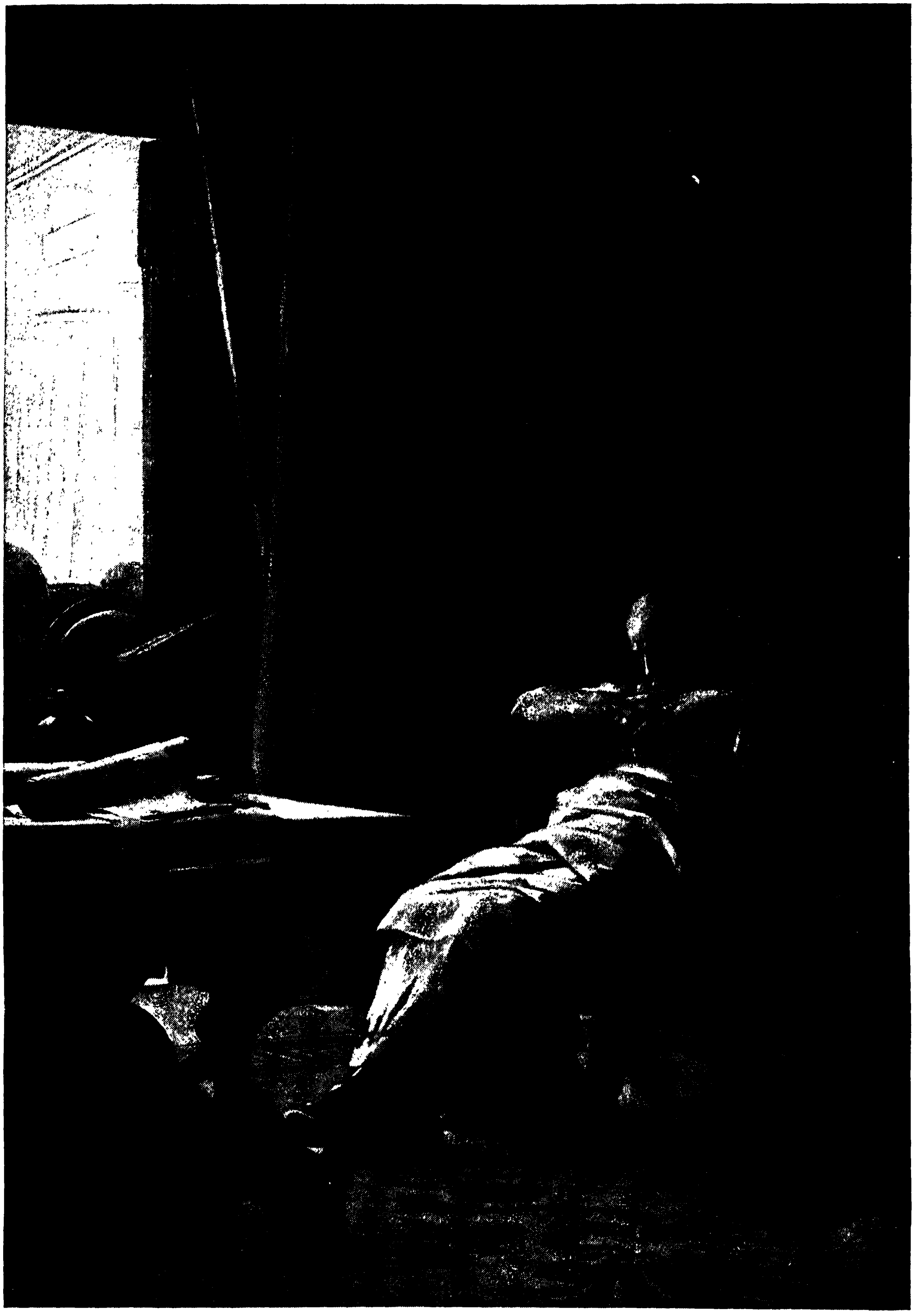
Hydrogen (weight 1) and helium (weight 4) are used to lift great balloons into the air—which is a mixture of nitrogen (14) and oxygen (16) and traces of other gases. The upper layers of air, miles above the earth, gradually become thinner; the oxygen, nitrogen and other gases are spread out, with large spaces between their molecules. If the balloon rises far enough it will reach a point where the air is no longer more dense than the hydrogen-filled or helium-filled balloon. A state of equilibrium is reached; the balloon stops rising.

If you have ever held a gold coin in one hand and a silver coin of the same size in the other, you have noted that the gold (atomic weight 197) is much heavier than the silver (atomic weight 108). Do you know how much a cubic foot of gold would weigh? About a ton. Yet all elements, even uranium, the heaviest of elements known in nature, are mostly space; for the nucleus of every atom is surrounded by space with here and there an electron dancing. It is the protons and neutrons in the nucleus that provide most of the mass and most of the weight of an atom. We are told that a thimble packed full of protons and neutrons would weigh a million tons!

TWO METALS THAT ARE LIGHT, YET VERY STRONG

We say a thing is "as heavy as lead" (atomic weight 207). Many trains, planes and other modern machines are built with aluminum, partly because it is light in weight (27) yet very strong. Aluminum pots and

ONE OF THE GREATEST ANCIENT SCIENTISTS



Culver Service

Archimedes, a Greek scientist. His famous experiments proved the relationship between density and specific gravity.

pans are lighter than iron ones. Magnesium (24) is even lighter than aluminum, and it is being used more and more in modern industry because of its lightness combined with strength.

HOW ARCHIMEDES SOLVED THE PUZZLE OF THE KING'S CROWN

Men knew about the density of various metals before they knew very much else about matter. Archimedes was a Greek scientist in the ancient city of Syracuse, in Sicily, when Hiero was king. Hiero gave a certain weight of gold to a jeweler to have a new crown made. The crown was delivered, and Hiero found that it weighed the same as the gold he had given the goldsmith. Yet the King suspected that he had been cheated. Perhaps the goldsmith had stolen some of the gold and mixed silver with the remaining gold—just enough silver to make the weight right. How could the King ever know?

Hiero sent for Archimedes, and ordered the scientist to solve the puzzle. Archimedes thought long over this. If he could have obtained the exact volume of the crown the rest would be easy. (The given weight of gold would come to a certain known volume. If silver were added, and the weight remained the same, the volume would increase. That is, the crown would be larger than if it were made of pure gold.) But how could you measure the volume of a crown, with all the decorations and curlicues?

One day, in the public bath in town, Archimedes noted how the water rose in the tank as his body sank into it. This gave him the clue! Each substance, completely immersed in water, must displace a volume of water equal to the volume immersed. Shouting "Eureka!," which means "I have found it," he ran home, called for a basin partly full of water, let the crown down into it and noted how high the water rose. Then he took out the crown and immersed a lump of gold of the same weight as that given to the jeweler, and noted how high the water rose. Then he knew whether or not the King had been cheated. This is only an old legend, of course.

SPECIFIC GRAVITY IS A TERM OFTEN USED IN SCIENCE AND IT SHOULD BE UNDERSTOOD

The amount of water which an object will displace is popularly called the specific gravity of the object. Now that scientists understand what density is—and what relation it has to atomic weight—they do not often have to use the roundabout way of measuring. Yet you will still find many references to specific gravity and so it will be well to consider it briefly.

The pull of gravity is different for each element. When we wish to measure the force with which gravity pulls on the different kinds of matter, we look for a material to use as a standard. Liquid water is a good material to use, for it can be found almost everywhere; everybody is familiar with it.

WATER IS HEAVIEST AT A TEMPERATURE SLIGHTLY ABOVE ITS FREEZING POINT

Ordinary water contains various things dissolved in it, especially gases, and these make a difference. So when we speak of water in this connection we mean distilled water. Even distilled water varies as to its gravity according to temperature. We must have a more exact standard. Water is densest —most shrunken, or heaviest—when it is 4 degrees Centigrade above its freezing point. Now we have a standard. The specific gravity of pure distilled water at 4 degrees Centigrade we call 1. If we find anything that has twice the weight as the same volume of water we shall say it has specific gravity 2; and so on.

A SUBSTANCE WITH A SPECIFIC GRAVITY OF LESS THAN ONE WILL FLOAT ON WATER

Here is a table which shows us the specific gravities of some important substances as compared with the specific gravity of water counted as 1. Those things which possess a specific gravity higher than 1 will sink in water; while those which have a specific gravity less than 1 will float upon water.

SOLIDS

Platinum (rolled)	22.1	Tin	7.3
Gold	19.3	Diamonds	3.5
Lead	11.4	Marble	2.8
Silver	10.5	Aluminum	2.7
Iron (wrought)	7.8	Potassium	0.9
Iron (cast)	7.2	Cork	0.2

LIQUIDS

Mercury	13.59	Sea water	1.03
Sulphuric acid	1.84	Petroleum	0.84
Blood	1.05	Alcohol	0.79
Milk	1.03	Ether	0.736

Gases, of course, have their own specific gravity, just as solids and liquids have. In this case we usually take the gas hydrogen, which is the lightest of all, and we state the specific gravity of other gases by comparison with it. If we call the specific gravity of hydrogen 1, that of oxygen is 16, and that of the mixture of gases we call air is about 14.4.

THE NEXT STORY OF SCIENCE IS ON PAGE 849.

Both pictures, Metropolitan Museum of Art, N. Y.

Model of fishing or fowling boat. It was found in the tomb of Meket-Re, a pharaoh of the Eleventh Dynasty.

EGYPT'S FASCINATING STORY

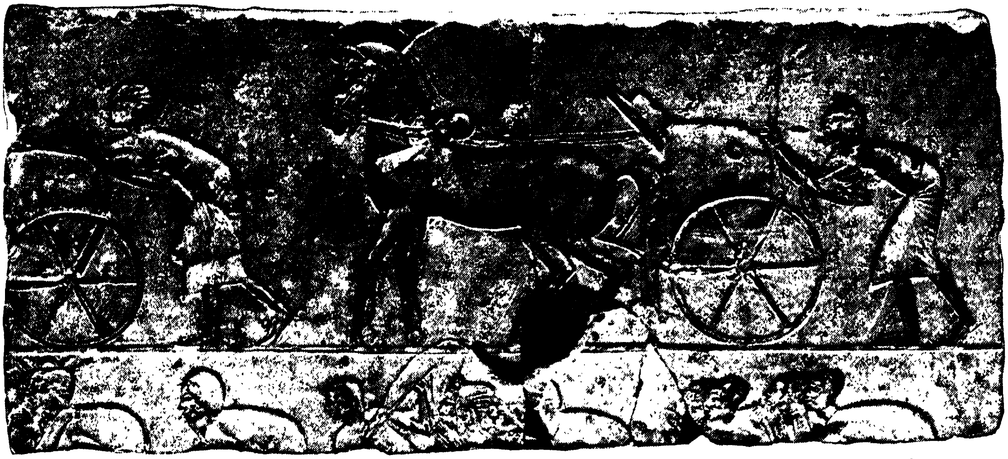
A SECRET is one of the most fascinating things in all the world. When you have found it out, part of its charm may have flown; but as long as you are kept wondering about it you are on tiptoe with expectation and excitement. Do you know of a country that kept shining secrets hidden for centuries? Golden sands, lying smooth and silent beside the stream of a long blue river, gave no sign of brilliant pageants that had long ago passed back and forth there. Rock cliffs stood calm and blank under the blazing sun, never revealing a hint of the treasure they were holding. Egypt—the word itself looks cryptic, secretive. The Nile, the ancient sacred river, the very life and heart of the long, narrow land of Egypt, seems to smile like a deep-eyed, beautiful creature always suggesting wonderful things that might be uncovered at any moment.

Beckoned by these gleams of mystery, and guided by a thread of historic truth, scholars set themselves to learn some of the age-old secrets hidden behind Egypt's strange smile. Patiently they dug and sifted the sands, persistently they pierced the doors of the rocks, seeking knowledge of men and events that made up the history of the early centuries of civilized life.

Painted wooden statuette, probably made in the Seventeenth or Eighteenth Dynasty.

We know that man had come a long way on the road to civilization before he invented writing, which provided a way of recording deeds for the benefit of later generations. This was the beginning of written history; and the earliest written history of the land of Egypt that has yet been discovered was probably inscribed more than six thousand years ago.

Six thousand years! It is a long reach of time over which to try to look back. While you count your own life-story by days and weeks, we reckon the life-story of old Egypt by stretches of hundreds of



Both pictures, Metropolitan Museum of Art, N. Y.

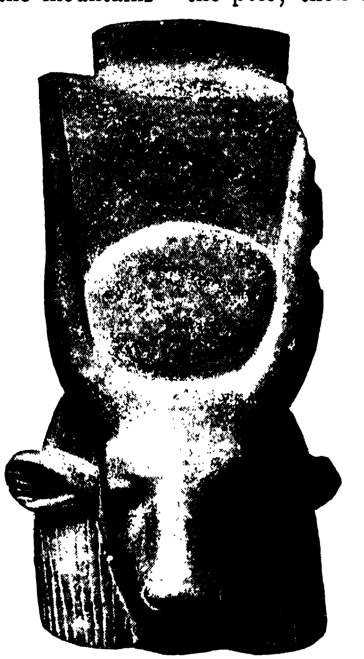
A carving of the Eighteenth Dynasty. Above we see two of the king's charioteers, standing behind their chariots.

years, catching sight of only the higher spots in the long, long prospect.

We have said that the Nile is the life of Egypt, and truly, for without the river no one could live in that sandy, rainless region. The desert, stretching all across northern Africa, pauses on the threshold of this river valley, whose waters come down from mountains far to the south.

With melting snows upon the mountains and flooding spring rains, the waters of the upper river are swollen. Down and down they flow—down and down and down, until the lower valley is but a broad expanse of water dotted here and there with palm groves. Irrigation canals and reservoirs catch the surplus—for the Egyptians learned, ages back, to control this water supply—and the rest spreads over the fields, depositing upon them the rich, black earth which will renew the fruitfulness of the soil. In this fertile ground—gift of the river—the crops prosper amazingly well.

But when the river has shrunk back within its narrower limits, the water must be lifted to the higher fields in order to keep the crops growing. The history of Egypt is, in part, the story of efforts to water the thirsty land. Next to the actual carrying of the precious liquid by hand came a simple primitive device which has been kept continuously in use until to-day. This is a sweep made up of a pole and a bucket, like an old-fashioned well-sweep. The bucket, dropped into the stream to dip up a load of water, is swung up and around by means of the pole; then the water is poured into an irrigation ditch or into another bucket, to be swung to a still higher level. In India this device is called a denkli, and in Egypt, a shadoof. It groans and creaks as it carries on its steady necessary work to help provide food for the life of the land. What wonder that the men of Egypt worshiped their river, source of life itself to them? Of course modern methods of irrigation have been brought to the land, further controlling the spreading waters.



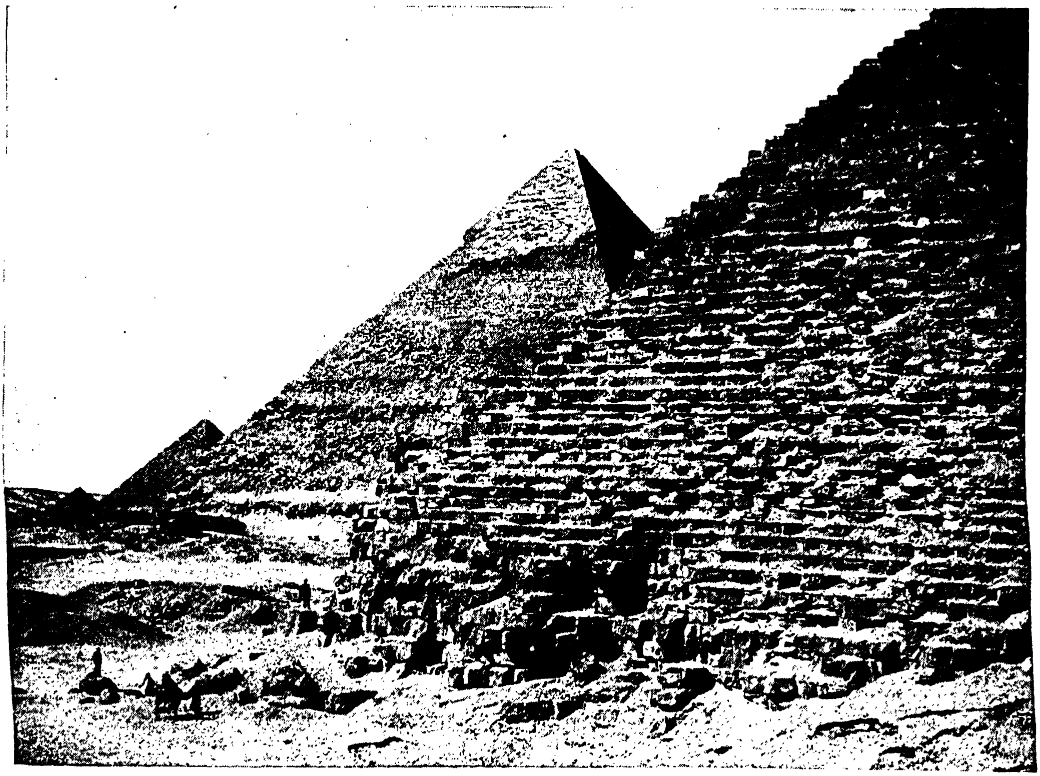
The goddess Hathor, with cow head and, above it, the disc of the sun.

Perhaps the first thing that you would look for if you went to Egypt would be the pyramids—particularly the Pyramids of Gizeh—built to be the tombs of pharaohs when Egypt was young and the sovereigns lived at Memphis, the city of Menes, who united Upper and Lower Egypt into one nation perhaps about 3400 B.C. and founded the First Dynasty (or family) of rulers. Never have kings or conquerors since had such massive tombs. The Great Pyramid, largest of them all, was made for Khufu, or Cheops, a monarch of the Fourth Dynasty of kings, reigning about 2900 B.C. Its base is a huge square which was originally 755 feet long on each side, inclosing nearly thirteen acres of ground. With the exception of a few passages and the funeral chamber, the structure was solid, layer upon layer of enormous stone blocks piled one upon another, each layer covering a little smaller square than the one before, until the top stood 482 feet above the ground level. (It is now only 451 feet high.)

What a scene must have been the building of such a mass, with such a base and such a height, so many centuries ago! You have watched motor trucks carrying bricks and stones for the buildings of to-day. Not so was the material for the pyramids transported. In the largest pyramid there was enough stone to build a good-sized modern city. More than two million limestone blocks, of about forty cubic feet each, were hewn from the hills on the other side of the Nile, floated over the river, and by enormous effort of human labor were drawn, pushed or rolled to their places in that monumental pile. Rollers, levers, pulleys and ropes were the contrivances used; the roadway was oiled; and a mighty inclined causeway was constructed, up which the material traveled to the plateau of the pyramid. All was controlled by the most careful engineering skill, all planned with the most exact calculation. We marvel now to see how each great block fitted upon its neighbor with astonishing exactness, with so narrow a seam sometimes that it can hardly be seen. The whole work is supposed to have taken from twenty to thirty years and to have been done by about a hundred thousand men at a time.

The outer casing was made of smooth and polished blocks, to form an even shining surface for each face of the four-sided mass; but these are now gone, leaving a series of rough, irregular steps, each so high that to climb them you must be pulled and lifted up.

Standing before the pyramid itself was



Ewing Galloway, N. Y.

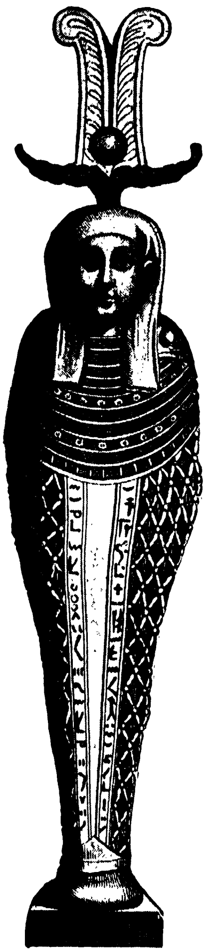
Corner of the Great Pyramid, the world's largest, made for Khufu, or Cheops, a monarch of the Fourth Dynasty.

the pyramid temple, where services were held on feast days; and from this temple a long covered causeway led down to the lower level beside the Nile, where a portico, or secondary temple, stood. Imagine the boats coming along the river and drawing up in front of the lower temple, where priests in their robes and courtly persons in their festive garments, disembarking, would gather for preliminary services before forming a solemn procession through the causeway to the upper temple to perform their rites in memory of the king who had superintended the building of this impressive and massive memorial.

And what was the object of all this thought and labor and expense? Simply to honor and glorify the reigning monarch and provide for a safe place for his small but sacred body after death? More than that: it was a symbol of a deep and solemn faith in the immortal life of the soul. To the ancient Egyptians, the most important thing in life was to plan for the soul's safety and happiness in the after-life, and as this was believed to depend upon the body being kept whole for the use of the soul, every safeguard was prepared to protect it from destruction.

There are several groups of pyramids not far from the modern city of Cairo, but none of the others can vie in size or importance with those of Gizeh. The earliest of them were "step" pyramids, built without the outer layer of facing-stones that came into use afterward.

A pyramid was a tomb for the king or one of his family. Lesser folk than royalty had burial places of different sorts. Near the pyramids were the tombs of officials and nobles connected with the court of the king. They are the kind we know as mastaba tombs, so named from the long, flat Egyptian benches which they resemble. One of these tombs, in a cemetery near old Memphis, was built perhaps 4,500 years ago by Perneb, Lord Chamberlain, Keeper of the Crowns and "Companion" to his king, probably one of the kings of the Fifth Dynasty.


Culver Service
Isis, chief Egyptian goddess. The cow was sacred to her, so she has a cow's horns.

In it, as in the other mastaba tombs, there were several chambers: a chamber for Perneb's statue carved in cedar; an adjoining chamber shut off from it by a thick wall with only a slit of an opening, through which the family and friends could look at the figure; and the main chamber, entered through a vestibule. The walls of the main room were covered with painted scenes telling the story of the man's daily-life pursuits and showing processions of slaves bearing offerings for his use. One wall contained a false door, before which food and other gifts were to be placed; and beyond it, but walled from sight, was the top of the deep shaft leading down to the burial chamber.

There is good reason for believing that after a few generations Perneb's descendants began to neglect the duty of bringing him offerings, that the tomb gradually passed from their thought and attention, and that robbers broke in to carry off all that was of value. In time the desert sands drifted in, nearly filling the chambers. While the walls of neighboring tombs disappeared in the long course of centuries, the stones being carried off to be used for building houses or other tombs, Perneb's escaped this fate because it was made a dumping place for the rubbish cast aside by the ravishers. Then in our own century it came to light again under the spade of the excavator. Stone by stone it was taken down and carried across the ocean to New York City, where it was all put together again inside the Metropolitan Museum of Art.

There, standing opposite the entrance door, you may see on each side of it a picture of Perneb, staff in hand, as if he were about to walk off to attend some court duty. Inside, you may study the many pictures on the walls, noticing how the people dressed and what they liked to eat and to do. You may face the false door, imagining yourself a member of Perneb's family about to place some choice little gift upon the offering table, that it might be at his disposal whenever he might feel a craving for the delicacies in which he delighted in life.

For the Egyptians believed that, in some mysterious way, in the new life to which he had gone the departed person would need the same sort of things that he had owned in his earthly life. So, into the burial chambers of royal and rich persons were put their valuable ornaments and other possessions, besides furniture, clothes and food for the use of the spirit of the departed. Models of human figures were also left in the tombs. It was firmly believed that they would become companions and servants in the new existence. Every one of these figures and objects was believed to have a double which would be ready for the double of the dead person at any time.

Both pictures, Metropolitan Museum of Art, N. Y.

An Egyptian game, probably made in the Twelfth Dynasty. The playing pieces, which are of ivory, are inserted in holes in the table.

The sight of these personal belongings brings us closely into touch with the Egypt of three or four thousand years ago. In the great museums in Cairo, Berlin, Paris, London, New York, Boston, Chicago and elsewhere we may see both curious and beautiful reminders of Egyptian life. In the British Museum, for instance, there are cases full of treasures, including dolls with clay beads for hair, other toys, little worn shoes and sandals from the feet of children, a fine lady's dressing-cabinet fitted with jars and bowls for ointments and other toilet articles, her elbow-cushions and dainty slippers. There, too, are the palette and paints of the scribe, musical instruments—in fact, hundreds of things that bring us almost face to face with the men, women and children to whom they belonged all those many long centuries ago.

It is the same in the Metropolitan Museum in New York, where you will find the most interesting models of buildings and boats, of masters and servants. A great man sits upon the deck of a boat, with musicians to entertain him, lotus lilies to furnish beauty, and scribes to give him reports, as well as rowers, steersmen and fishermen. There are other models of slaves at work in graneries, bakeries or stables—busy with the day's work of gathering or preparing food for many mouths.

These little models were made to be placed in tombs, and there they remained, shut away from the light and from the knowledge of men for centuries upon centuries.

Upon the walls of the tomb chambers, painted with devotion, there are many representations of the gods worshiped in life and to be met in the nether world after death. It is natural that the sun should have been generally adored as a ruler and life-giver in a land where the days were always flooded with sunshine. As the god Re (or Ra) he sailed across the sky in a celestial boat every day, to return in another boat upon another stream through the underworld.

From among the many local deities in different parts of the land a few became generally recognized and worshiped. Foremost among them was a family group of three—Osiris, Isis and Horus—around whom the following legend was woven. When the sun-god had been raised to the heavens, Osiris took Re's place as king upon earth, ruling wisely and generously until he was deceived and slain by his wicked brother Set. Isis, the wife of Osiris, after great sorrow and trouble found the body of her husband; and with the help of the jackal-god Anubis prepared it for burial: then by magic charms she brought back life into the body. Osiris, alive but unable to return to his earthly kingdom, became from that time the ruler of the nether world—lord of departed spirits. But Isis did not rest until their son Horus had avenged his father's death by overthrowing Set and taking his place upon the

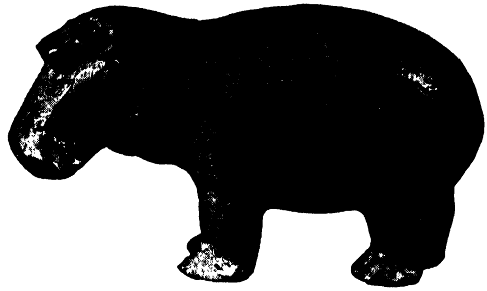
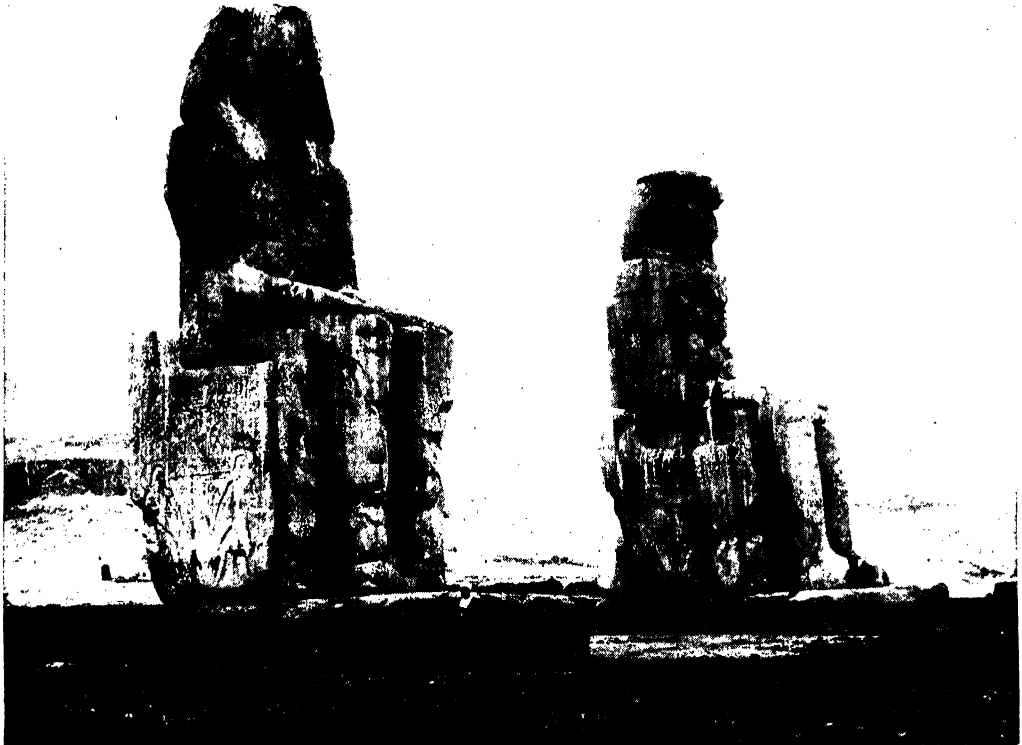


Figure of a hippopotamus, in decorative earthenware. It came from the tomb of Senbi, who lived at the time of the Twelfth Dynasty.

throne that had once belonged to Osiris.

Anubis, the jackal-headed deity, became known as the god of embalmment and the guide of the spirit to the realm of Osiris. Thoth, with the head of an ibis, was looked upon as the patron of letters, the originator of the fine arts, and the one who acted as scribe to the gods. The sky-goddess—sometimes as Hathor with a cow's head, sometimes as Bast with a cat's head, sometimes in other forms—had especial influence over the life of women. Osiris was the good being, Set the god of evil and harm. Horus, whose symbol was a falcon, had been originally connected with the worship of Re.

Because the life of the soul could not go on if the body were not preserved, an elaborate process of embalming it was gradually developed. For the rich and important a long and costly process was used, the very same process, it was claimed, that Anubis had used in preparing the body of Osiris. With accompanying prayers and rites the embalmers proceeded to remove perishable organs, to cleanse the spaces with palm wine and to fill them with aromatic material; then they let the body soak for seventy days in a preservative bath, becoming "slowly impregnated with immortality," as someone has expressed it. Meanwhile the family waited in a sorrowful atmosphere, living on plain, coarse foods; allowing themselves to go unkempt; and mingling their tears over the most sorrowful thought that their loved one had left them, never to return.



Ewing Galloway, N. Y.

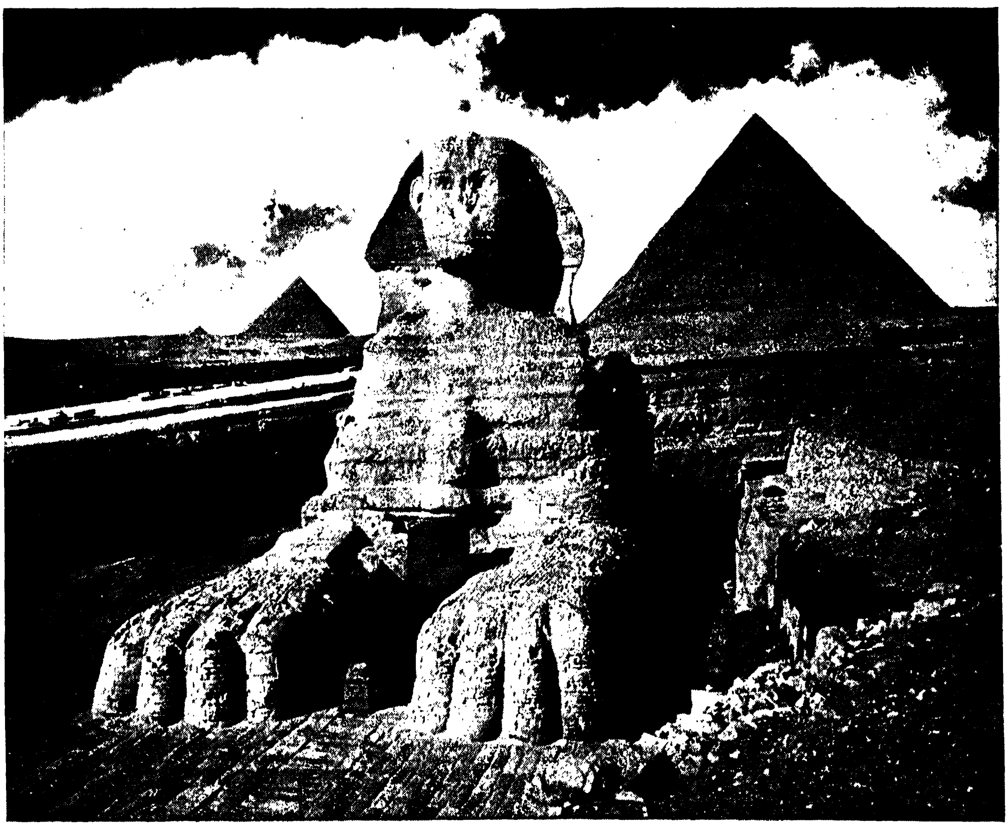
These huge statues near Thebes represent Amenophis III. They were once thought to be statues of Memnon.

The next step in caring for the mummy was to place amulets and rings and dried flowers upon the form and wrap it in layers of linen bandaging soaked in gums, with bits of preservative substances tucked in. When the mummy was encased in his coffin he looked like a statue of himself for the coffins were modeled to follow the outlines of the swathed form, the head covering being made to reproduce the features of the dead person, with eyes of enamel as a final touch. A painted wooden casket or a carven stone sarcophagus made a further guaranty against the body being molested. Less costly methods and materials were employed for those whose purses were not well lined with gold; but everyone hoped for the survival of his soul through the careful preserving of the body.

Not far from the Pyramids of Gizeh is an enormous figure hewn out of the living rock, with the head of a man and the body of a lion—the Sphinx—so large that it could scarcely be got into the largest of our modern buildings. From time to time, through the centuries, the sand which drifted over it has been cleared away, and the shape brought to light. An inscription between the fore-paws refers to Khafra and seems to show his connection in some way with the great mysterious form.

The face looks out to the far horizon with calm dignity and detachment, changeless through thousands of years, except for the wear of time and the wanton mischief done to it when Mohammedan soldiers used it as a target. It has an impressive majesty of its own. Some travelers have been astonished at noticing how similar the thick lips and the cast of the face are to those of some of the country youths of Egypt to-day.

The history of ancient Egypt falls into three great periods: the Old Empire, with its capital at Memphis; the Middle Empire and the New Empire with Thebes as the seat. The Old Empire lasted from, perhaps, 3400 B.C. to about 2100 B.C. Scholars disagree violently about these dates, and no one is able to be certain of them. There were twelve important families, or dynasties, ruling Egypt during these thirteen hundred years. Menes, as we have seen, founded the First Dynasty; and Khufu, or Cheops, was a monarch of the Fourth Dynasty. He it was who built the Great Pyramid, and perhaps also the mighty Sphinx. Some scholars believe the Sphinx was built by Khafra, who was also a king of the Fourth Dynasty. Senoferu, Third Dynasty, and Pepi, Sixth Dynasty were other strong men of the Old Empire. At about the Tenth Dynasty we find Heliopolis (City of the Sun) gaining in power, and in the Eleventh, Thebes became



Ewing Galloway, N. Y.

The Sphinx of Gizeh, one of the most famous statues in the world. It has the body of a lion and a human head.

the great city of Egypt. Ammon, or Amen, the god supreme over the other gods, was worshiped, and we see his name repeated in some of the kingly names, Amenemhat, and others.

The Twelfth Dynasty, the beginning of the Middle Kingdom, saw the high mark of Egyptian culture. Art and literature flourished. Trade was carried on with other lands, possibly as far away as Babylonia. The kings and nobles of the Theban period were buried in splendid rock sepulchres, in the Valley of the Kings' Tombs, along the limestone cliffs opposite Thebes. Far into the rock they penetrated, making long galleries and halls to approach the burial chamber with its huge sarcophagus of stone.

Near the ruins of Thebes are the still imposing remains of magnificent temples, for the pharaohs built the gods dwellings far grander than their own palaces. Even to-day the great halls, imposing gateways and rows of pillars form a most impressive and beautiful sight, whether in brilliant sunshine or deep purple shadow. As we gaze at them we fancy them once more in their first glory, with long processions of chanting priests and priestesses, a gorgeous display of magnificence when the king came to worship, amidst the stately monuments of gold and silver, adorned with ivory and precious stones.

Metropolitan Mus. of Art, N. Y.
This earthenware dancer, a product of one of the later dynasties, was once a decoration in a shrine.

If we look at the walls and columns of the temples, at the solid vaults, at the coffin-cases, at the sculptures and the wall-paintings, we shall find most of them covered with picture-writing. Until a century ago no one could guess what it all meant. Then at Rosetta, near Alexandria, a soldier of Napoleon's army found an engraved stone which served as a sort of key to unlock the mystery.

On the stone, known as the Rosetta Stone, is a certain decree about keeping a king's birthday, and the same decree is given in three different kinds of writing. The lowest is in Greek, which scholars know well; the top is in the Egyptian picture-writing used on the monuments, and the middle one is also in the Egyptian language, but in a more running kind of writing used for everyday purposes—messages of all kinds, suits at law, business contracts and the like.

Learned men, who love to solve the puzzles of the past, set to work to translate this decree. They compared it with certain lists of kings' names they had already studied, till at last it was all straightened out and the values of the signs were discovered, so that we can now stand by and listen to those who know hieroglyphics while they translate the old Egyptian writings almost as easily as if they were in a modern language.

This discovery and study have opened up to us the old books and chapters of books which are continually being found in the tombs. These are in long rolls, or papyri, so called from the material on which they are written, the inner part of the papyrus reed which grows in such profusion on the banks of the Nile. From the name papyrus comes our word "paper."

Part of the work of the scribes was to make copies of the papyri; and the one most copied is called the Book of the Dead, sections of which are believed to be older than the pyramids themselves. Certain chapters of this book were always laid beside the mummies, to instruct them in what to say and how to behave in the underworld. Our interest in the Book of the Dead is caught partly by the illustrations, but we find it fascinating, too, for the information it contains about the religious thought of Egypt: how men tried to fit themselves in life for a happy hereafter, how they expected to be judged, and how they believed they would live and work on their way through the underworld. For instance, it gives a very definite picture of the trial of a man's soul before forty-two judges in the hall of Osiris, when Anubis and Thoth would weigh his heart in the balances of justice and he would have to answer many questions. There are in the book, too, hymns to the gods and magical texts. Besides this, and other religious books, there are many other papyri of great age—fairy tales, war poems, medical and astronomical books and rules for behavior. These papyri give us a most vivid idea of the civilization of ancient Egypt.

WHERE A MIGHTY CITY ONCE STOOD

Ewing Galloway, N. Y.

Ruins of Thebes, a famous old Egyptian city, which stood on the site of the modern town of Karnak. The two pointed shafts shown at the left and right of the photograph are obelisks—monuments representing the sun-god, Ra. There were many hundreds of obelisks in ancient Egypt, but only about fifty are still standing. Many of these have been removed to other lands. Central Park, in New York, has an obelisk which came from Alexandria.

When looking at inscriptions we can always distinguish a royal name, because it is surrounded by an oval line, supposed to be a cord tied in a knot to preserve the name from contact with common ones. This oval is called a cartouche. Before the king's name will generally be found some Egyptian words composed of a sign like an umbrella and an insect over two half-circles. These signs mean King of the North and South, for Egypt is such a long, narrow country that it was long divided into two parts; and so we often hear of the double crown, which is made up of the red crown of North Egypt and the white crown of South Egypt.

Every year diggings and explorations are being carried on in the search for more temples and tombs, inscriptions and papyri, to fill in the gaps in our knowledge of the story of old Egypt —the fascinating story of a remarkable people.

We have already spoken of the tombs belonging to the period of the Middle Kingdom. (It lasted from about 2100 B.C. to 1600 B.C.) One tomb has wall-paintings representing the arrival in the country of a family such as that of Abraham, the great founder of the Jewish people. The story of his visit to Egypt in search of food, when there was a famine in his own country beyond the Isthmus of Suez, is familiar to us in the pages of the Bible.

We can well imagine that Abraham would tell his son Isaac stories of this visit to Egypt; that he in turn would tell them to his son Jacob, and Jacob to his sons, among them his favorite, Joseph. Let us follow this son after he was sold by his brothers. His sad journey lay over the "Bridge of Nations," the Isthmus of Suez and the Peninsula of Sinai, to slavery in Egypt.

Metropolitan Museum of Art, N. Y.
Queen Nefertiti, who lived at the time of the Eighteenth Dynasty some 1,400 years before Christ.

Baskets made like those in the Egyptian rooms at the Metropolitan Museum might well have been those which the chief baker carried on his head in Joseph's dream; the models of the granaries show how corn was stored, and bring to mind Joseph's great work of building storehouses and gathering in grain to prepare for the famine that lasted so long, because Father Nile brought too much or too little water to the wide fields.

Fashions changed so little in Egypt for centuries that we might imagine that the little statue of a treasurer was Joseph himself. We might fancy him earnestly discussing affairs of state with the king, to whom he became as a son, or traveling down the Nile on a tour of inspection in a boat like the model in the case near by. You remember how Joseph's brothers, then his old father Jacob, traveled to Egypt and were given land by the king. There the children of Israel settled and increased in numbers.

Very little is known about the history of Egypt at this time, for the kings who ruled then—believed to be a race of foreign invaders—destroyed monuments instead of setting them up. But when these Hyksos, or Shepherd Kings, passed away, the Eighteenth and Nineteenth Dynasty pharaohs, builders and soldiers, whose names are familiar and famous, took their part in Egypt's history.

The New Empire began with the Eighteenth Dynasty. These were the years when Israel lived in the "House of Bondage." Among these rulers was Thothmes III, who inscribed and set up the great obelisks which we call Cleopatra's Needles, though Queen Cleopatra lived centuries later.

One of the tall stone shafts now stands in London, the other in Central Park, New

York. Thothmes III was one of the first kings of Egypt to make war across the Isthmus of Suez, both on the nations in the mountains of Syria and in Mesopotamia, the valley of the two great rivers beyond the desert.

Part of his reign was shared by his queen, Hatshepsut, who, as sovereign in her own right, had been chosen "king." She, often called the Queen Elizabeth of Egyptian history, sent most interesting expeditions to discover unknown countries, and had an account of them, with fine illustrations, engraved on the walls of a magnificent temple which she built near Thebes. There is much that is interesting about this vigorous queen, who for political reasons tried so much to look like a man that she had a beard added to her portraits.

Of this same dynasty—the Eighteenth—was Amenhotep IV, who changed his name to Akhenaten in honor of the god Aten, a universal, or world, god, whose worship he strove to substitute for that of Amen, the deity of Thebes, and other local gods. Amen's name was replaced by that of Aten on statues and monuments. Great temples were built to Aten, and cities were founded in his name. Truth was the precious thing which the king most desired. His orders to painters and sculptors were that they should "let the chisel and the brush tell the story of what they actually saw," instead of following the conventions rigidly prescribed by priestly rule—conventions that caused many of the works of art to become lifeless symbols.

But the priestly party was strongly set against him, and the inherited faith of centuries was too firmly rooted to be overthrown during the lifetime of one man. Akhenaten's son-in-law, Tutankhaten, was forced to yield to the pressure of opposition, to restore the worship of Amen and to change his own name to Tutankhamen. The opening of this young king's tomb in 1923 made him a very real person to us.

Both pictures, Metropolitan Museum of Art, N. Y.
Akhenaten, a ruler of the Eighteenth Dynasty, who attempted to bring about great changes in religion.

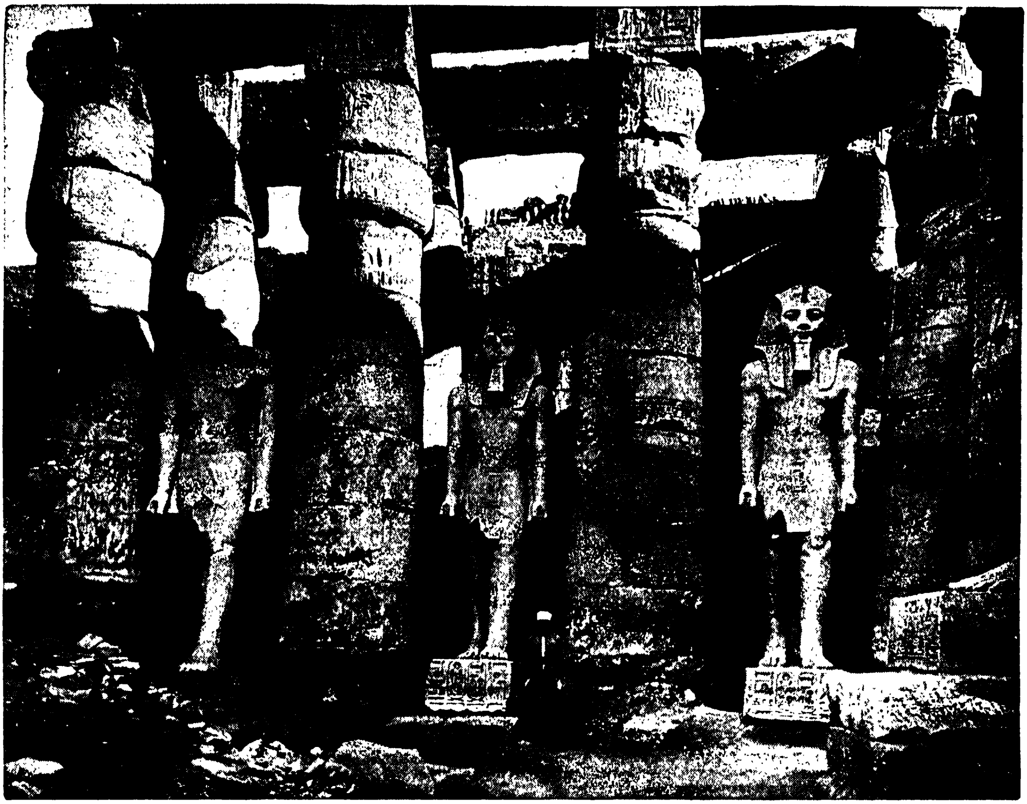
Amen, Egyptian sun-god, whose worship centered in Thebes. The Greeks and Romans called him Ammon.

Though Akhenaten failed in his effort to revolutionize thought and custom in the old land of the Nile, we find him the most interesting figure in all early history.

A little later, when the descendants of Jacob, the Children of Israel, had grown to be very numerous, they were harshly treated by the kings of the period, who had built up the empire again. Rameses II, a soldier-king and a mighty builder, is believed to have been the great oppressor of the Israelites, and we can see his face in the huge stone monuments he set up. Of more personal interest still is his mummy, which has been found with that of his father, Seti I, and those of others of his race. They have been placed in the museum in Cairo. Thus, the features into which so many looked with awe, perhaps even the little Moses, are known again to the world more than three thousand years after the great king's death. Of Seti I and Rameses II there are numberless stone portraits in statues and reliefs, giving us interesting impressions of them as men and as rulers. In the Metropolitan Museum there

Ewing Galloway, N. Y.

Ruins at Kom Ombo, a town on the east bank of the Nile, about 500 miles south of Cairo. Kom Ombo was called Ombos in ancient times. The picture-covered columns shown here formed part of a magnificent temple, built in the days of the Ptolemies. This temple was given over to the worship of the local gods Jebek and Har-oer.



Ewing Galloway, N. Y.

A striking view of the Temple of Luxor, with pictured columns and three gigantic statues of the pharaoh Rameses.

may be seen an earthenware bowl, covered with blue glaze and inscribed with the name of Rameses II, which may have belonged to the great king himself. There, too, is a door lintel taken from one of the temples that he built. As we look at it we wonder how many times his hand may have touched it as he passed in and out thirty centuries ago.

Magnificent were the temples and monuments set up by this dynasty of kings, the Nineteenth. Among them we find the massive ruins at Karnak and Luxor, near Thebes. Bricks such as the Israelites made for use in building cities for their hard taskmasters; necklaces and jewelry such as they may have taken when they "spoiled the Egyptians," are here in the museum before our eyes. In the great museum at Cairo and in the museums of many European cities we can find endless objects such as the king's daughter may have provided for Moses, whom she rescued and brought up in the palace—things which helped to frame his life from childhood onward. The toys and games, especially the animals, must have pleased him, and a garden with trees and a pond, like one that is pictured on a wall, would be delightful for a child to play in. The little Moses may well have heard music from instruments such as the pipes and harps preserved here, and he must have enjoyed sailing and rowing on the Nile in boats like the models on our museum shelves.

The wall-paintings from the tombs show in their bright colors how the Egyptians amused themselves in the time of Moses, as well as before and after. There are the gay parties with music and dancing; a father hunting water birds with a sort of boomerang, the child holding on to his leg for fear of falling out of the boat; the mother gathering lotus flowers; the family cat retrieving the birds three at a time. When the time came for lessons, reed pens, such as we can see, and red and black paints were the sort with which the boy must have learned to write. We can fancy how he must have enjoyed possessing one of those boxes of pens and paint, and can almost see him poring over the papyrus rolls which held so much of the learning of the wonderful old Egyptians.

The Ten Commandments, brought down from Mount Sinai by Moses after he had led his people out of Egypt, are foreshadowed in the forty-two commandments in the BOOK OF THE DEAD. The making and worship of the Golden Calf, which so angered the great leader, was suggested by the ancient worship of Egypt, brought home to us in endless forms by paintings and images of every description, as well as by the mummied forms of sacred bulls and other animals held in reverence, which have been found in tombs.

For about a thousand years after the brilliant line of the Rameses dynasty, the history of Egypt, on the whole, was one of gradual decline and gathering trouble. It was during this time that the priests of the splendid temples became richer and richer, more and more powerful, till at last they made themselves kings. When examining the mummies and their cases we notice how many are those of priests and priestesses, doorkeepers, incense-bearers, and other officers of the great religious colleges.

Dynasties of foreigners followed the priest-kings, and the country was breaking up into little states and everything was going down-hill, when the kings of Assyria—the land of the two rivers—seeing their opportunity for conquest, began to attack Egypt on her own frontier, and then pushed their way over the Bridge of Nations. They overran the whole of the country, spoiling the harvests, so that the people starved, and the fine temples and monuments began to fall into decay. We find the account of all this misery in the story of Assyria in the descriptions given by the conquerors with swelling pride of their successes in Egypt.

Metropolitan Museum of Art, N. Y.
Models of girls bearing various offerings to the dead.

Egypt revived after this for a little while under kings of the Twenty-sixth Dynasty, with their capital at Sais, not far from old Memphis. In their armies fought soldiers from Greece. But the Nile country was again devastated from end to end by the Assyrians till they, too, fell under a new great power that arose in Asia—that of the Persians.

The Egyptians took every opportunity to revolt against the Persians. Between the second and third revolts, in the fifth century before Christ, a traveler from Greece came to Egypt. He was an author anxious to collect material for his HISTORY OF THE PERSIAN WARS. This was Herodotus, the Father of History, who set down in a pleasant chatty way his impressions of the wonderful country, of the Nile in flood, of the pyramids and other great buildings. Much of his interesting book we can read to-day though Herodotus laid down his pen more than two thousand years ago.

The Persians in their turn were driven out by the world-conqueror Alexander the Great, of Greece. His stay was short in Egypt, but his brilliant passage has left marks for all time. He flashed across the desert to worship at the shrine of the god Jupiter Ammon, whom he claimed as an ancestor, and he planned and founded the great city of Alexandria, called after him, which under his successors became one of the most important cities in the world.

Three centuries before Alexander, as we have noted, an Egyptian king had employed Greek soldiers and had allowed Greek traders to settle in the Delta. Before this Egypt had been closed to foreigners; but after the Greeks found their way into the country, little by little their cleverness in trade, their surpassing skill in art and their learning spread Greek influence ever farther along the Nile. Naucrates became a famous Greek city during this time, and to-day explorers find Greek treasure of all kinds buried in various parts of the Nile delta.

The kings who succeeded Alexander were called Ptolemies. The first Ptolemy was one of Alexander's generals. They were great builders and restorers. To them we owe the Temple of Edfu and the temples on the Island of Philæ, near the great dam at Assuan. The Ptolemies favored the city named Alexandria after the founder of their fortunes, and started in it the famous library which, unfortunately, afterward burned. There, too, they founded a university to which came some of the most famous Greek scholars. Another Ptolemy built the tall lighthouse which, like the Pyramids, was one of the wonders of the ancient world. The flare from its top guided the shipping of Alexandria safely into its double harbor for long years; but not a trace of it now remains.

H. Burton—"The Times" copyright photograph

A masterpiece of ancient Egypt—a panel from the tomb at Luxor. The panel shows the King and Queen in their palace. Above the royal pair is the sun's disc, pouring forth light-giving rays.

The same Ptolemy had the Old Testament, which was originally written in the Hebrew language and was understood by comparatively few people, translated at Alexandria into Greek. This beautiful language was soon to be carried over the known world and to become the language of scholars everywhere. Another good work of this same king was to have a history of Egypt and its religion written by an Egyptian scribe named Manetho, who knew Greek well. Though his actual records have been lost, other writers made copies from Manetho, and thus the lists of kings and other particulars which he carefully compiled were not lost but have been of great use.

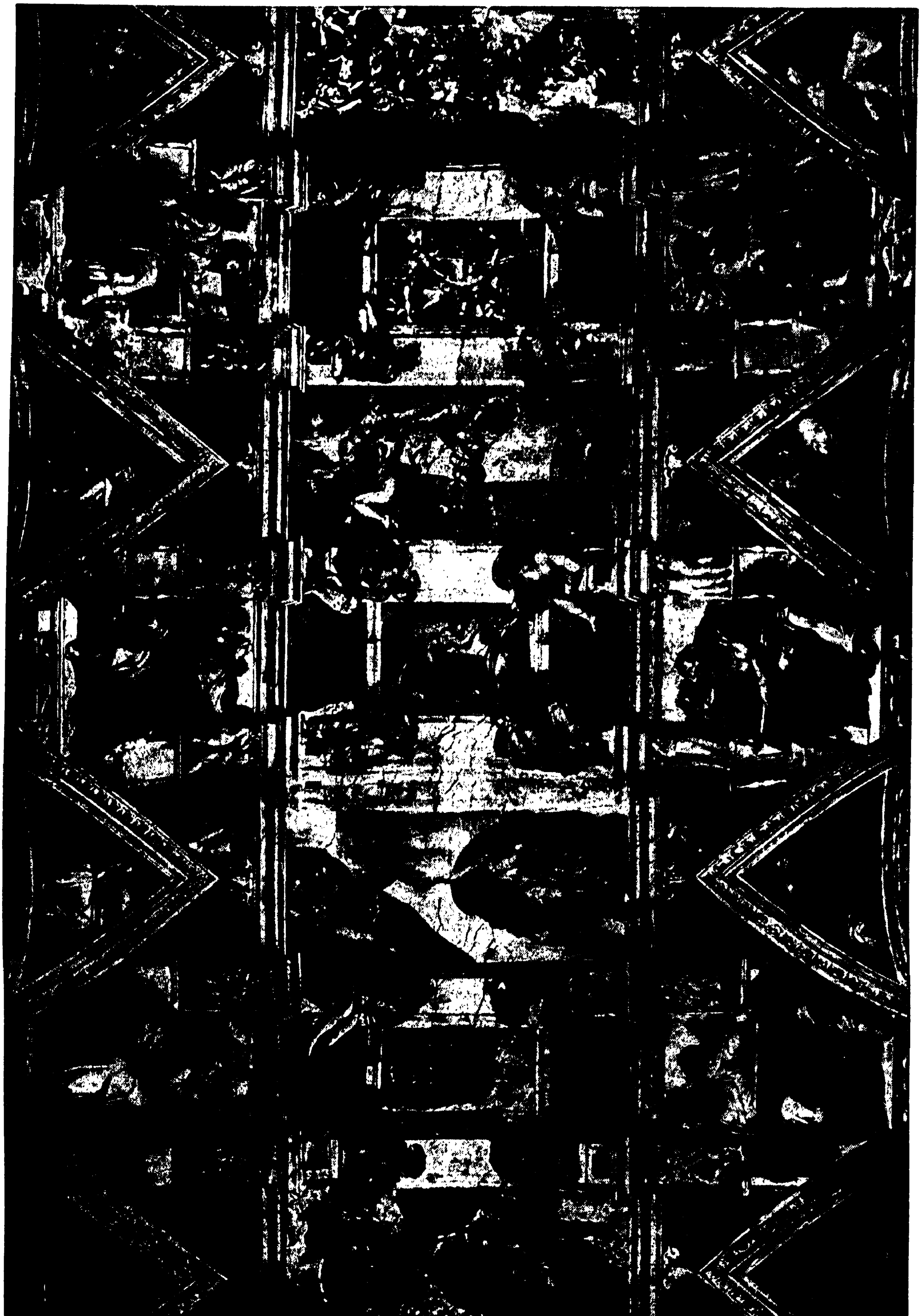
The Rosetta Stone was set up in the reign of Ptolemy V. We see now how it was that a Greek translation came to be put below in Egyptian writing. Both languages were then used in Egypt. And all the time that Egypt was becoming more and more Greek, "a shadow ever lengthening towards the East" was slowly creeping onward from Rome. It passed over Greece itself in the middle of the second century before Christ, and reached Egypt about a hundred years later.

It is a sad and absorbing story, how the independent kingdom became a Roman province. Upon this foundation Shakespeare constructed his play of Antony and Cleopatra. The fair Cleopatra was the last of the great Ptolemies. Rather than fall into the hands of the invading Romans, she is said to have allowed an asp to bite her. So, when they came to her palace they found her in all her regal splendor—dead. In Tennyson's words, Cleopatra says:

"I died a Queen. The Roman soldier found
Me lying dead, my crown about my brows,
A name forever!"

From Menes to Cleopatra, what a perspective of years! As we look back again, much of the old life will seem so vivid and real to us that we can almost hear the dancing feet of children at play in little worn shoes, the sad wailing of mourners carrying the mummy to its hidden tomb, and the hum and clatter of workers building structures of such size and solidity that never on earth have they been outdone.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 908.



THE MAGNIFICENT CEILING OF THE SISTINE CHAPEL IN THE VATICAN

Three heads in the Sistine Chapel by Michelangelo.

LEONARDO AND MICHELANGELO

HERE and there, in the progress of the world, time and fate turn author and tell a story, and the older the world grows the more fantastic the tale seems. Such a story comes in the growth of Southern Europe from the twelfth to the fifteenth centuries.

At the beginning of this period people knew very little about the universe. Their only mathematics were simple addition, subtraction and multiplication. Their idea of astronomy was a kind of chart of the heavens, from which it was possible to understand certain simple phenomena, such as the habits of the moon that controlled the Church festival of Eastertide. Greek and Roman culture, we must remember, had been stamped out of Italy by the repeated inroads of tribes of barbarians from Central Europe. It now made its home in Byzantium.

Over the continent of Europe, dark as night, a light of knowledge presently spread, directed from Spain, where the Moors were living as conquerors. Spain, in the twelfth century, was hundreds of years ahead of the rest of Europe; she had universities, observatories for the study of astronomy, and science laboratories, all the results of the Moorish occupation. The culture of the gifted Mohammedan peoples spread among the Christianized countries of Europe and aroused an intense curiosity.

It is difficult for us to realize how magical and wonderful was this awakening of a continent that seemed to have been lying asleep. Men were like children at school, learning for the first time the secrets of the world; hunger for knowledge sent them, often barefoot, with the student's wallet, begging their way from one university to another. To be a scholar in those days was to be a member of a secret brotherhood and to hold a sure claim on people's sympathy.

The same kind of curiosity was presently, in the fifteenth century, to lead to the discovery of the New World and to all the romantic and perilous voyages of the bold Elizabethan seamen.

In the meantime a sense of beauty, asleep until now, had begun to stir, as we have seen, in the countries where the Gothic spirit was felt, and first the Sienese, then the Florentines, Umbrians and Venetians were working and experimenting, generation by generation, toward a full realization of what great art meant.

In the fifteenth century came another element into art. Sultan Mohammed II conquered Byzantium, and the Greeks, flying westward, took refuge in Italy, bringing with them their rich sense of beauty, their immortal traditions.

It seems strange that in Italy, at one time the stronghold of Greek and Roman culture, pagan beauty should ever have slumbered, and that the active presence of the Greeks should have been necessary to remind the country of their old dominion; but that is one of the strange chapters in the story of this medieval and awakened Italy.

The Christians of the early centuries were surrounded by the buildings and the arts of Rome and Greece, and seemed simply to be unaware of how beautiful they were. The Christians pillaged the pagan halls to get pillars and capitals of their churches, taking away all the marble they could; and this astonishing indifference to the claims of the past went on for a thousand years, until the Greeks themselves came back. Then the Italians looked about and tried to rescue from further destruction any monuments that remained, and they began to turn to the ancients for study.

AN INTELLECTUAL AND ARTISTIC GENIUS TRIES TO FLY

Thus we see three marvelous forces working to produce the paintings and sculpture of the fifteenth and sixteenth centuries in Italy—first the early renaissance in Tuscany, due to the Gothic spirit; then the growth of learning which infected artists and made them restless, unsatisfied with their own achievement; then again the return of Greek culture from the East.

All these forces centre in one Florentine painter, Leonardo da Vinci, who lived from 1452 to 1519. He was an intellectual as well as an artistic genius, a man of most brilliant gifts, any one of which would have set him apart and set him on a peak among his fellows. His many-sided ability ought to count in proving that artists are not always impractical and purely visionary.

There was scarcely a by-road, certainly there was not a highway of learning, that he did not explore. He foresaw several of the inventions which hundreds of years later were to revolutionize social life. He was philosopher, architect, engineer, physicist, chemist, geologist; he made experiments in the use of steam power and in hydraulics. At one time he was military engineer to Cæsar Borgia; when he was over sixty, a guest in the Vatican, he neglected painting pictures for the pope in order to try once more to work out his idea of a machine that would fly in the air.

It would seem that to this man fortune had already come with both hands full; as if that were not enough, another gift was tossed to him—genius in art.

Unlike many painters and poets, there was no need for Leonardo to wait till he was dead to be called great; he was truly the living master, greater than his greatest picture—one of the most fascinating and compelling forces in a century already colored with genius and gold-dusted with heavenly ideals.

LEONARDO'S FAMOUS PICTURE OF THE LAST SUPPER

Very little of Leonardo's art is left to us, and this is partly because of the accident of circumstances, partly the painter's own willfulness—in one immortal instance—in working in a wrong medium, and partly his great distrust of self. It was as if he turned a searchlight of criticism upon his own work, to discover all defects, and by his very carefulness delayed bringing his work to completion. There are four great paintings of his left to us, and one of these is but a ghost of its own magnificence. It is the first of two pictures which leap to our thoughts when the name of Leonardo da Vinci is mentioned—The Last Supper.

Many people when thinking of the story of the Last Supper as told in the Bible think of Leonardo's picture of it—of that long table where Christ and the twelve disciples were seated, of the separate horror, fear and curiosity chasing themselves across the faces of the apostles as the Master said: "One of you shall betray me"; and one after another they asked, "Lord, is it I?" The expression in this picture of those human feelings, and of Christ's own superb and sorrowful indifference, is sheer genius.

THE PITIFUL DESTRUCTION OF A NOBLE MONUMENT

The Last Supper was painted in a method that peculiarly reveals the workings of the artist's wayward spirit. It was done for the Dominican Friars of Sta. Maria delle Grazie, at the command of Lodovico Sforza, the Duke of Milan, Leonardo's patron. The artist was engaged by this nobleman, at a handsome salary, to execute various works of art, the chief being an equestrian bronze statue of the duke's father.

BY LEONARDO AND ONE OF HIS PUPILS

A COURTIER, ATTRIBUTED TO DE PREDIS

BIANCA SFORZA, BY AMBROGIO DE PREDIS

MARY, SAINT ANNE, AND THE INFANT JESUS

THE MADONNA OF THE ROCKS

THESE TWO FINE PICTURES BY LEONARDO DA VINCI ARE NOW IN THE LOUVRE

MICHELANGELO'S CONCEPTION OF THE CREATION OF ADAM—FROM THE SISTINE CHAPEL

THE THREE FATES, BY MICHELANGELO

SOME OF MICHELANGELO'S NOBLE FIGURES

Three of the noble figures on the ceiling of the Sistine Chapel in the Vatican Palace, Rome.

The Holy Family, in the Uffizi, Florence, painted by Michelangelo when he was about twenty-five.

Upon this work Leonardo spent the best of sixteen years, tortured by his inability to work out his own superb ideal, again and again making a new sketch and beginning the figures afresh. At the end of the sixteen years the model was ready to be cast in bronze and was temporarily set up in an archway outside the duke's home, Milan Castle. Its fate is one of the sad stories in Italian history. Sforza's enemies, the French, had long been threatening him; now they besieged Milan, and the equestrian statue—the labor of years—was demolished by the archers of Louis XII.

LEONARDO MOST LABORIOUS WHEN HE WAS MOST IDLE

While Leonardo was busy on this group, however, he was working on a great number of other commissions, and among them the very important painting of The Last Supper on the walls of Sta. Maria delle Grazie. When the artist received the order to execute this work he felt something very like ecstasy; here was a subject he had yearned to paint. He made a great number of chalk studies, and the remnants of these are now widely scattered, the best being in the Accademia of Venice, and some rather fine heads in the library at Windsor, England. South Kensington Museum treasures some notes made by the artist describing the various attitudes and expressions of the apostles.

Presently Leonardo began the actual painting, and soon he was standing before it in his characteristic attitude of self-distrust and fastidious criticism, an ever-forward reaching to the ideal which was secret to his own soul, and was to his work what the sun is to the moon.

Seized by a sort of fury of vigor, he would toil from dawn to dusk without food. Then there would come on him strange moods when he would stand motionless, staring at the composition for an hour or two; and after this spell of thought he would leave the painting untouched for several days. When questioned on these habits by the prior, who, good man, thought the artist was merely wasting time, Leonardo explained that when he was most idle he was really most laborious.

RAGS AND TATTERS OF GREATNESS CLING TO THE FRAGMENTS OF A PICTURE

For several years Leonardo divided his energy between The Last Supper and the equestrian statue. Sometimes the artist would be seen to leave the group at Milan Castle and walk through the town in the hot midday to the convent beyond the gates. There he would add a few illuminating touches to the painting, and return to the castle.

In 1498 the picture was finished. It is a misfortune which can never be made up to us that the artist refused to work in fresco, which does not admit of the constant retouching that his ideals demanded. Instead, he painted in oils on the stucco surface of the wall. In a very short time the fabric crumbled, and the picture stands now in ruin. Although many copies have been made, the rags and tatters of greatness clinging to the fragments of the original make the finest of them seem a sorry imitation.

The other most talked-of picture by Leonardo is of a very different kind—a simple portrait of a Neapolitan woman, called La Gioconda, and known as Mona Lisa. In this face the artist painted his mastery of knowledge of character. As in the case of The Last Supper, he himself was standing apart, studying, as an intellectual exercise, the human emotions which stamp a face just as much as the definite features do. We can never feel, for instance, that Leonardo liked or disliked Peter or Judas, or liked or disliked Mona Lisa. He was fulfilling what he felt was the artist's vocation in figure-painting—the presentation of the human soul.

A PICTURE THAT MUST HAVE BEEN WORTH 4,000 GOLD CROWNS

La Gioconda was just an ordinary woman, and she hid her thoughts under an elusive, inscrutable smile. Leonardo spent four years painting the smile, *and* her thoughts. In its early condition this masterpiece must have arrested all men's eyes, and have been well worth the 4,000 gold crowns which King Francis I paid for it when Leonardo took it with him to France. The sky was very blue, and the Neapolitan's face was very fair, with sparkling eyes and pretty, red lips. Even now, with this brightness faded, it is one of the wonders of the world. It seems to be Leonardo's own way of stating a very old maxim—Mortal beauty perishes; Art remains.

Leonardo da Vinci is an eternal lesson to young students who want to paint before they can draw. Into the preliminary studies for his pictures he put an immense amount of care, and these char-

LEONARDO'S SMILING LADY

MONA LISA, THE MOST FAMOUS PORTRAIT IN THE WORLD, BY LEONARDO DA VINCI coal drawings not only foreshadow the paintings but mirror the genius which inspired the artist in all his work.

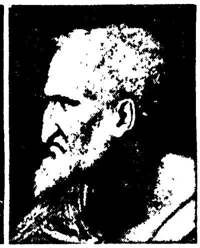
England has in her possession a treasure which many other nations envy, and by some curious fate it is tucked away in a corner of the Diploma Gallery at Burlington House—a collection of pictures very few people go to see. This treasure is a cartoon by Leonardo, one of the studies in charcoal for the group, Mary, St. Anne and the Infant Jesus, now in the Louvre. The pure and lovely face of Mary is Leonardo's conception of the beauty of motherhood. It is a work of a supreme master.

ANDREW

JUDAS

JESUS

JAMES



SIMON

THE MASTERPIECE OF LEONARDO ON A WALL IN MILAN—THE LAST SUPPER

There is a painting in the National Gallery, London, which has long been attributed to Leonardo but is now thought to be chiefly the work of Ambrogio de Predis, one of his pupils. It is called The Madonna of the Rocks, and is a copy of the original picture of this name by Leonardo, now in the Louvre. The French thus own three of Leonardo's four great pictures—the Mona Lisa, The Madonna of the Rocks, the Madonna and Child and St. Anne. The ruins of the fourth, The Last Supper, are still to be seen in Sta. Maria delle Grazie, Milan; the two fine portraits on page 825 have also been attributed to Leonardo, but are probably by his pupil, de Predis.

A great deal of the artist's work was destined to be lost. One of the paintings we should most like to have seen is a battle scene he worked at for some years in Florence. It was part of the decoration of the Council Hall, and the work was intrusted to Leonardo and Michelangelo. Thus two of the masters of the world, in whose two styles all styles meet, were laboring under the same roof. They were already known to each other. Leonardo was over fifty, Michelangelo still young.

It would be difficult to find two men differing more from each other in the pursuit of a common ideal. There never was an artist who brought less feeling and emotion, and more intellectual force, to bear on his pictures than Leonardo da Vinci; but in Michelangelo's painting and sculpture thought did not take the first place; rather he flung his own joy, his own sorrow, into stone and into painted figures, a restless pent-up spirit throbbing its way to freedom. He was essentially a sculptor, and his pictures show his vivid passion for line and form. To him, the body of man was indeed God's greatest work, and he paid little attention to landscape, light and shade, atmosphere, or any other aspect of natural objects.

Michelangelo, sculptor, painter, architect, poet, was the last of the great Florentines. His work seemed like a mighty challenge to the rest of the world, and, heard across the centuries, those spiritual trumpets are still faintly booming. The old-new Greek culture had laid its hold on his imagination and he had already inherited very nearly three centuries of Tuscan art: two influences which were like live wires, twisted together, fire-making.

This impetuous and forcible genius was naturally a great leader, and he founded in Rome, where he chiefly worked, a school which influenced the energies of nearly all the artists of Italy.

In the realm of painting Michelangelo's greatest achievement was the decoration of the ceiling of the Sistine Chapel in the Vatican. This work he undertook not very willingly, at the command of Pope Julius II in 1508. He said to the pope, rather querulously, that sculpture, not painting, was his trade, and that Raphael, the painter of Urbino, was much more likely to do the ceiling well. But the pope insisted—for the great good fortune of us all—and Michelangelo set to work, only reserving to himself the final comment of thenceforward signing all his letters, "Michelangelo, *Scultore*."

A CHAPEL WHICH STANDS ALONE IN THE NOBLE HISTORY OF ART

It is difficult for people who have not seen the Sistine Chapel to realize this vast piece of painting, which stands alone in the history of art, stupendous, without the shadow of a rival. Michelangelo accomplished it in four years, almost unaided, as the artists he summoned to Rome to help him did not fulfill his requirements, and he sent them away in disgust.

It would seem to us that the planning of this mighty work alone might have been one man's sole labor. In the central vault of the ceiling are nine large pictures telling the story of Creation, the Fall of Man and the Deluge. Between the windows, spaces are filled with twelve figures of Prophets and Sybils who are foreshadowing the coming of Christ. In the spandrels are painted stories from the Old Testament, such as the Brazen Serpent and the Death of Goliath. The lunettes are filled with figures of David's descendants and the ancestors of Mary. These large divisions complete, Michelangelo used up all possible extra spaces to paint figures of youths and children. There are in all about two hundred figures, of immense size, painted in vigorous and sometimes unusual attitudes, the whole vast work charged with the extraordinary vividness, aliveness and overweening strength which was the stamp of Michelangelo's creations. Looked at even now, after a lapse of 500 years, it would seem that those figures in the Sistine Chapel could step down, make some violent gestures and speak heroic words.

THE COLOSSAL SHAPES EXPRESSIVE OF THE ARTIST'S SOUL

When Michelangelo was about seventy he was ordered to paint The Last Judgment on the wall above the altar of the Sistine Chapel. This, his last fresco work, lacks the fire and force which mark the ceiling decorations, and shows what mannerism without genius can do.

Very few other specimens of the mighty artist's paintings are left for us. He never carried out the fresco designed for the wall of the Council Hall in Florence, where Leonardo was working. The cartoon foreshadowed a magnificence even surpassing that of the Sistine ceiling, but this, like many other treasures, was destroyed. The Deposition, in the National Gallery, London, ascribed to Michelangelo, gives some idea of his wild energy, his Titan-like strength. Another painting of his, The Holy Family, is in the Tribune of the Uffizi Gallery, Florence, and a very early picture of the same subject is in the National Gallery, London.

But when we think of Michelangelo, the painter, we think of the solitary and unrivaled magnificence of the Sistine Chapel, and we feel a little awed to think that one human being can be responsible for that immortal grandeur. We think of the artist toiling at the work, often through spells of great physical weariness and despondency, struggling to express his own soul in these colossal shapes.

THE LAST OF THE MIGHTY RACE OF FLORENTINE PAINTERS

His is a sad figure in a century of buoyant, happily inspired artists. To him genius was indeed the sorrowful gift, By temperament unfriendly and irritable, he alienated many people who might have made his life happier. His patrons did not reward him too well; poverty and family trials burdened him. When he died in 1564, an old man of eighty-nine, all the rest of his brilliant generation had gone, Raphael and Leonardo over forty years before. With him died the mighty race of painters who for three hundred years had made Florence famous.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 951.

The T. F. Healy Collection

Shakespeare reading a new play and acting out the parts for the members of his company.

THE WORKS OF WILLIAM SHAKESPEARE

WILLIAM SHAKESPEARE, the greatest writer who ever used the English language, and possibly the greatest writer in any language since the Golden Age of Greece, was born in Stratford-on-Avon, England, in 1564. He was baptized there on April 26 of that year, and it is commonly assumed that his birthday was three days earlier, April 23. His father was a prosperous dealer in wool and leather, who became an alderman in 1565, and high bailiff, or mayor, in 1568. His mother was Mary Arden, the daughter of a well-to-do landowner of the neighborhood. William was one of eight children; he was the third child and the oldest son.

Stratford in the second half of the sixteenth century was a flourishing market town, surrounded by fields and bordered by the river Avon. The small-town and country people in Shakespeare's plays show that his Stratford days were stored up in his memory and imagination. There are also many references in the plays to field and country sports; these references are brought in simply and naturally, often in the form of figures of speech, so they must reflect a very intimate knowledge which could only come from long experience.

There is no record to prove it, but it seems natural to suppose that Shakespeare went to the grammar school at Stratford. The school was a good one, and provided (for boys up to about the age of sixteen) a much more thorough education, in Latin grammar, rhetoric, poetry and drama than the modern schoolboy gets. Though Ben Jonson wrote of Shakespeare, after his death, that he had "small Latin and less Greek," Jonson had very high standards of classical learning, and what seemed to him little would seem to a modern observer a good deal. At any rate, Shakespeare learned enough Latin to read Ovid in the original, and it is apparent from his plays and poems that he loved the sensual, delicate, witty Latin poet. Shakespeare makes fun of a stuffy schoolmaster in LOVE'S LABOUR'S LOST; but in THE MERRY WIVES OF WIND-

SOR there is a sympathetic picture of a parson listening to a small boy (named William) reciting his Latin, and ridicule is directed against a servant woman who is too ignorant to understand the recitation.

When Shakespeare was about thirteen years old his father began to have financial troubles, and a tradition has come down from the poet's first biographer that he had to leave school for lack of money. However this may be, we know nothing more about Shakespeare's youth until he was eighteen. He remained in Stratford; he may have been apprenticed to his father (one of the legends says that when he killed a calf he would do it in high style and make a speech), and he almost certainly took part in the country sports of hawking, hunting the rabbit or the deer, and following the hounds.

Before he was nineteen years old Shakespeare married Anne Hathaway, the daughter of a farmer in the near-by village of Shottery. She was eight years older than Shakespeare. The marriage was by special license from the bishop, and it took place late in 1582. In May of 1583 their first child, a daughter, was christened Susanna. Two years later twins, named Hamnet and Judith after a Stratford baker and his wife, were born to the Shakespeares and christened in the Stratford church.

THE SEVEN YEARS ABOUT WHICH NOTHING IS KNOWN

After this (1585) there is no record of Shakespeare in Stratford for some years. The next time we hear of him is in 1592, when he is in London and already established as a playwright. What he did in those seven years is a mystery, answered sometimes by legends or by guesses, but never with any certainty. One legend has it that he was a schoolmaster in the country, and, for all we know, it may be true. It is certain that Shakespeare's father was gradually losing his money and position in the town, and Shakespeare must have done some work to support a wife and three children. The most famous of many legends about Shakespeare's life has to do with the reason he left Stratford. It is based, apparently, on Stratford gossip of the seventeenth century, and we have no way of knowing whether it is true or not. The story is that Shakespeare was caught poaching (stealing game) on the estate of Sir Thomas Lucy, the most important man in the neighborhood, and was prosecuted so severely that he had to run away.

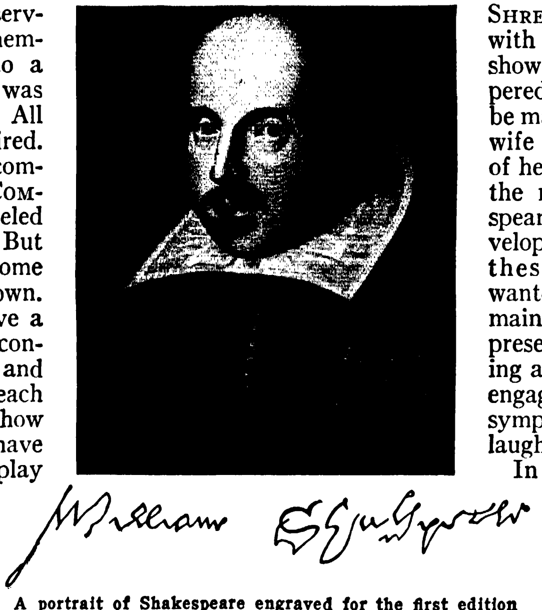
We do not know when he went to London or how he became associated with the theater, but in 1592, when he was twenty-eight years old, he was an actor and had already begun to write plays. We know this because one of the professional playwrights, a dissipated university graduate named Robert Greene, wrote a piece warning his educated fellow-playwrights not to trust the common actors; the piece mentioned scornfully one who was a regular *Johannes fac-totum* (Jack-of-all-trades), thought himself as able to write blank verse as the best of them, and was "in his own conceit the only Shake-scene in a country." This rude outburst was later the subject of an apology by one of Greene's friends, who said that he had met Shakespeare and found him not only an excellent actor, but a man of civil demeanor who was known to various important people for his "uprightness of dealing, which argues his honesty, and his facetious grace in writing, that approves his art."

THE ONLY TWO WORKS THAT THE POET HIMSELF HAD PUBLISHED

Shakespeare, then, had formed an association with one of the companies of actors in London and was serving both as actor and playwright. But soon after this, in the fall of 1592, the theaters were closed, first because of a riot and then because of the plague; they remained closed for the better part of two years. Shakespeare made good use of this time by writing the only two works he ever sent to the press himself, to be published under his own name, and to establish in the world his fame as a poet. VENUS AND ADONIS, the first of these poems, was published in 1593 by a printer named Richard Field, who came from Shakespeare's home town of Stratford. It is a love poem, with a story from ancient Greek mythology. It is written in the style of the Latin poet Ovid. In the summer of 1594 Shakespeare published THE RAPE OF LUCRECE, a graver and more serious work. Both poems were dedicated to the young Earl of Southampton; and the dedications show that Shakespeare had succeeded in finding a noble patron who was rich, prominent in court and interested in literature. Moreover the second dedication sounds intimate enough to make us believe that a personal friendship, not a mere patron-author relationship, existed between the two men.

The simplest way to consider the whole body of Shakespeare's plays, thirty-eight of them, is to divide them up as the Elizabethans were accustomed to do, into three groups: comedies, tragedies and histories. The dividing line between the groups is sometimes not very clear, and a few plays could be put in two groups, but in general the classification is useful.

The popular English comedy of the time had been rollicking and full of fun; but it was shapeless, a mere opportunity for the clown to play his tricks and make his jokes. Shakespeare wanted to write comedies that would be real plays. He learned much from Latin comedies, where the clown was a clever servant, or slave, whose schemings were woven into a story, or plot. There was unity and suspense. All this Shakespeare admired. Shakespeare's first comedy, therefore, The Comedy of Errors, is modeled on a Latin play. But Shakespeare made some contributions of his own. If it is absurd to have a pair of twins who are confused with each other, and who do not know of each other's existence, how much more absurd to have two pairs! So his play has two pairs of twins. The play was given for the law students of Gray's Inn as a part of their Christmas celebration in 1594. It is a lively, farcical play, well suited to such an occasion. It has a touch of romance which the Latin comedy lacked, and the general tone is less harsh and hard than that of Latin comedy. Shakespeare shows that he knows how to learn from models, and how to suit them to his own purpose.



A portrait of Shakespeare engraved for the first edition of his plays, in 1623. Below is Shakespeare's signature.

Latin comedy, however much it offered to an ambitious young English playwright in the way of structure and plotting, was cold and hard. Shakespeare always liked to work into the comic framework some romance—love and friendship, adventure and surprise, charms and magic. Yet he felt that his comedies should portray actual recognizable English characters—country bumpkins, city workmen, servants, court fools and clowns. The problem was how to combine the two, the laughable characters and the romance. In Two Gentlemen of Verona we see an early experiment. The main plot is romantic, a love story; it has lyrical passages of love poetry and the famous song Who Is Sylvia? But there is also Launce, a servant, who complains that his dog is hardhearted and sheds no tears at departure from the family and shows no manners in company. Launce is very English and very funny.

In Love's Labour's Lost Shakespeare made a comedy about courtiers and fine ladies, with much clever word play and wit. In The Taming of the Shrew he experimented with knockabout farce, showing how a harsh-tempered and violent girl can be made into a nice, docile wife by an extensive dose of her own medicine. But the main line of Shakespeare's interest and development did not lie in these directions. He wanted to make love the main subject of comedy, to present beautiful, charming and witty heroines, to engage the audience's sympathy and arouse its laughter at the same time.

In four great romantic comedies — A Mid-summer-Night's Dream, Much Ado About Nothing, As You Like It and Twelfth Night—this is exactly what he did. A Mid-Summer Night's Dream (1595) is set in the woods outside Athens, and everything is drenched in moonlight and illusions. There are the fairy king and queen, with their attendants, involved in a quarrel which leads to the fairy queen's falling in love with a rustic mortal wearing an ass's head. There are two pairs of lovers from Athens, who get mixed up, each pursuing the wrong person as a result of a mistake about the magic love potion. There is the wedding of the Amazon queen, Hippolyta, and the Athenian Duke Theseus, who is really more like an English country squire, with his horses and dogs, than like a duke or an Athenian. And there is a troupe of ordinary workmen from the streets of Athens (or London) who try their hands at putting on a play, with the most ridiculous results. Bottom, the weaver, who wants to play all the parts himself, and

Gramstorff Bros. Inc., Malden, Mass.
Anne Hathaway's cottage. This quaint, straw-thatched house, with its old-fashioned garden, is in the little town of Shottery, near Stratford-on-Avon.

who finds that somehow he has acquired an ass's head and become the darling of the queen of the fairies, is Shakespeare's first great comic character. And over the whole wonderful pageant presides Shakespeare's enchanting poetry, not dissolved but only strengthened by the comic point of view expressed by the fairy Puck: "Lord, what fools these mortals be!"

MUCH ADO ABOUT NOTHING (1598-99) has in it Shakespeare's wittiest lovers, Beatrice and Benedick, who are so sophisticated that they scorn the nonsense of love, only to fall into it themselves. They, who used to jeer at others, are now the victims, and only their wit saves them. "When I said I would die a bachelor," says Benedick, "I did not think I should live till I were married!" A melodramatic main plot, in which Beatrice and Benedick are minor characters, is finally solved through (or perhaps in spite of) the bumbling efforts of Dogberry, a watchman who always says the opposite of what he means and who can never finish his story. His pride and sense of dignity, his avoidance of any trouble, his love of words and his placid ignorance of their meaning, all make him the first and greatest of all comic policemen.

AS YOU LIKE IT (1599-1600) is a romantic comedy of the court and the forest. It has an exiled duke, a heroine in disguise as a boy, listening to her lover describe her beauty when he doesn't know who she is. It has cruel brothers who reform, a cynic in the forest whose greatest ambition is to be a fool, simple shepherds and their loves and a witty court jester. The story is woven together by the rural scene and by the charm and grace of Rosalind, the heroine.

In TWELFTH NIGHT (1600-1601) we have once more the confusion between twins (this time of different sex); we have the disguised girl in love, as in AS YOU LIKE IT; we have the witty court jester; and this time there is an atmosphere of roistering and revelry provided by Sir Toby Belch and his nitwit friend Sir Andrew Aguecheek. The vain and pompous steward, Malvolio, serves as the butt of a practical joke, and the play includes a comic duel between two people, neither of whom wants to fight. Viola, the heroine, is charming in her disguise; she moves through a maze of love, romantic danger and comic wit with modesty and confidence; she is wholly feminine. In this play Shakespeare reached the height of his powers as a creator of romantic comedy: the blend of love and adventure, wit and low comedy could scarcely be carried further.

Oddly enough, Shakespeare's greatest comic character occurs, not in the comedies, but in the history plays. This is Sir John Falstaff, the fat knight of the two Henry IV plays. He was introduced into the story in the first place to make vivid the legends about the wild youth of Henry V while he was still Prince of Wales; but the character of Falstaff so fascinated Shakespeare (and his audiences) that Falstaff was developed much more fully than history demanded. He is a magnificent old sinner, who steals, lies, drinks, cheats and is cowardly, but who shows such great imagination about what he does that he wins us over. His lies are not just mean, petty lies; they are so monstrous and outrageous that they become masterpieces of fiction. His thefts and cheats are never mere selfish tricks; they are mighty attacks on all the stuffy respectability, all the timid conformity of the world. His cowardice only proves that one's skin is real, while honor, fame and glory are but abstract ideals. The flesh is weak, we have been taught. Well, Falstaff has more flesh than anybody else, and therefore more weakness. But he is, finally, unconquerable. His imagination reaches to the pathos of life as well as to the absurdity; he knows that he is not only witty in himself, but the cause of wit in other men. Finally, when Prince Hal becomes king, Falstaff must be rejected, and in the play of Henry V his death is described. Surely no other character in all drama is so regretted.

Legend has it that Queen Elizabeth ordered Shakespeare to write a play showing Falstaff in love, and the result of the command is supposed to be THE MERRY WIVES OF WINDSOR. This play is of interest, not because it adds much to the character of Falstaff, but because it gives a picture, almost the only one in Shakespeare, of ordinary everyday life of middle-class people, such people as Shakespeare's neighbors in Stratford.

THE MERCHANT OF VENICE was listed among the comedies in the Folio of 1623, a collection of Shakespeare's plays published shortly after his death. THE MERCHANT OF VENICE is a play with two highly dramatic plot situations: a suitor wins his lady by choosing the right casket among three, and a man risks losing a pound of flesh when he can not pay a debt. Undoubtedly to the Elizabethans the play was a comedy; but to modern audiences the effect produced is more serious. This is chiefly because the part of Shylock, a Jewish moneylender, has become the "star" part, and his defense of his humanity wins sympathy from a modern audience.

After TWELFTH NIGHT Shakespeare was mainly concerned with writing tragedy for a period of seven or eight years, and the comedies he did write during that period have a curious, bitter flavor. They are TROILUS AND CRESSIDA, ALL'S WELL THAT ENDS WELL, and MEASURE FOR MEASURE. They all show a sense of the harsh realities of life, and of moral corruption, a feeling more generally found in tragedy. They make a very different sort of play from the romantic comedies of the earlier period.

The T. F. Healy Collection

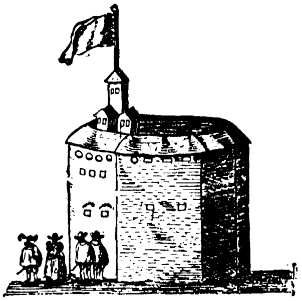
The fat, jovial knight, Falstaff, followed by his small, impudent page.

Finally, in the last two years of his active life as a playwright, Shakespeare wrote some tragicomedies, or dramatic romances, plays in which there is more serious and violent action than in comedy, but not the tragic ending. These are CYMBELINE (1610), THE WINTER'S TALE (1611) and THE TEMPEST (1611). These plays, like the earlier comedies, have charming heroines, but they have also a thing the earlier plays lacked; a dream-like quality.

Shakespeare's history plays were part of the great expression of national feeling and patriotism in Elizabeth's later years. They are based largely on a "chronicle" or history of England by Raphael Holinshed, and they cover roughly the period from Chaucer's lifetime (RICHARD II) to the coming of the Tudors to the throne a century later (end of RICHARD III). In addition, Shakespeare wrote a play on King John, and, with John Fletcher, a play on Henry VIII.

Shakespeare worked on the history plays, along with his developments in comedy, from the time he first began to write for the stage, up to *1600*. He learned something about structure in this form, just as he had in comedy. Christopher Marlowe had demonstrated how a single character could hold the episodes of history together and make unity out of them. Shakespeare, after some first experiments with tragedy in three Henry VI plays, followed Marlowe's method in his RICHARD III. Here we have an archvillain, devoted to evil for the pure pleasure of it, gloating over his wickedness in a fiendish way, and ending up tortured by dreams, and finally defeated and killed in battle.

In RICHARD II (1595), a play written in the same year as A MIDSUMMER-NIGHT'S DREAM and ROMEO AND JULIET, the hero is no longer the strong man who turns events to his own ends, but a weak, imaginative dreamer who loses his throne to a practical man of action, but whose beauty and sensitiveness win for him our sympathy. This is a much more subtle and mature play than RICHARD III. Besides structure, Shakespeare evidently learned something important about character and poetry in the history play. His finest achievement in this kind of drama, however, came in the trilogy of plays (three plays) about Prince Hal—HENRY IV Parts I and II, and HENRY V.



The Bettmann Archive

An old drawing of the Globe Theater in London. The flag was a sign that a play was being acted.

Social and political responsibility form the theme of these three plays. Here we have Prince Hal, a gay young prince who sports away his time at the tavern, joins in robberies (he returns the money) and in practical jokes, is friendly with the waiters in the tavern and will even disguise himself as one. He is a good fellow, who knows what he is doing, but he causes his royal father much grief. In contrast is Hotspur, who is Prince Hal's age, but who has used his youth to win glory and fame. Achievement, glory, accomplishment make up his life; family, home, pleasures are nothing in comparison to war. In contrast to Hotspur is Glendower, a Welsh chieftain, who is a capable warrior himself, but whose real pride is in his imagination. He is a poet as well as a soldier; he considers himself somehow supernatural, and he of course comes into conflict with the very practical and English Hotspur. Also in contrast to Hotspur is Falstaff, who can laugh everything away, even honor. Where is the ideal balance among all these? Shakespeare shows it to us in his Prince Hal, who can roister in the tavern and, when the time comes, save his father's crown on the battlefield, who realizes that Falstaff is too irresponsible and Hotspur too narrowly bent on achievement. Like all true heroes, Prince Hal comes from behind to win, and his appealingly human qualities make us side with him instead of with the good Hotspur. It is harder for us to side with Hal against Falstaff, when that choice has to be made; but the crown of England means responsibilities and dignity, not fooling, and Hal has the right sense of what it means to be a king.

In the last of the trilogy, HENRY V, we see Prince Hal, as king, leading his army to glorious victory in France. Nowhere has patriotic feeling been better expressed than in his speeches to his soldiers, the famous "Crispin Crispian" speech and the "Once more unto the breech, dear friends" at Harfleur. The play shows Welsh, Scots, Irish and English all united under a king who is first of all a man, and who, after victory, woos a French princess with humor and modesty.

In the history plays Shakespeare paid his debt to his national heritage. Many people know their English history from Shakespeare, and he is in great part responsible for that vivid sense the English have of what it means to be an Englishman.

The great period of Shakespeare's work in tragedy came after his development of comedy and history plays, but even in the early period he made a couple of experiments in the tragedy form. One of his earliest plays is TITUS ANDRONICUS, a play full of violence and sensationalism, as the taste of the time demanded. The playwrights of the day had learned from the Latin dramatist Seneca how to use ghosts, the motive of revenge, and physical violence to produce sharp effects, and Shakespeare's TITUS ANDRONICUS had all these violent devices. Though the play was popular, Shakespeare did not continue in this vein. He went back to tragedy later, when he had learned from history and Roman biography how to make character an essential part of tragedy.

His other experiment in tragedy in the

early period was a poetic, romantic story of love, ROMEO AND JULIET (1595). This play, made out of a rambling English poem, is essentially a lyrical expression of youthful love and fate. The poetry is the great thing in it. No qualities of character matter much; Romeo and Juliet are a pair of "star-crossed lovers," and their beauty lies in what they say and in what happens to them—not in what they are or what they do.

In 1599 Shakespeare turned to Plutarch's LIVES for subject-matter, and he made a play on the assassination of Julius Caesar. In Plutarch he found real subject-matter for character study, and his experience in the history play had made him capable of using it. Brutus, the idealist, who joins with lesser men in a cause which to him alone is noble; Cassius, the lean and hungry man, whose motives are far below those of Brutus but whose practical sense is keener; and Mark Antony, the triumphant politician, the man who knows how to sway the mob, are all pitted against each other in one of the great climaxes of history.

SHAKESPEARE WRITES HIS FOUR GREATEST TRAGEDIES

The four major tragedies of Shakespeare —HAMLET, OTHELLO, KING LEAR and MACBETH—followed in order from about 1601 to 1606. They carry further than ever before or since the exploration of man's soul under conditions of severest trial. HAMLET (1601-02) is based on an earlier play, now lost, of the old Senecan sort, with its ghost and its sensationalism and its ranting speeches. Shakespeare develops the character of the Danish prince into a mysterious and fascinating man, a philosopher and a fencer, a wily antagonist and a gentle and appealing person, a man disgusted with the rottenness of life around him and obligated to set it right, a poet and an actor who has to pretend madness to achieve his ends. The play is the finest of all Shakespeare's *for the stage,* simply because no character ever created offers so much to admire, to wonder at and to puzzle over, as does the character of Hamlet.

OTHELLO, WHICH SHOWS HOW EVIL MAY DESTROY GOODNESS

OTHELLO (1604) is a tragedy of honor, in which a great but simple man, the soldier Othello, is made the victim of the fiendish trickery of Iago. Generosity, self-control, dignity and virtue can be made the tools of evil, as Shakespeare shows, and when the evil is finally destroyed much good is destroyed, too. Nobility of soul like Othello's carries with it a certain kind of blindness, and that blindness leads to the most terrible of cruelties. Yet despite the fact that we see Othello over and over again as clay in the hands of the devilish Iago, we never lose our sympathy with him, which is a mark of Shakespeare's art.

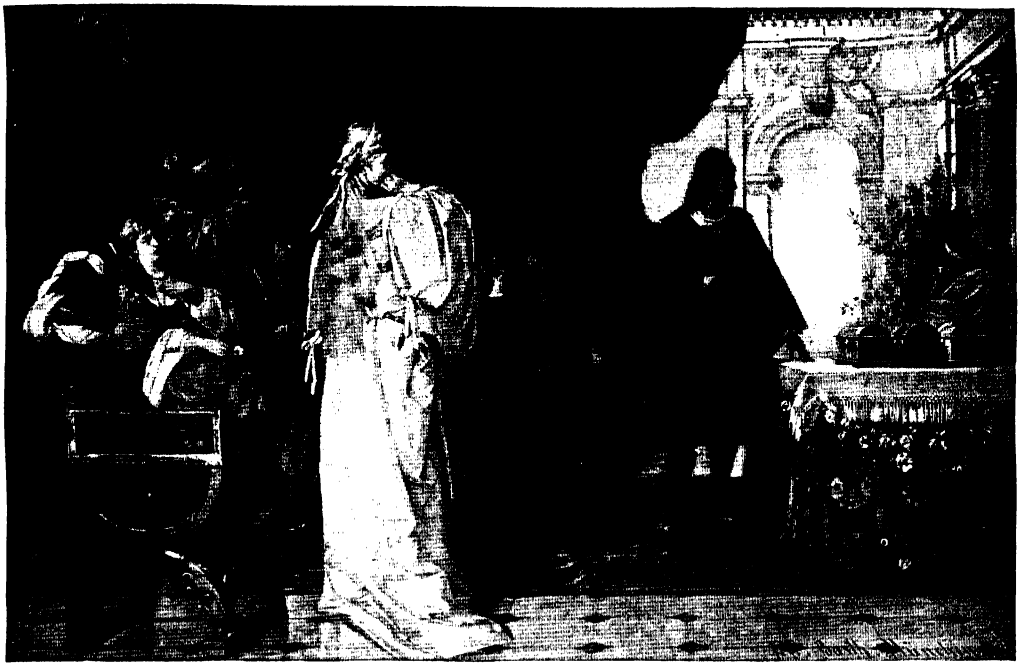
KING LEAR, A TRAGEDY OF SELFISHNESS AND GREED

KING LEAR (1605-06), often said to be Shakespeare's most magnificent work, is a tragedy of youth and age, of nature and man, of deep love and deep hate. The hero is a very old man, too old to be wise. In rejecting, from a sense of injured pride, the one daughter who loves him, he throws himself upon the mercy of his two other daughters, and there is no mercy there—only black cruelty and hatred. Nature itself turns upon him, and just as his pride is purged out of him and he learns love, his wits fail. He recovers only by the ministrations of his rejected daughter Cordelia, and he lives to see her hanged. The terrible anguish of the play is intensified by the subplot, which reinforces the main theme by the story of a father who misjudges his sons and suffers as Lear does. The Fool, Lear's attendant, and Edgar, who disguises himself as a lunatic beggar, only heighten the terrible pathos. Nature and mankind stand forth in terrible simplicity in this play. As the evil marches forward to its doom, there is upheaval and waste impossible to describe. Even more than of HAMLET could it be said of this play that "the rest is silence."

MACBETH, A TRAGEDY BASED ON CHARACTER

MACBETH (1606) is the most psychological of Shakespeare's tragedies. That is, MACBETH is first of all a study of character. The story traces the downward path of a fine and respected soldier who submits himself to the powers of darkness. It is interesting to see how far Shakespeare has come since RICHARD III; he no longer pictures evil as something foreign, strange and deformed, but as a quality of the imagination, present even in a good man if he will listen to it. The influence of fate is skillfully woven into the play through the "weird sisters," whose predictions first lead Macbeth astray. In Lady Macbeth, Shakespeare creates an unforgettable character whose guilt penetrates far into her subconscious mind.

After the great tragedies, Shakespeare



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A scene in THE MERCHANT OF VENICE. Bassanio is about to choose one of the three caskets. Portia, who loves him, watches anxiously, hoping that he will choose the right one, for whoever does so is the man she must marry.

wrote three more classical plays, TIMON OF ATHENS, ANTONY AND CLEOPATRA and CORIOLANUS; but they are rather specialized in their appeal. ANTONY AND CLEOPATRA is the finest of them, and in its great sense of the sweep of the Mediterranean world, the contrast between Roman and Egyptian civilization, and the characters of two peerless lovers, it almost reaches the level of the four great tragedies. It is a love tragedy of maturity, as ROMEO AND JULIET is a love tragedy of youth.

By 1612 Shakespeare had returned to Stratford, and, aside from one play which he helped John Fletcher to write (HENRY VIII), his work for the stage was over. In 1597 he had bought New Place, one of the best houses in Stratford; now he repaired it and moved into it with his family. He lived there about four years, and in 1616 he died. He was buried in the chancel of Trinity Church in Stratford, and a monument with a statue-bust of him was set up. Seven years later two of his fellow-actors, John Hemings and Henry Condell, brought out a collection of his plays, the First Folio (1623). In a poem introducing the book Ben Jonson said of Shakespeare "He was not of an age, but for all time."

Some part of the magic of Shakespeare's plays comes from the verse form that he most often used, and from the way in which he used it. This basic metre is unrimed iambic pentameter, each line of which is ten syllables long, with the accents on the second, fourth, sixth, eighth and tenth syllables, as in the line,

> Uneasy lies the head that wears a crown.

Iambic pentameter is well suited to the English language, and it was used long before Shakespeare's time, sometimes with rimed endings and sometimes without rimes, but no one made use of it so wonderfully as he did. Except for the songs, which are in various metres, and the humorous dialog, which is usually in regular prose, Shakespeare used iambic pentameter to express nearly every shade of thought and feeling. It gives added strength of feeling to the cry of Antony as he leans over the body of the murdered Caesar:

> O Mighty Caesar! dost thou lie so low?
> Are all thy conquests, glories, triumphs, spoils,
> Shrunk to this little measure? Fare thee well

It emphasizes the hopeless mood of Richard II, when he says:

> For God's sake let us sit upon the ground,
> And tell sad stories of the death of kings:
> How some have been deposed; some slain in war,
> Some haunted by the ghosts they have deposed;

Compare these lines with the serene loveliness of Lorenzo's speech in THE MERCHANT OF VENICE:

How sweet the moonlight sleeps upon this bank!
Here will we sit, and let the sounds of music
Creep in our ears; soft stillness and the night
Become the touches of sweet harmony,

or compare them with the youthful ardor of Romeo;

It seems she hangs upon the cheek of night
Like a rich jewel in an Ethiope's ear,

or to the fury of King Lear's outcry to the storm:

Blow, winds, and crack your cheeks! rage! blow!
You cataracts and hurricanoes, spout
Till you have drenched our steeples, drowned the cocks!

Besides the plays and the two non-dramatic poems of his early days, Shakespeare left a group of sonnets, written probably sometime before 1600 but not published until 1609, and then without the author's consent. If no plays of Shakespeare had survived down to our time, these sonnets alone would be enough to insure him immortality as an English poet. They deal with nature, love, decay and change, the hardships of life and its beauty, the immortality of verse and the perishability of everything else. The story behind them is obscure and complicated, but the poetry itself does not depend upon the mysterious story The series contains more individual great poems than any such group of sonnets ever written.

Shakespeare's plays have become a standard part of the education of the English-speaking peoples. This is a measure of their social and cultural importance. But the real proof of Shakespeare's greatness does not lie in this—it lies in the fact that for three and a half centuries, despite all the changes in fashions, in habits, in language even, his plays remain fresh and lively and interesting.

By HALLETT D. SMITH.

THE NEXT STORY OF LITERATURE IS ON PAGE 1113.

IMPORTANT DATES IN SHAKESPEARE'S LIFE

1564 Shakespeare was born in Stratford-on-Avon, England. He was baptized there on April 26, and it is believed that his birthday was April 23.

1568 When Shakespeare was four years old, his father was mayor of the town.

1577 When Shakespeare was about thirteen, his father began to have financial troubles. Tradition says that Shakespeare had to leave school for lack of money.

1582 Shakespeare was eighteen when he married Anne Hathaway.

1583 Their first child, Susanna, was christened.

1585 Their twin children, Hamnet and Judith, were christened.

1592 When he was twenty-eight, Shakespeare was an actor in London. The theaters were closed this same year.

1597 Shakespeare bought New Place, one of the best houses in Stratford-on-Avon.

1612 At about this time, Shakespeare had returned to Stratford with his family. His work for the stage was nearly over.

1616 Shakespeare died.

PLAYS OF SHAKESPEARE

Comedies

Play	*Date*
THE COMEDY OF ERRORS	1594
THE TWO GENTLEMEN OF VERONA	
LOVE'S LABOUR'S LOST	
LOVE'S LABOUR'S WON (thought to be the same play as ALL'S WELL THAT ENDS WELL)	
THE TAMING OF THE SHREW	
A MIDSUMMER-NIGHT'S DREAM	1595
MUCH ADO ABOUT NOTHING	1598–99
AS YOU LIKE IT	1599–1600
TWELFTH NIGHT	1600–01
THE MERRY WIVES OF WINDSOR	
TROILUS AND CRESSIDA	
ALL'S WELL THAT ENDS WELL	
MEASURE FOR MEASURE	

Tragicomedies

THE MERCHANT OF VENICE	
CYMBELINE	1610
THE WINTER'S TALE	1611
THE TEMPEST	1611

English Histories

KING JOHN	
RICHARD II	1595

English Histories *(Continued)*

Play	*Date*
HENRY IV, Part One	
HENRY IV, Part Two	
HENRY V	
HENRY VI, Part One	
HENRY VI, Part Two	
HENRY VI, Part Three	
RICHARD III	
HENRY VIII (in collaboration with John Fletcher)	

Tragedies

TITUS ANDRONICUS	
ROMEO AND JULIET	1595
JULIUS CAESAR	1599
HAMLET	1601–02
OTHELLO	1604
KING LEAR	1605–06
MACBETH	1606

Classical Plays

TIMON OF ATHENS	Written after the great tragedies
ANTONY AND CLEOPATRA	
CORIOLANUS	
PERICLES (parts of this play were probably written by an unknown author)	

SOME OF THE MUSIC AND PICTURES BASED ON SHAKESPEARE'S WORKS

MUSIC

A Midsummer-Night's Dream

Mendelssohn composed his masterly Overture to A MIDSUMMER-NIGHT'S DREAM when he was only seventeen years old. Seventeen years later, he wrote the incidental music to the play.

Romeo and Juliet

Gounod's opera, ROMEO AND JULIET.

Tschaikowsky's Fantasy Overture, ROMEO AND JULIET.

Berlioz' ROMEO AND JULIET, a dramatic symphony with chorus.

Prokofieff's ballet, ROMEO AND JULIET.

Macbeth

Verdi's opera, MACBETH.

Ernest Bloch's opera, MACBETH.

MUSIC FOR MACBETH, attributed to the seventeenth-century composer, Henry Purcell.

Othello

Verdi's opera, OTHELLO. Written when the composer was more than seventy years old, OTHELLO is considered one of Verdi's finest works.

Dvořák's Overture to OTHELLO.

The Merry Wives of Windsor

Verdi was nearly eighty years old when he wrote the brilliant score of the opera FALSTAFF, which was based mainly on this comedy.

The Overture to Nicolai's opera, THE MERRY WIVES OF WINDSOR, is very popular.

The Two Gentlemen of Verona

Franz Schubert wrote the music for the well-known song WHO IS SYLVIA, which is in Act IV, Scene II of this comedy.

Cymbeline

Schubert also wrote exquisite music for "Hark, hark! the lark," a song in Act II, Scene III.

Hamlet

Tschaikowsky's Fantasy Overture to HAMLET and incidental music for the play.

MacDowell's HAMLET AND OPHELIA, a symphonic poem.

Ambroise Thomas' opera, HAMLET.

King Lear

Berlioz' Overture to KING LEAR.

The Tempest

Tschaikowsky's Fantasy, THE TEMPEST.

Sibelius' incidental music to THE TEMPEST.

Honegger's Overture to THE TEMPEST.

Purcell's THE TEMPEST, a work for the stage.

Much Ado about Nothing

Berlioz' opera, BEATRICE AND BENEDICT.

The Taming of the Shrew

Hermann Goetz's opera, THE TAMING OF THE SHREW, is based on this comedy.

Antony and Cleopatra

The opera MARC ANTONY AND CLEOPATRA, by G. Francesco Malipiero, was first performed in 1938.

PAINTINGS AND ILLUSTRATIONS

The Two Gentlemen of Verona

W. Holman Hunt: The Two Gentlemen of Verona, Act V, Scene 4. Painting, in the Birmingham Art Gallery, Birmingham, England.

Walter Crane: Pen-and-ink illustrations.

A Midsummer-Night's Dream

Joseph Noel Paton: The Reconciliation of Oberon and Titania. Painting, in the National Gallery of Scotland, Edinburgh, Scotland.

William Blake: Oberon and Titania, with Puck and Fairies Dancing, Act IV, Scene 1. Drawing, in the National Gallery of British Art.

W. Heath Robinson: Illustrations.

Arthur Rackham: Illustrations.

As You Like It

John Everett Millais: Rosalind and Celia. Painting.

John Pettie: Touchstone and Audrey, Act III, Scene 3. Painting.

Adolphe Monticelli: As You Like It. Painting, in the Phillip's Memorial Gallery, Washington, D. C.

The Merry Wives of Windsor

A. W. Callcott: Anne Page and Slender, Act I, Scene 1. Painting, in the Victoria and Albert Museum, London, England.

Thomas Duncan: Anne Page and Slender, Act I, Scene 1. Painting, in the National Gallery of Scotland, Edinburgh, Scotland.

All's Well that Ends Well

Francis Wheatley: Helena, "There is your ring; And, look you, here's your letter," Act V, Scene 3. Painting.

The Merchant of Venice

John Everett Millais: Portia. Painting, in the Metropolitan Museum of Art, New York City.

The Winter's Tale

C. R. Leslie: Autolycus, "Here's one to a very doleful tune," Act IV, Scene 4. Painting, in the Victoria and Albert Museum, London, England.

The Tempest

Walter Crane: Illustrations.

Edmund Dulac: Illustrations.

Richard II

John Gilbert: Richard II Resigning the Crown to Bolingbroke, Act IV, Scene 1. Painting, in the Walker Art Gallery, Liverpool, England.

Henry VIII

John Gilbert: Cardinal Wolsey Going in Procession to Westminster Hall, Act I, Scene 1. Painting, in the Guildhall Art Gallery, London.

Hamlet

Eugene Delacroix: Hamlet and the Gravediggers, Act V, Scene 1. Painting, in the Louvre, Paris, France.

Eugene Delacroix: Hamlet. Watercolor, in the Albertina Collection, Vienna, Austria.

John Everett Millais: Ophelia. Painting, in the National Gallery of British Art, London, England.

George Frederick Watts: Ophelia. Painting, in the Watts Memorial Gallery, Limnerslease, England.

King Lear

Edwin Austin Abbey: King Lear, Act I, Scene 1. Painting, in the Metropolitan Museum of Art, New York City.

Ford Madox Brown: Cordelia's Portion. Painting.

Macbeth

J. B. C. Corot: Macbeth and the Witches. First Witch, "All hail, Macbeth!" Act I, Scene 3. Painting, in the Wallace Collection, London, England.

Albert P. Ryder: Macbeth and the Witches. Painting, in the Phillips Memorial Gallery, Washington, D. C.

John Singer Sargent: Ellen Terry as Lady Macbeth. Painting, in the National Gallery of British Art, London, England.

FAMOUS SHAKESPEAREAN ACTORS AND ACTRESSES

Name	*Dates*	*Nationality*	*Famous Shakespearean Parts*
Richard Burbage	1567?–1619	English	Foremost actor in Shakespeare's day. Excelled in tragedy, especially in the part of Richard III.
Thomas Betterton	1635?–1710	English	Foremost actor during the Restoration. Most famous part, Hamlet.
Charles Macklin	1697?–1797	Irish	Achieved great success as Shylock, Polonius and Iago.
David Garrick	1717–79	English	Foremost actor of the 18th century. Famous parts: Richard III, King Lear, Hamlet.
Mrs. Siddons (Sarah Kemble Siddons)	1755–1831	English	David Garrick's leading lady. A great actress and a great beauty, whose portrait was painted by the noted English artists Reynolds, Lawrence and Gainsborough. Most famous part, Lady Macbeth.
John Philip Kemble	1757–1823	English	Brother of Mrs. Siddons. Famous parts: Coriolanus, Brutus and Macbeth.
Charles Kemble	1775–1854	English	Brother of Mrs. Siddons. Famous parts: Macbeth, Romeo.
Edmund Kean	1787–1833	English	One of the greatest of all actors. Acted with Mrs. Siddons. Famous parts: Shylock, Richard III, Hamlet, Othello, Macbeth, King Lear.
William Charles Macready	1793–1873	English	A leading Shakespearean actor for more than forty years. Famous parts: Richard III, Coriolanus, Hamlet.
Edwin Forrest	1806–72	American	Famous as Othello, Macbeth and King Lear.
Fanny Kemble (Frances Anne Kemble)	1809–93	English	Daughter of Charles Kemble. Famous parts: Juliet, Portia, Beatrice.
Charlotte Saunders Cushman	1816–76	American	First native-born actress of top rank in the American theater. Toured America with Macready. A tragedienne, most famous as Lady Macbeth.
Edwin Thomas Booth	1833–93	American	Called the greatest American actor of Shakespeare. Famous parts: Hamlet, King Lear, Othello.
Sir Henry Irving (John Henry Brodribb)	1838–1905	English	Acted with Ellen Terry for many years. Irving was the first actor to be knighted. Famous parts: Hamlet, Shylock, Macbeth.
Helena Modjeska	1844–1909	Polish	Famous parts: Lady Macbeth, Cleopatra, Ophelia.
Dame Ellen Terry	1848–1928	English	Sir Henry Irving's leading lady. Famous parts: Ophelia, Portia, Beatrice.
Fanny Lily Gipsy Davenport	1850–98	American	Famous parts: Ophelia, Rosalind.
Sir Johnston Forbes-Robertson	1853–1937	English	Most famous part, Hamlet.
John Drew	1853–1927	American	Played with Edwin Booth. Later, Ada Rehan was his leading lady. Most famous part, Petruchio.
Robert Bruce Mantell	1854–1928	British	Acted in America for many years. Famous parts: Hamlet, Macbeth, Romeo.
Richard Mansfield	1857–1907	American	Famous parts: Shylock, Henry V, Brutus.
Otis Skinner	1858–1942	American	Acted with Modjeska, Ada Rehan and Mrs. Fiske. Famous parts: Shylock, Petruchio, Falstaff.
Edward Hugh Sothern	1859–1933	American	A brilliant comedian and romantic actor. Married Julia Marlowe in 1911. Famous as Hamlet and as Malvolio.
Ada Rehan	1860–1916	American	Comedienne. Famous parts: Katharine, Rosalind, Viola.
Mrs. Minnie Maddern Fiske (Mary Augusta Davey)	1865–1932	American	Most famous part, Mistress Page.
Mrs. Patrick Campbell (Beatrice Stella Tanner)	1865–1940	English	Forbes-Robertson's leading lady. Famous parts: Juliet, Ophelia, Lady Macbeth.
Julia Marlowe (Sarah Frances Frost)	1866–	American	Sothern's wife and leading lady. Famous parts: Rosalind, Ophelia, Juliet, Beatrice.
Maude Adams	1872–	American	Famous as Juliet and as Portia. (Miss Adams' most famous part was not in Shakespearean drama but in the beloved rôle of Peter Pan in Barrie's play of that name.)
Walter Hampden	1879–	American	Most famous part, Hamlet.
John Barrymore	1882–1942	American	Most famous part, Hamlet.
Dame Sybil Thorndike	1882–	English	Famous parts: Lady Macbeth, Rosalind, Portia.
Jane Cowl	1890–	American	Most famous part, Juliet.
Helen Hayes	1900–	American	Made a tremendous success as Viola.
Maurice Evans	1901–	American	Famous parts: Richard II, Falstaff, Hamlet.
John Gielgud	1904–	English	Most famous part, Hamlet.

POEMS ABOUT ANIMALS

Illustrated by Diana Thorne

The Moo-Cow-Moo*

By EDMUND VANCE COOKE
(1866-1932)

MY PA held me up to the Moo-Cow-Moo
So clost I could almost touch,
En I fed him a couple of times, or two,
En I wasn't a 'fraid-cat much.

But ef my papa goes into the house
En mamma, she goes in, too,
I just keep still, like a little mouse,
Fer the Moo-Cow-Moo might moo.

The Moo-Cow-Moo's got a tail like a rope,
En it's raveled down where it grows,
En it's just like feeling a piece of soap
All over the Moo-Cow's nose.

En the Moo-Cow-Moo has lots of fun
Just swinging his tail about;
En, he opens his mouth and then I run—
Cause that's where the moo comes out.

En the Moo-Cow-Moo's got deers on his head,
En his eyes stick out o' their place,
En the nose o' the Moo-Cow-Moo is spread
All over the end of his face.

Poor Dog Tray

By THOMAS CAMPBELL (1777-1844)

ON THE green banks of Shannon when
Sheelah was nigh,
No blithe Irish lad was so happy as I;
No harp like my own could so cheerily play,
And wherever I went was my poor dog Tray.

When at last I was forced from my Sheelah
to part
She said, (while the sorrow was big at her
heart,)
"Oh! remember your Sheelah when far, far
away:
And be kind, my dear Pat, to our poor dog
Tray."

Poor dog! he was faithful and kind to be
sure,
And he constantly loved me although I was
poor;
When the sour-looking folk sent me heartless
away,
I had always a friend in my poor dog Tray.

When the road was so dark, and the night
was so cold,
And Pat and his dog were grown weary and
old,
How snugly we slept in my old coat of gray,
And he licked me for kindness—my old dog
Tray.

Though my wallet was scant I remembered
his case,
Nor refused my last crust to his pitiful face;
But he died at my feet on a cold winter day,
And I played a sad lament for my poor dog
Tray.

Where shall I go, poor, forsaken, and blind?
Can I find one to guide me, so faithful and
kind?
To my sweet native village, so far, far away,
I can never more return with my poor dog
Tray.

The Broncho That Would Not Be Broken**

By VACHEL LINDSAY (1879-1931)

A LITTLE colt-broncho, loaned to the
farm
To be broken in time without fury or harm,
Yet black crows flew past you, shouting
alarm,
Calling "Beware," with lugubrious singing....
The butterflies there in the bush were
romancing,
The smell of the grass caught your soul in a
trance,
So why be a-fearing the spurs and the traces,
O broncho that would not be broken of
dancing?

*From Chronicles of a Little Tot, by Edmund Vance Cooke. By permission of the publisher, The Dodge Publishing Co.
**From The Collected Poems of Vachel Lindsay. Reprinted by permission of the publishers, The Macmillan Company.

You were born with the pride of the lords great and olden
Who danced, through the ages, in corridors golden.
In all the wide farm-place the person most human.
You spoke out so plainly with squealing and capering,
With whinnying, snorting, contorting and prancing,

"Nobody cares for you," rattled the crows,
As you dragged the whole reaper, next day, down the rows.
The three mules held back, yet you danced on your toes.
You pulled like a racer, and kept the mules chasing.
You tangled the harness with bright eyes side-glancing,

As you dodged your pursuers, looking askance,
With Greek-footed figures, and Parthenon paces,
O broncho that would not be broken of dancing.

The grasshoppers cheered, "Keep whirling," they said.
The insolent sparrows called from the shed
"If men will not laugh, make them wish they were dead."
But arch were your thoughts, all malice displacing,
Though the horse-killers came, with snake-whips advancing,
You bantered and cantered away your last chance,
And they scourged you, with Hell in their speech and their faces,
O broncho that would not be broken of dancing.

While the drunk driver bled you—a pole for a lance—
And the giant mules bit at you—keeping their places.
O broncho that would not be broken of dancing.

In that last afternoon your boyish heart broke.
The hot wind came down like a sledge-hammer stroke.
The blood-sucking flies to a rare feast awoke.
And they searched out your wounds, your death-warrant tracing.
And the merciful men, their religion enhancing,
Stopped the red reaper, to give you a chance.
Then you died on the prairie, and scorned all disgraces,
O broncho that would not be broken of dancing.

From The Lamb

By WILLIAM BLAKE (1757-1827)

LITTLE Lamb, who made thee?
Dost thou know who made thee?
Gave thee life, and bid thee feed,
By the stream, and o'er the mead;
Gave thee clothing of delight,
Softest clothing, woolly, bright;
Gave thee such a tender voice,
Making all the vales rejoice?
Little Lamb, who made thee?
Dost thou know who made thee?

The Tiger

By WILLIAM BLAKE (1757-1827)

TIGER, tiger, burning bright
In the forest of the night,
What immortal hand or eye
Could frame thy fearful symmetry?

In what distant deeps or skies
Burnt the ardor of thine eyes?
On what wings dare he aspire—
What the hand dare seize the fire?

And what shoulder, and what art
Could twist the sinews of thy heart?
And when thy heart began to beat,
What dread hand formed thy dread feet?

When the stars threw down their spears,
And watered heaven with their tears,
Did He smile His work to see?
Did He who made the lamb make thee?

Four Little Foxes*

By LEW SARETT (1888-)

SPEAK gently, Spring, and make no sudden sound;
For in my windy valley yesterday I found
New-born foxes squirming on the ground —
Speak gently.

Walk softly, March, forbear the bitter blow;
Her feet within a trap, her blood upon the snow,
The four little foxes saw their mother go—
Walk softly.

Go lightly, Spring, Oh, give them no alarm;
When I covered them with boughs to shelter them from harm,
The thin blue foxes suckled at my arm—
Go lightly.

Step softly, March, with your rampant hurricane;
Nuzzling one another, and whimpering with pain,
The new little foxes are shivering in the rain—
Step softly.

The Mountain and the Squirrel

By RALPH WALDO EMERSON (1803-1882)

THE mountain and the squirrel
Had a quarrel,
And the former called the latter "Little prig";
Bun replied,
"You are doubtless very big;
But all sorts of things and weather
Must be taken in together
To make up a year,
And a sphere.
And I think it no disgrace
To occupy my place.
If I'm not so large as you,
You are not so small as I,
And not half so spry;
I'll not deny you make
A very pretty squirrel track.
Talents differ; all is well and wisely put;
If I cannot carry forests on my back,
Neither can you crack a nut."

*From Slow Smoke, by Lew Sarett, copyright 1925, by Henry Holt and Co. Reprinted by permission of the publishers.

The Arab's Farewell to His Steed

By Caroline Norton (1808-1877)

This poem shows the traditional love of the Arab for the beautiful, swift desert horses. It tells of a man who sold his horse but found that he could not let him go.

My beautiful! my beautiful! that standest meekly by,
With thy proudly-arched and glossy neck, and dark and fiery eye!
Fret not to roam the desert now with all thy wingèd speed:
I may not mount on thee again—thou'rt sold, my Arab steed!

Fret not with that impatient hoof, snuff not the breezy wind.
The farther that thou fliest now, so far am I behind.
The stranger hath thy bridle rein—thy master hath his gold;
Fleet-limbed and beautiful, farewell!—thou'rt sold, my steed, thou'rt sold.

Farewell! Those free, untired limbs full many a mile must roam,
To reach the chill and wintry sky which clouds the stranger's home.
Some other hand, less fond, must now thy corn and bed prepare;
The silky mane I braided once must be another's care.

The morning sun shall dawn again, but never more with thee
Shall I gallop o'er the desert paths, where we were wont to be;
Evening shall darken on the earth, and o'er the sandy plain
Some other steed, with slower step, shall bear me home again.

Yes, thou must go! The wild, free breeze, the brilliant sun and sky,
Thy master's home—from all of these my exiled one must fly.
Thy proud dark eye will grow less proud, thy step become less fleet,
And vainly shalt thou arch thy neck thy master's hand to meet.

Only in sleep shall I behold that dark eye glancing bright;
Only in sleep shall hear again that step so firm and light;
And when I raise my dreaming arm to check or cheer thy speed.
Then must I, starting, wake to feel—thou'rt sold, my Arab steed.

Ah! rudely then, unseen by me, some cruel hand may chide,
Till foam-wreaths lie, like crested waves, along thy panting side;
And the rich blood that's in thee swells in thy indignant pain,
Till careless eyes which rest on thee, may count each starting vein.

Will they ill-use thee? If I thought—but no, it cannot be,
Thou art so swift, yet easy curbed; so gentle, yet so free;
And yet, if haply, when thou'rt gone, this lonely heart should yearn,
Can the hand that casts thee from it now command thee to return?

Return!—alas, my Arab steed! what shall thy master do,
When thou, who wert his all of joy, hast vanished from his view?
When the dim distance cheats mine eye, and through the gathering tears
Thy bright form, for a moment, like the false mirage appears?

Slow and unmounted shall I roam, with weary step alone,
Where with fleet step and joyous bound thou oft hast borne me on;
And, sitting down by that green well, I'll pause and sadly think,
" 'Twas here he bowed his glossy neck when last I saw him drink!"

When last I saw thee drink!—away! The fevered dream is o'er!
I could not live a day and know that we should meet no more!
They tempted me, my beautiful! for hunger's power is strong—
They tempted me, my beautiful! but I have loved too long.

Who said that I had given thee up? Who said that thou wert sold?
'Tis false!—'tis false! my Arab steed! I fling them back their gold!
Thus, thus, I leap upon thy back, and scour the distant plains!
Away! who overtakes us now may claim thee for his pains!

The Kitten and the Falling Leaves

By William Wordsworth (1770-1850)

See the kitten on the wall,
Sporting with the leaves that fall,
Withered leaves—one—two—and three—
From the lofty elder-tree!
Through the calm and frosty air
Of this morning bright and fair,
Eddying round and round they sink
Softly, slowly: one might think,
From the motions that are made,
Every little leaf conveyed
Sylph or fairy hither tending,
To this lower world descending,
Each invisible and mute,
In his wavering parachute.
—But the kitten, how she starts,
Crouches, stretches, paws, and darts!
First at one, and then its fellow,
Just as light and just as yellow;
There are many now—now one—
Now they stop and there are none:
What intenseness of desire
In her upward eye of fire!
With a tiger-leap half-way
Now she meets the coming prey,
Lets it go as fast, and then
Has it in her power again:
How she works with three or four,
Like an Indian conjuror;
Quick as he in feats of art,
Far beyond in joy of heart.
Were her antics played in the eye
Of a thousand standers-by,
Clapping hands with shouts and stare,
What would little Tabby care
For the plaudits of the crowd?
Over happy to be proud,
Over wealthy in the treasure
Of her own exceeding pleasure!

To a Mouse

ON TURNING UP HER NEST WITH THE PLOW

By ROBERT BURNS (1759-1796)

This poem has a number of Scottish words that are strange to us, such as *brattle,* which means clatter; *pattle,* a stick; *daimen icker,* an occasional wheat-ear; *thrave,* sheaves; *laive,* remainder; *foggage,* bits of grass and leaves; *snell,* biting; *coulter,* plow; *thole,* endure; *cranreuch,* frost.

WEE, sleekit, cow'rin', tim'rous
beastie,
O, what a panic's in thy breastie!
Thou need na start awa' sae hasty,
Wi' bickering brattle!
I wad be laith to rin an' chase thee,
Wi' murd'ring pattle!

I'm truly sorry man's dominion
Has broken Nature's social union,
An' justifies that ill opinion,
Which makes thee startle
At me, thy poor, earth-born companion,
An' fellow-mortal!

I doubt na, whiles, but thou may
thieve;
What then? poor beastie, thou maun
live!
A daimen icker in a thrave
'S a sma' request;
I'll get a blessin' wi' the laive,
And never miss't!

Thy wee bit housie, too, in ruin!
Its silly wa's the win's are strewin'!
An' naething, now, to big a new ane,
O' foggage green!
An' bleak December's winds ensuin',
Baith snell an' keen!

Thou saw the fields laid bare an' waste,
An' weary winter comin' fast,
An' cozie here, beneath the blast,
Thou thought to dwell,—
Till, crash! the cruel coulter passed
Out through thy cell.

That wee bit heap o' leaves an' stibble
Has cost thee mony a weary nibble!
Now thou's turned out, for a' thy
trouble,
But house or hald,
To thole the winter's sleety dribble,
An' cranreuch cauld!

But, Mousie, thou art no thy lane,
In proving foresight may be vain;
The best-laid schemes o' mice an'
men,
Gang aft a-gley,
An' lea'e us naught but grief an' pain,
For promised joy!

Still thou art blest, compared wi' me!
The present only toucheth thee:
But, och! I backward cast my e'e
On prospects drear!
An' forward, though I canna see,
I guess an' fear!

THE NEXT POEMS ARE ON PAGE 1006.

HOW THINGS ARE MEASURED

ONE of the corner-stones of our civilization is the system of weights and measures. We could not carry on the everyday business of life without it. The grocer weighs out so many pounds of potatoes for your mother; the druggist weighs drugs in making up your doctor's prescription. When you buy ribbon or cloth in a store, the sales person measures out the length you need. The tailor takes many measurements when he makes a suit for your father.

Measurements are also necessary in the crafts and professions. The carpenter uses his rule many times a day. Thousands upon thousands of measurements must be made in building a great bridge or a lofty skyscraper. Weights or measures or both are very important in chemistry, in physics, in astronomy, in zoology, in many other sciences. In fact a great thinker once said that science *is* measurement.

One of the most important measurements is *length.* We measure length when we find out the distance between two points. This may be very small, as when we measure a half-inch margin on a notebook page. It may be great, as when we calculate the distance of the earth from a sister-planet. The inch is a unit of length; so is the yard; so is the mile. Length is sometimes called linear measure.

Certain things have not only length, but also width. A floor, a table top, a building lot, a cotton plantation—all have both length and width. To measure things like these, we use a unit of *area,* such as a square foot, or an acre or a square mile. Area is sometimes called square measure.

Other objects have three dimensions: length, width and thickness. Bricks have three dimensions; so have baseballs; so have bottles and tables and chairs and houses. Length, width and thickness are all equal in the case of objects that we call cubes. Your little brother's alphabet block is a cube. When we measure a cube, or any other thing that has three dimensions, we find the amount of space that it takes up—that is, its *volume,* or its bigness. Some of the volume measures are named after the cube—cubic inches, cubic feet and cubic yards.

Suppose we want to find out what quantity of beans or milk will fit into a certain space. For this purpose we use a hollow container that has a certain volume and we fill it with beans or milk. We call a container of this sort a measure of *capacity.* A quart and a gallon are measures of capacity; so are a peck and a bushel.

Now we come to the two measurements of *mass* and *weight.* It is very important to know the difference between them. What is mass? It is, to put the matter as simply as possible, the actual amount of stuff there is in a body. An iron ball and a baseball of the same volume, or bigness, take up the same space. But there is more stuff packed into the iron ball than into the baseball. It has more *mass.*

The iron ball also has more *weight* than the baseball. Now when we come to consider weight, we must deal with the laws of gravitation. Gravitation is the force by which everything in this world attracts every other thing. If you let a baseball fall from your hand, it does not hang in space but falls to earth. The earth has pulled it down, has attracted it. We tell about the force of gravitation in the article beginning on page 739.

WE WEIGH THINGS BY FINDING OUT THE PULL OF THE EARTH ON THEIR MASS

The more mass an object has, the stronger will be the attraction between it and the earth. Our entire system of weights is based upon this fact. You see, the weight of an object simply represents the pull of the earth upon its mass. We calculate weight by means of a scale. This is an instrument which registers the pull of the earth in terms of certain units —grains, ounces, pounds and so on.

The nearer to the center of the earth a thing is, the stronger the pull of the earth upon its mass will be; that is, the more it will weigh. On the other hand, the farther it is from the center of the earth, the less it will weigh.

A bar of lead contains a certain amount of lead; its mass is always the same. But a bar of lead on a mountain top would weigh a little less than the same bar at the bottom of a mine, because it would be farther away from the center of the earth. If the bar of lead could be carried up a thousand miles into the air in a rocket ship, the lead would weigh considerably less than it did on the surface of the earth.

Since the weight of an object differs according to where it is weighed, it is clear that its mass would represent a more accurate means of measurement than its weight. Yet, we generally weigh things instead of finding out their mass. This is so partly because it is a rather difficult task to calculate the mass of an object, while it is generally very easy to weigh the same object.

Besides, there is very little difference between the weight of an object at one altitude, or height, and its weight at another, unless the second altitude is much greater than the first. For example, a bag of potatoes that weighs 10 pounds at sea level will weigh about 9 and 99/100 pounds if it is on the top of a mountain four miles high.

Of course a grocer would protest most bitterly if we made him weigh out potatoes on a rocket ship a thousand miles above the surface of the earth, since it would take many more potatoes to register ten pounds at that altitude than at sea level. But so far this situation has never come up. Both the grocer and his customer are satisfied to use weight rather than mass as a means of measurement in buying and selling potatoes and other things.

So much, then, for weight. Another important thing that must be measured is *time.* The second is the unit of time that has been adopted in practically all the civilized countries of the world. This unit comes from the spinning of the earth upon its axis. We use the word day to refer to the time that the earth takes to make a complete turn about its axis.

The day is divided into twenty-four parts, called hours. Each hour is divided in turn into sixty minutes, and each minute into sixty seconds. A second, then, is the 86,400th part of the time it takes the earth to spin around once. (We get the number 86,400 by multiplying 24 x 60 x 60.)

There are many, many other measurements besides those that we have just named. There is the *density* of an object, which is the relation between the stuff it contains and the space it takes up—or, to use the language of science, the ratio of its mass to its volume. There is the measurement of *energy.* There is the measurement of *velocity,* or speed in a single direction. There are also measurements of *pressure, heat, electrical current* and many other things.

ALL MEASUREMENTS ARE BASED ON THOSE OF LENGTH, WEIGHT AND TIME

It would be a terribly difficult task to learn to weigh and measure things if we had entirely different kinds of units for different kinds of measurements. Men have found, however, that all measurements are based on three—those of length, weight and time. Let us show how.

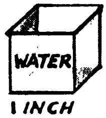
Suppose we accept the foot as our unit of length. If we wish to measure the area of a building lot, we do not invent an entirely different sort of measure. We use the square foot. If we wish to measure the area of a lot that is twenty feet long by twenty feet wide, we multiply its length by its width (20 x 20) and that gives us its area—400 square feet.

Suppose we want to measure volume. We still use the foot as the basis of our measure of volume, the cubic foot. If we want to measure the volume of a box, each side of which is two feet long, we multiply the length, width and thickness together (2 x 2 x 2). The volume of the box is eight cubic feet.

If we wish to measure speed, we take some measure of *length* and some measure of *time.*

VOLUME, MASS and WEIGHT

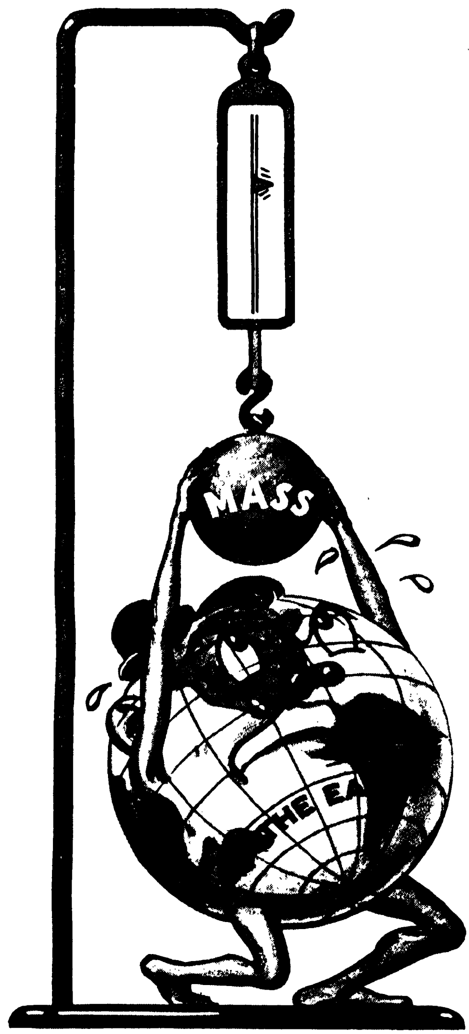
VOLUME



THE WATER AND THE LEAD HAVE THE SAME VOLUME — 1 CUBIC INCH.

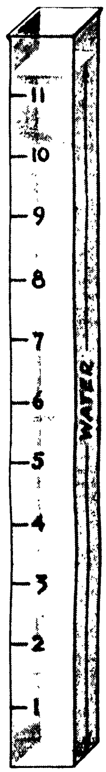
WEIGHT

THE SCALE REGISTERS THE PULL OF THE EARTH ON THE MASS OF AN OBJECT.



MASS

THE VOLUME OF THE WATER SHOWN IN THIS PICTURE IS MORE THAN ELEVEN TIMES AS GREAT AS THAT OF THE LEAD. YET THE WATER AND THE LEAD SHOWN HERE HAVE THE SAME MASS. THERE IS JUST AS MUCH STUFF PACKED IN THE SMALL AMOUNT OF LEAD AS THERE IS IN THE LARGE AMOUNT OF WATER.



We say that Bill Jones can walk three miles an hour; we say that a fast runner can go a hundred yards in ten seconds. Or suppose we want to measure energy. The unit called the foot-pound comes from the foot, a unit of *length*, and the pound, a unit of *weight*. The foot-pound is equal to the work done in raising one pound avoirdupois against the force of gravitation the height of one foot.

Now in calculating length, or weight, or time or the measurements that are built up from these three, we must have a series of units that all people will know and accept. Suppose, for example, that you tell an architect to build you a house as long as forty canes, laid end to end, and as wide as twenty canes. Canes are of many different sizes. Therefore, your architect might use one size of cane for his measurements, while you might have an entirely different length of cane in mind.

MEASUREMENTS THAT ARE ALWAYS THE SAME AND THAT ARE ACCEPTED BY ALL

But if you tell the architect that the house is to be so many feet long and so many feet wide, there can be no misunderstanding. You and he and all your friends accept the foot as a unit of measurement. A foot is a foot whether it is measured in Boston, or New York, or Chicago or San Francisco. And so it is with units of area and volume and time, and so on.

It took many centuries before men worked out accurate units of measurement. The first ones were rough and ready. Men used as measures the human hand, or the human foot, or the length of a furrow made by a plow or the distance that a man could travel in a single day's journey. The ancient Chinese had an uphill mile and a downhill mile. Since it is harder to walk uphill than downhill, they made the uphill mile shorter!

Of course measures like a human hand, or a human foot or the length of a furrow are very inexact. One man's hand or foot may be much longer than another's. A furrow made by one plowman might not be nearly so long as that made by another. As time went on, men found that it would be much more satisfactory to use measures that would never change.

Probably something like this happened. Old So-and-So, who lived thousands of years ago, became dissatisfied with the old measure of length, the human foot—any human foot. He prepared a stick as long as his own foot and used it to measure his fields. He then persuaded his friends and neighbors to prepare other sticks of exactly the same length and to use these sticks in all their measurements. It is clear that these people would have a far more satisfactory measure of length than ever before.

We do not know when the rough measurements of the earliest times gave way to a series of weights and measures based on accurate units. We know that the ancient Egyptians had such a system and that similar systems were used in other ancient countries. Unfortunately, different regions adopted different measures.

When the Romans established their mighty empire, they decided that they would set up a series of units that would be the same all over the empire. They made a rod of bronze that they called a *pes* (the Latin word for foot), and this served as the unit of length. They made a bronze weight that they called the *libra* or pound, and this served as the unit of weight. (The abbreviation lb. for pound comes from this Latin word). The bronze *pes* and *libra* were kept under guard in a temple. They became the standard units of length and weight.

After the fall of the Roman Empire, there was great confusion again. Each region developed its own system of weights and measures, and very unsatisfactory they were. In the course of time they were gradually made more accurate. Yet they were still far from perfect. The various units were jumbled together in the strangest way, apparently without rime or reason.

It was not until toward the end of the eighteenth century that a really scientific system of weights and measures was set up. This system was the work of a group of noted French scientists. They accepted as their unit of time the second, which was already firmly established; but they did not accept any of the other existing units of measurement.

THE FAMOUS METRIC SYSTEM IS BASED ON THE UNIT KNOWN AS THE METER

They chose as their unit of length the ten-millionth part of an imaginary line running through Paris from the Equator to the North Pole. After careful measurements, they worked out the length of this unit, which they called the meter (from the Greek *metron* or measure). It is about 39⅓ inches long. With the meter as a basis they set up the metric system, which is quite generally accepted as the best system of weights and measures that the world has ever known.

The metric system is ever so much simpler than our own. Take our various measures of


ORIGIN of some of our MEASURES
THE PALM
3 INCHES
THE HAND
4 INCHES
THE SPAN
9 INCHES
THE FOOT
12 INCHES
THE YARD
(DISTANCE FROM NOSE TO END OF THUMB OF HENRY I OF ENGLAND,
AS ESTABLISHED BY ROYAL DECREE.)
36 INCHES
THE FURLONG
(FURROW-LONG; LENGTH OF ONE FURROW.)
660 FEET

length, for example. Our chief unit of length is the yard. It is divided into 3 feet and the foot is divided into 12 inches. As for measurements larger than the yard, we have the rod, which is equal to 5½ yards or 16½ feet, the mile, which is equal to 1,760 yards or 5,280 feet, and other measures. All this is very complicated.

THE DECIMAL METHOD OF RECKONING IS USED IN THE METRIC SYSTEM

Reckoning is much simpler in the metric system. The meter is divided into ten parts and each of those into ten still smaller parts and so on. This is called the decimal method, and throughout the whole metric system the decimal method is used. American and Canadian money is reckoned in this way. Thus 10 mills make a cent; 10 cents make a dime; 10 dimes make a dollar.

A meter, then, is divided into tenths, hundredths and thousandths; the larger units are 10 meters, 100 meters and 1,000 meters. Each of these units has a name, consisting of the word meter plus a prefix taken from Latin or Greek. (A prefix is a combination of letters used before a word to give it different or added meaning.)

These prefixes are deci- (1/10), centi- (1/100), milli- (1/1000), all taken from the Latin; and deca- (10), hecto- (100) and kilo- (1,000), taken from the Greek. A decimeter, then, is 1/10 of a meter; a kilometer is 1,000 meters. As you see, the Latin prefixes are used for measures smaller than the meter; the Greek prefixes, for measures larger than the meter.

And so we have the following system of units of length: 10 millimeters make a centimeter; 10 centimeters make a decimeter; 10 decimeters make a meter; 10 meters make a decameter; 10 decameters make a hectometer; 10 hectometers make a kilometer. Isn't this an easy way to reckon?

As we said before, the meter is the basis of the metric system; all the other measurements are founded upon it. The unit of area is the *square meter;* the unit of volume is the *cubic meter,* or *stere.* The *liter* is the unit of capacity. A liter of anything is the amount that is contained in a measure 10 centimeters long by 10 centimeters wide by 10 centimeters deep. The unit of weight is the *gram.* It represents the weight of one cubic centimeter of pure water at a temperature of 4 degrees Centigrade (about 39 degrees Fahrenheit).

The same prefixes that are used with the word meter to indicate smaller and larger units are also used with liter and gram. Thus, a centiliter is 1/100 of a liter, while a kilogram is 1,000 grams. In the case of square measures, the word *are* is used for 100 square meters; the word *hectare* for 100 ares or 10,000 square meters.

The metric system was accepted by France in 1795. Since that time it has made amazing progress. Today the United States and the British Empire are the only countries of any importance that have not officially adopted the system. (Some of the countries that now use metric weights and measures also use the older systems.)

The United States and the British Empire still use the old weights and measures; however, scientists everywhere in these countries use the metric system. The American weights and measures are much the same as those employed in the English colonies of the New World before the United States became a nation. Now American and British systems differ slightly. The British gallon, for instance, is greater than the American gallon.

Since Canada forms part of the British Empire, she uses the British system of weights and measures, except in a very few cases. For example, a Canadian would say that Mr. Smith weighs 140 pounds. An Englishman would say that he weighs 10 *stone,* a stone being equal to 14 pounds. But such exceptions are rare.

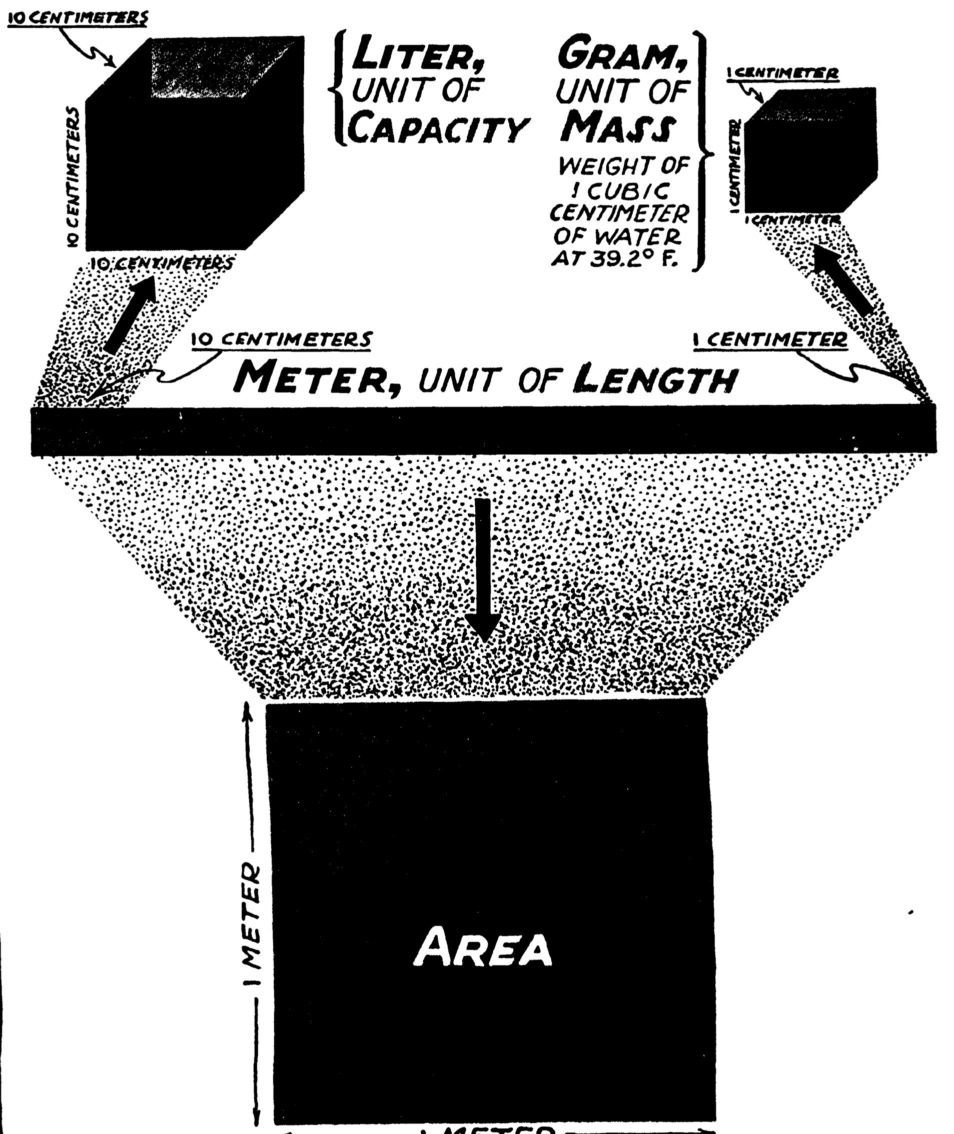
OTHER MEASUREMENTS EMPLOYED IN VARIOUS TRADES AND PROFESSIONS

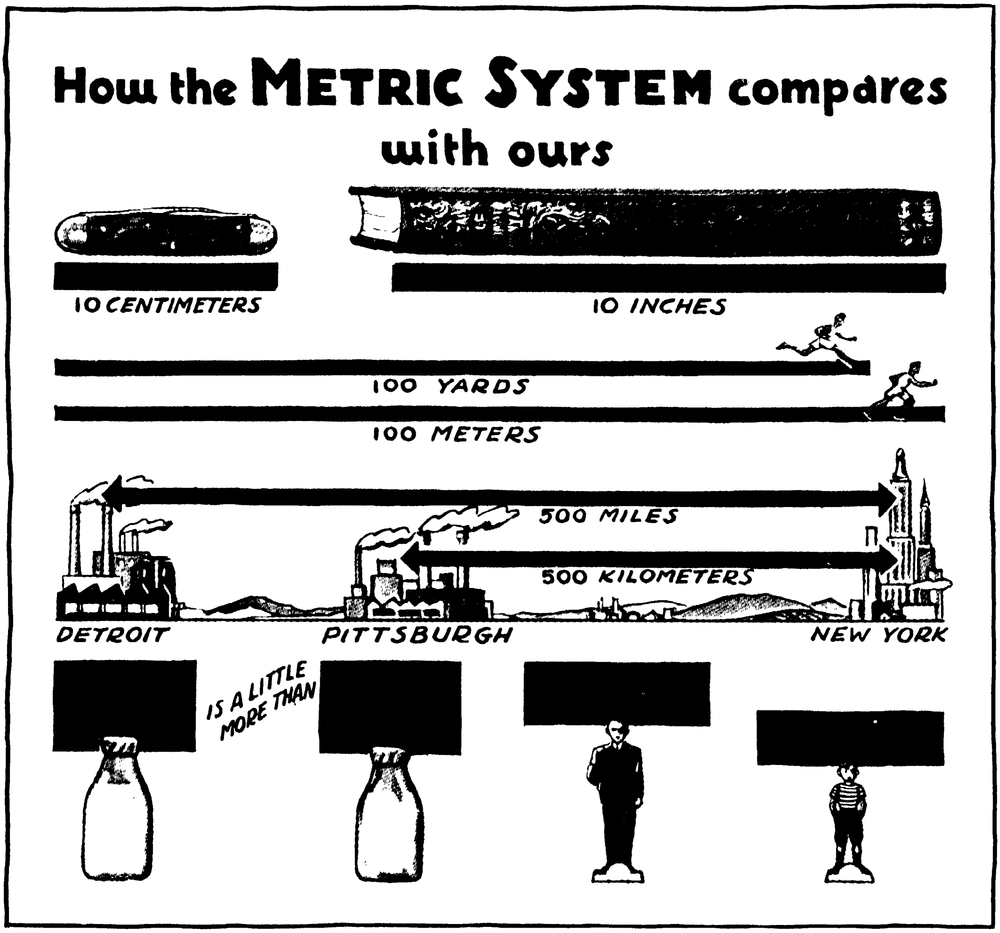
On the last page of this article we give a table of the common weights and measures. In addition to these, a good many others are used in various trades and professions. Printers, for example, reckon sizes of type not in inches but in *points.* A point is a seventy-second of an inch. The letters in this paragraph, for example, are set in 10-point type. That means that each letter is ten seventy-seconds of an inch high.

Tailors use the word *bolt* as a measure of cloth. The bolt generally measures 40 yards, though the length varies with different fabrics and manufacturers. Electricians often use the measurement called the *mil* (1/1000 of an inch) in electrical work, particularly in indicating the thickness of wire. When you come to the chapters on electricity, you will learn many other special measures used in that field.

Shoe sizes are reckoned by the old measure called the *barleycorn,* which is equal to a third of an inch. A size 10 shoe, therefore, is an inch longer than a size 7 shoe. The barleycorn is used in a system of thirteens. This

The METER as the basis of the METRIC SYSTEM





You will find it interesting to use the table on the next page in order to check the accuracy of the pictures.

means that when one reaches 13 in measuring shoes by barleycorns, one does not go on to 14 but begins all over again with 1.

Buttons are measured by *lines;* each line is equal to 1/40 of an inch. Therefore, when one speaks of a 30-line button, one means a button that is ¾ of an inch in diameter.

Astronomers often use very big numbers. If they measured distances only in terms of miles, the resulting figures in some cases would be so long that they might well discourage even an astronomer! Therefore, several measures of length larger than the mile have been adopted. The measure called the *astronomical unit* is equal to nearly 93,000,000 miles.

For particularly great distances the unit called the *light year* is used. The light year is the distance that light travels in one year—a really respectable distance, seeing that the speed of light is about 186,230 miles a second. A light year is equal to 65,700 astronomical units or—if you want the number in terms of miles—about 6,000,000,000,000 miles.

There are many other kinds of measurements besides those that we have given here. Now rulers and scales and containers and other things with which we weigh and measure are apt to vary just a bit. In practically every country, therefore, there is a government agency which has the task of seeing that weights and measures are kept as accurate as possible. In the United States there is the Bureau of Standards; in Canada, the Weights and Measures Service.

THE NEXT STORY OF SCIENCE IS ON PAGE 1152.

TABLE OF WEIGHTS AND MEASURES IN COMMON USE

LONG MEASURE

12 inches (in. or ″)	= 1 foot (ft. or ′)
3 feet	= 1 yard (yd.)
5½ yards or 16½ feet	= 1 rod (rd.)
40 rods	= 1 furlong (fur.)
8 furlongs or 1,760 yards or 5,280 feet	= 1 mile (mi.)
3 miles	= 1 league

SQUARE MEASURE

144 square inches (sq. in.)	= 1 square foot (sq. ft.)
9 square feet	= 1 square yard (sq. yd.)
30¼ square yards or 272¼ square feet	= 1 square rod (sq. rd.)
160 square rods	= 1 acre (A.)
640 acres	= 1 square mile (sq. mi.)

CUBIC OR SOLID MEASURE

1,728 cubic inches (cu. in.)	= 1 cubic foot (cu. ft.)
27 cubic feet	= 1 cubic yard (cu. yd.)
24¾ cubic feet	= 1 perch

WOOD MEASURE

16 cubic feet (cu. ft.)	= 1 cord foot (cd. ft.)
8 cord feet or 128 cubic feet	= 1 cord (cd.)

LIQUID MEASURE

4 gills (gi.)	= 1 pint (pt.)
2 pints	= 1 quart (qt.)
4 quarts	= 1 gallon (gal.)
United States gallon	= 231 cubic inches, in most states
British Imperial gallon	= 277.27 cubic inches

DRY MEASURE

2 pints (pt.)	= 1 quart (qt.)
8 quarts (qt.)	= 1 peck (pk.)
4 pecks	= 1 bushel (bu.)
United States bushel	= 2,150.42 cubic inches, in most states
British Imperial bushel	= 2,218.19 cubic inches

AVOIRDUPOIS WEIGHT

(Used for all goods except precious metals, precious stones and drugs)

437½ grains (gr.)	= 1 ounce (oz.)

AVOIRDUPOIS WEIGHT (*continued*)

16 ounces	= 1 pound (lb.)
14 pounds	= 1 stone (English)
100 pounds	= 1 hundredweight (cwt.)
2,000 pounds	= 1 short ton (S. T.)
2,240 pounds	= 1 long ton (L. T.)

TROY WEIGHT

(Used in weighing precious metals and precious stones)

24 grains (gr.)	= 1 pennyweight (pwt. or dwt.)
20 pennyweights	= 1 ounce (oz.)
12 ounces	= 1 pound (lb.; the troy pound is lighter than the avoirdupois pound, which contains 7,000 grains)

APOTHECARY'S WEIGHT

(Used in making up doctors' prescriptions)

20 grains (gr.)	= 1 scruple (℈)
3 scruples	= 1 dram (dr.)
8 drams	= 1 ounce (oz.)
12 ounces	= 1 pound (lb.; the apothecary's pound has the same weight as the troy pound)

TIME MEASURE

60 seconds (sec.)	= 1 minute (min.)
60 minutes	= 1 hour (hr.)
24 hours	= 1 day (da.)
7 days	= 1 week (wk.)
365 days or 12 months	= 1 common year
366 days	= 1 leap year
100 years	= 1 century

MARINER'S MEASURE

6 feet	= 1 fathom
6,080 feet	= 1 nautical mile
3 nautical miles	= 1 marine league
1 knot (measure of speed)	= 1 nautical mile per hour

HOW METRIC WEIGHTS AND MEASURES COMPARE WITH OURS

A meter is about 39⅓ inches (39.37 inches).

A centimeter is about ⅖ of an inch (.39 inch).

A kilometer is about ⅝ of a mile (.62 mile).

A square meter is about 10¾ square feet (10.76 square feet).

A hectare is about 2½ acres (2.47 acres).

A cubic meter or stere is about 35⅓ cubic feet (35.31 cubic feet).

A liter, liquid measure, is a little more than a quart, liquid measure (1.06 quarts).

A liter, dry measure, is a little less than a quart, dry measure (.91 quart).

A kilogram is about 2⅕ pounds (2.201 pounds) avoirdupois.

A yard is about 91½ centimeters (91.44 centimeters).

An inch is about 2½ centimeters (2.54 centimeters).

A mile is about 1⅗ kilometers (1.61 kilometers).

A square yard is about ⅘ of a square meter (.84 square meter).

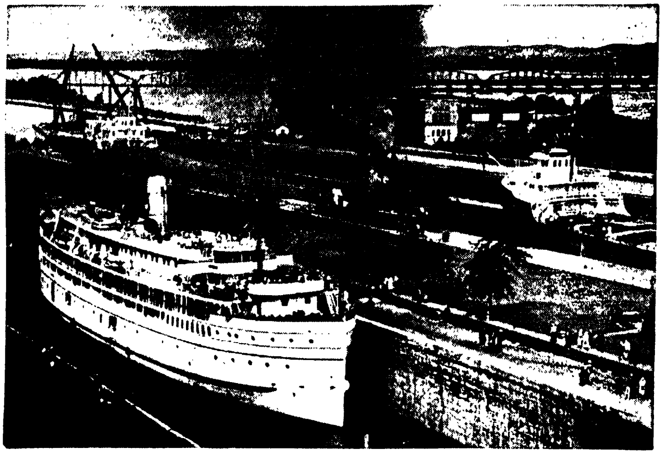
An acre is about ⅖ of a hectare (.405 hectare).

A cubic yard is about ¾ of a cubic meter (.76 cubic meter).

A quart, liquid measure, is a little less than a liter, liquid measure (.95 liter).

A quart, dry measure, is a little more than a liter, dry measure (1.101 liters).

A pound avoirdupois is a little less than half of a kilogram (.45 kilogram).



Ewing Galloway, N. Y.
Ships in the big locks of the Soo Canal, Sault Sainte Marie, Michigan.

CANALS

THE STORY OF MAN-MADE WATERWAYS

CANALS are man-made waterways, or, as they have more than once been called, big ditches. Their chief uses are: for navigation by boats, barges and ships to shorten natural water routes, and to cheapen the cost of carrying freight; for draining and reclaiming low, swampy land, or irrigating dry land; for carrying off polluted water from cities; for carrying pure water to cities; and for bringing water to power plants.

Some canals serve more than one purpose. For example, large drainage canals, like the Chicago Drainage Canal, are also used by boats and even ships. Some irrigation canals, as in southern California, are used to carry drinking water to cities and towns in the regions that are irrigated. In ancient times, especially, irrigation canals were also used as waterways.

Some canals are built entirely through dry land. Others are made by canalizing streams or rivers, and still others combine both methods. Canalizing a stream means straightening it and making it deeper so boats can pass through it. If the stream is not on a level, dams may be built, with locks so that boats can go upstairs or downstairs.

In canalizing a river, the engineers must always consider the current, which flows downstream usually at the rate of several miles an hour. This makes going upstream in a boat slower than going downstream; and it creates certain other problems. In canals built across country, anything more than a slight current will tend to wash away the banks and in time will fill up the channel.

For this reason, in digging a cross-country canal that will have earth banks and bottom, engineers make the bottom exactly level, to avoid any current. This kind of canal is usually a narrow waterway just wide enough for two boats to pass.

Courtesy, U. S. Engineer Office, Chicago, Ill.
A towboat and four barges in the long Illinois Waterway, which connects Lake Michigan with the Illinois River.

Ship canals are built from the sea, sometimes a hundred or more miles through flat country to inland cities, or to connect lakes or seas and oceans through isthmuses or narrow peninsulas. Where the canal goes from a flat, level country to higher ground, the canal must be built in sections, or reaches, of different levels; and where the different reaches meet they must be joined together by a lock. The great ship canal through the Isthmus of Suez goes through low, flat land all the way, and has no locks.

The great ship canal at the Isthmus of Panama had to be built through a high ridge of land; it would have been too expensive, and in fact almost impossible, to dig a sea-level canal. So there are short sea-level approaches, and the main canal is at a higher level. Ships enter the canal, go upstairs by means of locks, go through the main stretch of canal, go downstairs by more locks and so pass out into the ocean. See the article on The Panama Canal.

Inland, or cross-country, canals are built on the same principles. To use as few locks as possible they often follow the valleys of small streams or unnavigable rivers; they skirt around hillsides, and even tunnel through ridges and hills; embankments are built for them to go through deep cuts, and cross low places and ravines. They may even cross small streams on bridges.

HOW SHIPS GO UPSTAIRS AND DOWN BY MEANS OF LOCKS

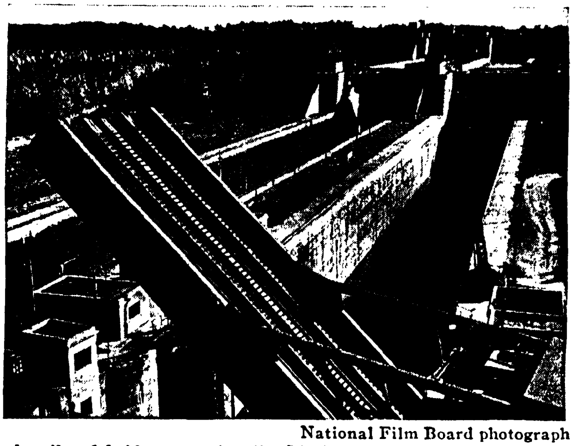
Locks were invented in Europe some time between 1400 and 1500. This marked the beginning of the great era of navigation-canal building which has continued to today. It is not definitely known who first made locks, but by the end of the fifteenth century they were being used on canals in Italy and Holland, and soon after that in France and other countries in western Europe. By using locks canals could be built through the upland regions of most of Europe. The upper reaches of many rivers could be connected. People living in little lonely inland pockets were brought together.

A lock is a water-tight chamber made of wood, masonry or concrete, between two sections of a canal that are on different levels. The walls extend from the bottom of the lower level to above the water level of the upper section. At each end of the lock chamber there are heavy gates, or doors, of wood or steel, hinged to the side walls of the lock and closing at an angle upstream. When these great doors are closed the water presses against them, making them water-tight. The gates at the opposite ends of a lock are never open at the same time. If they were, the water from the upper level would pour through the lock like a waterfall.

There are passages called sluices through the side walls and around the gates, and these sluices can be opened or closed by gates or valves. Through these sluices water can be poured into the lock to fill it, or can flow out of the lock, emptying it.

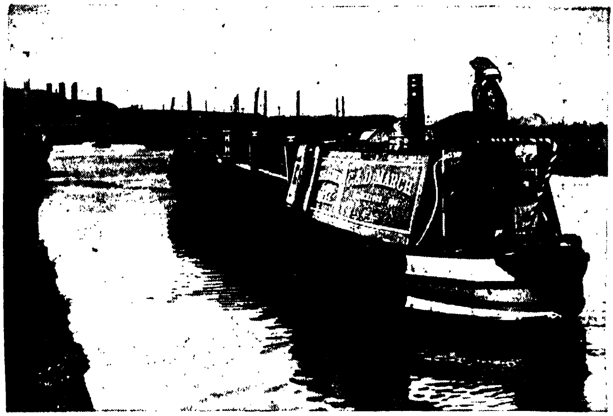
This is how a lock is operated. Suppose a boat is to be taken from the lower level to the higher level. The big gates are closed tight; and the upper sluice valve is closed, so no water can flow into the lock from above. The valve of the sluice at the lower gates is then opened and the water in the lock runs out, until the level is the same as the lower level of the canal. Then the lower gates of the lock are opened and the boat is moved into the lock. The lower lock gates are closed, and the lower sluice valve is closed. The upper sluice valve is then opened and water from the upper level gradually pours into the lock chamber. The boat in the lock floats up as the water rises. When the water level in the lock is the same as the level in the upper section, the upper lock gates are opened and the boat moves into the upper level of the canal.

In descending, the boat enters the lock, if it is filled. If not filled, the lower lock gates and sluice are closed. The upper gates re-



National Film Board photograph

A railroad bridge spanning the Welland Canal is lifted to allow passage of a freighter bound for Lake Erie.



Courtesy, British Information Services
With its woman skipper at the tiller, a British cargo boat makes its way along a canal in the industrial midlands of England.

main closed and the lock is filled from above. When full, the upper gates are opened and the boat enters the lock. The upper gates and sluice are closed, and the lower sluice opened to empty the lock. The boat floats down as the water level sinks. When the water in the lock is level with the water in the lower section of the canal, the lower lock gates are opened and the boat moves out into the lower section of the canal.

SOME OTHER DEVICES FOR LIFTING AND LOWERING BOATS

Other devices besides locks have been used to raise and lower boats from one level to another. Inclined planes made of wooden planks or of stonework have been built to haul the boats up or down, using a rope attached to a winch at the top of the incline, or slope. The Grand Canal in China had stonework inclines to transfer boats from one level to another. Inclines have been used in modern times.

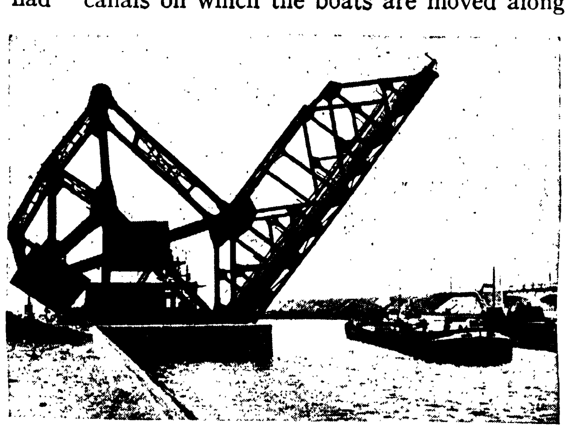
Another lifting and lowering device consists of huge tanks. A boat enters the tank and then the whole tank is lifted straight up, or lowered. This device is complicated and expensive, but it can make high lifts and change boats rapidly from one level to another. Inclines and other lifting devices are operated by steam or electricity. They are used only for small boats and on the smaller canals, to make very high lifts in a short distance, taking the place of several locks. There is no limit to the size of a ship a lock may handle.

Canals have been constructed from very early times. As we tell you later in this article, Egypt and Babylonia in very ancient ages (possibly 7000 B.C.) had networks of canals for irrigation purposes; and it is thought that a Suez Canal, for small boats, was dug before 2000 B.C. The Romans built canals in Italy and elsewhere.

We shall not consider in this article the canals of Holland, or of Venice and several other European cities, for those canals are really arms of the sea, round which man has built up the land.

We must mention, however, the Grand Canal of China, 1,000 miles of waterway (some of it rivers). It took more than a thousand years to build, and it was completed in 1289. This was the most important project of its kind in the world up to that time and for hundreds of years afterward.

Early canals were not very wide or deep, since boats were not large. These were pulled by mules or horses which were hitched to a tow-line, and walked ahead on a tow-path along the bank of the canal. Light boats in some countries were often pulled by men, and even by women in Eastern countries. Until recent times, when power boats or steam tugs and towboats came into use, few canals were more than 25 to 30 feet wide at the bottom, and 40 to 50 feet wide at the top of the sloping banks. The depth was about 4 to 5 feet. The speed of these horse-drawn boats was not more than about 2 miles per hour loaded, and 3 miles per hour light. There are still a few old-time cross-country canals on which the boats are moved along



British Combine Photos, Ltd.
A cantilever bridge in the Albert Canal at Antwerp, Belgium.

by horses or mules. However, on most of the world's canals and canalized rivers, the craft today move under their own power or are towed by tugs or electrical cars.

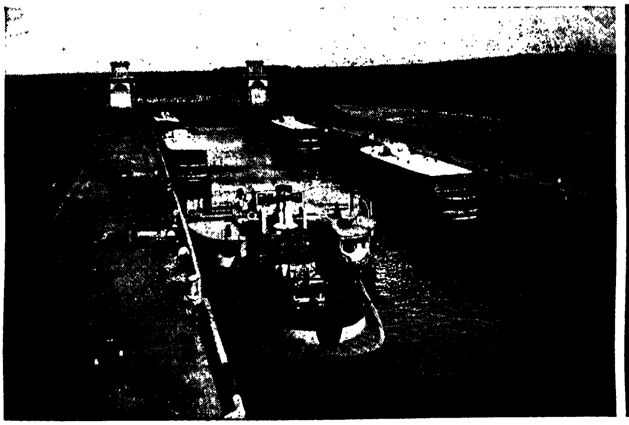
The Erie Canal, in New York State, was opened in 1825. It connected the Hudson River with Lake Erie and thus offered a waterway for freight from the port of New York to the Great Lakes region. More than any other single thing, it opened up the Middle West to colonization and prosperity. Traffic on the Erie was heavy for years, though the slow-going boats were towed along by mules or horses. Later the canal was enlarged, and finally it became part of the Barge Canal, on which freight barges can be drawn by towboats under their own power.

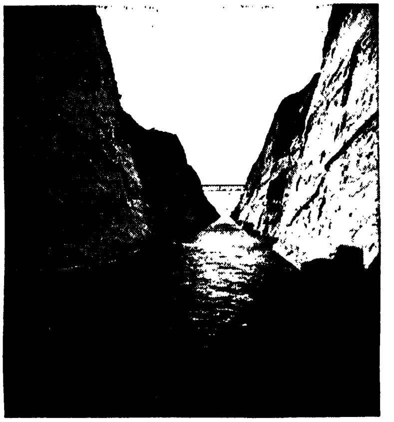
In the United States nearly all the other canals that once used horse-drawn boats have been given up, except some which have been deepened and widened and changed into barge canals. In the past four hundred years more than 15,000 miles of canals of every size have been built in Europe; about 4,500 miles have been built in the United States, and about 600 miles in Canada. Possibly more than 30,000 miles have been built throughout the world. Many small, older canals have been abandoned.

Canals for steamships and power-driven boats and barges began in 1869, when the Suez Canal was opened, connecting the Mediterranean and Red seas. Before this canal was built, ships going from Europe to the Far East had to sail all the way down the west coast of Africa and round the Cape of Good Hope. The canal which makes this long detour unnecessary is only 99 miles long. It was built by a French engineer, Ferdinand de Lesseps and took ten years (1859-1869) to build, at a cost of nearly $100,000,000. About 80,000,000 cubic yards of soil were dug out. This, as we have said, is just a great ditch built at sea level, and no locks are necessary. Its depth is 30 feet. It is 300 feet wide at the top and 262 feet wide at the bottom. The Panama Canal, opened for traffic in 1914, saves the long trip around South America, in going between ports on the Atlantic and Pacific oceans.

SOME MODERN CANALS IN EUROPE AND IN AMERICA

Modern canal building has followed two principal lines. One is the building of new, or enlarging of old, ship canals. The other is the canalizing of rivers and connecting of waterways with canals, to make long water routes in the interior and along the coastal areas of the country. Examples of such modern ship canals are the Kiel Canal across the narrow peninsula which joins Germany and Denmark. This canal was built by Germany to give a short sea route between the North Sea and the Baltic. Another ship canal is the one across the narrow isthmus at Corinth, Greece. This was attempted nearly two thousand years ago, but the three miles of solid rock proved too much for the ancient Greek engineers. Ship canals, such as the Manchester Canal in England, have been enlarged or rebuilt to take larger ships. The Manchester Ship Canal is lined with docks all the way from Manchester to near Liverpool, more than thirty-five miles. Part of the way is





Sovfoto Hellenic Dep't of Information

Left: ships in one of the great locks of the Moscow-Volga Canal, connecting the upper Volga River with the Moscow River. Right: the Corinth Canal, which cuts through the narrow Isthmus of Corinth, in Greece.

WORLD'S PRINCIPAL NAVIGATION CANALS

Name	Points Connected	Length (miles)	Depth (feet)
	UNITED STATES		
Cape Cod, Mass.	Cape Cod Bay—Buzzards Bay	13.5	32
Chesapeake-Delaware	Chesapeake Bay—Delaware Bay	48	27
Sabine-Neches, Texas	Beaumont—Orange—Port Arthur and Gulf	61	30
Houston Ship Canal	Houston, Texas—Gulf of Mexico	57.3	34
St. Charles Harbor, La.	Sabine—Calcasieu River	30	30
Keweenaw	Lake Superior—Keweenaw Bay	25	25
Sturgeon Bay	Sturgeon Bay—Lake Michigan	8.6	22
St. Mary's Falls, Mich.	Lake Superior—Lake Huron	1.61	24.5
Detroit River, Mich.	Including Lake St. Clair Canal	31	25
Lake Washington, Wash.	Lake Washington—Puget Sound	8	30
Chicago Drainage, Ill.	Lake Michigan—Lockport to Illinois River	38.6	22
Erie (N. Y. State Barge)	Troy—Tonawanda	340.4	14
Champlain, N. Y.	Troy—Whitehall	23.55	12
Oswego, N. Y.	Oswego—Three Rivers	23.5	12
Atlantic Intracoastal Canal System	Chesapeake Bay—Albemarle Sound	70	12
	Beaufort, N. C.—Cape Fear River, N. C.	93.5	12
	Cape Fear River, N. C.—St. John's River, Fla.	438	12
Gulf Intracoastal Canal System	Apalachicola River—Mobile Bay	217.4	9
	Mobile Bay—Mississippi Sound	84	10
	Mississippi Sound—New Orleans	50	9
	New Orleans—Corpus Christi, Texas	565.5	9
	CANADA		
Welland	Lake Erie—Lake Ontario	27.6	25
St. Lawrence Canals	Montreal—Cardinal (six canals)	47	14
Sault Ste. Marie	St. Mary's Falls	1.38	18.25
Rideau	Ottawa—Kingston	126.25	5
Trent	Trenton—Swift Rapids	224.45	6
Ottawa River Canals	Ottawa River (four canals)	7	9
	PANAMA		
Panama Canal	Atlantic Ocean—Pacific Ocean	50.7	41
	FOREIGN		
Suez	Mediterranean Sea—Red Sea	104.5	36
Manchester, England	Manchester—Liverpool	33.5	28
Kiel, Germany	North Sea—Baltic Sea	61	45
Midland Canals, Germany	Dortmund—Ems	150	8
	Elbe—Trave	43	8
	Berlin—Stettin	136	9.8
Rhine-Main-Danube, Germany	Upper Main to Danube	120	12
Odense, Denmark	Odense Island	5	20
Albert Canal, Belgium	Liège—Antwerp	80	16.5
Juliana, Holland	Maastricht—Maasbrecht	22	11.8
Maas-Waal, Holland	Maas River—Waal River	8	13
North Sea, Holland	Amsterdam—Ijmuiden	15	49
Midi Canal, France	Bay of Biscay—Mediterranean Sea	175	6.5
Rhine-Rhône, France	Connects Rhine with Saône	119	6.5
Rhône, France	Rhône—Marseilles	50.8	10.7
Burgundy, France	Connects Yonne and Saône	151	6.5
Dnieper-Bug-Vistula, U.S.S.R. (three canals)			
Berezina	Connects headwaters Dnieper and Dvina	66	
Oghush	Connects headwaters Dvina and Niemen	61	
Augusta	Connects headwaters Dnieper and Bug	127	
Volga-Baltic, U.S.S.R. two routes	Volga to Neva by Vichnyi Volochok	85	
	Volga to Neva by Tichvinsk Canal	117	
Baltic-White Sea	Leningrad—lakes Ladoga, Onega, Vygo and the White Sea (four canals)	141	
Kronstadt, U.S.S.R.	Kronstadt—Leningrad	16	20.5
Moscow-Volga, U.S.S.R.	Moscow River—Volga River	79	18
Don-Volga, U.S.S.R.	Volga River—Don River		
Amu Darya (Oxus R.)-Caspian Sea, U.S.S.R.	Amu Darya (Oxus R.)—Caspian Sea	400	
Grand Canal, China	Peiping—Hangchow	1,000	

by the canalized Mersey River. This is the most important canal in England; and it is very important to Manchester, for it makes that inland city a seaport. The same thing has happened on the continent of Europe. In Germany and Holland the lower course of the river Rhine is canalized; ships can now go up the river to Cologne, so that this inland city and others in the Ruhr coal-and-steel region are seaports. By means of the great Albert Canal, the important cities and waterways in Belgium are connected so as to make them practically seaports. There are networks of canals and canalized rivers in Europe so connected that it is possible to go by them from the English Channel to the Black Sea; from the Bay of Biscay across France to the Mediterranean; in Russia from the Baltic Sea to the White Sea. One notable canal, completed in Russia in 1944, is the Moscow-Volga Canal.

In North America the Houston, Texas, Ship Canal is another ship canal which connects an inland city with the sea. In Canada the "new" Welland Ship Canal was completed in 1932. It connects lakes Erie and Ontario around Niagara River and Falls. It is 27.6 miles long and has eight locks to overcome the 327 feet difference in the level of the lakes. Its depth is 25 feet, designed to take the largest ships on the lake, which are 16,000-ton ships. This canal is part of the great proposed seaway that may one day extend from Lake Superior to the Gulf of St. Lawrence. From Lake Ontario to Montreal it is proposed to canalize the St. Lawrence River by building two dams in the 48-mile International Rapids section of the river with canals and locks, and above Montreal to enlarge existing canals and locks at Lachine and other rapids, so these large ships can pass through.

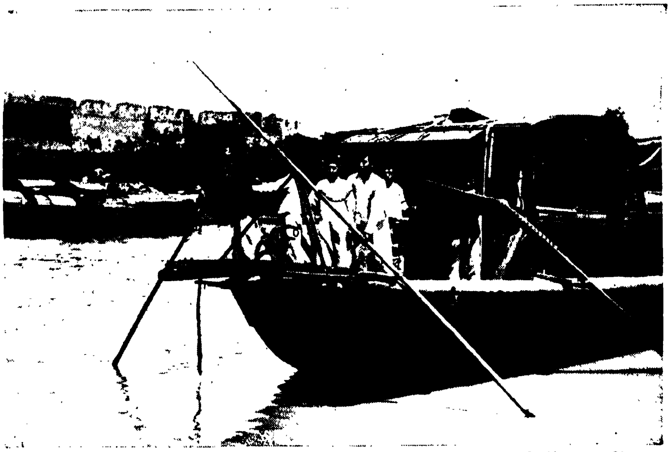
Europe has many thousands of canalized rivers connected by canals. The United States is canalizing the navigable rivers of the great Mississippi River system and the rivers of the coastal regions, and building canals to connect them in a great network of waterways. The lower Mississippi, below the mouth of the Ohio, is being shortened by cutting channels through "horse-shoe bends." The upper Mississippi and tributaries, such as the Tennessee, Cumberland, Ohio and Illinois, are canalized through their navigable courses by means of dams and locks to give a minimum nine-foot stage of water all year round. Much work is yet to be done on the Missouri, Arkansas, Red River and other rivers to the west.

Philip D. Gendreau, N. Y.

A ship passing through the Suez Canal on its way to the Red Sea. This famous waterway has no locks.

The Chicago Drainage Canal connects the foot of Lake Michigan with the Illinois River which flows into the Mississippi, making a continuous waterway from the Great Lakes to the Gulf of Mexico. It is proposed to build a canal from near Ashtabula, Ohio, on Lake Erie, to the Allegheny River just above Pittsburgh, making a link between the Great Lakes and the Ohio River. Another proposed link is a canal from the Tennessee River in northern Alabama to the headwaters of the Tombigbee River, which flows into the Alabama River above Mobile, and so to the Gulf. This plan is known as the Inland Waterways System.

Another great system is the Intracoastal Waterway System. This series of canals extends for more than 2,300 miles along the Atlantic and Gulf coasts. From Boston, Massachusetts, in the north, to Brownsville, Texas, at the mouth of the Rio Grande, the string of canals connects all the bays and sounds and the lower courses of all the rivers that flow into the Atlantic and the Gulf of Mexico. The channels are twelve feet or more in depth from Trenton, New Jersey, to Jacksonville, Florida. At New York, the waterway is connected with Lake Erie by way of the Hudson River and the New York State Barge Canal. At New Orleans, connection is made with the Inland Waterways System, so that fleets of barges pushed by powerful tugboats can navigate



Ewing Galloway, N. Y.

Poling a large canal boat along the Grand Canal, which connects the Yangtze Kiang and the Pei Ho, in China. The canal is about 1,000 miles long.

over all the waterways of the eastern half of the United States and Canada. One of these large steel barges will carry as much as fifty or sixty freight cars. Some of the important coastal canals in Massachusetts, Delaware and other Atlantic and Gulf states are wide enough and deep enough even for ocean-going vessels.

IRRIGATION CANALS OF ANCIENT EGYPT AND BABYLONIA

Irrigation canals came into use more than 6,000 years ago in Egypt and Babylonia; and at other remote times in India, China and elsewhere, in places of too little rainfall to raise crops. Great rivers, such as the Nile or the Euphrates, rise in mountainous regions with heavy rainfall in the early part of the year causing great floods. The lower courses of these rivers run through flat desert land for hundreds of miles. The ancients led the floodwaters off through canals to reservoirs from which other canals carried water great distances across the land. From these many branch canals, water was pumped by crude water-wheels into ditches which carried the water to irrigate the fields. In warm climates two to four crops could be raised a year, making irrigated land very productive.

The great Babylonian Empire and the ancient Egyptian Empire had their prosperity founded on these irrigation systems, just as the prosperity of southern California is increased by irrigation today. Destructive wars and neglect brought ruin to the canals, the cities decayed and the land returned to the desert. When the British gained control of Egypt they fostered the rebuilding of the irrigation system on a greater scale and with modern methods. They had dams built across the lower Nile to create reservoirs in the river, from which new canals led the water to greater areas. Old canals and reservoirs were improved, and modern pumps installed where needed. Egypt is today independent of the rise of the Nile and there are no more lean years, as told of in the BIBLE in the time of Joseph. The British have also improved the irrigation systems of India with new canals, and they had started, before the war, to foster canal building in the Euphrates and Tigris valleys. Some of the new canals are completed.

The greatest irrigation system today is in southern California. In 1913 a 200-mile canal was built to bring water to Los Angeles and the surrounding region, from Owen River in the Sierra Nevada Mountains. Later, more water was needed, so a new concrete-lined canal was built, 292 miles long, through which water is pumped from the lower Colorado River. This aqueduct has 150 miles of canal, 108 miles of tunnels and several great reservoirs for storing and purifying the water.

Another great system of irrigation canals is being built to increase irrigation in the San Joaquin River valley in California, south of San Francisco. Nearly all the water of this river is now used up by irrigation. There is much heavier rainfall in northern California than in southern California. The Sacramento River has great floods coming down from the north. This floodwater will be carried by canal around San Francisco Bay to supply irrigation for more than a hundred miles up the San Joaquin Valley. Above that a great dam is built, and water from it will go through canals 160 miles farther south. These canals are all lined with concrete.

There is another great irrigation canal in the Rio Grande Valley in Texas, and one is to be built to carry water from above the Grand Coulee Dam in Washington, to irrigate a large area in central Washington.

In Russia a 400 mile canal is being built, leading from the Amu Darya (the ancient Oxus River) in central Asia to the Caspian Sea.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 1053.

BEARS, RACCOONS AND THEIR KIN AND THE PANDAS

Courtesy, Northern Pacific Railway
A black bear in Yellowstone National Park.

THE bears and their smaller relatives belong to the order Carnivora, or flesh-eaters. That does not mean that they eat meat or fish exclusively. They do have the long canine teeth which are characteristic of the members of this order, but their molars, or cheek teeth, are quite different from the cutting teeth of the cats. The crowns of the molars are flatter and broader than those of the cat family and thus they are more adaptable to the grinding of food. This would go to show that flesh does not make up the bears' entire menu. Much of the bears' food consists of insects and vegetable matter such as roots, grass and berries, substances which have to be ground up rather than sheared off before they can be swallowed.

On account of certain similarities in the skull, bears at one time were believed to be close relatives of the weasels. But further research has led scientists to believe that they are of closer kin to the dogs. In Miocene times an animal existed which showed both dog- and bear-like characteristic. He is known as the bear dog or Hemicyon.

Bears are known as plantigrade animals, which means that they place the entire sole of the hind foot on the ground when walking, the same as man does. Many animals, such as the dog, cat and horse, are digitigrade, stepping only on their toes. (Digits are fingers and toes.)

Bears are animals of the Northern Hemisphere; only one form ranges south of the Equator. In the northern parts of their range bears become exceedingly fat as winter draws near and as soon as cold weather approaches they seek out a den; this may be among rocks, or a hole in a hillside or under the roots of a fallen tree. In this cozy den the bear goes into a winter's sleep, known as hibernation. At this time the bear's breathing and circulation slow down and the only nourishment the bear obtains is from the fat which covers the animal's body. Here in the den the bear stays until spring, and it is during this period that the cubs (the young) are born. At birth the young are very small; an American black bear cub will be about eight inches long and weigh ten ounces, while the mother may weigh over two hundred times as much. The cubs grow rapidly and are able to leave the den and follow their mother about when she emerges from her hibernation, at which time they are about three months old. Bears generally have cubs every second year, the cubs running with the mother for two summers.

Bears have poor sight and hearing but a very keen sense of smell and they depend upon their noses, to a great extent, to find food and detect enemies.

The brown bear of Europe and Asia is perhaps the best known bear in the world. Formerly the range of this bear extended from the British Isles across Europe and Asia to Japan and as far south as the northern boundaries of India. At one time a small form was found in North Africa. Over this large expanse of country the brown bear differs in color and size and many forms have

The black bear of the Himalayas.

Syrian bear, small, and light in color.

The Kodiak bear, largest flesh-eating land animal.

The hairy-eared bear.

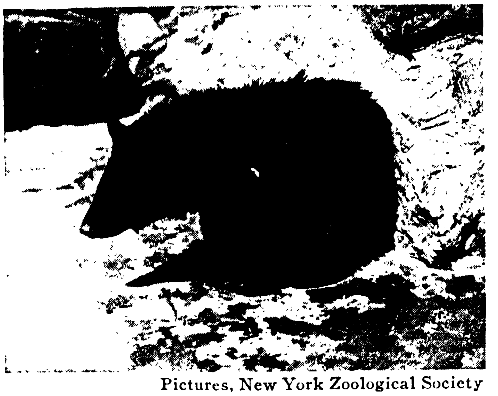
been described. It is difficult to know just how many there are as the bears of one locality are likely to vary greatly in size and also in color. At full growth males are generally larger than the females.

Brown bears feed on berries, roots, grass, vegetation, mice, marmots and other small mammals. They do occasionally kill larger animals and at times are destructive to livestock. It is seldom that they will molest man unless provoked, and the stories of their attacks are undoubtedly greatly exaggerated.

The European brown bear disappeared from the British Isles centuries ago but it is still found in many of the less settled parts of Europe, especially in Scandinavia and Russia. This form is also found in western Asia. This bear is commonly seen in zoos and circuses and is the performing bear which used to be displayed by the wandering gypsies. Other forms of the brown bear are the Syrian bear, a small and light-colored bear found in Asia Minor and Syria; the Kashmir brown bear, sometimes called the Isabelline bear, also a light-colored bear found from the Tien Shan to the western Himalayas; the Siberian brown bear with dark legs; the Kamchatkan brown bear found in Manchuria and the Kamchatka Peninsula; the Manchurian brown bear, a black or very dark brown bear found in Mongolia and Manchuria.

On Hokkaido Island, Japan, there is a brown bear which is a very close relative of the Manchurian bear. Some authorities believe it to be the same. Western China and Tibet have a bear of this group which is blackish in color, with a pale brown and whitish head. The hairs of the body are tipped with reddish buff or grayish white. This bear is known as the blue bear of Tibet.

A bald-faced grizzly.



Pictures, New York Zoological Society
A Japanese bear.

There was once a small bear of the brown bear group in the Atlas Mountains in North Africa. It was known as Crowther's bear. Two living specimens were captured near Tituan, Morocco, a century ago. They were small, thickset and brown. The specimens were not saved and as far as we know there is no skin of Crowther's bear in any museum. At the present time the animal is believed extinct.

The Alaskan brown bear in its many forms is confined to a very limited strip of land along the Pacific coast region of Alaska. Extending from the Alaskan peninsula south to British Columbia are many islands, and upon these islands and the near-by mainland these big brown bears find their home. The peninsula giant bear of the Alaskan peninsula, and the Kodiak bear found on Kodiak Island are the largest of the group; in fact, they are the largest land-living carnivorous (flesh-eating) animals existing today. Skins of these animals have measured over thirteen feet in length while the weight has been recorded as 1,500 pounds. These were exceptionally large male specimens.

The different forms of the Alaskan brown bear vary in color from dark brown or nearly black to pale yellowish. In the spring the chief food of these bears is grass and mice; roots are also eaten and the bears glean from the beaches any food cast upon the shore—seaweed, shellfish, fish or perhaps a dead seal or whale. Later, when the berries are ripe, the bears gather these. In June, when the salmon begins to run, the bears go to the rivers and gorge themselves on these fish. As with most bears the young are born in the winter den. At birth they weigh about one and one-half pounds. The number of young varies from one to four. They reach full growth when about seven years of age.

The grizzly bear has a more extensive range than the Alaskan brown bear. It was originally found from northern Alaska south throughout the Rocky Mountains to central Mexico and east on the plains to Minnesota, Nebraska and Kansas; but it has now been driven from most of its former territory. From British Columbia north through Alaska, the grizzly still exists and in some places is quite common. In the United States it is a very rare animal, found only in the more remote mountainous districts. Its only salvation is the national parks. Yellowstone National Park is noted for its grizzlies. This is the only place in the United States where you are likely to see a free grizzly.

The grizzly is a smaller animal than the Kodiak bear. An average male would weigh about 500 pounds and an exceedingly large one may weigh as high as 750 pounds. A measurement of eight feet for the length of the skin would be exceptionally large. In color the grizzly varies greatly. In general it is a dark brown, the long hairs of the back being tipped with gray or white. Some grizzlies are grayish yellow in color.

The grizzly has the reputation of being a fierce and dangerous animal. Before the making of high-powered rifles he undoutedly was a beast to be feared, but modern firearms have changed all this. He prefers to go his own way, minding his own business, but a wounded bear or a mother defending her cubs is a dangerous antagonist. As a rule he is shy, much preferring to beat a hasty retreat, but he will often allow a close approach as long as the wind is blowing from him to you, for he depends on his nose to tell him of danger, his hearing and eyesight being limited. It is never safe to prophesy

Photo, American Museum of Natural History

A museum exhibit that is true to life—mounted Alaskan brown bears, with a background of snowy mountains.

just what a grizzly will do, and never safe to take too much for granted.

In a recent hunting and camping trip to Alaska the writer saw twenty-two different grizzlies in a little over a month's time. All of these, with one exception, quickly retreated as soon as they knew a man was near. The exception was a large bear that was traveling along the trail our pack train was using. He continued coming toward us until about one hundred yards separated him from the leading horses. He then slowly climbed the bank and at a distance of less than 200 yards sat down on his haunches and watched us pass, reminding one of a small boy watching a circus parade. After the horses had passed, he climbed down the bank and resumed his walk up the trail.

On another occasion we watched for some time a mother grizzly and her two yearling cubs eating roots among our grazing pack horses. Occasionally one of the horses would raise his head and take a glance in the direction of the bears, but aside from that the animals paid no attention to one another.

The grizzly bear feeds on a great variety of food. He eats quantities of grass and roots, and berries when they are in season. He turns over stones and demolishes rotten logs for ants and other insects. He is very fond of the ground squirrels and marmots which are common over much of his range and he will spend hours digging them out of their burrows. He also feeds on larger animals and occasionally a grizzly will kill livestock. He will also eat carrion (the bodies of animals which have died). Usually two cubs are born to a grizzly mother. Sometimes there are three at a birth, and rarely four.

Young grizzlies can climb trees but as they grow older their ponderous weight and long claws hinder them so that they are no longer able to climb. Yet they can run with surprising speed when necessary.

The North American black bear at one time ranged throughout most of North America, from the Arctic Circle to central Mexico. It has been exterminated in many parts of the United States but may be found in extensively wooded regions in many of the eastern states, and is still common throughout all of the wooded district of Canada and

Alaska and the Rocky Mountain region of the United States. This bear is common in our western parts, where it becomes very tame, but in other sections of the country, where it is hunted, it is one of the shyest of animals. The black bear is smaller than a grizzly—usually weighing less than 300

The sloth bear of India has long, coarse hair, with white mark on the chest, and a gray muzzle.

pounds and measuring less than five and a half feet from nose to tail. In color this bear is black, generally with brown about the nose. A number of color phases, that is, variations, of the black bear, are quite well known.

The polar bear loves the cold water and pack ice of the Arctic regions. The young have pure white coats. Older bears are yellowish.

In the neighborhood of Montana, Colorado and Wyoming there is a brown phase which is known as the cinnamon bear. In some places of that region this brown phase is as common as the black, and cubs of both colors are found following the same mother. In a very limited region about Mt. Saint Elias, near the corner where Alaska, the Yukon and British Columbia meet, there is occasionally found a bear of a bluish gray color, the color varying somewhat in different specimens. This bear is known as the blue or glacier bear and is now believed to be a color phase of the black, for black and blue bear cubs have been found in the same litter. This is a rare form.

You probably know what an albino is—a plant or animal which lacks the coloring that ordinary members of its kind have. White mice are albinoes. A bear which by some is believed to be an albinistic form of the black bear is the inland white or Kermode's bear. It is a small white bear with buff on head and back. These bears are found south of the Skeena River in the Kilimat Arm section of Douglas Channel and on Gribble Island, British Columbia. Very little is known about this rare animal.

Throughout its entire range the black bear is an inoffensive animal, feeding chiefly on roots, berries, fruits, nuts, ants and other insects, also carrion, fish and flesh. It is exceedingly fond of acorns and beechnuts and at times will kill sheep, calves and pigs. It is also fond of robbing bees' nests of their honey and grubs. Black bears have from one to five young; generally two or three are born at a birth. Black bears are expert climbers.

The Asiatic black bear is about the size of a North American black bear, but has a squattier appearance and larger head and a white crescent on its chest. Some American black bears also have this white marking. Black bears in captivity can easily be taught to perform. The Asiatic black bear is found in Kashmir, Baluchistan, North China, Manchuria, Amurland, Formosa and south through Burma, Indo-China and Thailand (Siam). The animal lives in wooded districts. It feeds chiefly on plant life and at times raids the cultivated fields of natives.

Photos, New York Zoological Society

The spectacled bear of South America is the only bear to be found south of the Equator.

The smallest of all bears is the Malay bear. He is of a black color with a white or orange patch on the chest. The hair is short and coarse, the ears are small and rounded, the muzzle is whitish. The length of the Malay bear's head and body is about four feet. The animal is found from Assam, Burma and Indo-China, south through the Malay Peninsula to Sumatra, Java and Borneo. It lives in the forest and is an expert climber. It feeds chiefly on vegetable matter, nuts and fruits forming much of its food, but it will also eat flesh. It is very fond of honey and robs bees' nests.

The sloth bear of India is a long, coarse-haired animal of black color with a white chevron on its chest and a gray muzzle. It is a bit smaller than the Asiatic black bear. Its long lips, squat body and short legs give this animal a most grotesque appearance. It feeds chiefly on fruits, flowers and insects, the white ant or termite being a favorite food. The sloth bear is also extremely fond of honey and often does damage to sugar-cane. The number of young is generally two or occasionally three. The cubs have the habit of climbing on the mother's back for a ride when the animals are moving from place to place.

The spectacled bear of northwestern South America is a small black bear with white markings on the face. These markings sometimes go round the eyes, so that the animal has somewhat the appearance of one wearing glasses. This gave the animal its common name. The spectacled bear lives in the Andes Mountains of Colombia, Ecuador and northern Peru. This is the only bear that is found south of the Equator.

The polar bear's home is amid the ice and snow of the cold, Arctic regions. It is found all around the North Pole area, in Europe, Asia and North America. A thick white coat of hair protects this handsome animal from the cold. Only young bears have a pure white coat; in the older bears the hair takes on a yellowish tinge.

The polar bear is the most aquatic (water-loving) of any of the bears. It prefers to live on the pack ice near the water, where it can prey on seals which form its main food. Besides seals, the polar bear is fond of fish and when the carcass of a whale is stranded on the shore a number of bears crowd around to feed upon it. In the spring, when vegetation begins to grow, the polar bears may move inland and feed on grass and roots, but during most of the year flesh is the principal food.

The male bears do not hibernate but roam through the long winter nights. As the darkness of the long winter Arctic night approaches, the female moves inland where she digs out a den for herself in the snow. Here she remains until spring, and it is at this time that the young are born. Like other bears, at birth the polar bear babies are very small creatures, about the size of a rat, but they grow rapidly; and when the mother comes out of her den in the spring the young are able to follow her about.

Polar bears grow to large size, males sometimes weighing over 1,000 pounds and measuring over nine feet in length. Occasionally, bears drift south on the ice-floes and have been found as far south as Iceland and in St. James Bay in the southern part of Hudson Bay.

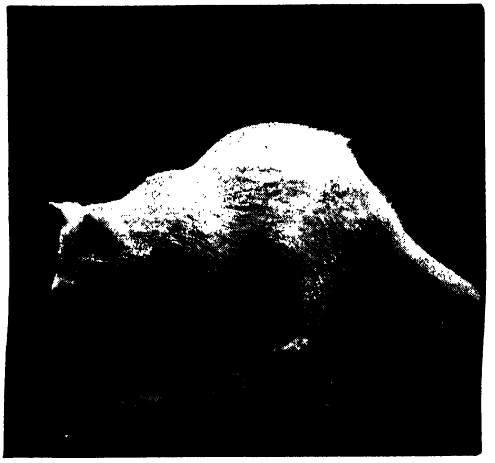
Polar bears are strong swimmers. It has been observed that they swim with their front legs only, the hindlegs trailing out behind acting as a rudder.

RACCOONS AND OTHER COUSINS OF THE BEARS

The raccoon, or 'coon' as he is known over much of the districts where he lives, is familiar to many. One cause of his popularity is his fur from which the coonskin coats are made. He is a stockily built animal about two feet long. His tail, about ten inches long, has rings of black and light fur. His muzzle is sharp, and across his face is a black strip that looks like a mask. The color of the coat varies considerably; brownish gray is the chief color, but some specimens have a strong yellowish cast while others are much darker brown with gray tips on the longer hairs. As a general rule the darker the animal is, the more valuable is the fur. Black specimens are now being bred for their fur, and albinistic forms quite frequently occur. The raccoon is known, however, by his black mask and ringed tail.

The raccoon is found throughout most of the United States. To the north its range extends but a short way into southern Canada, but to the south it ranges through Central America to northern South America.

The raccoon likes water and is a strong swimmer. Its favorite home is by the shores of ponds and lakes or along streams where it can puddle in the water for morsels of food. It is very fond of crayfish, mussels and other forms of water life which it finds by



Photos, New York Zoological Society

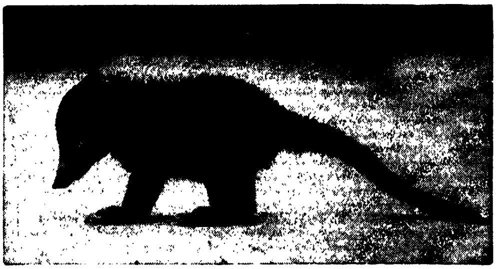
At the left is an eastern raccoon. This animal uses its forepaws very cleverly. Notice the long "fingers." At the right is an albino raccoon, with pure white fur and light eyes.

feeling in the mud with its forefeet. It also eats fish, frogs, birds, eggs, reptiles, fruit and vegetables and it enjoys raiding cornfields when the corn on the ears is good and tender. The raccoon is a good climber and generally makes its den in the hollow of a tree. The young, in the latitude of New York City, are born in April or early May. There are generally from three to six in the litter. In June the young may appear sunning themselves in the branches outside the den hole. A month later they accompany the mother on her hunting expeditions. These young stay with the parents until the following spring.

The raccoons go into a partial hibernation in the northern part of their range. During the colder part of the winter they may den up in a hollow tree, very often the entire family together, and remain there until the approach of spring. They are often abroad again long before the snow has gone. Their thick fur keeps them warm.

Courtesy, U. S. Forest Service

A ringtailed cat near its rocky den. This animal is also called cacomistle, and civet cat, and bassaris. Its range is western North America from Oregon down through Mexico and Central America.



The coati, a cousin of the raccoon. This animal, found in the Americas, makes an interesting pet.

The raccoon is strictly nocturnal (active at night); it is seldom abroad during the day, although occasionally it takes sun baths well up among the branches of a tree. This picturesque animal is trapped and hunted only for its skin and is not difficult for hunters to trap. It is hunted at night with trained dogs which follow the trail until the raccoon is forced to take refuge in a tree. There the animal is at the mercy of the hunter's gun. It is a brave fighter, however, and few dogs will care to attack a raccoon singlehanded.

If caught young and brought up by hand, raccoons make interesting pets; but it is seldom that a raccoon captured when fully grown ever becomes thoroughly tame.

The crab-eating raccoon is found in northern South America. It is quite similar to the common raccoon in outward appearance but has much shorter hair. Consequently it has the appearance of a much longer-legged animal.

The coati is about the size of the raccoon but has a long tail and a long snout-like nose. There are two main forms of these animals, the white-nosed coati, found from northern Mexico to Panama, and the red coati, found throughout northern South America as far south as Paraguay. The coati is more arboreal in habits than the raccoon. (Arboreal means living in trees.) Generally going about in droves, coatis search both the ground and trees for food, which consists largely of fruits and vegetable matter. They also eat reptiles, birds, eggs and insects. They do most of their hunting during the daylight hours. A coati makes an interesting and amusing pet and is frequently kept by natives. It has an endearing kind of awkwardness.

Both pictures, New York Zoological Society
The panda, a native of Asia. It is the size of a large cat.

On account of their long snout they are often falsely called ant-eaters by animal dealers, which is very confusing, for the ant-eater is quite different.

The little cacomistle, or ringtailed cat, an alert-looking animal, dwells in western North America from Oregon south to Panama. In general color the cacomistle is pale yellowish gray with numerous black hairs scattered over its back and head. Its head and body are about thirty inches long, and its beautifully ringed tail is about fifteen inches long. The cacomistle is known by many different names, including civet cat and bassaris.

It seems to prefer to live among rocks and cliffs but is equally at home among trees, for it climbs well. It feeds to a great extent on rats and mice but also likes birds, insects and fruits. The young, generally three or four to a birth, are born in May or June. The den is often in a hole in a tree or it may be a cave among the rocks.

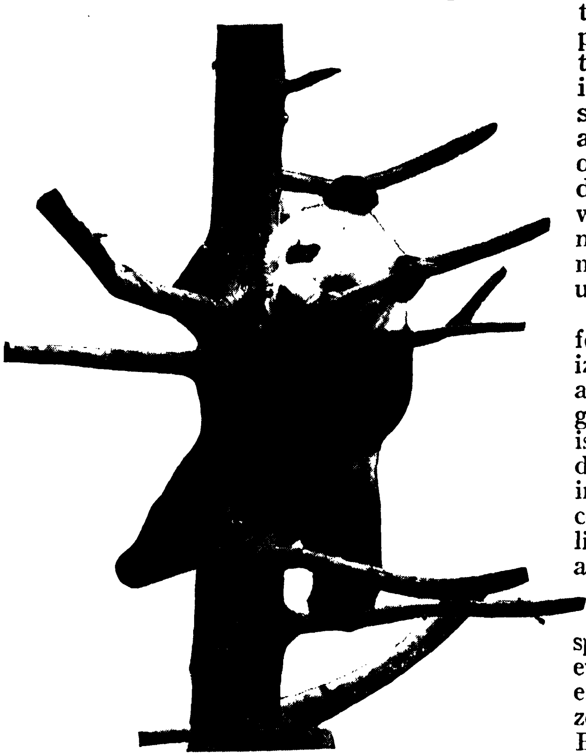
The kinkajou is a long-bodied, short-legged reddish-brown animal with a prehensile, or grasping, tail. The kinkajou is frequently sold by animal dealers under the inappropriate name of "honey bear." It becomes very tame and makes a delightful pet, being easy to keep alive on a fruit diet. The kinkajou inhabits the forests from central Mexico to central Brazil. Arboreal in habit, it rarely descends to the ground, finding a living among the branches of the trees—fruit, and other vegetation and birds' eggs. It is also said to be very fond of honey.

The bassaricyon looks like the kinkajou; unless both animals are closely examined, it could easily be mistaken for one. However, in skull characters, they differ widely, one way by which animals are classified. The bassaricyon has forty teeth, the same number as the raccoon, while the kinkajou has but thirty-six. In habits these creatures are much the same. The bassaricyon is found in the forests of Central America and northern South America.

The panda is a beautiful animal about the size of a large cat. This animal and the giant panda are now put in a family by themselves. Once it was thought that the pandas belonged to the same family as the bears. The panda is red in color with black feet and legs, a long bushy tail that is ringed and light fawn-colored markings about the head. It is found in the mountain forests of southeast Himalaya, in northeastern India, upper Burma and in the Yunnan and Szechwan provinces in southwestern China, at an elevation of 7,000 to 12,000 feet. Though this interesting animal may sometimes devour insects, its food is chiefly vegetable, bamboo shoots, leaves and various fruits being to its liking. Captive individuals appear to be fond of eggs, so these might be included in their diet in the wild. They make interesting pets but unfortunately do not appear to be hardy in captivity.

The giant panda is a strikingly colored animal, creamy white with black ears, black spots over the eyes, a black band extending over the shoulders, black feet and legs and darker underparts. It is about the size of a small black bear. Its range is very limited in extent, in the mountains of Szechwan and northern Yunnan provinces of western China, at an altitude of from 6,000 to 10,000 feet.

At this altitude the mountain sides are covered with a dwarf bamboo, and it is in the bamboo that the giant panda makes its home. Bamboo appears to be its only food. In the spring and summer the tender shoots are taken, but in the fall and winter the leaves and stalks are eaten. The panda does not hibernate as do the bears of that region. This I can personally vouch for, having followed their tracks for many miles in the snow and having seen the animal itself during the winter. The panda is fond of taking sun baths in the boughs of some large trees, a fact which often leads to its downfall for its white color makes the animal very conspicuous.



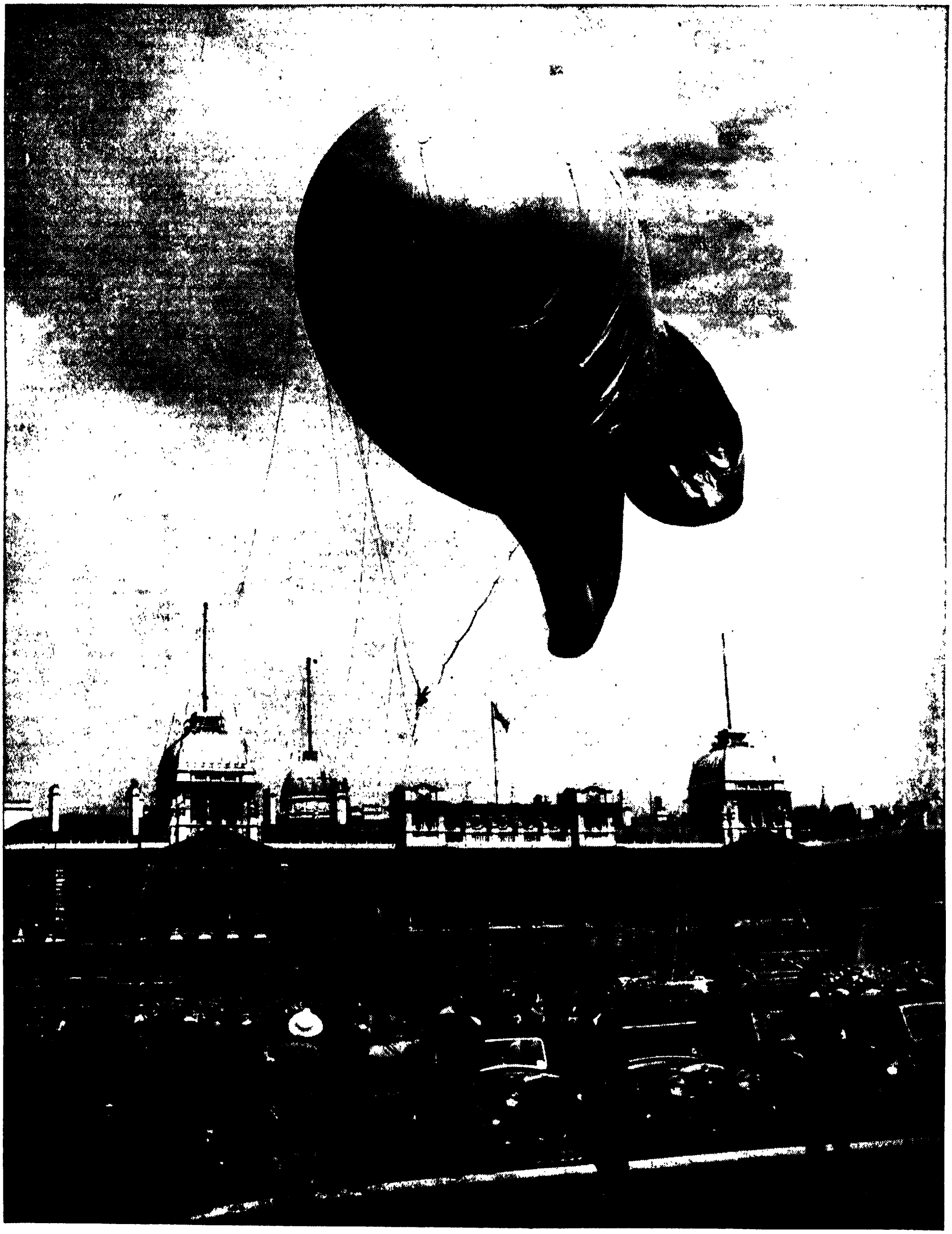
New York Zoological Society

The giant panda, a rather rare animal, found in western China. It is related to the panda, shown on the preceding page. The giant panda is a great favorite with visitors to the zoo.

Up until 1936 few people realized that such an animal as the giant panda existed. The panda's home was so inaccessible and covered such a limited territory, and the food was so restricted that no live specimens were ever captured for exhibition at the zoos of the world. But at last, in the year 1936, one of America's greatest zoos, the Brookfield Zoo in Chicago secured a female baby giant panda. This animal, Su-ling by name, became very popular. Her odd coloring and playful nature made her so great an attraction that the zoo soon secured a second specimen named Mei-mei. In 1938 the New York Zoological Park obtained another young giant panda and named it Pandora. Both to children and to adults Pandora soon became the most popular animal in that zoo. During the New York World's Fair Pandora moved her residence to the fair grounds and there she delighted thousands of persons with her playful antics and entertaining ways. Since that time other giant pandas have been exhibited in the zoos of North America and Europe.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 997.

WHAT IS A BALLOON BARRAGE?



© British Combine.

This is an ingenious method of combating air raids. Balloons filled with hydrogen gas are attached to thin steel cables which, in turn, are attached to heavy reels or winches. The reels are placed around a factory, munitions dump or even a city. The balloons are allowed to rise several thousand feet. If the propeller of an attacking plane strikes either a balloon or a cable, it is almost sure to be wrecked. If the raiders suspect that a balloon barrage is near, they fly high to avoid it. This lessens the accuracy of their bombing. When a balloon is struck by bullets, it loses gas, and slowly sinks to the ground, where it can be patched and used again.

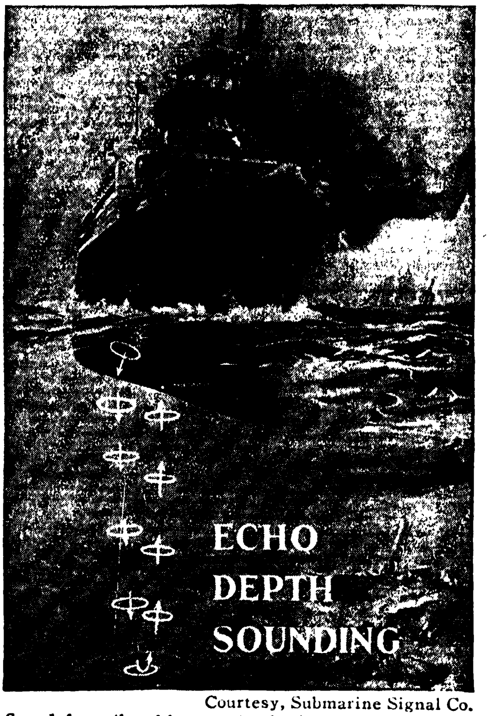
HOW DEEP IS THE SEA?

THE sea varies in depth quite as much as the land varies in height. There are slopes descending gradually from the shore and getting deeper and deeper; there are plains and table lands that run for miles at about the same depth; and there are precipices with sheer descents into chasms over six miles deep.

All these facts are known as the result of thousands of soundings taken over many years in various parts of the ocean. Charts have been prepared of the Pacific, Atlantic and Indian oceans showing the depths discovered at different places. Interest in the study of ocean depths was increased when it was discovered that telegraphic messages could be sent by cables laid under water. This was about the middle of the last century. Since then, various expeditions have gone out for the purpose of measuring, or sounding, the depths.

Up to 1912 the deepest sounding recorded anywhere was 5,269 fathoms, which is sixty-six feet less than six miles. This was in the North Pacific near the island of Guam, in the Ladrones. This sounding was made by the American ship Nero in 1906, but in 1912 the German vessel Planet found a deeper place forty miles northeast of Mindanao, one of the southern islands of the Philippines. This great depth, which has been known ever since as the Planet Deep, is the continuation of a deep trough in this part of the Pacific discovered by the Planet earlier in the same year, and the depth recorded was 5,352 fathoms, or six miles and 414 feet. In 1924 the Japanese vessel Manchu found a deeper place fifty miles off the coast of Japan. It let out 32,644 feet of wire without touching bottom. More recently a depth of 35,410 feet has been found in the Mindanao trench.

In the Atlantic the deepest sounding recorded is 4,562 fathoms in the Nares Deep, north of the West Indies; and in the Indian Ocean the deepest is 3,828 fathoms in the Wharton Deep, south of the East Indies. A fathom is six feet.



Courtesy, Submarine Signal Co.

Sound from the ship goes to the bottom and returns. The time taken for this trip indicates the depth.

The average depth of the ocean is from 10,000 to 15,000 feet. Of all the soundings taken in different parts of the world, about fifty exceed 4,000 fathoms, and it is interesting that, though roughly the great depths of the sea correspond to the great heights of the mountains, the greatest sea depths are about a mile in excess of the greatest heights on land. To travel from the top of the highest mountain to the bottom of the greatest depth in the sea would mean covering a perpendicular distance of over twelve miles, and this on a globe six feet in diameter would be represented by a scratch measuring not more than a tenth of an inch in depth.

How do men find out the depth of the sea? The simplest plan is to let down a weighted rope, marked off at intervals. When the weight has touched the bottom, the depth will be indicated by the rope marker at the sea's surface. But this method will do only for comparatively shallow depths.

When it comes to sounding great depths, it is necessary to use other methods. Until 1920 the most accurate device was a fine wire with a weight attached, which was let down to the bottom. As the weight, or sinker, touched bottom, the depth was automatically recorded. However, this method was not always accurate as it was possible for the wire to be carried by currents, so that it was not certain that the depth had been taken vertically.

Before we examine an improved method for measuring ocean depths, let us consider how we would determine the distance of a certain place if we knew only that, in an automobile going at 25 miles an hour, it would take us four hours to get there and back again to our starting point. Since the automobile covers 25 miles each hour, it will have traveled 100 miles in four hours. Therefore, the distance to the place in which we are interested is 50 miles, that is, one-half of the distance for the complete trip.

We are now ready to apply this reasoning to the measurement of ocean depths. We send a sound signal through the water and record the time which elapses between that instant and the moment when the sound comes back as an echo reflected from the ocean bottom. Since we know the speed of sound in water, we can then calculate the distance to the bottom.

Ingenious electrical instruments have been invented which send out the sound-wave, measure the time taken for its return to the ship, and then automatically record the depth of the bottom.

WHAT DOES THE PATTERN IN A BRICK WALL MEAN?

The bricks which are commonly built up to make a wall are 8 inches long, 4 inches wide, and about 2¼ inches thick. The bricklayer binds them with mortar, which is made by mixing together with water either lime and sand, or cement and sand. Mortar, however, is not a strength to the brick-work, but a weakness, and because the mortar joint is a weak point the bricklayer avoids arranging his bricks so that one joint comes directly over another.

If a wall were built with the mortar joints directly over each other, and a heavy weight, such as an iron column, were placed on a part of the wall, all the mortar joints would give way under the strain, and the column would sink and push the bricks down or out. Brick-work is built in a regular pattern to avoid weak joints, and this pattern is called a bond.

Some forms of bond are American, English and Flemish. In English bond the brick wall is built of layers, or "courses," of bricks laid alternately, one row all lengthwise and the next row all endwise. A brick put lengthwise is called a stretcher; a brick laid sidewise is called a header. We can easily see how stretchers and headers in alternate layers prevent the weak mortar joints from coming over each other. In order to start the rows of headers right, a small piece of brick has to be built in next to the first header of the row; and this piece is called a closer. The pattern of Flemish bond is different, and some people think it looks better; each row is composed of alternate headers and stretchers. In American bond five or six rows of stretchers are so laid that the joints do not come together. Then a row of headers is laid.

WHAT ARE THE SPOTS THAT WE CALL FRECKLES?

What we usually speak of as freckles are spots of yellowish brown color which are seen on the skin of some people. They occur chiefly on the face, on the neck and on the hands, that is, on the parts of the skin unprotected by clothes. Some people are much more likely than others to have this coloring produced, and in some it disappears quite quickly, while in others it lasts a long time.

Often the freckles are the result of the action of the sun which causes certain cells of the skin to produce coloring matter or pigment. There are cases, however, in which freckles do not appear to be caused by very hot sunshine or exposure, but are an inherited trait.

Brown spots which sometimes develop on the skin of old persons are not freckles.

WHO WAS THE MAN KNOWN AS BUFFALO BILL?

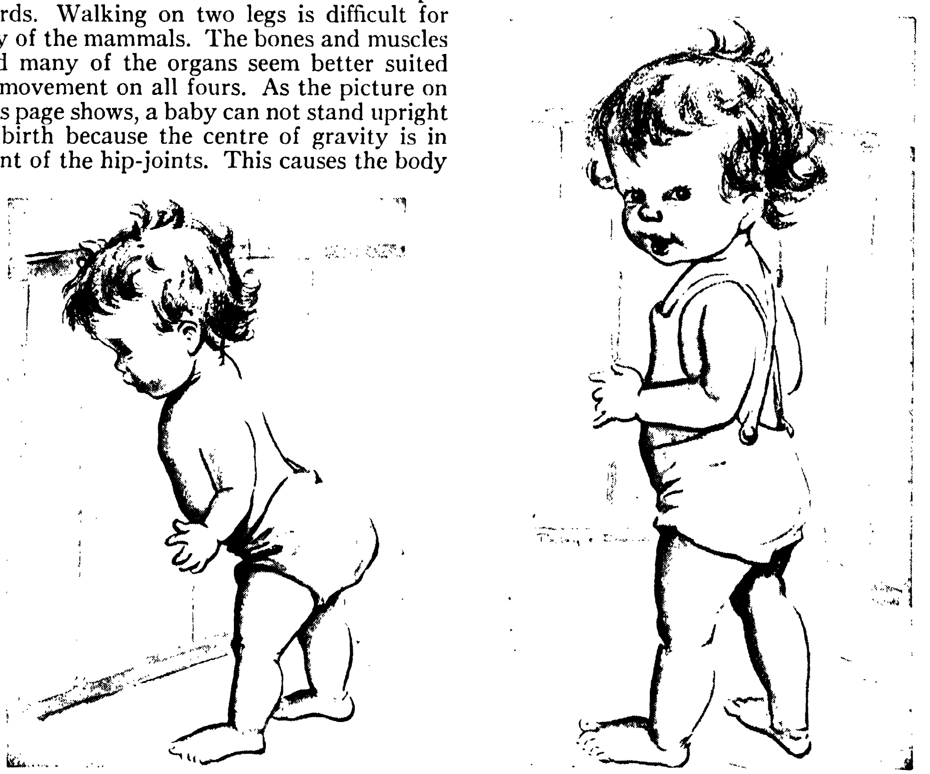
Buffalo Bill was a real person. His name was William Frederick Cody and he was born in Iowa in 1846. In 1860 he became one of the riders of the Pony Express which carried the mail from St. Joseph, Missouri, to Sacramento, California. During the Civil War he served as scout and guide and also in the cavalry. He was then engaged by the Kansas Pacific Railroad to furnish buffalo meat for the laborers on construction work. In eighteen months he killed nearly 5,000 buffaloes, thereby gaining the name by which he is best known.

Afterward he served several years against the Indians, was a member of the Nebraska Legislature and, in 1883, organized his Wild West Show to represent life upon the plains before the region was thickly settled. For many years it was very popular, not only in the East but in Europe. He published several books before his death in Denver, Colorado, in 1917. He is buried in a tomb blazed from the rock on top of Lookout Mountain, twenty miles from Denver.

WHY MUST A BABY LEARN TO WALK?

Many animals are able to run about almost as soon as they are born. A chicken walks at once, and a calf is soon frisking about its mother. A baby is born quite helpless and requires a long time to learn to toddle along.

The reasons are difficult to tell in simple words. Walking on two legs is difficult for any of the mammals. The bones and muscles and many of the organs seem better suited to movement on all fours. As the picture on this page shows, a baby can not stand upright at birth because the centre of gravity is in front of the hip-joints. This causes the body to lean over frontward. As the child grows, changes occur in the body. The centre of gravity shifts and is now back of the hip-joints, and so it is possible to stand. You might expect the child to tip over backward when the centre of gravity shifts. This is prevented by a strong band of muscle and tissue in front which aids in keeping the balance. And, as you know, when a child can easily stand alone, he very soon walks.



The picture at the left shows a baby several months old, in her play-pen. She is not yet able to stand without holding to the fence of the pen. See how her body leans forward. In the next picture we see the same child a few months older. Now she can stand and even walk without support. Her back is straight. The centre of gravity has shifted from in front of the hip-joints and is now back of the hip-joints.

WHY WILL A SLATE PENCIL WRITE ON SLATE BUT NOT PAPER?

The slate pencil writes on slate because the slate is harder than the pencil. As you write, you press the pencil against the slate, and the pencil rubs off, leaving marks on the slate. You can see for yourself that this is true, because the pencil grows shorter, the more you use it. You know this is true for another reason. You can wash off the slate-pencil marks and the slate is left bare and smooth, ready to be used again.

The slate pencil will not rub off upon paper because the paper is not hard enough. If you pressed a slate pencil sharply against a paper, the paper would tear.

Now let us see what makes a lead pencil write. Actually it does not contain lead at all, or any metal. Nearly all metals are too hard to mark paper—that is, to rub away against paper so as to leave marks; and there are no metals whose colors would show well against paper. A "lead" pencil is made up of tiny crystals of carbon. This form of carbon is called graphite, from the Greek word for "writing." The crystals are small and of such a shape that they can easily be rubbed away from one another.

The firmer and harder we press with our pencil the more graphite is rubbed down by friction on to the paper to record the track of our pencil. So you see, both the slate pencil and the lead pencil, and crayons as well, "write" by rubbing off particles of themselves on the writing surface. Blackboard chalk writes in this way; you can see the chalk on the board.

WHY DO DARK CLOTHES KEEP US WARMER THAN LIGHT CLOTHES?

A thing is dark, even in the light, because, instead of reflecting, or throwing back the light from its surface, it keeps the light, or absorbs it. Light and radiant heat are really the same thing, and as a rule anything absorbing or reflecting the one absorbs or reflects the other. So light clothes throw back from their surface the light and the heat that strike them. Probably nothing will throw back all the light and heat that strike it, and even the whitest snow will melt under the sun's rays. But while light things keep only a little of the light and heat that fall on them, dark things absorb practically the whole, and so they get warm.

WHY DOES A WASP'S POISON NOT HURT THE WASP?

We can ask the same question about many animals and plants containing substances poisonous to creatures of other kinds, but not to themselves. For instance, why should a poisonous serpent biting itself or another serpent of the same kind do no harm with its poison?

We are gradually coming to realize that the answer is to be found somewhere in the chemistry of life. The fact that different creatures differ from one another must mean, among other things, that each kind of creature has a chemistry peculiar to itself. That is the real explanation of the fact that the wasp's poison is not poison to the wasp, nor the snake's poison to the snake.

Each kind of creature, then, has its own special chemistry. For the purposes of its own life it produces certain substances, useful as means of offense or defense. But it is in the very nature of the case that no kind of living thing could produce and retain substances poisonous to itself and still live.

WHY DO WE GET HOARSE WHEN WE HAVE A COLD?

The voice is produced in a little box in the throat called the larynx, in which are two membranes called the vocal cords, stretching across the box. By their vibration and contraction, they produce the different noises and sounds which make our voice. Now, when we get a cold in the throat these vocal cords swell up and become filled with fluid, and are therefore thick and irregular. The result is that they are unable to produce a clear note, and so the voice sounds thick or hoarse. It is as if the string of a fiddle were soaked in hot water at spots along its length until it had become uneven, and swollen or thick. It would then be unable to vibrate properly, and we could not produce a clear note with it. It would sound scratchy or hoarse.

WHAT IS THE SALVATION ARMY?

In 1865 William Booth, a Methodist minister, founded a mission in London for the "salvation of mankind from all forms of spiritual, moral and temporal distress." It grew rapidly and in 1878 adopted the name "Salvation Army."

Within three-quarters of a century the Salvation Army spread over the world, to 97 countries and colonies, and now preaches in over 100 languages. In addition to its 17,500 religious centers, it has 1,600 institutions which minister to the needy. Among these are hospitals, nurseries, settlements, children's homes, work for prisoners, and shelters and food depots.

In addition to weekly religious instruction to children and young people in Sunday schools, the Salvation Army operates the Corps Cadet Brigade of young people from the ages of thirteen to eighteen who engage in a six-year course of Bible study, Salvation Army doctrines and related subjects intended to prepare them to be leaders in the Army.

The Scouting program, with its camping fun, is open to all children and youths. Boys from eight to eleven are called Chums, and the girls, Sunbeams. Boys from twelve to eighteen are Life Saving Scouts, and the girls are Life Saving Guards.

The Young People's Legion, a religious and social organization, has recreation, handicraft and hobby classes, dramatics and other activities. From the age of ten on, children may find instruction in music without charge.

WHY WILL ORDINARY GLASS NOT BEND LIKE STEEL?

Different kinds of matter have different properties; some kinds will bend, or can be hammered into thin sheets, or drawn into long wires without breaking, while others will not. The differences depend on the way in which the molecules of the thing in question are joined to each other. Glass is one of the things that are more or less rigid and brittle, while wax, for instance, can be molded into any shape.

But it is very interesting to find that the same thing may sometimes be brittle and sometimes plastic, according to circumstances, and the most important of these circumstances is the temperature. Glass itself gives us an instance of this. It is quite true that ordinary glass will not bend, or, rather, that it will not bend much, though special plastic glass is easy to bend or mold.

If we make even ordinary glass hot—red-hot or a little less than red-hot—it will bend quite readily into any shape we please. Then we can cut it with scissors, or draw it out with pincers, or mold it into any shape we like. This is the general rule with a great many things which are rigid and brittle when they are cold. It must mean, of course, that when the glass is made very hot, its molecules do not hold on to each other so tightly.

HOW DOES THE COLOR OF A FLOWER GET INTO THE BUD?

You have seen the tiny brown seeds of the dandelion floating through the air on their fluffy parachutes. They fall to earth at last and sink into the ground. Packed in each brown seed are cells that rest during the winter and wake up in the spring, and food to nourish the cells when they wake up and start growing. As they grow, they split apart and form more cells, each pair of new cells like the one which split. The new ones grow and multiply and the coating of the seed bursts open and the forming of new cells continues. Some cells join together to make roots, some to make leaves and stems and the parts of the flowers, and so on.

Now you want to know what makes the color of the flowers. If you will turn to page 5614 you may read about the mysterious little chromosomes and genes in the cells that are responsible for the size of the plants, the shape of the leaves, the color of the flowers and many other things. Chromosomes are thread-like bodies. When a cell divides, its chromosomes divide also. They divide lengthwise. Scientists believe that much smaller bodies, called genes, lie along the length of the chromosomes like beads on a string, hundreds of genes on each chromosome. Each gene controls a tiny part or characteristic of a plant or animal. Certain genes, for instance, control the color of a flower; and so, even while the brown seed is resting in the earth, it contains the genes which will make the dandelion yellow like its parent; and the yellow is in the bud before the flower opens because the color-genes were in the seed.

This brings us to the subject of heredity. Color in flowers generally follows certain laws of heredity which scientists have discovered. Pages 5613 to 5618 tell about these laws.

WHAT DO WE MEAN BY THE BULB OF A PLANT?

Mother Nature has developed a wonderful way of storing up food during the winter months for the use of certain young plants when they come to life in the spring. She does this by means of the bulb, a big bud more or less in the form of a bulb. The bulb we know best is the onion. Flowers of the lily family, and others, also have bulbs.

A bulb, which generally develops underground, consists of a cluster of scale-like leaves growing from the end of a short stem. In the centre of the bulb is a thick little bud. The leaves surrounding this central bud contain the food that the plant will need when it starts to grow. These storage leaves in turn are protected by outer layers of thin leaves.

There are two kinds of bulbs. The lily and the tulip have *scaly bulbs*. These consist of narrow and thick leaves that overlap like the shingles on a roof. Plants like the onion and the hyacinth have bulbs with broad leaves that wrap around like a series of coats. They are called *tunicated* or *coated bulbs*. A tunic, you know, is a kind of coat.

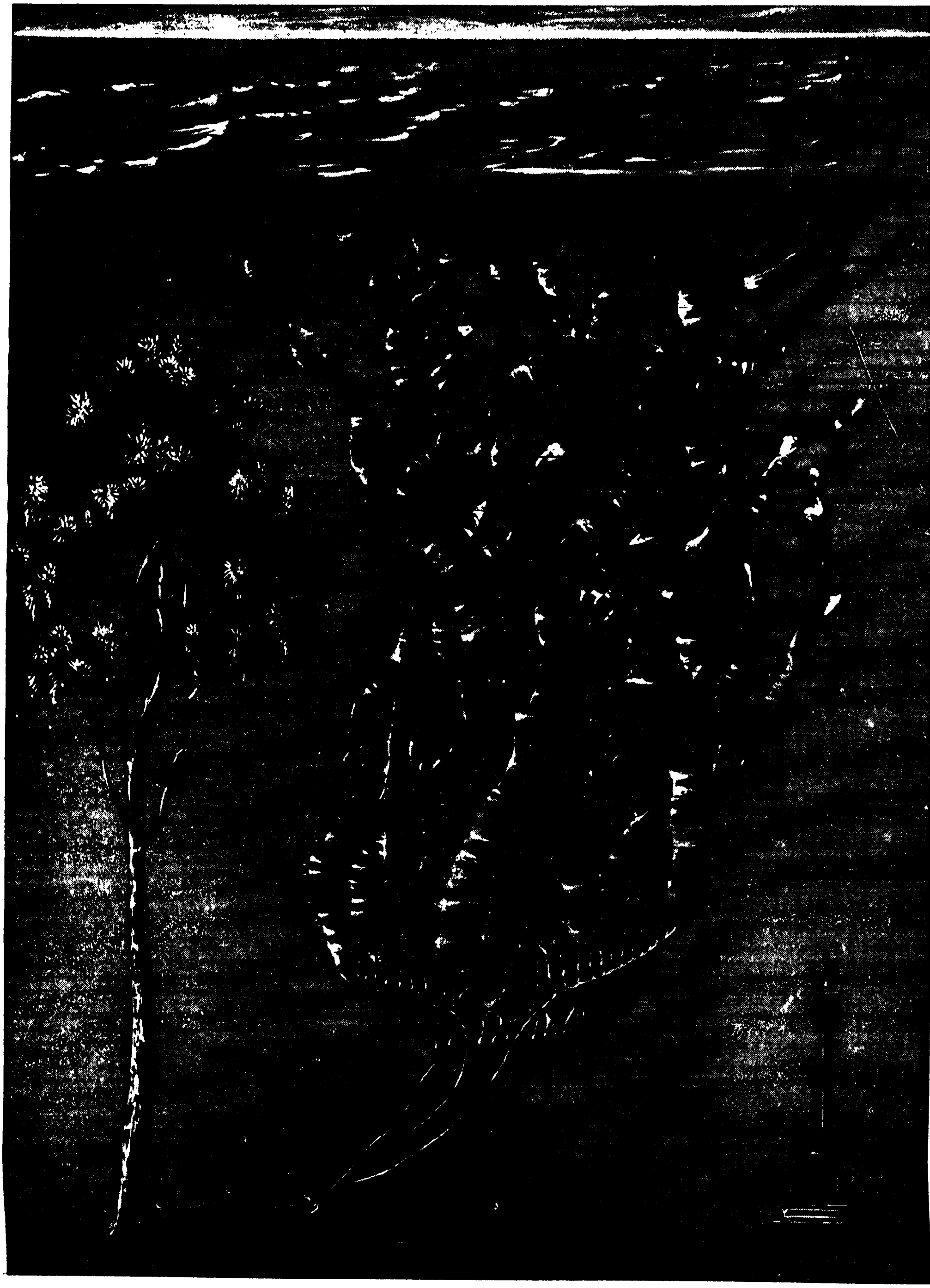
CAN FLOWERS TALK TO ONE ANOTHER?

No. Flowers are wonderful in many ways, and they can do many things, which even men can not do; but they can not talk to each other, either by words or by expression or by any other kind of movement. Only the animal world can do this, because only in the animal world has life developed what is called a nervous system.

No plant has a real nervous system, much less anything like a brain. We know that many of the lower animals can, in effect, talk to each other, but all of these have some kind of nervous system.

THE NEXT WONDER QUESTIONS ARE ON PAGE 1353.

THE GREAT PLANT CLIMBING IN THE SEA



The most amazing plants grow in water and not on land. Shackleton's ship, the Quest, found gigantic marine forests near Tierra del Fuego, and soundings showed that some of the monster seaweed plants peeping above the water were 600 feet high, over 100 feet taller than the tallest land tree—the Australian eucalyptus, shown on the left, which sometimes reaches 500 feet. The monument on the right is 145 feet high. Seaweed is valuable to man for the chemicals which can be extracted from it, particularly potash, sodium and iodine.

PLANTS AND THEIR ANCESTORS

WHEN living creatures began to be we do not know, but some of the great events in their history are clear. It is almost certain that plants got the start of animals, for plants are able to feed on air, water and salts, while animals are seldom able to feed at such a low level.

It is almost certain that the first thoroughly successful creatures were microscopically small. They swam about in the sea by means of one or more vibrating lashes of living matter. They possessed chlorophyl or some other coloring matter which enabled them to use the power of sunlight, and they were probably nearer to plants than to animals.

Whenever and wherever well-lighted shallow waters were established, some of the pioneer free-swimming plants would anchor themselves, and thus began the history of fixed seaweeds. When we look at the beds of seaweed exposed at low tide, we are looking at a very old type of vegetation; and it may be that some of the beautifully colored kinds are extremely ancient forms of life.

When continents and ocean basins were established, and when the shores were slowly raised, as often happens, the conditions began to be favorable for land plants, which gradually appeared, with true roots for absorbing water and salts from the soil, and true leaves for absorbing gases from the air. Or it may have been that some of the simple plants of the sea made their way up estuaries to rivers and lakes, and, after sojourning in swamps and marshes for ages, began at last to colonize the dry land.

Some of the liverworts of to-day may be representatives of the ancient pioneers. In any case the rock-story does not show any fossil land plants in the earlier strata, while there are plenty of traces of seaweeds; so that it is safe to conclude that plant life was at first aquatic. We may perhaps picture three great epochs.

1. The primeval Open Sea, teeming with small swimming green plants.
2. The floor of the illumined Shallow Sea, with anchored aquatic plants whose descendants varied greatly through ages and ages, some of them having characters that fitted them to live on "dry" land.
3. The beginning of land vegetation descended from salt and fresh water ancestors.

In each age some kinds made themselves more and more at home where they were, while others pushed on to new adventures and conquests. The simplest plants that live an independent life are among the fresh and salt water algæ. Such are the diatoms, single-celled plants with beautifully sculptured shells of flint, which abound both in fresh and salt water. Such are the tiny plants that form a green coating on the cool and shady side of trees and gate-posts, coming off on your fingers like wet paint.

But many of the seaweeds are very far from simple, and among the brown ones especially we find mimic roots and stems and leaves. The root, however, is only a holdfast, an anchor, and the leaves, or fronds, absorb water with the oxygen and carbon dioxid dissolved in it. In the brown seaweeds there is chlorophyl as in the green ones, but some yellow pigment is added. In the red seaweeds, though one can hardly believe it, there is chlorophyl again, but it is masked by an entirely different red pigment, which may perhaps help the plant to avail itself of the very blue light of moderately deep water.

On the shore the green seaweeds are most abundant in the shallow water, and red ones in the deeper water; the browns, like the bladder-wrack, are in between. Waving about like flags in the water are the great tangles, but we do not see much of them except at the very lowest tides. One of the giant tangles, much burned to yield potash and iodine, has a stem a hundred feet long and fronds of several hundred feet. In actual length these kelp-tangles exceed the height of the Big Trees of California, but they have no strength of tissue; they float in the water, buoyed by numerous gas-bladders.

THE PLANTS THAT FEED ON OTHER PLANTS OR ANIMALS

Parallel to the seaweeds or algæ are what we call the Fungus Family—molds and mildews, mushrooms and toadstools. They are without chlorophyl and cannot live an independent life. Many of them feed on rotting matter; the others prey on living plants or animals. The simplest kind of fungi are the almost ever present bacteria, single-celled plants of very small size, which cause rotting, some kinds of fermentation, and many diseases, such as plague, cholera and tuberculosis. Many of them, however, are useful.

Very interesting are the incrusting lichens which we see on stones and trees, for they are "double plants," consisting of an alga and a fungus living together in a partnership that helps both. The fungus-partners serve to fix and to shelter; and they absorb the water and salts. The alga-partners have chlorophyl or some allied pigment, and are able to build up carbon compounds. It sometimes happens that the fungus-partners get the upper hand and absorb the algæ, but this means putting an end to their own existence. They cannot continue long without their green allies.

THE PARASITE WHICH FORCES THE GREEN ALGÆ TO BE ITS SLAVE

One of the discoverers of the secret of lichens writes of them very vividly:

> The master is a fungus, a parasite which is accustomed to live upon others; its slaves are green algæ, which it has sought out, or indeed caught hold of and compelled into its service. It surrounds them, as a spider its prey, with a fibrous net of narrow meshes, which is gradually converted into an impenetrable covering; but while the spider sucks its prey and leaves it dead, the fungus incites the algæ found in its net to more rapid activity—indeed, to more vigorous increase.

It should be mentioned here that in the lichens it is the fungus-partner that produces the spores, but the algæ enter into the partnership almost from the very first. Lichens may be flat or tufted or hairy; and their colors are often fine. Reindeer-moss, on which reindeer largely depend, is a lichen; and so is Iceland-moss, which is used in making a delicate food for invalids. Another interest of lichens is that they do a good deal in the way of weathering the rocks and beginning the formation of soil on the mountain-tops.

Lichens do not lead on to anything else; and, of course, the molds, mildews and mushrooms and other fungi cannot be considered as leading to the higher plants, for they do not live independently. Therefore, it must be supposed that the next step in the development of plants after the seaweeds, was that which led to liverworts and mosses.

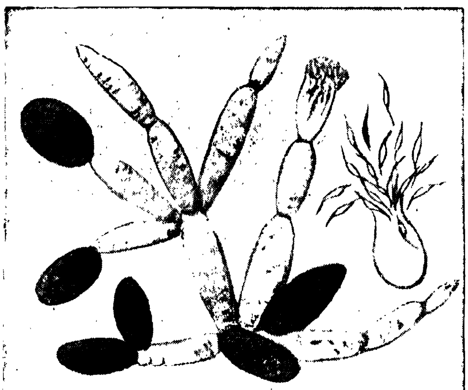
THE MYSTERY IN THE KNOB AT THE END OF THE STALK

Spreading on moist banks of clay, or on the rocks by the side of a waterfall, there are often flat, sprawling green liverworts. Many of them do not get beyond the level of prostrate fronds, but others are divided into lobes, which look like attempts to make leaves. These are often very well ventilated and provided with numerous internal spaces, in which the work of building up carbon compounds goes on effectively, though the light of the places where the liverworts flourish is often very

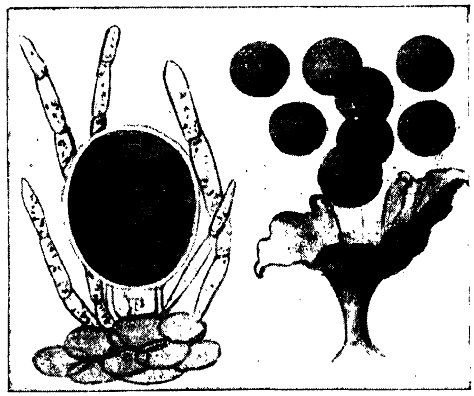
THE LIFE-STORY OF A PIECE OF SEAWEED

1. This is the common bladder-wrack seaweed of our island coasts. Air bladders enable it to keep floating, and the ends of some of the branches are swollen and have little dimples called conceptacles.

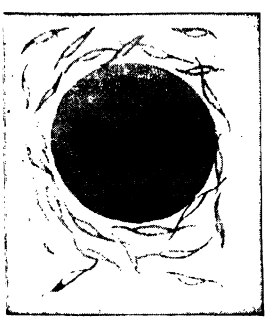
2. This is a section through part of a swollen end, showing two of the dimples. Inside each is a mass of hairs which are the male parts of the seaweed. The globular bodies are the female parts.



3. The male parts branch out, and the ends swell and become filled with yellow grains. When ripe, the ends burst, and the grains, each with a pair of tiny hairs to help it to move in water, are thrown out.

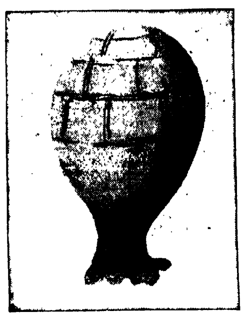


4. The egg-bearing organ is surrounded by the male hairs. It contains eight little egg-cells, which it discharges into the conceptacle, and then into the sea. On the right the egg-cells are escaping.



5. The egg-cell is now surrounded by the sperms, which are enabled to move about by hair-like attachments.

6. The sperm and egg blend and form a fertile egg-cell ready to germinate.



7. The fertilized egg develops into a young seaweed plant, with sucker-like attachments.

8. The young plant now grows and branches, as shown here, and at last becomes a mature plant.

dim. The liverworts make spores inside a knob on the end of a delicate stalk; and these spores, falling on the damp ground or carried away by water, develop into liverworts with male and female organs. The spore-making generation arises, as always, from a fertilized egg-cell.

Fond of moist and shady places, mosses are among the most beautiful of plants. They are very delicate—sometimes like tufts of hair, sometimes like prostrate feathers, sometimes forming spongy cushions, as in the well-known bog-moss. They are what might be called sociable, for if there is one there are many. They soon fill up any suitable place; they multiply quickly, and even a detached fragment can grow into a complete moss. Although they prefer moist places, many of them are able to survive on dry walls or tree-trunks. They can be dried till their leaves are crisp, but a heavy shower puts them right again. They absorb water by their whole green surface, and also by thread-like rootlets that fix them to their station. They form a class of pigmies, but they often show a considerable advance of the liverworts, having short stems and numerous leaves.

HOW THE EGG-CELLS OF THE MOSSES ARE FERTILIZED

If we peer into the top of a vigorous moss plant, we may see the male and female organs, which correspond to the flowers of higher plants. Often the two kinds are on separate plants. The microscopic egg-cell, which lies in the recess of a body shaped like a flask, is fertilized by a swimming male cell, and the fertilized egg develops into a spore-case or capsule borne on the end of a delicate stalk. Thus there are two generations, the ordinary leafy moss plant, which has male and female organs, and then the spore-producing generation. The strange thing is that the second generation grows on the shoulders of the first. When a ripe spore-cell is carried from the burst capsule by wind or water or insect, and lights on a moist place, it grows out into a delicate threadwork, much resembling some of the green algæ, and from this there arises the leafy moss plant.

This complicated life-history—spore-bearing plant to egg-bearing plant and then to spore-bearing plant again—is called *alternation of generations*. In one of the cave-mosses, where the light is very scanty, the threadwork gives out an emerald light. Some of the cells act like reflecting mirrors. The liverworts and mosses are among the simplest land plants of to-day, but there is no reason to believe that they led on to anything higher in the gradual development of the plant kingdom.

It may be that this is the Golden Age of ferns, for there are as many living now as there have been in the past, and far more than in the ancient days of the Carboniferous Era. They are very varied, from delicate filmy ferns, which one might almost mistake for mosses, up to bracken ferns six feet high; from the delicate maidenhair ferns to giants like the royal fern and the tree ferns. There are some seven thousand different kinds, and they range from the tropics to the Arctic. They show a great advance on mosses, for they have numerous vessels for transporting fluid materials within the plant, and the spore-bearing and egg-bearing generations are both of more elaborate structure than in the mosses.

THE LITTLE PLANT MANY PEOPLE HAVE NEVER SEEN

When we look on the under side of the fronds of a fern we see brown spore-making organs, and it is often easy to dust our hand with the minute spores. When a spore of a fern lights on suitable moist soil it develops into a little plant which many people have never seen. This bears the sperm-bearing and egg-bearing reproductive organs, and from its fertilized egg-cell there develops the spore-making fern plant.

In the time when the coal-bearing rocks were being formed (the Carboniferous) the most prominent plants were ferns, horsetails and club-mosses, along with some relatives of these, which are known only as fossils. There was a great vegetation of flowerless spore-plants, and it was from this stock that there arose the seed-plants which by and by conquered the whole world.

FERNS AND MOSSES AS ANCESTORS OF FLOWERING PLANTS

It is a complicated story, and most of the chapters are still unread, but the main thing is that in very early times—probably in the Carboniferous Age—seed-plants arose from the great stock to which ferns, horsetails and club-mosses belong. In the flowering plants that we are familiar with there are two kinds of spores just as there are in water-ferns and some club-mosses—one kind of spore is represented by the young pollen-grains produced by the spore-making organs we call *stamens;* and the other kind of spore is formed inside the spore-making organs we call *ovules,* and develops into a structure called the embryo-sac, which contains the egg-cell.

But the pollen-grain commonly contains, when ripe, three cells, and that is all that is left of the male generation. These three cells pass down the pollen tube which grows from the pollen-grain when it is landed by wind or insect or otherwise on the tip of the pistil; and one of the three, a sperm-cell, reaches the egg-cell inside the embryo-sac and fertilizes it, so that a young plant begins to develop. It is interesting that in cycads, and in the maidenhair tree, the fertilizing male cells should still be free-swimmers with many lashes, resembling the free-swimming male cells of the great fern alliance.

THE EMBRYO AS THE GRANDCHILD OF THE PLANT IT GROWS ON

Turning to the other side of the flower, we find that the space in the ovule produces a structure called an embryo-sac. This comes to have eight cells and one of the eight is the egg-cell. After it is fertilized by the sperm-cell, it develops into a young embryo plant in an ovule. The embryo plant and the surrounding parts of the ovule together constitute a seed. But, as Dr. MacGregor Skene says in his delightful book on Common Plants, "the embryo is not the child of the plant on which it grows, by which, in the early stages of its life, it is nourished; it is the grandchild. Between the two there is an intermediate generation, reduced to a few cells, never having an independent existence, but still recognizable." All this is difficult, but it is worth puzzling over.

THE SEEDS THAT DRIFT ABOUT IN THE WIND

The young plant gets a good send-off in life. While the ancient spore-plants were spread abroad by spores, their successors, the seed-plants, are spread abroad by seeds; and this is the surer way. In the geological Middle Ages (called the Mesozoic) there was a great wealth of cycad-like plants, along with their predecessors—the ferns, horsetails, club-mosses, and the now extinct relatives of these. The cycads, the maidenhair trees, and the conifers are true seed-plants, but they do not quite rise to the level of flowering plants. In a pine tree the female cones bear on the upper surface of each scale two ovules which are quite naked. In early summer these scales open, and the pollen-grains—each of which has two air-bladders, or floats—are drifted by the wind and caught in a drop of sticky fluid on the tip of the exposed ovule. It is not till the next summer that the fertilization of the egg-cell takes place, and it is not till the third year that the winged seeds are liberated and borne about by the winds.

The true flowering plants are divided into two great classes, the Dicotyledons, with two seed-leaves (cotyledons)—such as buttercups, chickweeds, roses and daisies; and the Monocotyledons, with one seed leaf—such as the lily and the daffodil, the orchid and the grass.

TRUE FLOWERING PLANTS ARE THE MOST NUMEROUS

Now, in the monocotyledons the leaves usually show a number of large strands joined by delicate cross-connections; in dicotyledons the strands or bundles usually form a more noticeable network. The stem of a dicotyledon can go on growing in thickness indefinitely, but in most monocotyledons the stem does not increase in diameter after it is formed. Everyone is familiar with the tapering stem of an ordinary dicotyledonous tree, and the cylindrical stem of a monocotyledonous tree such as a palm. Finally the parts of the flower in monocotyledons are usually in threes, while the others are usually in fours or fives.

It is not yet possible to make a true census of the vegetable kingdom, because many thousands of plants have yet to be identified. However, botanists have estimated that the total count must be nearly half a million. Of these the True Flowering Plants are by far the most numerous. They are probably followed in order by the Fungi and Bacteria, Seaweeds or Algae, Mosses and Liverworts, Lichens, Flowerless Plants with Vessels, and finally by the Naked-seeded Plants.

The high place on the list of the parasite plants is striking, but it is important to know that the true flowering plants lead the fungi and bacteria by a proportion of about ten to four. In fact, the true flowering plants may be called the great conquerors of the vegetable kingdom.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 1013.

A PERPETUAL CALENDAR

To ascertain any day of the week, look in the Table 1 for the year required. Under the months are figures which refer to corresponding figures at the head of the columns of Table 2.

For example: To know on what day of the week December 18, 1934, fell, look in Table 1 for 1934. In a parallel line under December is the figure 6. Now look at the 18th day given on this page in column 6 and you will find it to be a Tuesday.

TABLE 1

Common years, 1753 to 1951	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1761 1789 1807 1835 1863 1891 1925 1767 1795 1818 1846 1874 1903 1931 1778 1801 1829 1857 1885 1914 1942	**4**	**7**	**7**	**3**	**5**	**1**	**3**	**6**	**2**	**4**	**7**	**2**
1762 1790 1819 1847 1875 1909 1937 1773 1802 1830 1858 1886 1915 1943 1779 1813 1841 1869 1897 1926	**5**	**1**	**1**	**4**	**6**	**2**	**4**	**7**	**3**	**5**	**1**	**3**
1757 1785 1814 1842 1870 1898 1927 1763 1791 1825 1853 1881 1910 1938 1774 1803 1831 1859 1887 1921 1949	**6**	**2**	**2**	**5**	**7**	**3**	**5**	**1**	**4**	**6**	**2**	**4**
1754 1782 1805 1833 1861 1889 1907 1935 1765 1793 1811 1839 1867 1895 1918 1946 1771 1799 1822 1850 1878 1901 1929	**2**	**5**	**5**	**1**	**3**	**6**	**1**	**4**	**7**	**2**	**5**	**7**
1755 1783 1806 1834 1862 1890 1919 1947 1766 1794 1817 1845 1873 1902 1930 1777 1800 1823 1851 1879 1913 1941	**3**	**6**	**6**	**2**	**4**	**7**	**2**	**5**	**1**	**3**	**6**	**1**
1758 1786 1815 1843 1871 1899 1922 1950 1769 1797 1826 1854 1882 1905 1933 1775 1809 1837 1865 1893 1911 1939	**7**	**3**	**3**	**6**	**1**	**4**	**6**	**2**	**5**	**7**	**3**	**5**
1753 1781 1810 1838 1866 1894 1917 1945 1759 1787 1821 1849 1877 1900 1923 1951 1770 1798 1827 1855 1883 1906 1934	**1**	**4**	**4**	**7**	**2**	**5**	**7**	**3**	**6**	**1**	**4**	**6**
Leap years, **1756** *to* **1952**												
1764 1792 1804 1832 1860 1888 1928	**7**	**3**	**4**	**7**	**2**	**5**	**7**	**3**	**6**	**1**	**4**	**6**
1768 1796 1808 1836 1864 1892 1904 1932	**5**	**1**	**2**	**5**	**7**	**3**	**5**	**1**	**4**	**6**	**2**	**4**
1772 1812 1840 1868 1896 1908 1936	**3**	**6**	**7**	**3**	**5**	**1**	**3**	**6**	**2**	**4**	**7**	**2**
1776 1816 1844 1872 1912 1940	**1**	**4**	**5**	**1**	**3**	**6**	**1**	**4**	**7**	**2**	**5**	**7**
1780 1820 1848 1876 1916 1944	**6**	**2**	**3**	**6**	**1**	**4**	**6**	**2**	**5**	**7**	**3**	**5**
1756 1784 1824 1852 1880 1920 1948	**4**	**7**	**1**	**4**	**6**	**2**	**4**	**7**	**3**	**5**	**1**	**3**
1760 1788 1828 1856 1884 1924 1952	**2**	**5**	**6**	**2**	**4**	**7**	**2**	**5**	**1**	**3**	**6**	**1**

TABLE 2

	1	**2**	**3**	**4**	**5**	**6**	**7**	
1	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	**1**
2	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	**2**
3	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	Tuesday	**3**
4	Thursday	Friday	Saturday	SUNDAY	Monday	Tuesday	Wednesday	**4**
5	Friday	Saturday	SUNDAY	Monday	Tuesday	Wednesday	Thursday	**5**
6	Saturday	SUNDAY	Monday	Tuesday	Wednesday	Thursday	Friday	**6**
7	SUNDAY	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	**7**
8	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	**8**
9	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	**9**
10	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	Tuesday	**10**
11	Thursday	Friday	Saturday	SUNDAY	Monday	Tuesday	Wednesday	**11**
12	Friday	Saturday	SUNDAY	Monday	Tuesday	Wednesday	Thursday	**12**
13	Saturday	SUNDAY	Monday	Tuesday	Wednesday	Thursday	Friday	**13**
14	SUNDAY	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	**14**
15	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	**15**
16	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	**16**
17	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	Tuesday	**17**
18	Thursday	Friday	Saturday	SUNDAY	Monday	Tuesday	Wednesday	**18**
19	Friday	Saturday	SUNDAY	Monday	Tuesday	Wednesday	Thursday	**19**
20	Saturday	SUNDAY	Monday	Tuesday	Wednesday	Thursday	Friday	**20**
21	SUNDAY	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	**21**
22	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	**22**
23	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	**23**
24	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	Tuesday	**24**
25	Thursday	Friday	Saturday	SUNDAY	Monday	Tuesday	Wednesday	**25**
26	Friday	Saturday	SUNDAY	Monday	Tuesday	Wednesday	Thursday	**26**
27	Saturday	SUNDAY	Monday	Tuesday	Wednesday	Thursday	Friday	**27**
28	SUNDAY	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	**28**
29	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	**29**
30	Tuesday	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	**30**
31	Wednesday	Thursday	Friday	Saturday	SUNDAY	Monday	Tuesday	**31**

The new style calendar was introduced in 1752. That year is the same as 1772 from January 1 to September 2, and the same as 1780 from September 14 to December 31. September 3rd to 13th were omitted in the introduction of the new-style calendar.

THE STORY OF BRAVE WILLIAM TELL

WILLIAM TELL was said to be the finest crossbowman in Switzerland and the best handler of a boat on the storm-swept lake of Uri. He lived quietly in a mountain cottage with his wife and children whom he loved warmly. He hunted deer in the mountains and went fishing on the lake. His children never lacked good food and clothing. His home was trim and neat. There was no family in that district more firmly established in peace and contentment.

William Tell and his son. This artist has chosen to show the apple pierced by the arrow, not cut in two.

One day Tell went to the fair at the near-by town of Altdorf to sell the deerskins that he had been collecting, and to buy warm winter clothing for his family. He made a good bargain for the deerskins, and he was striding across the village square, happy and at peace with all the world. In an hour or more he would be singing a song on the road to his mountain home. Suddenly he felt his arm seized and found himself in the grip of an Austrian soldier. In another instant he was surrounded. The soldier who had seized his arm pointed to a pole with a cap on the top. "It is death not to bow to that cap!" said the soldier.

A silence fell upon the whole square. People left off their trading and crowded round the group. A thing greater than trade was at stake now—a man's freedom, a nation's liberty. William Tell brought his eyes from the cap on the pole to the soldier's face. "I have done nothing unlawful," he said slowly.

"You have insulted the majesty of the Duke!" said the soldier.

William Tell kept a steady eye. "Why," said he, "should a man show reverence to an empty cap?"

At this there came from behind the soldiers the figure of the Governor of the district, the tyrant Gessler. It was this Gessler who, set over the freedom-loving Swiss by their conqueror and oppressor, the Duke of Austria, had trodden liberty under foot. He had murdered and imprisoned all who stood against him, and, as a last barbarity, had declared that everyone who did not do homage to the Duke's cap set up on the pole should die.

William Tell faced the Governor. He feared no man. No one could break his proud spirit. In his mountain he had brooded upon the shame of the slavery which enchained his country and had already spoken with his friends of resistance. Never would he do homage to the badge of the tyrant.

"So you would make a jest of the sign of majesty?" asked the Governor, approaching Tell, while the soldier saluted. At that moment there came from the crowd a child's cry of "Father! Father!" The crowd turned about, opened out and William's little son, who had come without leave to the fair, was rushing to his father. The Governor caught the boy's arm. "Is this the traitor's son?" he asked.

"Hurt him not," said Tell. "He is my first-born."

"Oh, I won't hurt him!" answered the terrible Gessler. "If any harm should come to him, it will not be by me, but—by you."

A horrible smile lighted his eyes. "Here," said he to a soldier, "take the boy and tie him to the trunk of that linden tree over there, and place an apple on his head."

"What is this for?" demanded Tell.

"I am told that you are called the best crossbowman of Switzerland," replied the Governor, "and I should like to see an exhibition of your skill. And I am willing to pay for a good show. You are as good as dead this minute for refusing to salute the Duke's cap. But I am in a merciful mood. Listen! If at this distance you can shoot an arrow so as to split the apple on the curls of your first-born, I will let you go free. If not—if you miss the apple, or kill your child—I will execute you, here and now."

"Have you no mercy?" cried Tell, trembling with indignation. "And do you think I will attempt to save my own life at the risk of my son's?"

"I am doing you a favor," replied Gessler. "By a lucky shot you may save your life, and go home!"

Tell held out a hand which was trembling. "How can a man aim with a steady hand an inch above his son's temple?"

Gessler laughed brutally. "You either shoot an arrow, or die."

"Then I will die."

"And first your child shall have his neck wrung before your eyes!"

A blinding passion of indignation swept over the noble soul of the mountaineer. "Give me the bow," he said. "One thing in mercy I ask. Let the child's face be turned away from me. Let me not see his eyes fixed upon me."

A way was cleared between father and son. A dense multitude stood on either side. The boy, with his face to the tree, bound by ropes to its trunk, felt the apple weigh like lead upon his head. A dreadful silence fell upon the market square. William Tell chose two arrows. One he thrust in his girdle; one he fitted to his bowstring. Then for a moment he stood, bowed, his eyes downward: he was praying. You might have heard a leaf fall, so still was the place.

Then Tell raised his head; his eyes were steady; his hands had become still; his face was like iron. He brought the crossbow to his shoulder and laid his eye to the feather of the shaft. Twang!

The arrow shot forward, and buried itself deep in the tree. The apple fell in equal parts on either side of the boy's head. A roar of cheering went up to heaven, and Gessler turned to Tell.

"A good shot, traitor!" he said cruelly. "But tell me, for what reason did you take two arrows?"

Tell laid his hands upon the arrow in his girdle. "If the first arrow had hurt my child," he said, "this one by now would be through your heart!"

"Oh! So I run in danger of my life?" said the Governor. "But I will keep the pledge I gave you. You shall not die. I will give you your life. But the rest of that life you will spend in the dungeons of my castle, and your bowstring will not then be a danger to me."

At this Tell was seized again, and rushed by the soldiers through the scowling mob to the quay, where the Governor's ship was moored. But it chanced that as the ship crossed the lake of Uri a storm arose, savage and wild, and it seemed as if everyone would be drowned. The Austrians could not manage the vessel and began to abandon hope.

In their panic they remembered that Tell was reputed the best sailor in that part of the world, and spoke to the Governor. "Loose him," said Gessler, "and let him save us." So Tell took the helm, and under his guidance the little ship soon righted herself. But as he headed her for the shore he was thinking, not of Gessler and the Austrian soldiers, but of freedom—freedom for himself and for Switzerland. He resolved to free himself and save his country.

He brought the ship close to a rock that jutted out from the coast, and then, as it shot past, he sprang suddenly upon the rock, and left the Austrians to save themselves. Swift of foot, he scaled the rocks, climbed the cliff and made his way across the mountains to a place on the road which Gessler, if he saved himself, would have to pass. Here he lay concealed among the bushes, with an arrow fitted to his bowstring, his heart set on delivering Switzerland from the tyrant.

As he waited, darkness fell among the mountains. Presently there came to him the tramp of feet. "And if I live to return to Altdorf," Gessler was saying, "I swear I will destroy the whole brood of this traitor Tell, mother and children, all in the same hour!"

"You shall never return!" said Tell to himself. And as the soldiers went marching on, he let fly the arrow, and Gessler dropped dead in the dust.

With their leader fallen, the soldiers became confused and fled. But Tell's friends rallied around him.

Thus William Tell inspired the rising of the Swiss people, which led to the overthrow of the Austrians and made Switzerland a free country.

They would have made him king, but he shook his head and went back to his home among the mountains. This legend of brave William Tell has inspired many artists, writers, musicians for more than six centuries.

THE SWISS GUARDS WHO DID THEIR DUTY

THE Swiss have often been noted for brave deeds, but one of those we like to think about most was done by Swiss soldiers far away from their own beautiful country, in Paris, in 1792, the year of the Revolution.

The French kings had learned to rely on the Swiss, and had formed a guard of honor of trusty yeomen from Lucerne and other cantons, and called it *Les Gardes du Roi,* The Guard of the King.

When the mob stormed the Tuileries Palace, where the royal family were, on August 10, 1792, the Swiss Guards stood firm, defending King Louis XVI and his queen, so that the angry rioters could reach them only over the bodies of the Swiss. One after another the soldiers were massacred, fighting bravely till two battalions were overcome; others fell on September 2 and September 3. The Swiss Guards were almost wiped out. Only a few remained alive.

The great Danish sculptor Thorwaldsen designed a beautiful memorial for the Swiss Guards, which has been sculptured out of the natural rock in the Glacier Garden at Lucerne. It represents a wounded lion pierced by a broken weapon, defending with its paw, as it lies dying, a shield bearing the fleur-de-lis of France. On the rock over the lion's head we read: *Helvetiorum fidei ac virtuti,* a Latin inscription which means "To the fidelity and courage of the Swiss." Then the names are given of those brave officers and men who fell, not in defense of their own country, but simply in devotion to a foreign king.

If you ever go to Lucerne, be sure to see the lion, for it is a touching monument to loyalty, carved in the Alps of the men's native land. More than 150 years ago they fell, but their memory is still dear in the land of their birth.

Culver Service

At Lucerne, this lion, carved in the everlasting rock, tells the story of the Swiss Guards who died trying to defend the French king. The Latin words above the lion mean: "To the fidelity and courage of the Swiss."

A FRUGAL HERO OF ANCIENT ROME

ROME became a great power because her citizens were honest, single-minded men who worked hard, loved their country, governed it wisely and fought for it bravely. In its early days the little state was surrounded by enemies, and men would be called from their farms outside the city to defend it against the Volscians, the Samnites and other peoples who were their neighbors in the narrow peninsula of Italy.

One of the bravest of the early Romans was the farmer-statesman, Manius Curius Dentatus, who fought bravely against Rome's enemies when need arose. Humble by birth, he had won the esteem of his fellow-countrymen so that three times they elected him to the consulship, the highest office of the state, and twice gave him a triumph—a great honor for a Roman.

But when the fighting was over, Dentatus would go back to his farm, and work there with his own laborers in the fields until his country called for him again; for he was a man of sturdy, self-respecting character, living a simple country life. For him luxury and ease had no attraction.

It is said that the Samnites once sent messengers to him with valuable presents and much gold in the hope of bribing him over to their side. They found him seated beside his hearth cooking a meal of turnips in an earthen pan. When Dentatus saw the gold, he refused it with contemptuous laughter, saying that he would rather rule over those who lived in plenty than to be a possessor of wealth himself, and that he was neither to be overcome in battle nor bribed by money. So the Samnites, shamefaced, had to return home, carrying the presents they had brought.

It was men of this type who built up the great Roman Empire. In their hands the state was safe; but when love of gain and pleasure became the heart's desire of the Romans, their empire could stand no longer, but gradually fell apart.

THE RACE FROM MARATHON

"REJOICE, we conquer!" Gasping out these words as joyfully as his parched tongue can utter them, a poor wornout youth drops lifeless into the arms of those Athenians who have hurried out of their city to learn his tidings. His faint whisper goes from mouth to mouth: "Marathon is ours! We won! We won!" Anxiety turns to joy throughout the city.

The story of the victory of Marathon is one of the most thrilling the world has ever known. It takes us back over two thousand years to one of the first decisive battles in the world's history. Darius, the Mede, has made himself master of Asia and, angry at interference on the part of some little Greek state, he assembles his picked soldiers, summons various Persian tribes and sails over the Ægean Sea to conquer all the Greek states.

Athens is the first large city in his conquering path. The Athenians feel the need of aid from the famous Spartans, whose state lies 120 miles to the south, across the Isthmus of Corinth. The army of the Medes and Persians is fast approaching, and Athens will soon be attacked. How are the Spartans to arrive in time? The rulers of Athens, seated in grave council on the Acropolis, send for Pheidippides, their champion runner, who has won for his state the myrtle crown at the famous Olympic games. The city fathers command him to run and urge Sparta to come to their aid. For two days and two nights Pheidippides runs, swimming the rivers and climbing the mountains in his path.

But the Spartans are envious and mistrustful of Athens. Though brave and fearless, they lack intelligence; and, besides, they are a very superstitious people, and so Pheidippides is sent hurrying back with the news that their army will come, but can not start until the full moon.

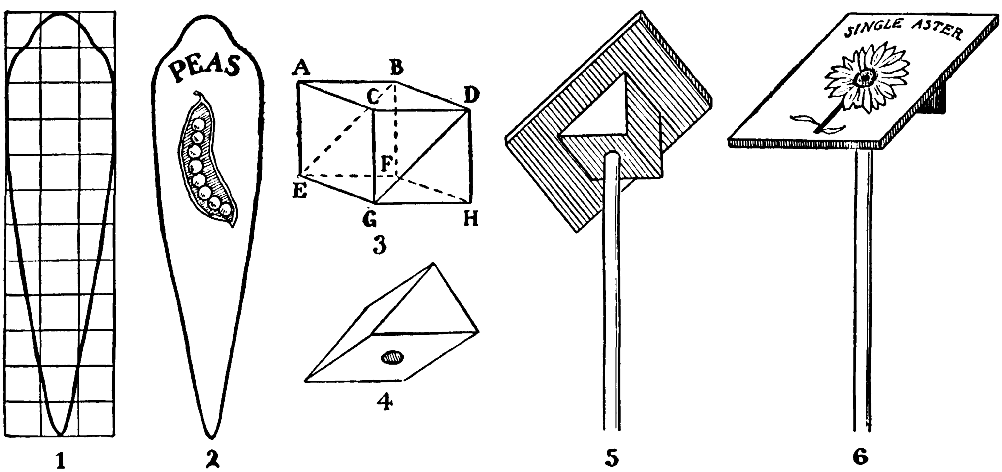
Pheidippides races back to Athens again. The Athenians have now been thrown on their own resources. The Persians have landed and the Athenians resolve to oppose them at once. The weary but dauntless Pheidippides takes his long spear and his heavy shield, and marches with 10,000 picked men to meet the foe. We read on page 914 of the famous battle at Marathon where these 10,000 Greeks took their stand and drove back the mighty army of Medes and Persians—but this story is of Pheidippides.

With Marathon fought and won, the victorious Greeks call to Pheidippides to take the glad news to the capital. Flinging down his shield, he runs over hill and valley the twenty-six miles to Athens. There, sinking into the arms of friends, and gasping, "Rejoice, we conquer!" the gallant runner dies.

THE NEXT GOLDEN DEEDS ARE ON PAGE 1255.

ATTRACTIVE SEED-MARKERS

AFTER you have prepared the soil and planted the seeds in your garden, you will have to rely on your memory to tell you what seeds have been planted in any particular row—that is, until the plants have come up out of the ground. To enable them to know at all times just where they have planted their seeds, some gardeners place a stick in the ground and on top of this they set the packet in which the seeds pattern of the marker, using the design in Figure 1 (each square represents a square inch). Trace out this pattern on the board, and cut it out with a jig-saw if one is available. If not, use a small handsaw to cut roughly to shape and then whittle off the superfluous wood with a sharp carving knife or pocketknife. When this has been done, bevel the edges with your knife and sandpaper them to make them smooth.



How to make the two seed-markers described in the present article.

were originally contained. This system has its disadvantages. For one thing, the garden is apt to look rather unsightly until the plants grow up and the sticks are removed. Again, rain may soak the packet on the stick until it is impossible to make out any of the printing on it. Or else a gust of wind may carry off the packet.

It is easy to make wooden seed-markers that will be attractive and that will remain sturdily on duty until it is time to remove them. The first marker that we are going to describe is simple but effective. It is to be made from a smooth board from ⅛ to ¼ of an inch thick. Make a paper

On the top of the marker print the name of the plant in black or red water color and underneath this make a drawing of the fruit or vegetable in question (see Figure 2): you may copy the illustrations to be found in THE BOOK OF KNOWLEDGE. Paint the fruit or vegetable the appropriate color with water colors; then, after the paint has dried, apply a coat of shellac. When you have made as many markers as are necessary and have inserted them in their appropriate places, your garden will present a very attractive appearance.

There is another type of marker that is particularly suitable if it is to be of a permanent nature. For this you will need first of all a cylindrical stick from one and a half to two feet long; the stick to which rockets are attached will answer the purpose very well. You will also have to have a block of wood two inches square.

Draw diagonals on two of the opposite sides of the block (EB and GD in Figure 3). Then saw the block into two segments, or parts—ACBDEG and BDFHEG, in Figure 3. These two segments will serve for two different markers. A hole is to be made in one of the segments with a gimlet or other boring tool at the place indicated in Figure 4. This hole is to be just wide enough to permit the cylindrical stick to pass into it, and it is to be at least ¼ inch thick. Dip the cylindrical stick in wood glue and place it in the hole. If the stick is too large for the opening, sandpaper it until it fits. If it fits too loosely, it would be well to place a little plastic wood about the sides of the hole, before you insert the stick in it.

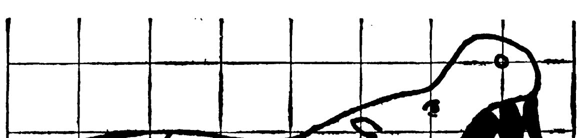
Next you are to prepare a little slab of wood, 3 inches by 4 inches by ¼ inch. On one side print the name of the plant and make a colored painting of it with water colors. Then finish with a coat of shellac, as you did in the case of the other type of marker that we described above.

The next step is to place the slab in position, painted side up, on the side of the block opposite the cylindrical stick (see Figure 5). The slab is to be fastened to the block by means of wood glue; it may also be nailed or screwed down to the block. Your marker is completed; Figure 6 shows how it looks when ready for service. The end of the cylindrical stick is now pointed and the stick is inserted in the ground to a depth of about six inches.

TOY ANIMALS FOR YOU TO MAKE

EVERYBODY loves a circus. It is not very often however that one can see a circus. Wouldn't you like to have one of your own, to which you could go as often as you liked? A real circus would cost thousands of dollars. It is possible however to make a little circus that will delight you and your friends. The lions and tigers and hippos and wolves of this circus will make a very brave appearance, but they could not possibly harm you or your friends for they are all of wood.

Here are three toy animals for your circus, which can be made from thin, soft wood or even from the tops and bottoms of old cigar boxes. Directions for making other animals for your menagerie are given in other volumes, but you will find it easier first to make the bear, the wolf and the hippo as shown in the following simple but very effective patterns.

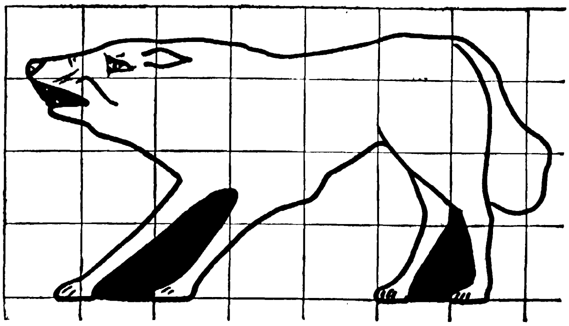


The hippo is easy to cut out.

While some children copy patterns from their animal books, you will find it quite easy to make your patterns for these animals if you first lay out your sheet of paper in 1 inch squares. As the bear, the wolf and the hippo have each been drawn on squared paper just like yours, you may count each square in the picture as 1 inch and note the general proportions of the animal. This enables you to make several marks or dots as guides for drawing the rough outline of the animal in question. Now carefully check your drawing with the corresponding one shown in this book and make any desired final changes in your pattern.

Your pattern may now be transferred to the thin wood (this should be not less than ⅛ inch nor more than ¼ inch in thickness) either by using carbon paper or by cutting out and tracing on the outline with a pencil. If you have decided to use cigar boxes, these must first be cut apart and the tops and bottoms should be made smooth by scraping or sandpapering. Cedar, from which most cigar boxes are made, is well adapted to the purpose unless heavier toys are wanted.

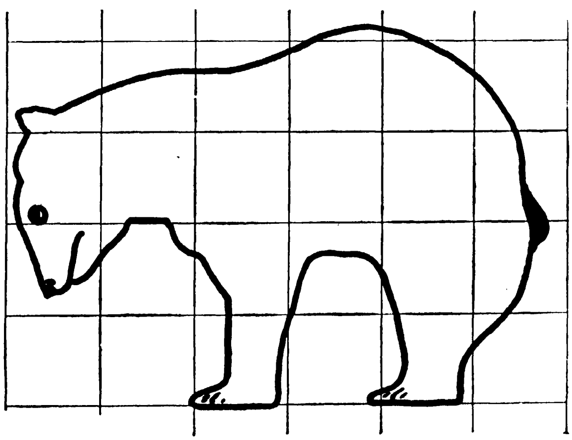
The animal is next shaped either with a scroll saw or by whittling. The cutting should be done very carefully, as the outlines make so many different angles with the grain of the wood. It is not in the least like straight cutting with the grain, or even straight cross-cutting, and the wood sometimes has a way of splitting off an important part of the animal's anatomy. Sometimes much of this difficulty with short grain can be prevented by noting the direction of the grain in the wood before the pattern is transferred.



Do not cut between the wolf's legs.

A base is next needed upon which to mount each animal. Each one of these should be at least 1¼ inches wide, and about as long as the total length of the animal. After each animal and its base have been sandpapered and balanced, the base is carefully nailed to the animal's feet with two or more small brads or nails. Be sure that your animal is placed along the centre line of your base, or else he may topple over on the slightest provocation. Animals that collapse so easily delight the hunter but not the circus man!

Now you are ready to give the animal his color. Any spots or other decorations which you decide to put on these animals should be painted a bright color with common oil paints or with water colors. In fact, these should be painted brighter than is actually desired. If used, water colors should be applied with a brush not too full of color. Care should be taken that it does not spread into the grain of the wood. When this or the oil paint is dry, an oil stain of the proper shade can be rubbed over both wood and decoration with a soft cloth. Later it should be rubbed down with two or more coats of wax. If only common oil paints are used the spots and other markings should be made after, rather than before, the first coat is applied. The colors for each animal will be left to your judgment. For example, you may paint the bear brown, black or white, depending upon which one of these bears your toy most closely resembles. But what colors are proper for the wolf and the hippo?



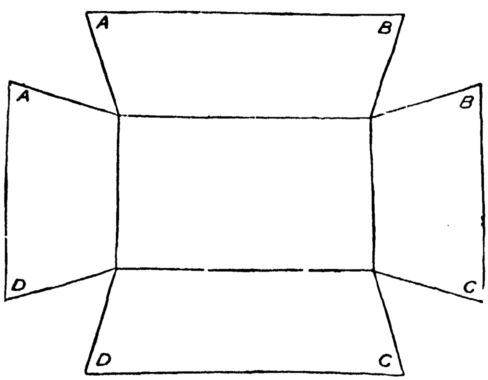
Watch the grain of the wood in making the bear.

You will find suggestions for making three more animals for your menagerie on page 1775 in Volume 5. In the patterns given in other chapters in this book, we add certain details that will make your task a bit more difficult. The principles followed, however, will be just the same, so that it would be well to master the methods explained in this chapter. Lay out your 1-inch squares as carefully as possible and be sure that you draw your animals accurately. Above all, you should not work too rapidly, you should stop now and then to examine the work already done.

HOW TO MAKE A GIRL'S WORKBOX

HAVE you ever thought of the joy it brings to have a real workbox of your own? Of course you could buy one at the store, but it is really easy to make a box like the one in the picture.

Take a piece of cardboard thick enough to make a firm foundation, and on this trace the lines below. Cut the cardboard all



The pattern of the girl's workbox.

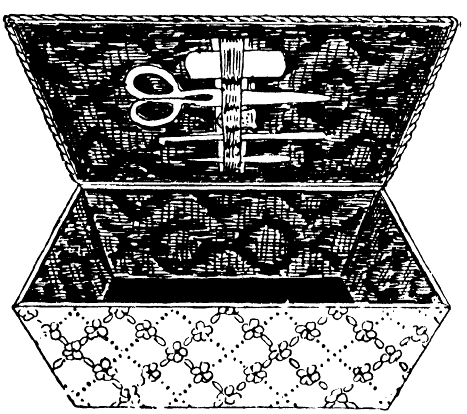
around the outlines of the diagram. Bend the four pieces which are intended to form the four sides. Do this while following the lines carefully, so that the bottom of the box will be quite even. Straighten the cardboard again, and cut two pieces of cretonne, each one covering entirely the piece of cardboard which includes the bottom and sides of the workbox. Cut the material about a quarter of an inch bigger all round than the cardboard, to allow for turning in the edges, which otherwise would fray and look untidy; then glue the cretonne on the cardboard, back and front. When this is done, let it dry for one day.

The next thing to do is to bend your covered cardboard again, just as you did before. This will be quite easy now, for although you cannot see the lines, the cardboard will bend naturally and without any difficulty in the same place. Join the corners A together by sewing the cretonne on the two sides with over-and-over stitches using a needle with strong thread to secure the corners, top and bottom, very firmly. The same thing must be repeated in the corners marked B, C, D.

The workbox now stands, and is covered and lined. Some cord, sewn round the foot of the box will make a neat finish and slightly raise the box. Now the cover must be made, and this is the most interesting part of the work. Cut a piece of cardboara to fit exactly the top of your workbox; then, before putting on the cretonne as you have done on the other part, put a layer of cotton-wool to form padding, and cover it over with the material. Do this on both sides of the cardboard, taking great care to turn the edges in, as described for the other part of the box, before gluing the cretonne down. A strip of material is fixed on the inside of the lid, and sewn at regular intervals, to receive a thimble, a pair of scissors, a crochet needle and other things. The cover is then put on the box part by slipping two small pieces of cretonne under both cover and back of box, one on each side, to form hinges. These are then sewn very firmly, so that the lid can be opened and closed without getting torn or unstitched.

A silk cord running all round the top will hide the joining of the cretonne, back and front, and can be sewn with light, long stitches, tacking the cretonne on both sides, thus making the edge of the box quite firm and neat. This gives a pleasing finish to the box.

Your workbox is now ready. You will find that not only is it extremely decorative, but it will give you long service. It will



The workbox lined and ready for use.

provide you with ample space for your sewing things, and it will enable you to keep them neatly and to have them ready at all times for whatever tasks you may have to perform—from making a dress for a doll to mending a rip in your clothes. A workbox of this sort shows how easy it is to make useful things with a few odds and ends and a certain amount of skill and patience.

HOW TO REFINISH A PIECE OF FURNITURE

PERHAPS you now have in your room a piece of valuable furniture the varnished surface of which has become scratched or spotted or otherwise unsightly. If neither the grain of the wood nor the color shows to advantage, you may well decide to refinish it. In case the grain of the wood is truly beautiful, it would be a great mistake for you to cover it with paint or with some other similar finish, or even to use too dark a stain. In most cases oil or wax can give your piece of furniture a finish which will prove most satisfactory both in appearance and for use.

REMOVING VARNISH

Prepared varnish-remover may be used to loosen the old varnish, which is then easily wiped off with a piece of cotton cloth, but it is often better to scrape and then sandpaper the old finish from the piece of furniture before the new finish is applied.

This scraping is usually done most easily with a steel scraper, which may be bought in any hardware store for a small amount. Pieces of window glass, however, will be found entirely satisfactory if you do not have a metal scraper.

In either of these two cases, scrape with the grain of the wood but not across it. Hold the steel or glass scraper firmly at an angle of about 45 degrees, with the top inclined away from you. It should be pushed steadily away from you if you are to obtain the best results possible. Ordinarily this can be done most easily by pressing the thumbs back of the scraper and holding it at the desired angle with the fingers placed in front of it.

RENEWING SCRAPER EDGE

If the steel scraper fails to remove the varnish after a time, it is due to the loss of its cutting edge. These are easily renewed by first filing the edges perfectly straight, and then turning back new burrs, or cutting edges, with another steel surface (the shank of a screwdriver will answer the purpose). Whenever this difficulty arises in scraping varnish with the edges of a piece of glass, it is necessary to secure a new piece.

Sometimes it is not possible to use these scrapers in removing the old varnish from irregular parts or from corners. However, it is important to have every trace of the old finish removed before the new finish is applied. Of course prepared varnish-remover may be used, as suggested above. Ammonia (full strength) may also be applied for the purpose. This will quickly loosen the old varnish, which is easily removed with cheesecloth or any soft rag.

Be careful not to allow the ammonia to remain on the surface longer than is needed, as the fumes may stain the wood after the varnish has been loosened. If by any chance this should happen, you may bleach the stained parts to their original color by applying a solution of oxalic acid, which is made by dissolving 2 tablespoonfuls in about 1 pint of hot water. In case this is used, its action should be watched with care in order that the stained parts may not be bleached too much.

SANDPAPERING SURFACES

After all traces of the old varnish have been removed, the surfaces should be finished smooth with fine sandpaper. The piece of furniture is now ready to be oiled. Raw or unboiled linseed oil should be used, but if this is not thinned with a little (1/3 to 1/4) benzine, it will tend to become gummy when it is applied.

The mixture of raw linseed oil and benzine may be applied either with a brush or with a piece of cloth. It should then be allowed to stand for several hours until the wood has absorbed as much of the oil as possible. If convenient the oil should be applied one day and allowed to stand overnight or even longer. Otherwise it will be necessary to repeat this process until the desired body of finish is obtained.

FINAL TOUCHES

Regardless of the number of hours the mixture is allowed to stand on the piece of furniture, all remaining traces of oil should be wiped off with a soft rag (a woolen rag is preferable). Then rub the surfaces hard with a piece of felt to polish it. You will be better satisfied with the finish if you repeat this oiling process several times, although this is not necessary. The final polish is given by applying one or more coats of floor or furniture wax and by rubbing each coat of wax as was done with the oil.

If you have followed the above directions carefully, you will have a beautiful piece of furniture that will compare favorably with a new article. Indeed a fine old piece of furniture, beautifully finished, is often more desirable than many a new article.

THE GAME OF ZOO-GUESS

JANE was giving a party for her friends. Her mother brought in a big board with two sheets of white paper pinned to it. Then she sat down at a table at the other end of the room, and in front of her the children saw a bundle of little pink envelopes.

"We are going to play Zoo-guess," explained Jane's mother. "First, each boy must choose a partner. Next, two couples are to begin the game. The boys will take two pieces of black chalk, and they will stand by the board. The girls will stand by me at the table. I shall give each of them an envelope, and when I say 'Go' they must run to their partners and give them the envelopes. The boys will open these and they will find a piece of paper in each envelope with the name of an animal written on it. They try to draw the animals on the paper fastened to the board. The moment the girls can tell what the boys are trying to draw, they must run to me, and tell me what the animals are meant to be. The girl who gets to me with the correct answer first will win a prize."

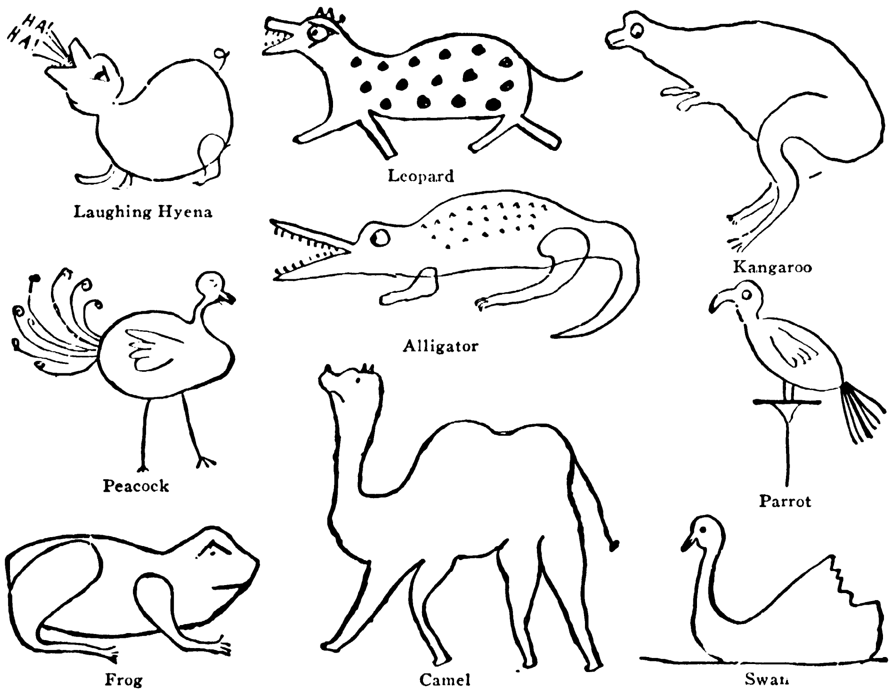
Then the fun began. Two boys, black chalk ready, stood by the board and their partners stood at the table. Jane's mother gave each girl an envelope and said, "Go!" The girls ran to the boys and gave them the envelopes. The boys tore them open, read the names of the animals on the pieces of paper they found and began to draw them.

One of the girls saw her partner draw a curly line that suggested an elephant's trunk, and without waiting for anything more she ran back to Jane's mother and said: "It's an elephant."

"Wrong! Go and look again."

The girl ran back. She saw that the curly line that she had mistaken for an elephant's trunk was meant for a swan's neck. Before she could get back to Jane's mother another girl had managed to guess what her partner was drawing, and so she won.

Of course the other children who played also made mistakes now and then. You see, they were so anxious to tell Jane's mother what the animals were that they never waited for the drawing to be finished, but began to guess the very moment that they saw a beak or a tail, or what they imagined (often wrongly!) was a beak or a tail.



Some of the animals the children had to guess.

A SMALL REED BASKET OR HAMPER

HERE we are going to learn how to make a little basket, which may be used as a doll's hamper or as a receptacle for very small things.

First of all we must carefully measure off seven pieces of "Number 4" (or fairly thick) reed or cane. Most of the big toy-shops sell this material for weaving, or of course you may buy it from any basket factory, if there is one near the place where you live.

If we make the hamper, 3 inches high, each piece of cane must be 16 inches long. These 7 lengths of cane are for the foundation of our hamper, and we will call them the *spokes* whenever we refer to them, as they remind us of the spokes of a wheel. These spokes are very important.

Form a cross with 4 spokes across and 3 spokes upright, the 3 upright spokes being in front as in picture 1.

Hold these spokes between the thumb and the first finger of the left hand.

Our next step is to select a long piece of "Number 1" (or fine) cane, which we shall call the *weaving-cane,* as it weaves in and out of the spokes, just as the threads of any woven material pass over and under each other.

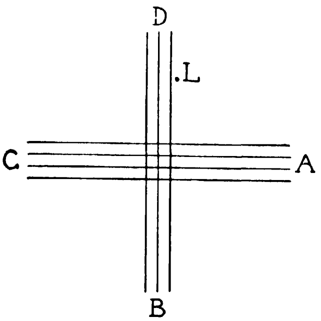
We must hold the weaving-cane in our right hand, a few inches from one end. Place this end of the weaving-cane at dot L in picture 1, and pass it under the four spokes at A, over the 3 spokes at B, under at C, and over again at D. We draw this as tightly as possible and pass the cane under the tiny end to form a *tie.*

In picture 2 we are able to see just how the weaving-cane travels, if we follow it from the letter L.

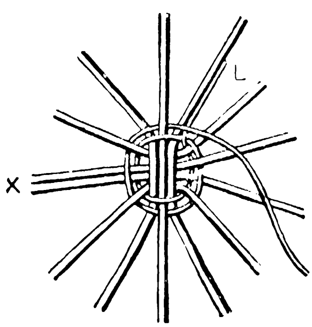
From this point we weave over one spoke and under the next until we have passed 8 spokes, which brings us to the left side of picture 2, where we see two spokes taken together. Some of us may think that this is a mistake, but it represents the correct method. In weaving we must have an odd number of spokes, because where the weaving-cane passes over one time, the next time it must go under.

At the place marked X in picture 2, we take two spokes together and treat them just as though they formed one spoke.

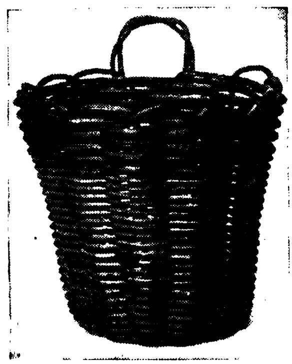
By taking the two spokes together, we manage to fasten the odd number in quite securely. Continue the weaving over and under, taking care, when you come to the spoke with the little bit beside it (L in picture 2) that you treat that spoke and the little bit as one. Always weave in the direction in which you began.



1. Position of the spokes.



2. Beginning to make the basket.



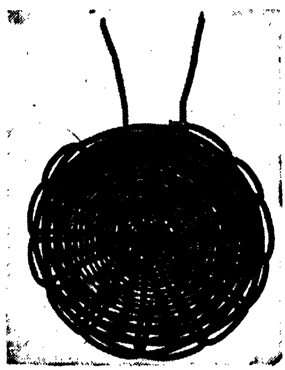
3. The basket without the lid.

If we have done our weaving correctly, the weaving-cane will now pass under the spoke over which it passed the last time round.

We must continue our weaving until we have covered about 1 inch from the centre of the basket. Then cut off one of the two spokes taken together and what is left of the tiny bit of weaving-cane where we started the weaving process.

One very important thing which it would be well to make a note of just here is the right way to hold the work. Hold the work in the left hand perpendicularly, the weaving-cane being held in the right hand just like a skipping-rope about 2 inches away from the basket. We now slip the first finger out and hold the cane between the thumb and second finger.

Don't think that Mr. First Finger has nothing to do. He is a very important person and acts as a guide to Mr. Weaving-cane, guiding and pressing him always into his proper place. We must be careful at all times never to pull the weaving-cane, but to bend it round the spokes, moving the basket up and down at the same time.



4. The lid of the basket.

Every touch of our fingers has a permanent effect on the ultimate shape of our basket, and no subsequent pressure will change this in the least bit. That is why it is so important to do your weaving correctly. Of course we shall be able to do our second basket much better after we have had the experience of doing the first.

How are we to turn up the cane to form the sides of our hamper?

We notice that the alternate spokes are on the top of the weaving-cane. These spokes we must bend away from us. Weave round once again, when of course the other spokes are on top. These also must be bent away from us. We must continue weaving as before, taking care to keep the spokes nearly at right angles to the bottom of the basket.

We must remember, as we weave the side, when the weaving-cane is going behind a spoke, to draw that particular spoke back with the guiding finger and to slip the whole hand behind it in order to put the weaving-cane in place. The more we press on the spokes in drawing them back, the more the sides of our basket will slant outward. A delightful feature of basket-weaving is the fact that we can make our baskets in a great variety of shapes.

By this time the side of our basket measures 2½ inches from the place where we turned it up. Here we take a length of Number 4, or rather thick cane, to weave the other ½ inch of the basket. An important point to learn just now is how to join a new piece of cane.

We must always finish off the end of the old weaving-cane, when we have come under a spoke, by pushing the loose end of the weaving-cane down the side nearest to us of the same spoke. Take a new piece of weaving-cane and pass the end down the far side of this spoke. Both the old and the new weaving-cane pass behind the same spoke, but the place of joining does not show at all on the right side of the finished basket.

In order to complete our basket, we must cut an inch off each spoke with the exception of two, which we leave to form the handle, as is shown in picture 3. Each spoke must be turned back the opposite way from which we have been weaving, and pressed down the far side of the next spoke until it lies level with the last line of weaving. To form the little handle, we cross the two spokes and push the ends down so that one end goes in where the other starts from.

Now that our basket has been finished, we must make a lid for it, for our basket would seem incomplete without one. This lid is made in exactly the same manner as the bottom of the hamper. In making the

5. The basket complete.

lid, we should use 7 spokes, each being about 6 inches long.

When the weaving exactly fits the top of our basket, we finish by pushing the spoke-ends down the sides of their neighbors to the left.

Our basket is now provided with a lid and ready for any task we set for it.

HOW TO MAKE A SIMPLE KITE

THERE are many different kinds of kites. Some are simple, like the one that we are about to describe in this article. Others are made to resemble boxes, animals, people and many other things besides. Kites are used by scientists who study the atmosphere, as well as by children at play.

The kite that we are about to describe is made of simple materials, and costs very little. First, we must have two sticks, each ¼ inch square; one should be 30 inches long and the other 25 inches long. These two sticks may be of different dimensions from those given above, provided that you keep the same proportions. You will be able to get these sticks very easily. Fruit crates or other boxes, which your grocer will be glad to give you, will furnish you with an abundant supply. In cutting a stick from a board, be sure that you cut in the direction of the grain. Lay a ruler along the grain and mark two straight lines of the ıgth, ¼ inch apart. In cutting do not cut too closely to these knife may slip, or else the board

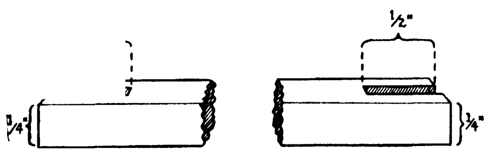


Figure 1.

may split. It is safer to make the first cuts at least ½ inch away from each of these lines and then to whittle your stick down to the lines. In making the first cuts on the board, use a ruler or a straight board as a guide for your knife.

The longer of the two sticks will be the *spine* or vertical stick; the shorter will be the *cross-piece* or horizontal stick. Make a notch with a knife at each end of the two sticks; this notch, which will be ½ inch deep, will be parallel to the sides (see figure 1). The two notches on each stick must correspond, as in figure 1.

Now draw a line across the longer of the two sticks, the spine, at a point one quarter of the distance down from one end. Next, draw another line ¼ inch down from the first line. Now mark the centre point of the cross-piece. This cross-piece must balance perfectly at the centre, or else your kite will not fly properly. Place the cross-piece at its centre on a knife-blade. If it inclines to one side or the other, whittle down the heavy end till the stick balances.

The cross-piece should now be placed on the spine between the two lines that you have drawn, in such a way that the exact centre of the cross-piece will come at the

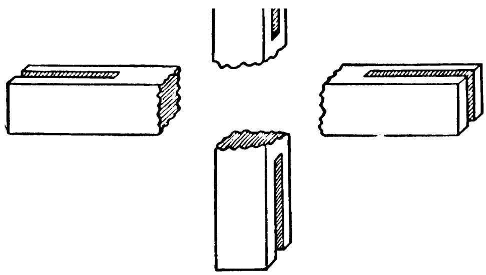


Figure 2.

exact centre of the two lines. The two sticks should be placed in such a way that the notches at the end of each will follow the arrangement shown in figure 2. Be sure that the sticks are at right angles to each other. We are now going to fasten them together securely. We are not going to use nails, because these might easily splinter the wood. The two sticks are to be lashed together by means of a stout string. First wind the string diagonally around both sticks in both directions, as shown in figure 3.

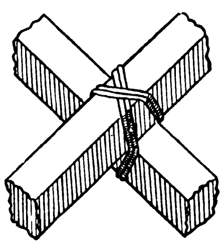


Figure 3.

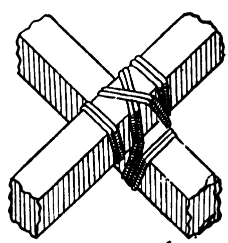


Figure 4.

Then wind the string around each stick in turn, as in figure 4, and tie the two ends together. Coat the string with glue or with shellac.

We are now to add the outer frame of the kite. Take a ball of strong string or cord and tie a knot about four inches from one end. Put the string through the top part of the spine in such a way that the knot will catch at the further end (figure 5). Then slip the string into each of the other notches in turn. The string should be drawn tightly, but not tightly enough to bend the sticks. When the string has been passed through all four notches, tie it to the free end of the string at the top of the spine. Be sure that your two sticks are still at

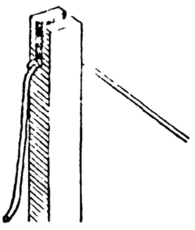


Figure 5.

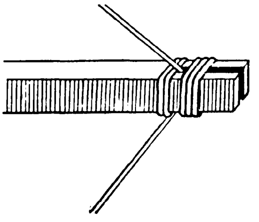


Figure 6.

right angles to each other. If they are not, press down on one of the sticks until you are certain that you have the correct adjustment.

We next secure the outer string more securely to the end of the two sticks by winding a piece of string around each end, from a point ¼ inch beyond the notch to a point ¼ inch from the end of the stick (see figure 6). Clip off all the loose ends of the strings. The frame of the kite is now ready; it will look like figure 7.

We are now ready to attach the paper covering to the kite. You will need a large sheet of thin, tough paper for this purpose. A sheet of brown wrapping paper will do; or else you may use a large newspaper. The paper must be large enough to cover the entire kite from the top to the bottom and from one side to the other. If you cannot find a sheet of paper large enough for this purpose, you can make a single large sheet by pasting two or more smaller sheets together at their edges.

Place the kite on top of the paper, and with a pencil draw a line around the kite, about ¾ of an inch outside the frame. Cut out the paper along this line. Apply glue or paste to the edge of the paper to a distance of an inch from the edge. Fold the edges of the paper carefully over the frame and paste them down, using as much pressure as possible.

Now tie one end of a long cord around the top of the spine. Pass the cord through a ring of metal or any other solid substance; this ring should have a diameter of about ½ inch. A wire bent in the shape of a ring will serve the purpose very well. After you have passed the cord through the ring, make a mark on the cord at a distance, from the top of the spine, of the length of the spine plus five inches. Then fasten the cord, at this mark, to the bottom end of the spine. Now tie the end of another cord to one end of the cross-piece. Pull up the first string as tightly as possible by pulling on the ring, until the highest point of the string is directly over the intersection of the two sticks. Then, keeping the ring in position, pass your second string through the ring and, drawing it tightly, tie it to the other end of the cross-piece. These two intersecting strings make up what is known as the bridle of the kite.

The long string by which you are to fly the kite, the *towline,* as it is called, is to be passed through the ring and then woven alternately over and under each of the four strings that meet at the ring. It is then to be tied securely (figure 8).

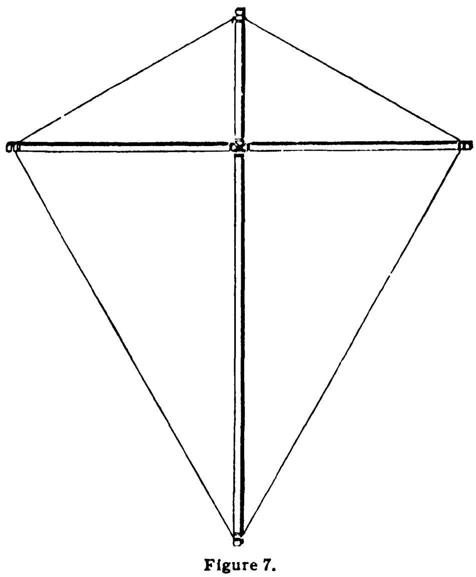


Figure 7.

You are now to attach a tail to the kite, about ten feet long. Fasten a piece of cord of that length to the end of the spine. Then tie pieces of paper to it at intervals of a foot, and place a cloth streamer at the end.

Your kite is now ready to fly. It should be taken out when there is a fairly strong breeze. The towline should be wound around a stick, so that you will be able to let out string without difficulty. When you are ready, have a friend take the kite by the bottom end, leaving the tail free. Holding the towline, go off about ten yards in the direction from which the wind is blowing. When a strong breeze comes up, your friend is to toss the kite up into the air and you are to run with the towline as fast as you can. The kite should then soar off steadily.

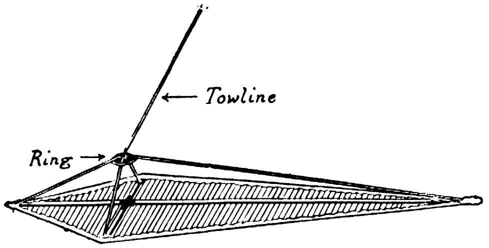
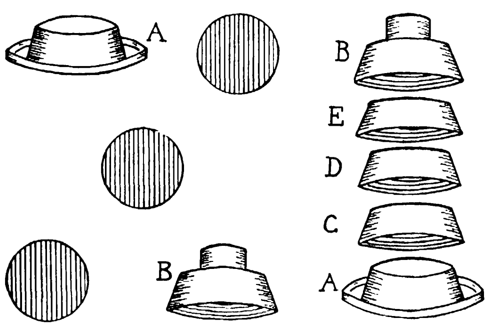


Figure 8.

If the kite does not rise, the tail may be too heavy; in that case you should make it lighter. If the kite wobbles, the tail is too light and you should add to it.

HOW THE CONJURER MAKES HIS MONEY

EVERY boy has a liking for bright dimes, so I am going to tell you a way of making them for yourself, not imitation coins, but real good money. The only drawback about the process is that each dime you make costs the same amount to produce, but you need not tell your friends that.



To coin money, of course, you need a "die." The die, in this case, is in two parts, as illustrated in picture 1—a sort of little anvil (A) and a cover (B), the one fitting over the other. With this are used three "blanks" of bright metal, supposed to be silver, but in reality tin. To show the trick, you put one of these on A, which is just large enough to receive it, and cover it with B. You stamp it by bringing down one end of your magic wand smartly upon it. If you don't happen to have a magic wand, a ruler or even a lead pencil will do just as well. You now lift off the upper die, when the blank is found to be transformed into a bright dime. You take this off, put another blank on the little anvil, cover it, and stamp it as before. When the upper die is lifted, the second blank has been coined into a dime. Once more the process is repeated, and a third dime is the result. The secret lies in the construction of the little anvil (A). This looks like a solid bit of brass, but it isn't. Instead of being all in one piece, as it appears to be, it consists of four distinct parts (A, C, D, E) as shown in picture 2. These are, in fact, mere shells, fitting one over the other in regular order. The cover (B) has no specialty.

To prepare for the trick you must, in the first place, provide yourself with three ten-cent pieces, the newer and the brighter the better. One of these you place on A, and cover it with C. You place another dime on C and cover it with D; and, lastly, place the third coin on D, and cover it with E. So arranged, the whole looks exactly as A does in our first picture.

To show the trick, you lay the first of your blanks on E, and cover it with B. After stamping it as already described, you lift off B, pressing its sides lightly. The effect of this is that E comes away inside B, carrying off the blank between them, and leaving the uppermost dime exposed. The process is repeated for each dime.

The little apparatus, which is known as the Magic Mint, is so neatly made that, when duly prepared with the needful dimes, you need have no fear, unless you are exceptionally clumsy, of lifting off more than the proper shell or shells. A hint may be given to the grown-up reader. Apart from its attraction for the juvenile performer, this will be found an admirable trick for exhibition by good-natured uncles or other relatives.

HOW TO PLAY CHINESE CHECKERS WITH AN ORDINARY CHECKERS SET

THERE are many different varieties of the fascinating game known as Chinese checkers. Here is a variety that can be played by two boys or girls on a checkerboard with an ordinary set of checkers. You will find it quite easy to learn all the moves of this fine game.

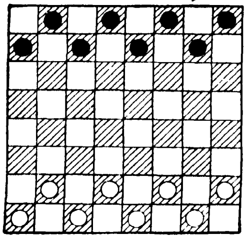


Figure 1

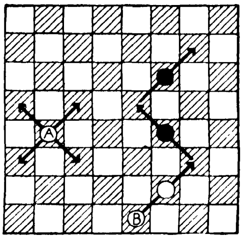


Figure 2

Each side is to play with eight checkers, which are placed on the checkerboard as in Figure 1. The object of the game is to move your pieces forward until they are all on the dark squares of the last two rows on the side of the board that is away from you. The player who manages to put his pieces in this position first is the winner of the game.

You may move only on the dark squares. A piece may move one square in any direction, provided that the space is unoccupied. Thus, in Figure 2, piece A may move to any one of the four squares indicated by the arrows, if these squares are not occupied. If the square next to piece A is occupied by piece B, and if the following square in the same straight line is not occupied, piece A may jump over piece B and land in the unoccupied square next to B. If, after jumping over B, there is, in any direction, the same combination of occupied and unoccupied squares, A can continue to jump. Figure 2 shows the jumps that a piece (here it is B) can make in one move. A piece may jump over any other piece, either his opponent's or his own. But he is not compelled to jump, as would be the case in checkers. When a player has moved one square ahead in any direction or has jumped with one of his pieces as many times as he can, it is his opponent's turn to move.

DOLLS' FURNITURE FROM CEREAL BOXES

FOR your doll's cradle, dresser, chair and table you will need three round cereal boxes and a square one; pink, blue and brown crepe paper, and a piece of cardboard eighteen inches long and twelve inches wide. Make the furniture by following directions under the picture.

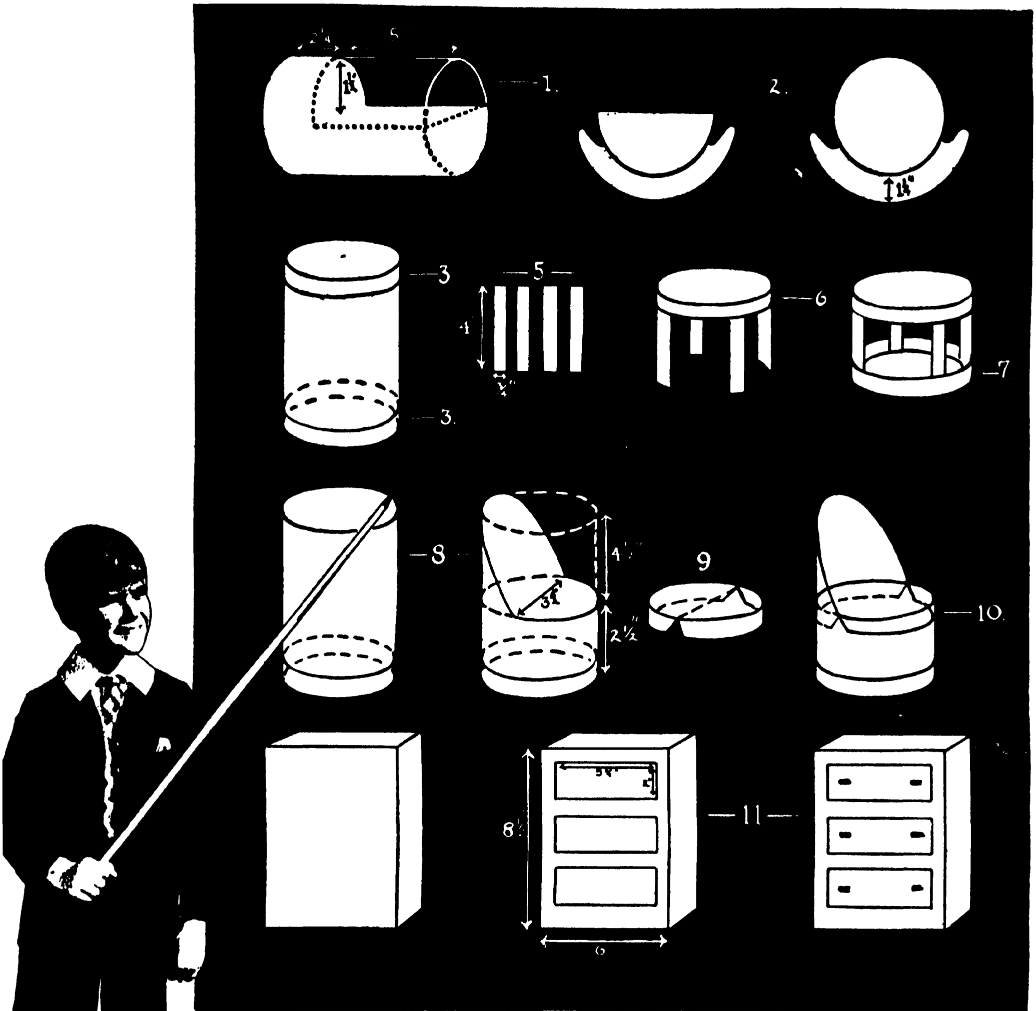
The chest and table are to be covered with crepe-paper wood. To make this, put paste on the cardboard, lay brown crepe paper over it and push it into wrinkles, and trim the edges off with a knife as mother trims off the overhanging edges of piecrust. When you have pasted the crepe paper on the front of the chest, press around the drawers with the tip of a finger to make them show plainly. Make knobs by rolling strips of brown crepe paper, half an inch wide and ten inches long, into tight rolls. Paste down the ends, and paste the knobs to the drawers.

To cover the cradle, stretch out a twelve-inch square of pink crepe paper. Crush it into a ball. Open it and cover the inside and edges with this paper, which has been wrinkled up to look like quilted material. Use paste sparingly, and put it on the cradle, not on the paper. Cover the outside with plain white paper, then with pink crepe paper. Cover each side of the rockers with pink, trimming off extra crepe around the edges. Paste the rockers to the cradle.

Take a square of pink crepe paper seven and a half inches square. Fold it in three thicknesses. It is now seven and a half inches long and two and a half inches wide. Paste it over the hood of the cradle. Now you must make some ruffles. Cut two pieces of pink, four inches wide and twenty-six inches long. The crinkles should run across the strip. Cut two more pieces, four inches wide and eleven inches long. Gather the strips into ruffles with needle and pink thread. Paste the tops of the ruffles around the cradle, the long strips at the sides, the short ones at head and foot. Paste blue crepe-paper bows at sides and foot.

The chair may be covered with blue crepe paper, like the bows on the cradle. For a rug, paste blue crepe paper over a square of cardboard. Add a border of brown.

DOLLS' FURNITURE FROM CEREAL BOXES



HOW TO CUT THE FURNITURE

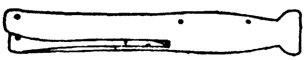
Bobby's blackboard sketches show how. Follow them carefully.

1. Cut a tubular oatmeal box. Follow dotted lines in sketch.
2. Cut, from cardboard, two rockers to fit at head and foot of cradle.
3. Cut off the top and bottom of an oatmeal box.
4. Cover them with brown crepe paper.
5. Cut 4 legs. Cover with brown crepe.
6. Paste legs in place.
7. Paste bottom of table in place.
8. Cut oatmeal box like a chair.
9. Notch the top.
10. Slip the top in to make a seat.
11. Paste three pieces of cardboard onto the front of a cereal box to look like drawers.

Courtesy, Dennison Manufacturing Company, Framingham, Mass.

THE FIGHTING CLOTHESPINS

THE materials for this toy consist only of two round clothespins, a few pieces of thin wire, which you may buy at any plumber's, a pin and a piece of strong black thread. Coarse thread is best.



1. Clothespin, with holes.

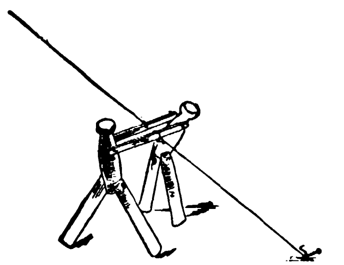
2. Body of pin.

3. Slip for arm.

We first take two clothespins and pierce them with holes at the places marked in picture 1. That will give us in each pin four holes in all—one about ¾ inch from the top, one through the middle of the pin just above the legs, and one through each leg near the bottom. The holes should be made with a small brad awl which should be as sharp as possible.

Having made the holes, we cut off the legs right at the top, where they are joined to the body of the pin, leaving the top of the pin as seen in picture 2. Now we take two thin slips of wood about three inches long, and make three holes in each—one in the centre and one near each end, as in picture 3. We take the pieces of thin wire and join the slips of wood we have just made to the body of the pins, one slip of wood to each side, as seen in picture 4. These slips are to do duty for arms. We bend over the wire at each end into the form of a loop, so that the arms will not slip off, but we must leave room on the wire so that the arms can work round easily. Then the wire outside the loops can be cut off if it is too long.

Now the legs must be attached, wires being put right through the lower holes in the body, and the legs put on the wire by the holes which we have made. These also must work very easily, and the wires should be bent into loops at the ends and cut off just as when the arms were put on. We now take a strong piece of black thread 9 or 10 inches long, and tie one end of it through the hole in the middle of one of the arms, making a loop at the free end of the thread. A long piece of black thread should be tied to the other arm, using the hole in the middle of the arm.



4. The wrestlers ready for work.

Through the loop at the end of the shorter thread we put a pin and set it firmly into a carpet. Take hold of the far end of the long thread. Holding the thread so that the wrestlers just touch the carpet with their feet, jerk the thread. The wrestlers will now go through many amusing antics, which will seem very mysterious.

HOW TO MAKE INVISIBLE INK

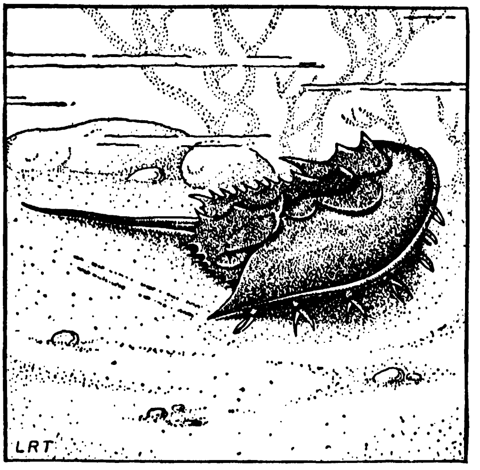
HERE is an ingenious method of secret writing. A prisoner's friend, say, will write him a letter. The warden will scan it carefully but will see nothing amiss. When the prisoner receives it, however, he rubs a dirty finger between the lines of the visible writing and new lines soon appear. The secret is simple. His friend has written between the lines of visible writing a second letter written in milk, and the passing of the dirty finger over the milk lines makes this second letter visible.

An unusual sort of ink may be made by taking 10 grains of arrowroot and boiling it in one gill of water and then, when cold, adding 25 drops of tincture of iodine. The writing made with this ink is visible when written, but it becomes fainter and disappears in about 4 days.

Some inks, invisible when used, become visible by heating. Dissolve one drachm of chloride of cobalt and also one drachm of gum arabic in an ounce of water; the result is an ink which is quite invisible, but which becomes blue when the paper is heated. This ink disappears again when the paper becomes cold.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 1149.

THE WORLD OF THE CAMBRIAN PERIOD



The king crab of China, the nearest living relative of the armored trilobite of the Cambrian Period.

THE Cambrian period is the first period of the earth's history for which we have an abundance of remains of animal life. The name Cambrian is taken from Cambria, the ancient Roman name for northern Wales. It was at Cambria that the rocks of this period were first studied in 1822.

If we could be magically transported to that long-ago period, we would not be able to recognize the world we know so well to-day. Much of what is now dry land formed the muddy bottoms of warm, shallow seas, and the outlines of the continents were very different from those of to-day. As far as we know, Cambrian plant life consisted almost entirely of seaweeds, so that the landscape must have appeared barren indeed without the trees and flowers and other plants to which we are accustomed. Possibly some mosses and lichens, the lowliest forms of vegetation, clung to the damp rocks. There was neither the song of bird, nor hum of insect, nor the rustling of leaves, to break the stillness of those far-off days. The everlasting beat of the waves on the shore, or the sound of the wind and the rain were the only noises to break the silence. Few of us would care to live in such a world.

Deep beneath the surface of much of England and a large part of Wales and Scotland is a great bed of slaty Cambrian rock. In some places this rock lies more than five miles below the ground and is almost three and a half miles thick.

Most of North America to-day is probably underlain by these rocks. In Canada is found the greatest known thickness of Cambrian rocks. This occurs in British Columbia, where the layer is 40,000 feet thick. In the United States the corresponding rocks are not so thick, perhaps 12,000 feet, and there are no broad expanses of them. They are found in long narrow strips from the Adirondacks to Newfoundland, and also southward along the eastern skirts of the Appalachians into Alabama. Large areas are also found in Wisconsin and Missouri fringing much older rocks. At the bottom of the Grand Canyon of the Colorado in Arizona Cambrian rocks are also exposed.

In southeastern Pennsylvania and elsewhere geologists discovered the Cambrian rocks to have the wonderful and curious property of splitting into the very hard, smooth thin sheets called slates. These slates are widely used for roofing and other purposes.

Not all of this Cambrian layer is composed of smooth and fine-grained sheets of slate. It contains strange things and records, remains of great masses of rock that existed before it was formed. We find ripple-marks of the waves that beat on shores that disappeared millions of years ago, and pebbles worn smooth and round by long years of tossing about by the breakers of those far-off days. Even marks of raindrops that fell on the soft, sandy mud, and sun-cracks which formed when the mud had partly dried, are found in this rock that now lies so far underground.

But this is not all. Forms of curious creatures, utterly unlike the life of our day, are found preserved in the earth. Some of these are shown in the pictures. The upper picture on page 907 shows them as they are believed to have existed. The lower picture shows them as they are found at the present day, imbedded in the slaty Cambrian rock.

It is thus easy to see that this colossal bed of rock, deeper than the loftiest mountain in eastern North America, and now many thousands of feet below most of the country, was once at, or near, the surface. But it was worn down or sunk below sea-level. Thousands upon thousands of feet, even miles, of other strata were piled on it in places. The terrific weight pressing on it from above and the expansive forces caused by the great internal heat of the earth pressing on it from below, bent and twisted the great bed of rock in various ways. Finally it was transformed into the hard slate that resists fire and water, and is so valuable to man.

MUCH OF THE LAND WE LIVE ON WAS ONCE THE BOTTOM OF A SEA

Careful study by geologists has revealed the fact that this hard, smooth slate was once mud, and that it was deposited on the shores and bottoms of large shallow seas. We see, therefore, that much of what is now the United States and British Columbia was in those days the bed of a vast sea.

Unlike the barren land surface, the Cambrian seas teemed with life. It is believed that the first living things came into existence in the seas, and during the long Cambrian period life made enormous strides. Creatures wonderfully made—such as the curious little phyllopods, swam about, and jelly-fish pulsed their way through those ancient seas. There were also brightly colored sea worms and varieties of sponges.

One of the most common animals to be found scattered about in the warm waters of the Cambrian period were the brachiopods. The bodies of these little creatures were enclosed in a two-valved shell, which looked very much like a miniature Roman lamp. Because of this resemblance, the brachiopods are sometimes called lamp shells. During the Cambrian period there were many different species of them, but to-day only about a hundred species are to be found in all the world.

STRANGE CREATURES LIVED IN THE ANCIENT CAMBRIAN SEAS

The cephalopods, ancestors of the living pearly nautilus, made their appearance in the Cambrian period. The soft bodies of the earliest forms were encased in straight, tapering shell cones, but later the shells began to be coiled, as we can see in our pictures. The cephalopod shells were divided into a number of chambers which in life were filled with gas to enable the animals to float on or near the surface of the water and to reduce the weight of their shell houses.

However, the dominant form of life in the Cambrian period was the trilobites, soft-bodied creatures enclosed in a curious shell made up of joined segments, or sections. Trilobites were the first fossils to attract the attention of naturalists. For a long time they were thought to be beetle wings, caterpillars, insects without wings, or fossil butterflies. They were really crustaceans—relatives of spiders, crabs and lobsters.

The word trilobite means "three-parted" and refers to the way in which the bodies of these creatures were divided lengthwise. Behind the shovel-shaped head and down the centre of the animal was a body region something like the body of a lobster. On each side of this central body region was a thinner flattened portion from which long rows of slender, jointed legs extended. These legs enabled the trilobite to swim or crawl along the sea bottom. A pair of feelers extended from the animal's head. While most trilobites were only a few inches long, a few of them reached a length of over two feet.

Late in the Cambrian period the trilobites developed the ability to roll themselves up into a tight ball in order to protect the softer and more delicate body parts on their under side. When curled up in this manner, the trilobite was able to present his enemy with a completely armored surface that could not be pierced.

TRILOBITES RULED THE WARM WATERS OF THE EARLY WORLD

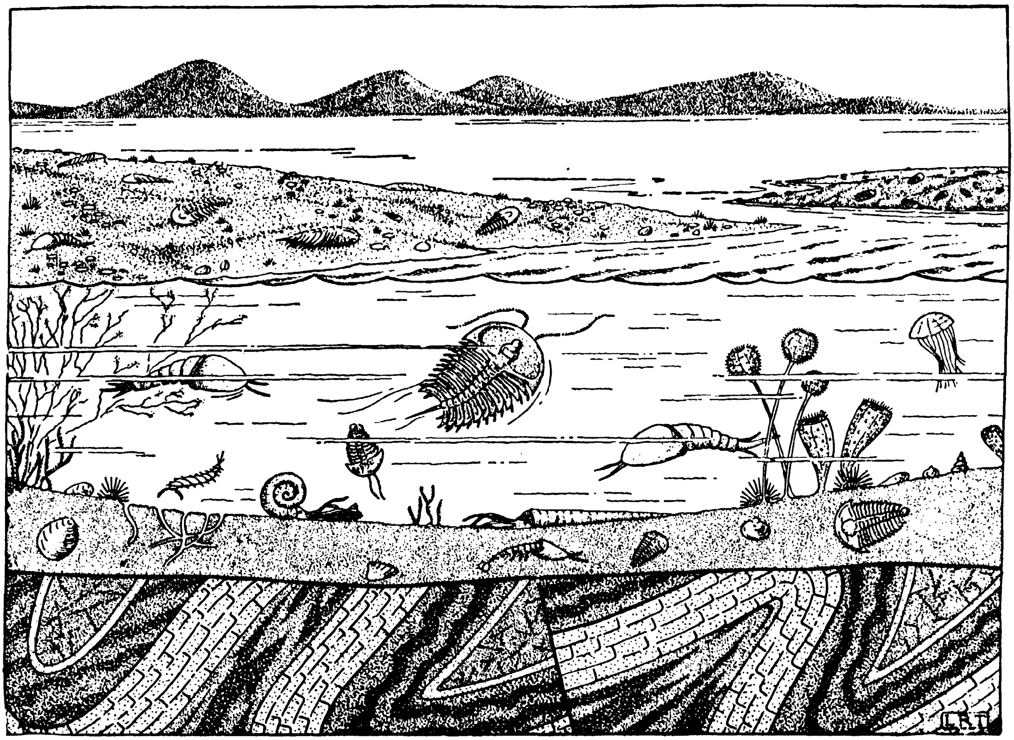
The Cambrian seas were inhabited by more than a thousand different kinds of trilobites. Some had large compound eyes with as many as fifteen thousand facets. Some had no eyes at all. Still others had bodies covered with spines. Some burrowed in the mud and some floated in the water. However, the more elaborate kinds of trilobites did not occur until late in the Cambrian period. The presence of creatures with so many elaborately developed characters at such an early period is evidence that life must have existed long ages before the Cambrian dawn.

Generally, the trilobites were flesh-eaters and acted as scavengers in helping to keep the sea bottoms cleaned of dead animals. Others were plant-eaters, and a few were mud-eaters, getting their nourishment from the tiny food particles scattered through the sea mud.

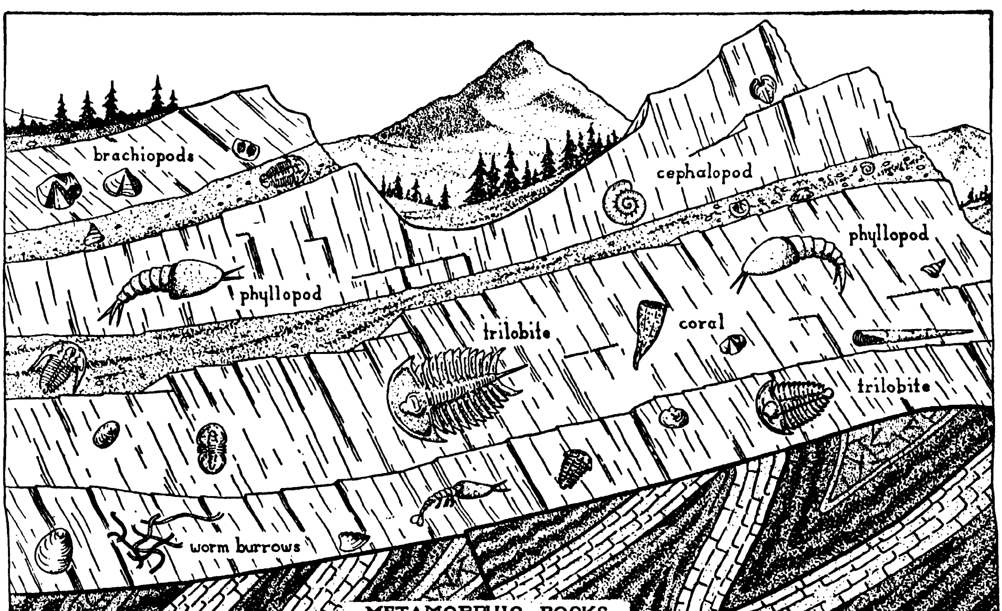
No trilobites are living to-day. They all died out many millions of years ago. The mud into which their bodies sank turned in time to rock and preserved them for us to see in our museums.

THE NEXT STORY OF THE EARTH IS ON PAGE 1031.

AN IMAGINARY VIEW OF THE CAMBRIAN



A cross-section through the Cambrian sea, showing some of the curious animal life of that far-off period.



A section through the slaty Cambrian rocks, showing fossils (greatly enlarged) in the crumpled-up strata.

Courtesy, Metropolitan Museum of Art

Near the Parthenon, on the northern rim of the Acropolis, is the Erechtheum, the house of Erechtheus and Athena. The Athena of the Parthenon was guardian of the Empire. The goddess of the Erechtheum protected the city. This temple was the centre of religious life in Athens. It was built in Ionic style and was noted for its sculptured flower ornaments and the statues of maidens called caryatides, which take the place of pillars on the south porch. This temple was completed more than four hundred years before the birth of Christ. The portions that remain have kept for us much of the beauty of the original building, which is described under Greek and Roman builders. Erechtheus was a Greek hero or demigod. He was brought up by Athena, and was worshiped as a god of agriculture in the earliest period of Athenian history.

Philip D. Gendreau, N. Y.

All that is left of the Parthenon, the lovely temple to Athena, on the Acropolis, in Athens.

THE STORY OF ANCIENT GREECE

IN the eastern part of the Mediterranean Sea is a jagged peninsula pointing south. Men call it Greece. It is a small land; yet it was a great and glorious country in ancient times. For a while it was the heart of civilization. The Greeks made wonderful gifts to the world in art, in literature, in philosophy, in the science of government; they became the teachers of the generations that followed. And today the influence of Greece is felt in a hundred ways.

Let us examine the scene upon which the drama of Greek history was played. Greece is almost cut in half by the sea. The southern part, called the Peloponnesus, is connected with the northern part of the country by the narrow Isthmus of Corinth, now cut by a canal. (The table at the end of this chapter will give you the pronunciation of Peloponnesus and other Greek and Oriental names used in the chapter.)

Greece is a mountainous land—a land of lofty heights and narrow valleys and small plains. Only a fifth of the soil can be cultivated; elsewhere there are extensive forests and pasture land, covered with scrub and thistle. There are numberless bays and inlets; good harbors abound on the eastern coast. To the east of the Greek peninsula, in the Aegean Sea, there are many islands, some of them very small. They form a series of stepping-stones between Greece and Asia Minor.

The earliest inhabitants of Greece probably lived there at the time of the Stone Age. Later, men from Crete and other islands to the north, in the Aegean Sea, landed on the Greek peninsula and made a number of settlements there. These Aegeans, as they are called, had a fairly advanced civilization. The people of Crete had made particularly great progress. They built magnificent palaces, adorned with murals (wall-paintings) and statues of stone and bronze. They did beautiful work in pottery and produced fine brass armor. They had surprisingly effective sewage systems.

The Aegeans built strongholds in the Peloponnesus about 1600 B.C. at Mycenae and Tyrins. In time Mycenae became very powerful and held under its rule much of the Greek mainland, as well as many islands in the Aegean Sea. The ruins of the royal palace of Mycenae still exist, though the palace was built in the fourteenth century B.C. This palace consisted of a number of

Pictures, Metropolitan Museum of Art.

Terra-cotta figure of a little girl on a swing, from Crete.

Terra-cotta figure of a lady in an armchair, from Crete, about the eighth century B.C.

buildings set on a steep hill and surrounded by a huge wall almost sixty feet thick in places.

While the Mycenaean civilization was at its height, another race—the Greeks, or Hellenes—moved down into the peninsula through the mountain passes of the north. They were nomads, or wanderers, roaming from place to place, driving their herds and flocks before them. They belonged to the Indo-European race, and their original home had been in Asia.

The first of these Greeks, the Achaeans, formed the spearhead of this migration; they pushed beyond the Isthmus of Corinth into the Peloponnesus. Later a second wave of Greeks, the Dorians, entered the Peloponnesus; they overcame their own kinsmen, the Achaeans, and also the Aegeans who had settled in Greece long before. Other Greek peoples—the Aeolians and the Ionians—settled in the peninsula. The Aeolians found homes in Thessaly and Boeotia; the Ionians, in Attica. Look on the map for these areas.

The wandering Greeks settled down and began to cultivate the land; they found that olives, grapes and various kinds of grains grew there particularly well. At this time the Greeks were divided into tribes. Each of the tribes had its own king, who was accustomed to seek advice from a council of elders. An assembly made up of all the warriors of the tribe met from time to time and voted on certain questions put before them by the council. The Greeks did not know how to write in those days. Some of the tribes had rememberers, whose duty it was to learn by heart and never forget the things that would be recorded in writing in a more civilized age—the laws and history of the people.

At first the members of the tribes lived in a number of small villages. In the course of time these villages were combined to form independent city-states, each with a king of its own. An acropolis, or citadel, rose on a height in the middle of the town; it contained the king's castle. The power of the city extended to the surrounding territory. The king and the council met often in the market-place, where they settled disputes and carried on the business of state.

The Greeks extended their conquests in the course of the centuries that followed. By the year 1000 B.C. they had won most of the islands in the Aegean Sea as well as the coastal areas of Asia Minor. One of these coastal areas, Ionia, became a center of Greek civilization, because it came in close contact with the more highly advanced civilizations of the East.

In about 1000 B.C. the Greeks began to use a written alphabet. For some time they had traded with the Phoenicians, the greatest traders of the time, who lived in Asia Minor. The Greeks took over the Phoenician alphabet, consisting of twenty-two consonants, and used it to write Greek words. Furthermore, they improved upon it by adding vowels. Our own A B C comes from the Phoenician alphabet, introduced into Europe by the Greeks.

As the city-states grew in importance, a number of changes took place. The more powerful men managed to increase their holdings of land. In time they formed a class of rich nobles. They did not remain on the land, but left their estates in charge of overseers while they lived in the cities. They had the leisure to exercise themselves in the use of arms; therefore they became the principal fighting men of the state. This

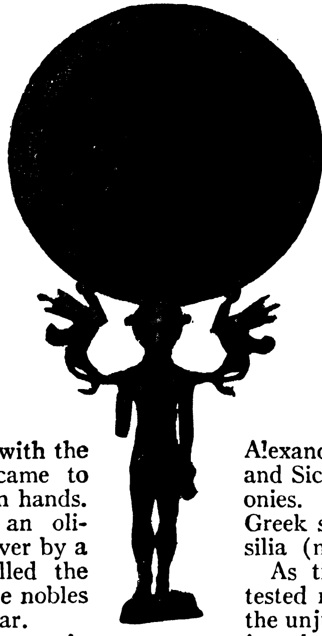
A woman making cakes, terra-cotta from the fifth century B.C.

added to their power and influence. In time the king's council was made up entirely of nobles.

As for the small landowners living in the country, they became steadily poorer. Some of them went into debt and lost their fields to the richer landowners; they then had to become day laborers. Some were even more unfortunate; they were forced to sell themselves in order to pay their debts, and so they became slaves.

The nobles not only oppressed the poorer classes but even succeeded in doing away with the power of the king. They came to hold all the power in their own hands. The city-state had become an oligarchy, or government ruled over by a few. There was a ruler, called the archon, who was elected by the nobles and who served for only a year.

The period when the nobles were in power—roughly from 750 to 600 B.C.—is often called the Age of the Nobles. Though the nobles were harsh rulers, this era was one of increasing prosperity for Greece. The Greeks became skillful navigators. Their fishing boats brought in great supplies of sardines, anchovies and tuna fish, which became important articles of diet.



Bronze mirror, sixth century B.C.

The Greeks also extended their commerce by leaps and bounds. The cities that they had established on the Asiatic coast became important trading centers, rich and bustling. In time Athens, Corinth, Aegina and other cities on the Greek mainland also built up a flourishing trade. Greek merchant ships bore their cargoes of pottery, woven goods and metal work to their Mediterranean neighbors. They brought back grain and furs from the areas of the Black Sea, carpets and silverware from the East and bronze vessels from Etruria, in Italy.

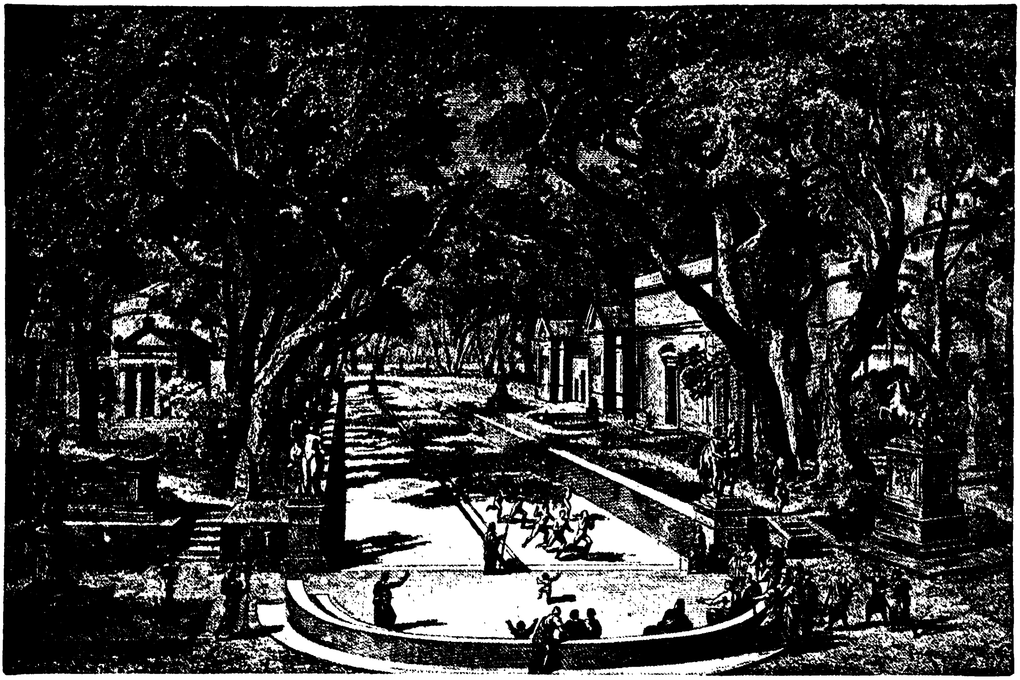
Both pictures, Metropolitan Museum of Art, N. Y.
A bronze centaur, made in the sixth century B.C. The centaur was a legendary figure, half man, half horse.

As the Greeks increased their foreign trade, they established new colonies all over the Mediterranean area. They occupied almost all the large island of Cyprus. They established the trading city of Naucratis in Egypt, where Alexandria now stands. Southern Italy and Sicily were dotted with Greek colonies. There was also a prosperous Greek settlement as far away as Massilia (modern Marseilles, in France).

As time went on, the people protested more and more bitterly against the unjust rule of the nobles. They objected particularly to the fact that the laws were not in writing, but were handed down from one generation of rulers to another. And so in some cities the nobles decided to appease the people by providing a written code of laws, which would give a clear idea of men's rights.

In Athens, which was destined to become one of the foremost cities of Greece, the first code was drawn up by a man called Draco. It set terrible penalties for violations of the law. So severe was it that to this day we use the word Draconian to refer to laws which are very harsh. The Draconian code did little to help the people.

In 594 B.C. a noble called Solon was



The famous "dromos," or racecourse, of Sparta, where the boys and young men were trained in sports.

elected archon of Athens. He was a wise and good man and the first great statesman of Greece. He helped the poor by giving all men equal rights in the courts and by canceling debts which threatened to enslave the debtor. He drew up a constitution which gave all but the lowest classes a voice in the government. He was so renowned as a lawgiver that even today a man who makes wise laws is sometimes called a Solon.

The Age of the Nobles was followed in many cities of Greece by the Age of the Tyrants (about 600-500 B.C.). This is what generally happened in these cities. A member of the noble class would want to get the power in his hands. To bring this about, he would first help the people to overthrow the government. Afterward he himself would seize the power and become the ruler of the city-state. He would not be called a king, but a tyrant.

We generally think of a tyrant as a cruel, despotic sort of monarch. But in those days a tyrant was simply a man who had no royal ancestors but who became a ruler by seizing the government. He was not necessarily a wicked man. Some of the tyrants, such as Pisistratus of Athens, Periander of Corinth and Polycrates of Samos, are reckoned among the most just rulers of the Greeks.

They governed wisely, protecting the people from the nobles. They built many fine buildings and temples. They were also patrons of literature, art and philosophy. In fact the Age of the Tyrants saw the rise of a new spirit of learning, especially an interest in science, in Ionia. Thales and Pythagoras were two students and teachers of science who flourished at this time. We tell you about them elsewhere in our book. Look up their names in the Index.

Though at first the people felt grateful to the tyrant for helping them in their fight against the nobles, they came to feel that they were not free under such rulers. And so the inhabitants rose against the tyrants in one city after another. By the year 500 B.C. almost all the tyrants had been driven from their thrones. They did not entirely disappear from Greece. Every now and then a new one would achieve great power. But their number was few after 500 B.C.

In Athens the tyrant Hippias, son of Pisistratus, lost his throne in 510 B.C. A public-spirited noble, Cleisthenes, now brought about a series of reforms that set up a true democracy in Athens. He granted the right of citizenship to all freemen, and he restricted the power of the nobles. Great power was given to a Council of Five Hundred, for which all citizens were eligible, and to the Assembly, made up of all the citizens. The most influential leaders of the state were now the ten *strategoi,* or generals, chosen by the people. They led the army in war, and also had a large measure of control over the treasury of the government.

Cleisthenes sought to prevent the rise of new tyrants by means of a very unusual law. This provided that once a year the people might declare any prominent citizen dangerous to the state and might banish him for ten years. The people would gather on an appointed day in the market-place. Each citizen would write on a tile or a piece of broken pottery the name of the man whom he wanted to see exiled; then he would put it in the urn used for voting. At least 6,000 votes had to be cast; the man who had the most votes against him was exiled for ten years. The word for tile in Greek is *ostracon.* Hence when the citizens banished a man in the way we have described, they were said to ostracize him.

Athens, which had extended its rule to all of the district of Attica by 500 B.C., was the largest and most important democracy of the day. There were many other democratic city-states in Greece, though the exact form of government varied.

It is important to note, however, that only citizens shared in the benefits of democracy. The *metics,* or foreigners living in a city, had no political rights. Neither had the slaves. There were great numbers of these unfortunate creatures in almost all the city-states of Greece. Most of them were barbarians (people from other countries) though they included some Greeks. Some were captives taken in war; other were victims of slave raids; still others were criminals condemned to slavery for certain crimes. They served in households, or in industry or in the mines and quarries of Greece.

The women of most of the city-states profited little by the establishment of democracy in Greece. They spent most of their time in the women's quarters of the house; they performed their household tasks and very little else. They were not permitted to be present with men at social gatherings; nor could they witness public spectacles.

Not all the city-states of Greece were democracies at this time. There were a number of oligarchies, particularly in the Peloponnesus. And then there was Sparta, which was neither a kingdom, nor an oligarchy nor a democracy, but a combination of all three. Sparta, a city of Laconia, had built up a powerful state that included all of Laconia

This picture, reproduced from a painting by Fernand Cormon, shows the women of Athens greeting their menfolk after the naval battle of Salamis (480 B.C.), in which the Greek fleet utterly defeated the Persians.

and a part of Messenia, to the west.

Only the citizens of Sparta had full political rights. The other inhabitants of Laconia and of the Spartan part of Messenia did not have the right to vote. These non-citizens were divided into two classes: the perioeci and the helots. The perioeci were freemen and were permitted to own land. The helots were like the serfs of western Europe in the Middle Ages. They had to serve their masters; they were not permitted to leave the land on which they worked; and their children after them had to serve in exactly the same way.

The helots were descendants of people who had been conquered many generations before. Since they had always greatly outnumbered the Spartans, the early leaders of Sparta had feared that some day these serfs might overwhelm their masters. To ward off this danger a lawgiver, Lycurgus, introduced a new policy. In accordance with this policy the Spartans deliberately turned their backs on commerce, agriculture and the arts. They set out to make themselves such mighty warriors that they could keep the helots in their place for all time.

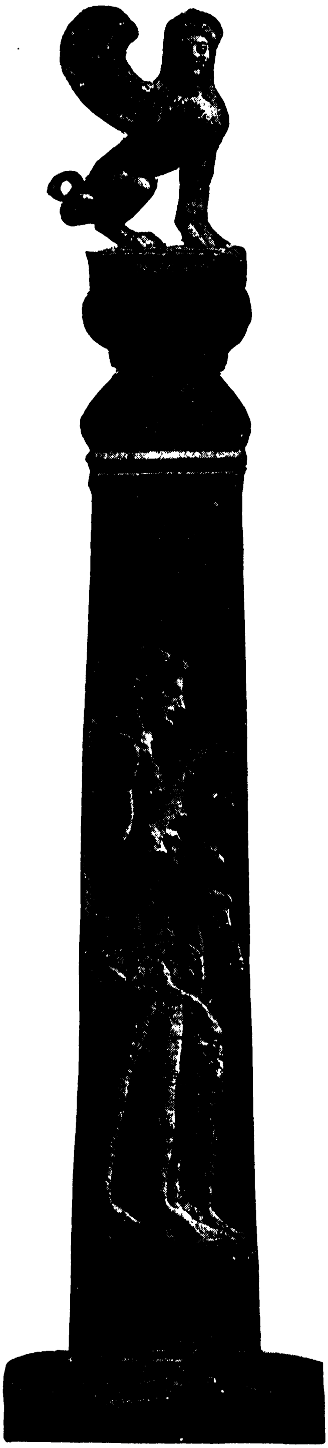
Sparta became an armed camp and her citizens became professional soldiers. Training for the army began at an early age. Puny or deformed infants were considered useless to the state; they were taken to a near-by mountain top and left to die of cold and hunger. Promising lads were taken from their families at the age of seven and put under the control of the state.

They lived in barracks in the hardest and simplest way possible. They were taught to bear hunger and fatigue; once a year each boy got a terrible whipping in order to put his endurance to the test. Theft was encouraged, since it was thought to teach cleverness; but if a boy was caught stealing, he was flogged. Boys were taught to read and write and little else. These boys of Laconia learned to express themselves as briefly as possible. We still say of a man of few words that he is laconic.

At the age of twenty the youth became a soldier. Thereafter he thought any other occupation was beneath him. The helots tilled the soil; commerce and industry were left to the perioeci. The Spartans scorned wealth. This was natural enough, since their money was made of iron and was so heavy that a man could carry very little of it with him.

The citizens of Sparta had a considerable share in the government. They were all members of the Assembly, which voted on measures proposed to it by the Senate. There were two kings; but these were military leaders and they had little political power. The real leaders of the state were the officials known as ephors. They were in charge of the training of the young. They also watched over the conduct of all citizens, perioeci and helots.

Sparta became the foremost military power in Greece, and she acquired great influence in the Peloponnesus. Before the end of the sixth century B.C. she had half-persuaded, half-compelled her neighbors to join her in a union called the Peloponnesian League. You may be sure that Sparta was very prominent in this body. She was supported by the aristocratic elements in the cities of the League.



Metropolitan Museum of Art, N. Y.
A Greek stele (stone slab), with a sphinx on top.

As we have seen, Athens had sovereignty over all of Attica by 500 B.C.; Sparta ruled over Laconia and much of Messenia. Most of the Greek city-states, however, continued to be independent. They were little sovereign powers, each with its own laws and its own army. They were separated from one another by the mountains and inlets that divided up the Greek peninsula. Therefore each developed its own local dialect and its own customs and traditions. Patriotism toward one's city took the place of patriotism toward one's country. Cities often went to war with one another.

Yet there were certain bonds that drew the Greek city-states together. For one thing, they had a common religion. The Greeks believed in a number of gods. Each city had its own local ones; but there were some whom all worshiped. Among the most important of these were Zeus, king of gods and men, and his queen Hera; Apollo, god of the sun; Poseidon, ruler of the sea; Dionysus, god of wine; Athena, goddess of wisdom; Aphrodite, goddess of love; Hermes, messenger of the gods. They were said to live on Mount Olympus, in Thessaly.

They had their shrines all over Greece. The most famous of these, perhaps, was the temple of Apollo at Delphi. The god was supposed to visit the temple and to have speech with its priestess about the affairs of men. So people came to Delphi from far and wide to seek advice from the god-inspired priestess. This was called consulting the oracle.

This terra-cotta figure, of about the fourth century B.C., shows a fashionable Greek lady.

The shrine of Apollo at Delphi and the other shrines of the gods of Olympus were considered to be the common property of all the Greeks. To take care of these religious monuments, they set up councils, called *amphictyonies,* in which all Greek cities were represented.

Both pictures, Metropol. Museum of Art

Two happy little girls at play, a terra-cotta group of the fourth century B.C.

Athletic games formed another tie between the Greek communities. In very early days the Greeks had been accustomed to hold contests in racing, wrestling, jumping and other athletic sports at the funerals of heroes. Later these contests came to be celebrated in honor of the gods. The most famous of all were the games of the city of Olympia, in the Peloponnesus. The first Olympic games, we are told, were held in 776 B.C. They were held every four years after that time. The Olympic games attracted contestants from every part of Greece. Besides athletic contests, there were literary competitions. The victors received laurel wreaths; they won great fame for themselves and their native cities. The Olympic games of modern times represent a revival of the ancient games.

The Greeks were also bound together by a common language. There were a number of different dialects, it is true; but Greeks from one district had no difficulty in understanding those from another. It was a wonderfully expressive language, which could set forth a great many shades of meaning; and the Greeks were proud of it.

The Homeric songs formed still another link. In Ionia there had arisen a group of professional bards, or poet-singers, who composed songs telling of the bold exploits of the old Greek warriors. In time the separate songs were combined into a series of epics based on the old legend of a Greek expedition against the Asiatic city of Troy. Only two of these epics—the ILIAD and the ODYSSEY have come down to us in complete form. (See our chapter on Greek literature.)

Among the most famous of the bards was Homer. So great was his renown that at one time he was supposed to be the author of all these epics, which came to be known as the

Homeric songs. All the Greeks knew and loved these wonderful compositions. They cherished the memory of the famous expedition against Troy, when all Greece had been united.

The Greeks, therefore, considered themselves as a people bound together by religion, language, a common body of literature and common traditions. They called themselves Hellenes, after a common ancestor (a legendary figure), named Hellen. Their country they called Hellas. They gave the name of barbarians to those not of the Greek blood, even though these "barbarians" might have an advanced civilization, like the ancient Egyptians.

Toward the beginning of the fifth century B.C. the Greek city-states seemed destined to be drawn closer together than ever before in the face of a common danger. An Asiatic people, the Persians, had become the masters of a vast area extending from India to the eastern shores of the Mediterranean Sea. (See General Index, under Persia.) By 500 B.C. this Persian Empire had swallowed up the Greek cities of Ionia in Asia Minor. It threatened to enslave all Greece and perhaps to spread over the continent of Europe.

L. M. Levin

This map shows us some of the most important areas occupied by the Greeks and kindred peoples about 500 B.C.

In the year 499 B.C., while Darius I was king of Persia, the Ionian cities revolted against their Persian overlords. Athens and Eretria, on the island of Euboea, sent help to their unfortunate fellow-Greeks in Asia Minor. It was in vain. The Ionian revolt was crushed in 493 B.C.; and panic spread throughout Greece.

Darius now determined to punish Athens and Eretria for their share in the Ionian revolt, and at the same time to become master over all Greece. In 492 B.C. he sent out an expedition for this purpose. The Persians conquered Thrace and Macedonia; but while their fleet was rounding Mount Athos on its way to the Greek peninsula, many ships were wrecked. The Persians, therefore, decided to return home.

The Persian king made preparations for another invasion of Greece. He announced that Athens and Eretria were doomed. The other Greek cities would be spared if they sent him earth and water as a sign of submission. Some of these cities yielded, out of fear of Persia's might. Sparta, however, determined to stand by Athens, and she persuaded most of the cities in the Peloponnesian League to follow her example.

THE PERSIANS INVADE GREECE FOR THE SECOND TIME IN THE SUMMER OF 490 B.C.

In the summer of 490 B.C. the Persian fleet sailed westward across the Aegean Sea, carrying an army of some 30,000 men. The Persians landed near Eretria, captured that unfortunate city and made slaves of the whole population. Then the fleet sailed on to Marathon, which lies on the coast of Attica, northeast of Athens. After landing here, the Persians drew up their forces on a plain near the shore. The Athenian army took up its position in a narrow valley facing the foe.

The men of Athens had sent a swift runner to Sparta in search of aid. He reached that city, 150 miles away, the day after he started. But his mission was in vain. The superstitious Spartans informed the messenger that they could not march until the moon was full. And so the Athenians were left to face the Persians with the help only of a small force from Plataea. There were 10,000 Greeks in all, opposing an army several times as large. They were under the command of a general called Callimachus. The real leader, however, was Miltiades, an experienced officer, who had fought against the Persians in the Ionian revolt.

THE ATHENIANS PUT THE PERSIANS TO ROUT IN THE BATTLE OF MARATHON

The Persians were armed with bows and arrows and short swords; the Athenians relied on their long spears. Hitherto in most of their battles the Persians had overwhelmed their enemies with showers of arrows. But the Greeks did not wait to be overwhelmed. Miltiades ordered them to charge at a run. Thus they were not exposed to the deadly arrows for a long time, but soon came to close quarters with the foe. The Persians, in spite of their numbers, were no match for the Greeks in the hand-to-hand fighting that followed. After losing many men, the Persians retired to their ships.

The Persian commander now sailed around Attica and suddenly appeared before Phaleron, which at that time was the port of Athens. (Athens lies about five miles from the sea.) He had intended to surprise the city. But to his dismay he found that the conquerers of Marathon were encamped close by; they had hurried there from the plain of Marathon. The Persians did not dare to land, but sailed back to Asia.

THE ATHENIAN VICTORY AT MARATHON CHANGES THE WHOLE COURSE OF HISTORY

The Battle of Marathon was one of the most important in the history of the world. It halted the westward march of the Persian Empire, which had hitherto conquered all its foes. It made the Greeks lose their almost superstitious fear of the Persians. It greatly increased the reputation of Athens, which had beaten off the attack of the Persians almost singlehanded.

The Persian peril was not over by any means. Darius, a very energetic man, began to prepare a third expedition against Greece. But then he heard of a revolt in Egypt, which at that time was under the Persian yoke. The Persians had to crush this rebellion and so the Greeks had a breathing space. Darius died in 486 before he could overcome the Egyptians.

KING XERXES, SON OF DARIUS, PREPARES FOR A THIRD INVASION OF GREECE

His son Xerxes carried out the reconquest of Egypt. Then he started to build up an army which, he expected, would crush the Greeks by sheer force of numbers. Some of the Greek states did not wait for the Persians to strike, but hastened to submit. Others tried to remain neutral in the coming struggle. Only Athens, Sparta, Sparta's allies in the Peloponnesian League and a few other communities determined to stand together. It was decided to give the chief command on sea as well as on land to Sparta, as the chief Greek military power.

In 480 B.C. Xerxes and a great Persian army, numbering some 200,000 fighting men, crossed the Hellespont on a bridge of boats. (The Hellespont, now called the Dardanelles, is a narrow strait between Asia Minor and Europe.) The Persians made their way westward along the shores of Thrace and Macedonia and down into Thessaly. A great fleet of some 700 ships kept pace with the army, hugging the shore all the way. It bore a large part of the army's supplies.

Soon all Thessaly yielded to the Persians, and central Greece was threatened. The Greeks decided to make a stand. The Greek fleet of about 300 ships stood off Artemisium, in northern Euboea, and held off the enemy vessels. At the same time Leonidas, the Spartan king, with 10,000 men, held the narrow pass of Thermopylae, between the steep mountains and the shore. Since the Persian fleet carried much of his supplies, Xerxes had to keep close to it, and this was the only place near the sea where he could get through the mountains.

For several days the Greeks held the Persians at bay. Then a traitor led the enemy along a path to the rear of the Greek force. When he heard of the enemy's approach, Leonidas realized that he could no longer hold the position. He bade most of his troops seek safety in flight, and with 300 Spartans and a few others, he prepared to resist to the end. The brave Greeks fought on stubbornly until not a man was left alive. Later they were buried where they had fallen. On this spot was set a memorial tablet with the words: "Stranger, tell the Spartans that we lie here in obedience to their laws."

Pericles, leader of the Athenians from 460 to 429 B.C. He was a wise statesman and a generous patron of the arts.

The Persians swept on through central Greece toward Athens. In the meantime, the Greek fleet holding off the Persians at Artemisium withdrew upon learning of the defeat at Thermopylae and the advance of the Persians. Making their way south, the Greek ships rounded Attica and sailed up to the island of Salamis.

The foremost man in Athens at this time was Themistocles. He had persuaded the Athenians to build a mighty navy, which formed the backbone of the Greek naval forces. He now believed that the Athenians' only hope of safety lay in the fleet, and that they should not try to hold off the Persian army advancing upon Athens.

The Athenians had sent messengers to the oracle at Delphi, and the priestess had urged them to have confidence in their "wooden walls." Themistocles convinced his fellow-Athenians that these wooden walls referred to their wooden ships, and he persuaded them to abandon the city. Embarking on their ships, they were borne to places of safety on the opposite side of the Bay of Salamis.

Soon the Persians entered Athens, which they burned to the ground. In the meantime the Persian fleet was drawn up off Phaleron, which, as we have seen, was the port of Athens. Themistocles sent a trusted slave with a "secret" message to Xerxes that the Greek ships were planning to slip away. In order to trap them, the Persian ships rushed into the narrow strait between the island of Salamis and the mainland, where the Greek ships were stationed.

And now a great naval combat—the Battle of Salamis—took place. The Persian ships, closely crowded together, got in one another's way and so could not take advantage of their superior numbers. Many of them were sunk; the rest were driven off in disorder and made their way back to Asia. Xerxes, disheartened, now withdrew, leaving his general Mardonius with the greater part of the army to winter in Thessaly.

In the spring of 479 Mardonius led his army into Attica again. Once more the countryside was looted and the Athenians fled to the safety of the island of Salamis. This time the Spartans sent help to Athens. A Spartan army under King Pausanias joined forces with the Athenians and the other allies. Pausanias took command over all the Greeks, who numbered 60,000 men—a mighty host for that time.

The Persians made their way northward from Attica to meet the allies, and another famous battle was fought at Plataea, in August, 479. Again the spears of the Greeks proved to be more than a match for the arrows of the Persians. Mardonius himself was slain; the remnants of his army fled and made their way home as best they could.

In the meantime the Greek warships had

sailed across the Mediterranean to Ionia. The Persian fleet was stationed at the peninsula of Mycale, where there was a strongly fortified Persian position. On the same day as the Battle of Plataea another battle took place at Mycale. The Persian army was defeated and the enemy's ships were destroyed.

The Athenians and the Spartans pressed the fight against the Persians and they freed many Greek cities in the islands of the Aegean Sea. It seemed for a time that the glorious victories over a common foe might weld all the Greek city-states together into a single strong nation. But Sparta and Athens now had a falling-out.

The Persians had destroyed the walls of Athens. The Spartans tried to persuade the Athenians not to rebuild their walls, saying that Sparta would protect them against foreign foes. It was clear that the Spartans gave this advice because they did not want Athens to become too strong. So the Athenians went ahead, building new walls. They also fortified the Piraeus, a promontory not far from Athens, and constructed a great dockyard there. By the time all this had been accomplished, Athens had become so strong that there was nothing the Spartans could do about it. But they never forgave the Athenians for disregarding their wishes.

For a short time after that, the Spartans kept their leadership over the Greek forces. But then they began to weary of overseas adventures and they decided to withdraw from the anti-Persian alliance. This decision gave Athens a wonderful opportunity, and she took full advantage of it.

In 477 B.C. she persuaded her allies to join her in a new permanent alliance against the Persians. The island of Delos, sacred to Apollo, was chosen as the meeting-place of the allies' representatives. The new body, therefore, came to be known as the Delian League. The wealthier cities were to contribute ships; the others, money. From the very outset Athens held a leading position in the League. Each of the member cities was bound to Athens by treaty. The commander of the allied fleet was always an Athenian; Athenians were in charge of the treasury, which was on the island of Delos.

Under the leadership of Cimon, son of Miltiades, the fleet of the League drove the Persians from Thrace and the coastal areas of Asia Minor. Two parties now arose in Athens. One party, under Themistocles, proposed to keep aloof from Sparta and to make Athens supreme among all the cities of Greece; the other, led by Cimon, wished to be friendly with Sparta.

Themistocles, an Athenian leader of the fifth century B.C. He was exiled from Athens and died in the service of Persia.

Cimon, who was very popular because of his recent victories, won the day. Themistocles was ostracized in 472 and had to leave Athens. Several years later he was accused of treason. Not wishing to face trial at Athens, he made his way to the court of the Persian king. He was heartily welcomed, and he spent the rest of his life in the service of Persia.

In the year 464 B.C. a severe earthquake wrecked most of the houses of Sparta and killed many inhabitants. The helots seized this opportunity to revolt; they were joined by some of the perioeci. The Spartans called on their friend Cimon for aid. He persuaded the Athenians to send an army to help the Spartans put down the revolt. But then an amazing thing happened. For some reason that we do not know, the Spartans coldly bade the Athenians depart. Indignant at this insult, the men of Athens turned against Cimon and ostracized him. As for the Spartans, they crushed the rebels without the help of anyone.

From that time on, the Athenians would have nothing more to do with Sparta but proceeded to carry out the plan favored by Themistocles, to make Athens the most powerful city of Greece. They began to reduce the cities belonging to the Delian League to the position of subject states. Those which tried to leave the League were cruelly treated; a number of new cities were forced to join.

Pericles, a handsome young noble who had always championed the cause of the people, now came into power at Athens. (He had been named as one of the ten generals.) Like Themistocles before him, he believed in making Athens the seat of a mighty empire. He completely won over the Athenians to his views. From 460 B.C. to the year of his death, in 429, he was their trusted leader. So great was his influence that this period is called the Age of Pericles. This was the Golden Age of Athens and of all Greece.

Hardly had Pericles come into power when the Athenians found themselves with two wars on their hands. Pericles had persuaded them to bear down hard on certain commercial rivals—particularly Corinth and Aegina—which were not members of the Delian League. At last these two cities took up arms against their oppressor. Pericles eagerly accepted the challenge. Nor did he hesitate to make war at about the same time on Persia, which was then attempting to put down another serious revolt in the land of Egypt.

Sparta was an ally of Corinth, and so she was drawn into the struggle, which became known as the First Peloponnesian War. At first Sparta did not take an active part in the fighting, and Athens had things pretty much her own way. She won several decisive victories over Corinth and Aegina. Pericles then built two Long Walls about five hundred feet apart, to connect Athens with the Piraeus. The walls were sixty feet high and wide enough for two chariots abreast. They enclosed a broad road from Athens to her chief source of supplies—that is, the sea.

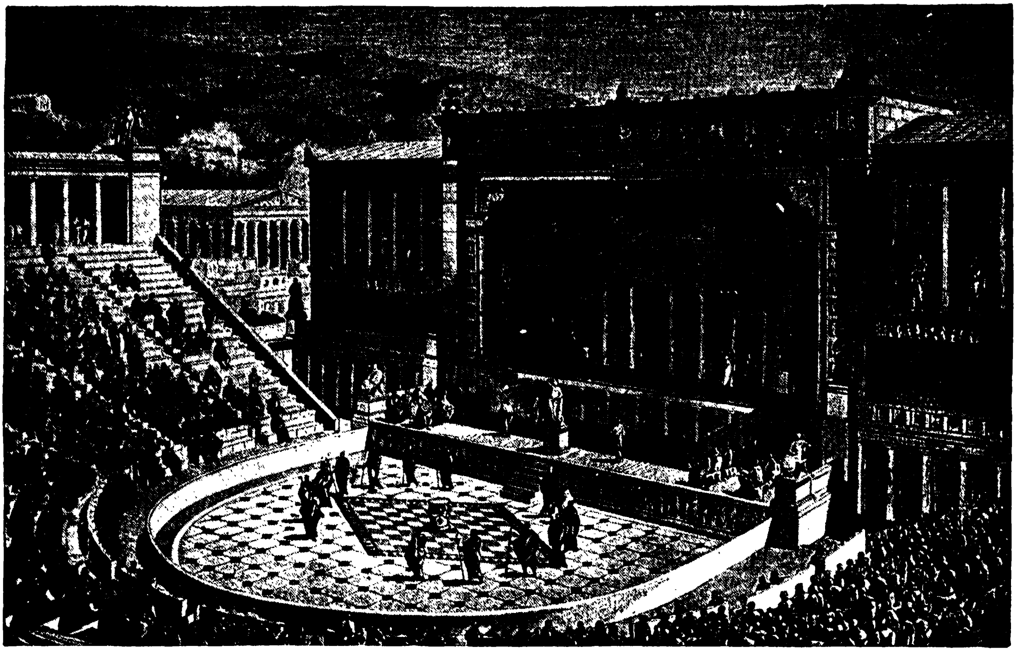
In 457 B.C. Sparta began to fight at the side of her allies. The war continued for years; both sides were so evenly matched that neither one could conquer. At last, in 445 B.C., the Athenians and their foes signed a so-called Thirty Years' Peace, which left things much as they had been. The war with Persia had been brought to an end several years before. In this war, too, neither side had been able to defeat the foe.

The Delian League was now transformed into an Athenian Empire. In 454 the treasury had been removed to Athens because of the danger that it might be seized by the Persians. In 444 a further step was taken. The Athenians announced that they would use the funds of the League to beautify their city.

It was clear by now that the contributions of the allies of Athens to the treasury of the League were really tribute paid to a sovereign power. Athens showed her mastery in other ways. She made the cities of the League adopt her particular type of democracy. She also imposed upon them her money system as well as her weights and measures.

Yet Athens gave something in return, for she granted protec-

The glory of the Parthenon was the huge ivory and gold statue of Athena. It was the work of Phidias, one of the grandest sculptors the world has ever known.



The Theater of Dionysus at Athens, where the tragedies of Aeschylus, Sophocles and Euripides were performed.

tion to the members of the League. The powerful Athenian navy patrolled the seas. There were no foreign invaders, and piracy almost disappeared. Commerce flourished; the fields, no longer trampled by invaders, yielded abundant harvests. It was an era of peace such as the Romans later enjoyed under the emperors known as the Antonines.

Athens now became the center of Greek civilization. At this time the city, together with the outlying districts of Attica, had about 350,000 inhabitants—a big population for those days. Citizens and slaves, about equal in numbers, accounted for four-fifths of the population. The rest consisted of metics, who, as we have seen, were foreigners living in Athens.

The Athenians considered their city the finest in all Greece. They were proud of the bustling market-place; of the splendid athletic fields in the open country outside the city walls; of the big theater on the slope of the Acropolis, a height in the center of the city. They were particularly proud of the majestic temples of the Acropolis, with their lofty columns of marble.

The private houses of Athens were quite plain in appearance. They were one- or two-story structures of sun-dried brick, built around a central court that was open to the sky. The streets were narrow alleys; there were no sidewalks or pavements. They were sure to be muddy after a heavy rain. They were also sure to be filthy at all times—at least according to our modern standards of cleanliness. Housewives had the unfortunate habit of throwing their household refuse out into the street. But well-bred ladies first gave out a warning cry, so that any passers-by might have a chance to get out of the way.

The children romped merrily in the central court of the house; they played tag and rode on swings. When a boy was old enough, he was sent to school. An old slave, called a *paidagogos,* would take him to the schoolroom, carrying his books and other supplies. It is interesting to note that this word *paidagogos,* which means leader of a child, has given us the word pedagogue, or teacher. A teacher, you see, leads the young along the path to knowledge.

The boys learned to read and write, to play the lyre and sing. They were not taught mathematics, or geography or the natural sciences (zoology, botany, physics and so on). As for the girls, most of them learned only housework; and this was taught at home; for a respectable Athenian woman was still expected to be merely a good housewife, busy with her domestic duties.

If a young Athenian had enough money, he sometimes continued his education by studying with some well-known Sophist. The Sophists were professional lecturers, who traveled from city to city. They taught grammar, mathematics, astronomy and the natural sciences. Above all, they taught the art of making fine speeches—a very valuable art if a young man intended to become a public figure, for the men of Athens greatly admired eloquent speakers.

Metropolitan Museum of Art, N. Y.
A fine bronze horse of the fifth century B.C.

The citizens of the city included a number of craftsmen, traders, small shopkeepers and ordinary laborers. However, a great many citizens did not work at all. If a man had even a modest amount of money, he could provide slaves who would work for him. Many of the poorer people who did not care to toil as carpenters or masons or laborers earned enough to live on as paid jurors. So Athens was filled with citizens who had plenty of leisure.

They had a good deal of time, therefore, to attend to public business. It did not matter whether a man was rich or poor; he was expected to serve the state to the best of his ability. If he was rich, he was required to give money for liturgies, or public services of various kinds. Other citizens gave their time.

All took part in the meetings of the Assembly, which voted on important matters of state. Thousands served as jurors. Furthermore even a humble citizen might become a powerful city magistrate, for all the officers of the state, with the exception of the ten generals, were now chosen by lot.

This was, indeed, a government "of the people, for the people and by the people"—provided, of course, that one did not consider foreigners and slaves to be people. It was not an ideal government. The good citizens of Athens sometimes let their prejudices get the better of them and then they would do foolish or even wicked things. Yet there was much truth in the statement of Pericles that the Athenians were "all sound judges of a policy, even if few could originate one."

In the prosperous and freedom-loving city of Pericles the arts and sciences flourished as never before. There were great architects, painters and sculptors. Many of the historic buildings on and near the Acropolis were put up at this time, including the great temple to Athena, the Parthenon. Inside the Parthenon, Phidias, greatest sculptor of all time, made a colossal statue to Athena out of ivory and gold.

The renowned dramatists, Sophocles and Euripides, wrote some of their finest plays at this time. Herodotus was at work on his HISTORIES, which tell us almost all we know of the Persian wars in the early part of the fifth century. Hippocrates, father of medicine, also flourished in the Age of Pericles.

There were great thinkers, too, and they found in Pericles a generous patron. Among them was Anaxagoras, who scorned the old myths and aimed to give men a true idea of the world. He taught, for example, that the sun was not a god, but a glowing rock, "larger than the Peloponnesus." And then there was the wise and good Socrates, whose most gifted disciple, Plato, was perhaps the noblest philosopher of all.

Athens became the marvel of Greece, the marvel of the world. Men flocked to the city to admire her splendid temples and monuments and statues, to listen to performances of her immortal plays, to learn wisdom from her learned men. Even today there are some who think that the Age of Pericles in Athens was the most brilliant era in the history of mankind. (See General Index, under Greek literature; Greek philosophy; Sculpture, Greek.)

The glory of the Age of Pericles was soon to fade. The very greatness of Athens aroused the jealousy of Sparta and other cities of Greece. Besides they feared, perhaps rightly, that Athens meant to rule over them all some day as she did over the cities of the Delian League. Their hostility toward Athens became more and more open as time went on. For their part, the Athenians made no effort to win the confidence of the cities outside of the League.

One incident led to another. At last, when Thebes, an ally of Sparta, attacked Plataea, which was friendly to Athens, both Sparta and Athens took up arms. And so in 431 B.C. the Second Peloponnesian War broke out. Almost all the city-states of Greece took part in it. Athens had the support of the Aegean cities that made up her empire. Sparta led the Peloponnesian League into the war and was also allied with Thebes and various other cities, which had been alarmed by the Athenians' ambitious plans.

In 431 the Peloponnesian allies entered Attica and ravaged the fields as the Persians had done before them. The people in the outlying communities had to seek refuge within the walls of Athens. As for the Athenians, they sent out their powerful navy to destroy their foe's commerce and raid the coasts of the Peloponnesus.

In 430 a plague broke out in the port of the Piraeus and soon spread to Athens. The city, swollen as it was by crowds of refugees, suffered terribly. The plague raged for several years and swept away a third of the population. Its most renowned victim was Pericles, who died in 429 B.C.

The loss of Pericles was fatal to Athens. The state passed into the hands of scheming politicians, who had little ability. And yet, so great was the strength which Pericles had built up that Athens held her own. Ten years of indecisive warfare were ended at last by the Peace of Nicias in 421 B.C. (Nicias was an Athenian general.)

Unfortunately for Athens, Alcibiades, a nephew of Pericles, became one of the ten generals of the city. He was a handsome and clever fellow and his eloquence swayed men. Though the Athenians had suffered so much in the previous fighting, he persuaded them that their hopes of continued greatness lay in war. And so the Athenians began to adopt a hostile policy toward some of their neighbors.

Metropolitan Museum of Art, N. Y.
Monument for grave: woman with servant.

In 415 B.C. they organized a great expedition against the Greek city of Syracuse, on the island of Sicily, which had oppressed certain cities allied to Athens. The Athenians placed Nicias and Alcibiades in command of the expedition. But before it started, Alcibiades was accused of having damaged several sacred images. Fearing to stand trial, he deserted to the Spartans.

The Athenian expedition against Syracuse set out at last. For two years the army remained in Sicily, and at intervals it carried on the siege of Syracuse in a half-hearted sort of way. At last, in 413, disaster struck the Athenians. Their fleet was utterly destroyed; their army was hemmed in and forced to surrender. The commanders were slain; the rest of the prisoners were sold into slavery.

Sparta had done nothing hitherto, in spite of the fact that Athens had been openly hostile to her. She now sent an army to invade Attica. In this hour of peril, Athens was deserted by her allies; her old enemies, the Persians, gave aid to the Spartans. For a time the Athenians held out against desperate odds. They even won several brilliant victories under the leadership of Alcibiades, who had changed sides again. But then the tide of battle turned and Athens met with one disaster after another. At last, in the year 404 B.C., the Athenians were forced to surrender.

They had to accept severe terms. The Long Walls and the fortifications of the Piraeus were destroyed. The Athenian fleet, with the exception of twelve vessels, was handed over to the Spartans. Bitterest blow of all was that the Athenians had to acknowledge the leadership of Sparta.

Death of Pericles. This great Athenian leader died of the plague in 429 B.C.

the outbreak of war between Persia and Sparta, because Sparta had openly aided Cyrus against his royal brother. The Spartans at once invaded Asia Minor. Taking many of the Ten Thousand into their ranks, they won many victories. They freed almost all the cities of Asia Minor and advanced quite far inland.

But Sparta soon found herself with another war on her hands, nearer home. When she insisted on interfering in the domestic quarrels of Thebes and Corinth, they turned against her. Soon Athens and several other cities joined the fight against Sparta. This was the beginning of the Corinthian War (395-87 B.C.).

The proud Spartans suffered several defeats. They now bargained with the Persians for peace and even succeeded in obtaining Persian help against the allies. At last Artaxerxes dictated the terms of a general peace. This King's Peace, as it was called, gave back all the Greek cities of Asia Minor to the Persians, and left the chief power in Greece in the hands of the Spartans.

Sparta now lorded it over the other city-states of Greece. But before many years passed, a rival challenged her leadership. The city of Thebes was the leading spirit in a powerful Boeotian League and she encouraged the members of the League to defy Sparta. The Spartans determined to teach these upstarts a lesson. In 371 they sent an army of 10,000 men to invade Boeotia. They came up with the Thebans and their allies at Leuctra.

Now the Thebans were commanded by a skillful general, whose name was Epaminondas. He massed his troops on his left wing, and their attack carried all before it. When the center and the right of the Thebans joined battle, the Spartans were put to flight.

The victory of Leuctra assured Thebes a position of leadership in Greece. Under Epaminondas the Thebans carried the war into the Peloponnesus and conquered the greater part of it. But it soon became clear

From the head of a mighty league of states, Athens had sunk to the position of a second-rate ally of Sparta.

The close of the Second Pelopponesian War had left many Greek soldiers unemployed. They soon found a market for their services. Cyrus, a Persian prince, had revolted against his brother, King Artaxerxes. He raised an army of 13,000 Greeks and some Asiatic troops, in order to seize the throne. The armies of the two brothers met near Cunaxa, in the heart of the Persian Empire, in 401 B.C. The Greeks defeated the Persians opposed to them; but Cyrus was slain and his Asiatic troops fled.

Artaxerxes remained master of the field. He summoned the leaders of the Greeks, on the pretext that he wanted to talk over with them the terms of a truce, and had them put to death treacherously. The Greeks, now reduced to 10,000, chose new leaders, including a young Athenian, Xenophon, and made good their retreat through a thousand miles of enemy country. At last they reached the shores of the Black Sea, near the friendly Greek city of Trebizond. "The sea, the sea!" they cried in joy, as they caught the first glimpse of the blue waters. Xenophon has given us a vivid account of the retreat of the Ten Thousand in his ANABASIS, or Inland Expedition.

The expedition of Cyrus had two important results. For one thing, it showed the Greeks that the Persian Empire was fatally weak and open to attack. It also led to that Thebes owed her success to the genius of one man. Epaminondas was slain in the Battle of Mantinea in 362 B.C.; and the Theban might suddenly collapsed.

Athens, Sparta, Thebes—each had exercised great power in its turn, but had failed to unite the city-states of Greece. But now the Greeks were to be united against their will by a state that lay on the northern shores of the Aegean Sea—the kingdom of Macedonia. The Macedonians were really Greeks and spoke a Greek dialect. But they were held to be barbarians by Athens and Thebes and Sparta and the rest because they were the least advanced of all the Greeks.

The Macedonians had long had their own kings, but the Greek city-states to the south had paid little attention to them. In the year 359 B.C. a clever and ambitious man, Philip II, came to the throne. As a boy he had been taken as a hostage to Thebes. He had learned how the Greeks lived; he had also learned the art of war from Epaminondas, the conqueror of Sparta.

When Philip became king, he completely made over the Macedonian army. He drilled the soldiers after the Theban fashion and they became invincible in battle. The Macedonian phalanx, a flying wedge of heavily armed soldiers, carried all before it. The Macedonians conquered one land after another and added to their territory until it extended as far east as the Hellespont and as far north as the Danube.

Soon Philip's interests began to clash with those of Athens, which had regained some of her lost power and had a number of possessions in the northern areas of the Aegean. The other Greek cities also looked upon this ambitious northerner with suspicion. But he used bribes and promises liberally and for a time the cities failed to unite their strength against him. His influence in Greece grew until finally he was elected president of the Pythian games. This was a post which carried with it great honor.

Demosthenes, an eloquent statesman of Athens, saw through Philip's plans. In the Assembly at Athens he rose again and again to deliver a series of wonderful orations against Philip—the orations that we call Philippics. At last he aroused the Athenians to action. Allied with Thebes and other cities, Athens sought to overthrow the Macedonian king. But it was too late. Philip utterly defeated the allies in the battle of Chaeronea in 338 B.C.

He soon won mastery over all the city-states of Greece except Sparta. Instead of enslaving the Greek cities, he caused them to unite in a league. He then formed a military alliance with the league. Soon he persuaded this Corinthian League, as it was called, to join him in a war against Persia. But before he could leave for the war, he was slain by a band of Macedonian conspirators in the year 336 B.C.

Philip II was succeeded by his son, Alexander III, one of the greatest monarchs the

A banquet given at Athens in 416 B.C. in honor of Agathon, a poet. This event is described in Plato's famous Symposium, or Banquet. Alcibiades, entering at the left with some of his friends, is greeted by Agathon.

In 399 B.C. an Athenian jury condemned the wise philosopher Socrates to die by swallowing poisonous hemlock. Here we see him drinking from the fatal cup.

world has ever known. One of his tutors was the famous Greek thinker Aristotle, who taught the boy the great works of Greek literature and particularly Homer's ILIAD. Alexander was filled with admiration for the marvelous exploits of the old Greek warriors, and he longed to imitate them. He also determined to avenge himself upon the Persians for the harm that they had done to Greece in the past.

Alexander was twenty years old when he became king. After he had put to death the conspirators who had slain his father, he marched to Corinth, where the Greeks swore to be faithful to him and elected him commander-in-chief in the war against Persia. He then set out to subdue the unruly tribes that dwelt in the northern and western areas of his land.

While he was gone, the city of Thebes turned against him. He resolved to teach the Greeks a lesson that they would never forget. He sped to Thebes with his army, and took the city by storm. He slew many Thebans, enslaved the rest and completely destroyed the city, sparing only the temples of the gods and the house of Pindar, the greatest of all Theban poets.

At last, in 334 B.C. he was ready to carry on the war against Persia. He crossed the Hellespont with an army of Macedonians and Greek allies and started to make his way down Asia Minor. The Persians tried to stop him at the river Granicus, but they were scattered. Alexander owed his life in this battle to his companion Clitus, who slew a Persian warrior as he was about to stab the young king.

After the victory at the Granicus, Alexander made his way down the coast of Asia Minor, freeing the Greek cities in that area from Persian rule. He restored democratic rule in these cities; they became members of the Corinthian League and his allies. He then continued his onward march. At last he came upon the Persian king, Darius III, and a large army at Issus. Here a terrible battle was fought in October, 333 B.C. The Persians were driven from the field and Darius fled to the river Euphrates.

Alexander now marched against Syria and the Phoenician seaports where the Persian fleet was based. All these cities except Tyre surrendered without a struggle; Tyre was captured after a siege of seven months. The Persian fleet was thus cut off from its harbors and its supplies. It fled and played no further part in the war.

In 332 B.C. Alexander conquered Egypt, which still formed a part of the Persian Empire. He now proceeded to build a great city on the westernmost mouth of the Nile River; he called it Alexandria after his own name. While the army was busy laying out the city, Alexander with a few friends made his way across the desert to the oracle of Ammon, an Egyptian god whom the Greeks had identified with Zeus. He entered the holy place alone. When he came out the priests hailed him as the son of Zeus.

Alexander returned to Asia and crossed the Euphrates River in order to seek out the Persian king, who had collected another vast army. The two armies met near Arbela in 331 B.C., and again the Persians were routed. Soon afterward Alexander entered the populous cities of Babylon and Susa. He also captured Persepolis, the Persian capital.

The Macedonian king was now master of Persia and ruler of a mighty empire, made up of many races—Macedonians, Persians, Medes, Egyptians, Phoenicians and Greeks. He sought to create a new kind of state—one in which all races would be considered equals. They would all worship their royal master (for was he not the son of Zeus?), and they would live in peace among themselves.

Alexander began to carry out this plan by giving many posts in his government to Persians, Egyptians and Phoenicians, as well as to Macedonians. He wore Persian dress and adopted a number of Persian customs. Many of the Macedonians resented their king's policy of friendliness to foreigners. Some of them even conspired against his life in 330 B.C., but the plot failed.

The Macedonian king pushed on to the northernmost provinces of Persia—Sogdiana and Bactria—where there was still a good deal of resistance. In Sogdiana he captured Bessus, the murderer of Darius, and had him put to death. It was not till 327 that all resistance in these regions came to an end. Alexander now sought to make his position more secure by marrying Roxana, the daughter of a Persian chieftain.

Flushed with success, Alexander had taken to drinking heavily and making merry with his companions. One day, after all had drunk a good deal, a bitter quarrel arose. Clitus, who had saved Alexander's life at the Granicus, reproached the King for having abandoned the customs of his royal ancestors. In anger Alexander ran his friend through with a spear, killing him instantly. Later the King was overcome with sorrow. To ease his grief, his friends assured him that as a god he could do no wrong.

In 327 B.C. Alexander invaded India. In addition to Macedonians and men from the city-states of Greece, his armies now contained a number of Persian soldiers. In the three years that followed he advanced as far as the valley of the Ganges River, fighting many battles along the way. He turned back at last against his will, only because his army had had enough of conquest and refused to follow him any farther.

In the spring of 323 B.C. Alexander returned to Babylon and busied himself with new plans of exploration and colonization and conquest. But he caught a fever and on June 13 he died at the age of thirty-three, after a reign of thirteen years. He was buried in a golden coffin at Alexandria and was worshiped as a god.

Men call him Alexander the Great, and, in spite of certain weaknesses, he well deserves that name. He was a mighty general, who won many victories and who carved out a vast empire that extended from the Sahara Desert to far-off India. But he was not merely a conqueror. He was a far-seeing statesman who tried to bring about a better world in which all people would be as one.

Alexander's empire fell to pieces after his death. His generals made a half-hearted effort at first to maintain the empire under

The famous Athenian orator Demosthenes strengthening his voice by making himself heard on the seashore above the noise of the waves.

After his death Alexander the Great became a legendary figure, credited with many imaginary exploits. This old print shows one of them. Alexander, disguised as a messenger, makes his way to King Darius.

the joint rule of the half-brother of Alexander and the infant son of Alexander and Roxana. But the real power was in the hands of the governors of the empire, who soon fell to fighting among themselves. There followed a generation of constant warfare in which Asia and Greece and the African land of Egypt took part.

At last, by the year 290 B.C., Alexander's empire had been split up into three powerful states, each under the rule of one of his former generals. Antigonus held Macedon; Seleucus was the master of the old Persian Empire; Ptolemy was the ruler of Egypt. The successors of Antigonus and Ptolemy managed to keep Macedonia and Egypt more or less intact for generations to come. But the Seleucids, as the descendants of Seleucus were called, were forced back from the eastern areas of their domains, until at last they ruled only over the land of Syria.

And so vanished Alexander's dream of a brotherhood of peoples led by a single mighty ruler. Yet his conquests had a deep influence upon the ancient world, for they carried Greek civilization throughout Egypt and Persia and many of the lands that lay beyond. So widespread was Greek culture in the three centuries that followed the death of Alexander that we call this era the Hellenistic Age. (The Greeks, remember, were also known as Hellenes.)

In all the lands that had formed part of Alexander's empire, most men had at least some knowledge of the Greek language. Everywhere, too, Greek art and science and letters flourished. The Greek civilization transplanted to the big cities of Egypt and the East came to rival the civilization of Athens and the other cities of Greece.

Alexandria, in Egypt, won particular fame as a center of culture. In the Museum, or university, established by a successor of Ptolemy, the greatest thinkers and scientists and literary men of the Greek world carried on their studies and taught eager students. This institution had a library containing many thousand rolls of parchment.

If Greek civilization had a great influence upon the people of other lands, it was also influenced in its turn. The Greeks came to know and even to accept the gods of the East. They came to admire the learning of Chaldean and Persian sages; they became familiar with Oriental customs and traditions. So, while the civilization of the Hellenistic Age was Greek in form, it represented a blending of many civilizations.

The cities of Greece had hailed the death of Alexander and the confusion that followed; for they saw a chance to recover their former independence and power. Athens took the lead in abolishing the Corinthian League, which had been a tool of Macedonia, and in setting up a new Hellenic League. But Macedonia soon crushed it.

The Greek city-states formed other leagues in the third century B.C. Two of them, the Aetolian and the Achaean leagues, became quite powerful. But they were unable to withstand a new menace that had arisen in the West—the Italian republic of Rome. This warlike city had already annexed much of the Italian peninsula and was steadily extending its conquests. By the third century B.C. it had begun to overrun the Greek cities of southern Italy.

The Greeks could do but little while the "cloud in the West," as a wise Greek called Rome, grew more and more threatening. For a time, indeed, Rome's eastward march was halted, while she had to fight two grim wars to the death with Carthage—the Punic Wars of 264-41 and 218-01 B.C. She was the victor in both of these struggles.

Philip V of Macedonia fought as an ally of Carthage against Rome in the Second Punic War. He was forced to sue for peace in 205 B.C. But he continued to intrigue against Rome and it proved to be his undoing. His armies were routed in 197 B.C. at the Battle of Cynoscephalae, in Thessaly. This Philip had oppressed some of the Greek cities, and therefore his fall was hailed by many of the Greeks.

But as time went on and the ambitious designs of the Romans became clearer, the Greeks turned to the leadership of Macedonia, which was plotting a war of revenge against Rome. The Macedonian king Perseus was defeated at Pydna in 168 B.C., and Macedonia was divided into four republics, which were forbidden to have anything to do with each other. Twenty years later Macedonia was annexed outright to Rome.

Corinth succeeded in uniting some of her neighbors in a last desperate struggle against Rome. But this rising was crushed when the Romans captured Corinth in 146 B.C., destroyed the city and enslaved the population. Rome did not as yet annex Greece to her growing empire, but she kept close watch on the cities of the peninsula. Long before Greece became a Roman province in the first century B.C., the Greeks had ceased to be independent.

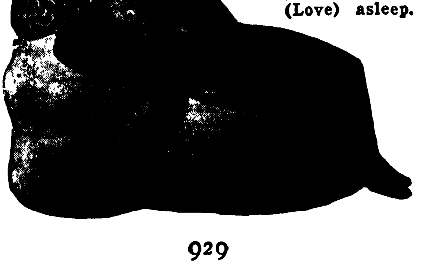
Yet, as a Roman poet once said: "Captive Greece led captive her proud conqueror." As early as the third century B.C. captives from the Greek cities of Italy and Sicily had begun to serve in the households of Rome and had given their masters some idea of the wonders of Greek civilization.

In the second century B.C., as Roman armies marched through Greece again and again, the Romans were more and more delighted with the civilization with which they now came in close contact. They admired the beautiful temples, the lifelike statues, the graceful pottery, the wonderful work in gold and silver and bronze. They were inspired, too, by the literature and the philosophy of the Greeks.

As time went on, wealthy young Romans were sent to Greece, and particularly to Athens, to round out their education. In Rome and the other cities of Italy, Greek teachers were very popular. Educated Romans prided themselves on their knowledge of the Greek language, literature, music and art. Roman civilization came to be a blend of Greek and Roman culture.

Since the days of the Romans, many generations of men have been inspired by ancient Greece. Our own debt to this little land on the Mediterranean Sea is very great. Hundreds of words in English have been derived from the Greek language: words like orchestra, meter, geometry, geology, geography, chemistry and hydrogen.

The influence of Greek architecture and sculpture is seen in many of our noblest buildings and statues. We still find inspiration in the works of Greek dramatists, historians, orators and philosophers. And last, but not least, we owe to the ancient Greeks not only the very name of "democracy," but also the idea of the democratic form of government—the government in which all citizens are equal before the law and in which the people rule through leaders whom they have freely elected.



Metropolitan Museum of Art
Statue of Eros (Love) asleep.

In another chapter of The Book of Knowledge we carry on the story of Greece to our own day. There were many brave and wise men among the descendants of the ancient Greeks; but never again did their land rise to its former greatness

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 1021.

HOW TO PRONOUNCE GREEK AND ORIENTAL NAMES AND TERMS USED IN THIS ARTICLE

(Y in the words in parentheses is pronounced as in my.)

Achaeans (ah-kee'-anz)
Acropolis (ah-crop'-oh-liss)
Aegina (ee-jy'-nah)
Aeolians (ee-oh'-lih-anz)
Aetolians (ee-toh'-lih-anz)
Alcibiades (al-see-by'-ah-deez)
amphictyonies (am-fik'-tih-oh-neez)
Anabasis (ah-nab'-ah-siss)
Anaxagoras (an-ak-sag'-oh-rass)
Antigonus (an-tig'-oh-nuss)
Aphrodite (af-roh-dy'-tee)
Apollo (ah-pol'-oh)
Arbela (ar-bee'-lah)
archon (ar'-kon)
Artaxerxes (ar-tak-surk'-seez)
Artemisium (ar-tee-mish'-ih-um)
Athena (ah-thee'-nah)
Attica (at'-ih-kah)
Bactria (bak'-trih-ah)
Boeotia (bee-oh'-shah)
Boeotian (bee-oh'-shih-an)
Callimachus (cah-lim'-ah-kuss)
Chaeronea (ker-oh-nee'-ah)
Cimon (sy'-mon)
Cleisthenes (klyss'-thee-neez)
Clitus (cly'-tuss)
Cunaxa (koo-nak'-sah)
Cynoscephalae (sin-oss-sef'-ah-lee)
Cyrus (sy'-russ)
Darius (dah-ry'-uss)
Delos (dee'-loss)
Delphi (del'-fy)
Demosthenes (dee-moss'-theh-neez)
Dionysus (dy-oh-ny'-suss)
Dorians (doh'-rih-anz)
Draco (dray'-koh)
Epaminondas (ee-pam-ih-non'-dass)
ephors (ef'-orz)
Eretria (er-ih-tree'-ah)
Euboea (yu-bee'-ah)
Euripides (yu-rip'-ih-deez)
Granicus (grah-ny'-kuss)
Hellen (hel'-en)
Hellenes (hel'-eenz)
helots (hel'-ots or hee'-lots)
Hera (hee'-rah)
Hermes (her'-meez)
Herodotus (hee-rod'-oh-tuss)
Hippias (hip'-ih-ass)
Hippocrates (hip-pok'-ray-teez)
Iliad (il'-ih-ad)
Ionians (y-oh'-nih-anz)
Issus (iss'-uss)
Leonidas (lee-on'-ih-dass)
Leuctra (look'-trah)
liturgies (lit'-ur-jeez)
Lycurgus (ly-kur'-guss)
Mantinea (man-tih-nee'-ah)
Marathon (mar'-ah-thon)
Mardonius (mar-doh'-nih-uss)
metics (met'-iks)
Miltiades (mil-ty'-ah-deez)
Mycale (mik'-ah-lee)
Mycenae (my-see'-nee)
Naucratis (noh'-krah-tiss)
Nicias (nish'-ih-ass)
Odyssey (od'-ih-see)
oligarchy (ol'-ih-gar-kee)
Olympia (oh-lim'-pih-ah)
Olympus (oh-lim'-puss)
ostracon (oss'-trah-kon)
paidagogos (py-dah-goh'-goss)
Pausanias (poh-say'-nee-ass)
Peloponnesus (pel-oh-paw-nee'-suss)
Peloponnesian (pel-oh-paw-nee'-shan)
Periander (peh-rih-an'-der)
Pericles (per'-ih-cleez)
perioeci (per-ih-ee'-see)
Persepolis (per-sep'-oh-liss)
phalanx (fay'-lanks)
Phaleron (fal'-er-on)
Phoenicians (fee-nish'-anz)
Piraeus (py-ree'-uss)
Pisistratus (pih-siss'-trah-tuss)
Plataea (plah-tee'-ah)
Plato (play'-toh)
Polycrates (poh-lik'-ray-teez)
Poseidon (poh-sy'-don)
Ptolemy (tol'-eh-mih)
Pydna (pid'-nah)
Pythagoras (pih-thag'-oh-rass)
Salamis (sal'-ah-miss)
Seleucids (see-loo'-sidz)
Seleucus (see-loo'-kuss)
Socrates (sok'-rah-teez)
Sogdiana (sog-dih-ay'-nah)
Solon (soh'-lon)
Sophist (sof'-ist)
Sophocles (sof'-oh-cleez)
strategoi (strah-teh-goy')
Thales (thay'-leez)
Themistocles (thee-miss'-toh-cleez)
Thermopylae (ther-mop'-ih-lee)
Thessaly (thess'-ah-lee)
Tyrins (ty'-rinz)
Xenophon (zen'-oh-fon)
Xerxes (zurk'-seez)
Zeus (zooss)

THE BLOOD IN OUR BODIES

Harold M. Lambert from Frederic Lewis

A drop of diluted blood under the microscope shows this little boy the red cells which give blood its color.

FOR many years, people thought that the blood was a special liquid in us which carried the features we inherited from our forefathers. A person was supposed to be tall or short, or to have brown eyes or blue eyes, because of some special substances or characteristics carried in the blood. We now know that this is not true; but because of this ancient belief, our language still has phrases in it which refer to the blood as the carrier of inherited features. Therefore, we sometimes speak of the "blood line" when we mean the line of relationship between a person and his parents, grandparents and great-grandparents. If a person had a great number of good characteristics, his blood was thought to be of a better grade than that of ordinary folk. People with a long line of famous ancestors were sometimes called "blue-blooded," which meant that they had a very special kind of good blood.

We know today, however, that blood has nothing to do with any of these inherited features. We know that the things we inherit from our ancestors are carried in the chromosomes in our germ cells and in that way are passed down from father to son. The blood itself has nothing to do with this process, except to nourish the germ cells, as blood nourishes all of the cells in the body. Blood is the liquid material which carries oxygen and food and bathes all the cells in a watery bath.

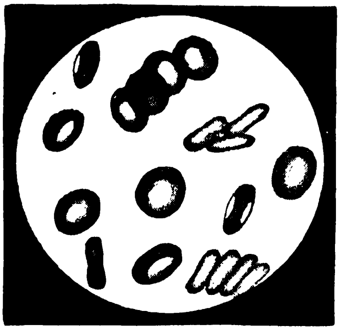
Very simple animals, such as the one-celled ameba, live in water all the time. They receive their nourishment from the water and excrete their waste products directly into the water in which they live. The higher animals, which live on dry land, exist outside of the water by having all the cells of the body continuously bathed in a fluid similar to the water surrounding the ameba. This fluid has been changed in some respects so as to adapt it to circulation within the body, but it performs the same job as the watery environment of simple animals. This fluid, in human beings and all higher animals, is the blood. The blood, or parts of the blood, continually bathes each and every cell of the body.

The blood is a complicated fluid having a liquid part called the plasma, in which are found a vast number of very tiny cells, too small to be seen except under the microscope. These cells, which are often referred to as corpuscles, are of three kinds, called red blood cells, white blood cells and platelets. We shall describe them in more detail soon.

The liquid part of the blood, or plasma, is a nearly colorless liquid. Human plasma, if seen in large amounts, has a faint yellow or greenish color. In some animals it is entirely clear, like water. Plasma contains—besides the corpuscles—various blood proteins, gases and minerals, as well as special chemical substances called hormones and enzymes. The plasma is really the means of dissolving or suspending (holding) all of the other parts of the blood.

Sometimes people speak of having "acid blood," but the blood is usually neither acid nor alkaline. It is most often very nearly neutral in its reaction. The blood of the arteries is usually a little more alkaline than the blood in the veins. There are ways to keep it always very close to the neutral point, so that if food is taken into the body which might move it toward the acid side, certain changes begin to counteract the acid effect of the food. Rarely does an acid or alkaline stage of the blood develop, and this occurs only after certain extremely severe disease states involving the kidneys, lungs or other important internal organs. If a person's blood did become really acid it would be impossible for that person to live.

The most noticeable cells in the blood are the red blood cells. If a small drop of blood is diluted with some weak salt water and placed on a glass plate under the microscope the red cells can be seen in large numbers floating around in the blood. A single red cell looks something like the wheel of an automobile. (Think of a solid wheel, of course, not one with spokes.) It is thin in the center, and thicker near the rim, just as the tire is thicker than the center of the wheel. When a cell is flat it is called a disc, and when it is thick near the edge and thin near the center, on both sides, it is said to be biconcave; so we may say the red cells are biconcave discs. A single red cell does not look red under the microscope; it looks pale yellow. But if many of these cells are seen together in blood they have a red color. It is the millions of red cells lying so thickly together in the blood that give it the typical red color.



Red cells are biconcave discs.

The red cells can not move of themselves, but must be whirled along with the stream of blood and carried by it much as a piece of wood floats on water, and travels with the current. The only use of the red cells in the blood is to carry oxygen to the tissues and to carry away carbon dioxide from the tissues.

The red cells are much the most numerous of any of the cells in the blood. Even though they are extremely numerous it is possible to count them. To do this we take a very small, known amount of blood, and count the cells in it, and then calculate the number of red blood cells in a larger amount of the blood. The total number of red cells in the body is probably about thirty-five trillion. In a portion of blood about the size of two pinheads (one cubic millimeter) there are normally about five million red blood cells. Men ordinarily have a few more red cells than women, and a newborn child has about one million more than a grown person. It is possible, by counting the blood in the way we described, to determine whether a person has the proper number of red blood cells.

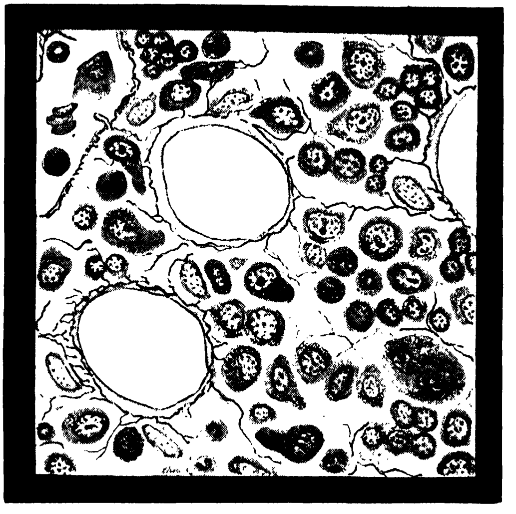
Red blood cells are being destroyed all the time. Apparently they become worn out by circulating through the blood stream and begin to break up into small pieces. It is possible sometimes to see these fragments of red cells in a sample of blood under the microscope. The red blood cells probably get old and begin to break into pieces after one or two months. It has been estimated that about one million of them wear out every second of our lives. The fragments are then picked up by the liver and spleen and part of the material of the old cells is saved and stored away to be used in the manufacture of new blood cells.

In addition to the normal destruction of them, many other things may decrease the number of cells present. When the total number of red cells drops to a certain point, we say that an anemia has been produced, or that a person is anemic. Anemia may be produced from the loss of blood from bleeding, or by the chemical destruction of red cells. The venom of snakes, certain poisons of bacteria, or special substances called hemolysins which may be produced within the body, and salt water solutions weaker than that in the blood—all may cause chemical destruction of the red cells. Anemias can also be produced if anything interferes with the making of new red blood cells.

New red cells are being produced at about the same rate as old ones are being destroyed in a healthy person. They are produced inside our bones. This is surprising, because bones seem to be hard, dead things which merely give shape to our bodies. The truth is, however, that inside the bones is a living tissue called the marrow, in which young red cells and some of the other kinds of blood cells are continually being made. It is in the marrow of the ribs, spinal column and bones of the limbs that the red blood cells are manufactured. If a piece of the marrow is looked at under the microscope, large numbers of very young red blood cells can be seen there. These begin as small cells with a nucleus but without any coloring matter in them. As they grow older they come to have coloring matter which makes them red, and they lose the nucleus. At about this time they are picked up by the blood circulating through the marrow of the bone and so they go out into the regular blood stream.

At this stage the young cells can be recognized by a very fine lace network within them. About one in a hundred of the red cells in the blood stream can be recognized as a new, nearly grown, red blood cell. If anything interferes with the making of new red cells, there will be a sudden decrease in the total number of them. For instance, if not enough iron is taken in the diet, or if some poison is present which poisons the bone marrow, or if there is a lack of certain special substances in the lining of the stomach, production of new red cells will be slowed up or stopped.

In well people there is a small change in the number of red cells during the day, and from day to day. There are usually fewer red cells in the morning, with a gradual increase during the day. Severe muscular exercise will increase the number of red cells in the circulating blood stream. Living on high mountains where there are fewer oxygen molecules in the air than at lower altitudes may cause an increase in the number of red cells in the blood. In fact, any lack of oxygen (such as would result from severe lung trouble, for instance) may cause a considerable increase in the number of red cells in the blood stream.



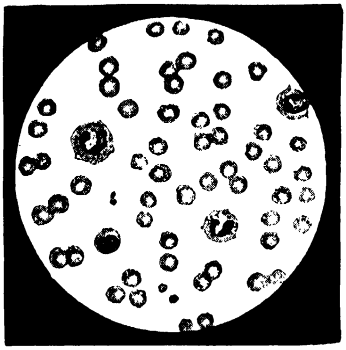
A slice of bone marrow under the microscope. The large cells are fat cells; most of the small ones are red blood cells.

The coloring matter in the red cells which gives blood its red color is a very important chemical substance called hemoglobin. It is hemoglobin which makes it possible for red blood cells to carry a large load of oxygen to the tissues. Hemoglobin is made up of a protein with a substance called hematin. Hematin is a pigment, or coloring matter, which is very widely found in animal and vegetable life. It is closely related to the substance which makes the green color of the plant world, and to the substance which gives the brilliant colors to the feathers of birds and the shells of birds' eggs. It is one of the most widely distributed coloring compounds in nature.

Hematin is always found to have iron in it. Hemoglobin, then, contains iron. Each molecule of hemoglobin contains four atoms of iron and each iron atom can combine with a molecule (two atoms) of oxygen. In that way, one molecule of hemoglobin can carry four molecules of oxygen in a special loose combination so that it can easily and readily give up some of the oxygen again when it reaches the tissues. This compound of oxygen plus hemoglobin is called oxy-hemoglobin. Oxy-hemoglobin, then, is formed whenever blood containing hemoglobin, or hemoglobin itself, is exposed to air or to pure oxygen gas. But the oxygen in oxy-hemoglobin is very loosely held; and it can be readily given up. This ability to form a compound which can be taken apart easily is the special job of hemoglobin in the red corpuscles of the blood.

Let us see now what happens to the hemoglobin during circulation of the blood through the tissues and lungs. On leaving the tissues, the hemoglobin has very little oxygen combined with it and is called reduced hemoglobin. This is the dark red or purple hemoglobin. It gives its color to the blood in the veins. As blood passes through the lungs, much oxygen is picked up by the iron atoms in the hemoglobin, forming oxy-hemoglobin. Oxy-hemoglobin has a very bright red color which it gives to the blood leaving the lungs. Now the oxy-hemoglobin is carried to the tissues in all parts of the body. By this time the tissues have used up most of their oxygen so that when the fresh blood arrives they take oxygen away from it. In losing some of its oxygen, the blood loses its bright red color and becomes dark red again. It is this dark blood (with reduced hemoglobin) which returns through the veins to the lungs for another load of oxygen.

A small amount of oxygen is dissolved in the plasma of the blood. But if this were the only means of carrying oxygen we would need about sixty times as much blood as we have, to supply the tissues. Now we see the importance of iron in the molecule of hemoglobin. It is the ability of each atom of iron to combine with a molecule of oxygen that enables the hemoglobin to carry such a large load of oxygen. If a large number of red cells should be destroyed, as in anemia, the oxygen-carrying ability of the blood will be less. If the anemia is severe the blood carries so little oxygen that the person is short of breath. Breathlessness is often noticed in people with a small number of red cells in their blood.



The smaller cells shown here are red; the few large ones are white blood cells.

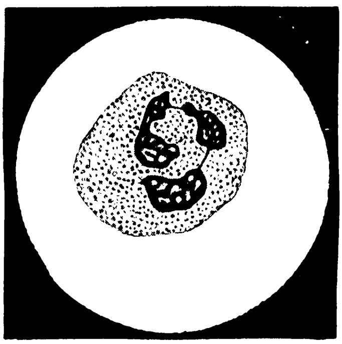
The second kind of cells in the blood which we have to study are called white cells, or leucocytes. These cells, unlike the red cells, have a nucleus. However, they have no hemoglobin, no coloring matter. White cells are often four or five times as large as red cells, but they are not nearly so numerous. The red cells outnumber the white by about six hundred to one. There are two general types of white cells, one type which is non-granular and the other type containing tiny grains, or granules.

The granular white cells come from the bone marrow, as do the red cells, and are developed there from very simple young forms of cells. These then go through stages of development which can be followed under the microscope until they become full-grown, adult granular cells. They are able to move about much as an ameba does, by throwing out a part of the cell wall, then pulling the rest of the cell along after it. They are apparently able to squeeze out through very tiny holes in the blood vessels and in that way to leave the blood stream. After leaving the blood stream they move through the fluid in the tissue spaces until they arrive at any desired spot.

Now the reason for describing this movement is to tell about the main job of the granular white cells. When harmful germs, or microbes, get into the tissues they produce an inflammation. In a short time the white cells move into the inflamed region and begin a mortal battle against the microbes. Whenever a splinter enters your finger it carries microbes through the skin with it. In a very short time, large numbers of white cells can be seen migrating to the area where the damage occurred. As we watch this battle we can see the white cells move up to the microbes, kill and devour them. If there are large numbers of microbes it may require a vast army of white cells to win the battle.

In the fight between the cells and the microbes many white cells are overcome. If a great number of white cells are destroyed, they may come to form a thick, milky substance in the tissues; this is called pus. Sometimes it is necessary to open the wound and let the pus out. We must remember, then, that pus is made up of the bodies of the white cells which were killed in the battle against the disease germs.

Large numbers of white cells may be called into battle in severe illness. Then the body produces more white cells. It is possible, as we know, to count the blood cells to see if the number of white cells has increased. Sometimes it can be determined whether a disease is present or not by the number of white cells in the blood. Usually when we are healthy and well the white cells have little or nothing to do. They simply go around through the blood stream or through the tissues looking to see if everything is all right. We might say that they are the policemen of the body, and when no marauders are around they have no work to do. It is important to have a police force in the body at all times, however, because one never knows when he may need to be protected from some microbe intruders.



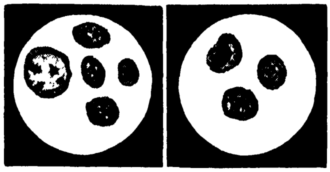
An enlarged view of a leucocyte, showing the grains and the divided nucleus.

The other kind of white cells, those having no granules, are called lymphocytes and

THE WHITE CELLS FIGHTING FOR A LIFE

In this picture is seen a deadly battle in the blood between microbes of typhoid fever and white blood cells floating in the blood stream. Swarms of typhoid germs are seen invading the blood, and the white cells are mobilized to resist the invaders. Each white cell has swallowed several germs, and if cells can swallow and digest the germs fast enough, they will win the battle. Sometimes the germs win. The scientific name for white cells is leucocytes. In normal blood they are much less numerous than red cells. Careful study of the leucocytes in some diseased conditions can be helpful in determining the nature and course of the illness.

monocytes. These white cells are not manufactured in the bone marrow. The lymphocytes, we know, are made in the lymph nodes which are located under the arm, in the groin, and in the neck. They grow from simple primitive lymph cells. They are carried through the lymphatic vessels and enter the blood stream—by way of a vein—at the side of the neck.



Left: Lymphocytes, showing the large nucleus, with a thin layer of cytoplasm. Right: Monocytes, with small, indented nuclei, and grains in the cytoplasm.

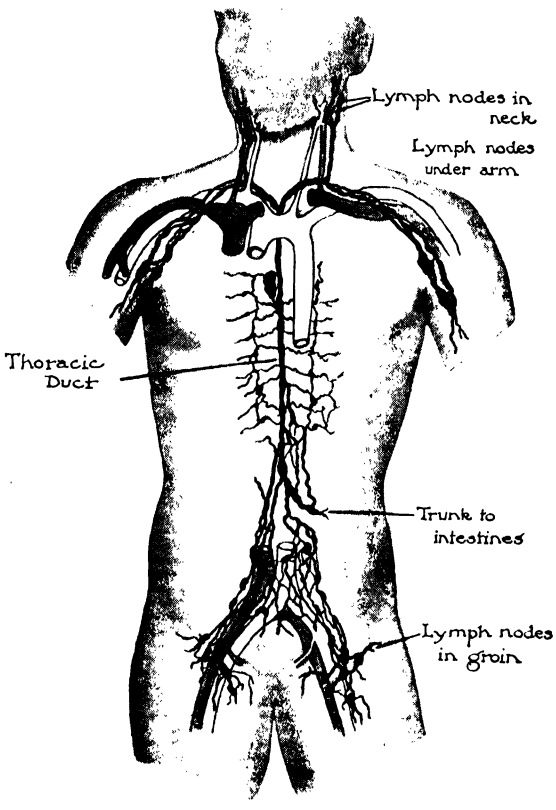
The lymphocytes do not move about of themselves as the granular white cells do, but they probably take a part in some of the battles against microbes. Their exact duties are not well understood, but it is thought that they defend us against tuberculosis and cancer, because we find so many of them in the blood of a person with one of those diseases.

We may think of the whole lymphatic system of the body as a kind of bridge between the digestion of food and the final use of digested food through the blood.

Monocytes look much like the lymphocytes but probably develop from large scavenger cells found in the tissues outside of the vessels. According to some authorities, they can move about like the granular white cells. Monocytes are able to devour and digest foreign particles and are supposed to remove bacteria and foreign matter from the blood.

The main task of the white blood cells, then, is to protect us from microbes by killing them and digesting them. In addition, if any tissues have been destroyed by the germs, those dead tissues must be digested and removed by the white cells before new tissues can be built in their place. This is a second important job for the white cells. The white cells also aid in absorption of food from the intestine and they take part in the clotting of blood. The various jobs of the white cells are extremely important in maintaining good health.

The third kind of cells which are found in the blood are called blood platelets. These are not true cells and may simply be fragments of tissue broken off from giant tissue cells present in bone marrow. Some have thought they were pieces of broken-up red blood cells, but this is probably not true. Anyway, these platelets are very small, about a quarter the size of red cells. They have no nucleus but they contain a few tiny granules. Their importance to us is that they take a very prominent part in the clotting of blood, as we shall see later.

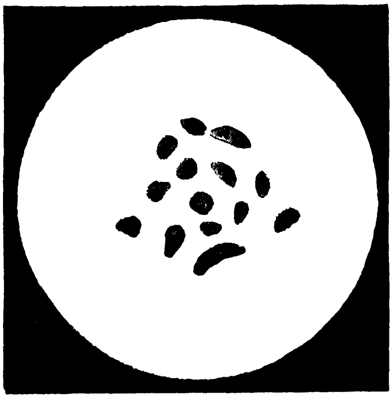


The main channels (black) of the lymphatic system, shown in relation to the chief arteries (white) and veins (gray).

We must now look at the liquid part of the blood more closely. The liquid plasma is about nine-tenths water. In it are dissolved various proteins, gases and salts. The important proteins in the plasma, which are called serum proteins, are albumin, globulin and fibrinogen. These substances, produced within the body, have a very important part in regulating the amount of water which we retain. In certain kidney diseases where the proteins of the blood are lacking, the tissues swell up with water. The serum proteins also determine how much water is retained in the blood, so that we always have the same amount of fluid in us and the blood never becomes too thick or too thin.

The plasma also carries food from the intestine to the tissue cells. It carries off some of the broken-down parts of the food after they have been used or burned up. These waste products are carried in the plasma to the kidneys which remove them so that they do not poison the body.

Still other substances dissolved in the plasma are salts. One of the most important of these is plain salt or the sort you use on the table. This salt is the most common one found in the blood plasma. The exact use of this salt is not known, but it probably helps to make the right kind of solution for circulation through the tissues. Ordinary table salt dissolved in the plasma seems to make the best kind of fluid for bathing all of the tissue cells. This proper kind of fluid is necessary for the nourishment and the good health of the individual cells. Salt is also used in making the hydrochloric acid produced by the stomach, which is such an important substance in digestion of our food.



Blood platelets, which play an important part in clotting. They do not have any nuclei, but instead contain tiny grains.

Other salts in plasma aid in the transport of carbon dioxide from the tissues to the lungs (where we get rid of it by breathing it out). The salt most concerned with this is sodium bicarbonate. You perhaps know sodium bicarbonate as the baking soda which is used in cooking. Baking soda is found in the blood in certain very definite proportions, and illness will occur if this proportion is disturbed. Carbon dioxide, like oxygen, can be dissolved in the plasma, but only small amounts of both of these gases can be carried by the plasma alone.

Perhaps it will help you to understand where carbon dioxide comes from if you think of the body as a huge factory, with many furnaces. Every cell is a furnace. We eat food. The food is broken down into tiny parts and carried by the blood stream through the body, and each cell picks up the food it requires. Food contains carbon, and carbon is good fuel. Oxygen is the only thing that will light the fuel and keep it burning. So we take oxygen from the air, the blood brings it to the cells, and it burns the carbon. Our bodies are kept warm because these little furnaces are going all the time. The burned-out carbon, or carbon dioxide, is of no further use to the body. It must be carted away as ashes must be carted away from a furnace; and the blood does this.

Sodium bicarbonate makes it possible for the blood to carry large amounts of carbon dioxide. Chemical compounds are formed with carbon dioxide and sodium bicarbonate and the potassium within the red cells so that a very large load of carbon dioxide can be taken up from the tissues and held in chemical combination until it reaches the lungs. There this combination breaks down again, releasing the carbon dioxide which can then be breathed out through the lungs. This, then, is one of the special measures for carrying carbon dioxide similar to the special arrangement of the hemoglobin for carrying oxygen.

If blood is collected in a cup and allowed to stand for a few minutes it will set like a jelly. If the cup is tilted the blood will act like a small clot of jelly and will not pour as the liquid blood did. Now if you looked at a portion of this jelly under the microscope you would see that there are great numbers of small fibers running through it. These fibers are arranged in a tangled mass, among which are trapped as in a net the red cells, white cells and many blood platelets. Under the microscope it may be noticed that many of the fibers seem to radiate, or extend out, from little clumps of blood platelets. If the clot of blood is allowed to stand for a while it begins to shrink, and as it shrinks it squeezes out a clear fluid. That is the liquid plasma leaving the clot.

The clotting of the blood takes from three to ten minutes, depending upon certain conditions. It can be speeded up by adding calcium or foreign substances to it. Clotting can be slowed or entirely prevented by the addition of certain chemicals. When tissues are cut or torn, the blood begins to escape from the blood vessels around the wound. The blood forms a clot which stops up the tear in the tissues and prevents further bleeding. In this way clotting is a means of protecting the body from loss of blood.

Acme
To prepare plasma, blood is chilled. Red corpuscles sink to the bottom of the bottle, leaving the plasma at the top.

Clotting of the blood is produced by the liberation of a substance called thromboplastin from injured cells, platelets or tissues. Thromboplastin does not circulate in the blood stream and therefore as long as the tissues are not injured, no clotting of the blood will occcur. But once the tissues are cut, and the walls of the blood vessels are pierced, the blood comes in contact with thromboplastin. Blood containing calcium and a substance called prothrombin unite with the thromboplastin to form a new chemical compound called thrombin.

The next thing that happens is a combination of thrombin with the protein called fibrinogen which we spoke of above. When thrombin and fibrinogen unite they form fibrin fibers which hold the blood cells together in a jelly-like clot. This is how the fibrinogen of the plasma is finally made into the strong, tough, little fibers that help to stop bleeding from the tissues.

Clotting of the blood is the first step in repairing a cut or tear of the tissues. In the next step, the white blood cells come into the region, kill off all of the microbes and eat up, or digest, the damaged tissues. Then the healing of the wound can begin.

Everyone has had a bleeding cut at some time or other during his life. Let us see what happens when considerable blood is lost. Any bleeding or loss of blood is called a hemorrhage. On the other hand, the blood may pass into surrounding tissues or neighboring organs such as the stomach or intestine. This is called an internal hemorrhage. The effects on the body in either case are about the same. If a large quantity of blood is lost suddenly, the person usually notices shortness of breath. That is because the loss of red cells lessens the oxygen carried in the blood. The person becomes pale and weak and his heart begins to beat much faster. He will become very thirsty because of the loss of the fluid part of the blood. With loss of blood, the vessels are no longer completely filled. The body meets this situation by reducing the size of the blood vessels so that the remaining blood will more nearly fill them.

Acme
In carefully labeled bottles, blood is kept in refrigerator "banks," at hand when transfusions are needed.

Now the spleen plays a part. The spleen is an organ which stores red cells for just such an emergency. By contracting, it forces cells out into the circulation to replace those lost. After a time, fluid seeps into the blood vessels from the tissues. Because of his great thirst the injured person will drink more water, which helps to replace the tissue fluids and plasma. The next change is a slower one, in which blood proteins are built up. Finally, new red cells are carried from the bone marrow as fast as they are fully developed. After a severe hemorrhage large numbers of these young cells can be found in the blood stream. Eventually, the full number of red cells will be regained. It takes about five weeks to restore a pint of blood.

BLOOD TRANSFUSIONS RESTORE HEALTH AND SAVE LIVES

A person can lose about half the total amount of blood in his body and still live. However, when a person has lost a great deal of blood, the doctor can help him recover more quickly by injecting into his veins blood given by another person. This procedure, called blood transfusion, has saved many people from death or a long illness. But it is first necessary to match the blood given with the blood of the person who is to receive it. The reason for this is that all human beings belong to one or another of the four general blood types. These blood types are known by number. Usually, people with *type one* blood can give blood to others having *type one* blood; people with *type two* can give blood to others with *type two,* and so on. In addition, most people with *type one* blood can give blood to people of any other blood type. Providing the bloods are properly matched there is little or no risk in transfusion.

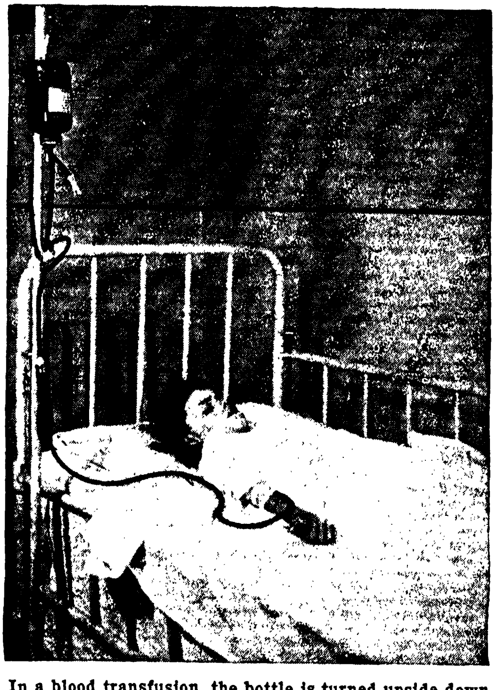
Before World War II, it was learned that other substances could often be used in transfusion. Since the body possesses a large reserve supply of red cells which can be called into the circulation after a hemorrhage, it is often sufficient to replace only the fluid part of the blood. Plasma, therefore, came into wide use as a transfusion material. It has certain great advantages. In the first place, plasma need not be "typed" before injection. Plasma can be collected from large numbers of people and given to any patient without regard to his blood type. Another advantage is that plasma can be dried and stored in bottles for long periods of time. In the preparation of plasma the red and white blood cells are taken out and thrown away. The liquid part of the blood is then frozen and dried in the frozen state. In this form it is most suitable for storage or shipment.

Transfusions may be made with whole blood, plasma, salt-water solutions or other substances. Often it is best to give a transfusion of whole blood when red cells as well as plasma are needed promptly. But the difficulties of storing and shipping whole blood make it impractical for use by armies. Salt-water solutions have been extensively used in transfusion as a substitute for the fluid of the blood, but they are wholly lacking in necessary blood proteins. It is likely that in the future artificially produced protein substances can be added to make salt water a satisfactory transfusion material.

From what we have learned about the blood, it is clear that blood or plasma from any healthy person can be used for transfusion providing it is of the proper type. Blood from animals can not be safely used because it contains substances which may be harmful to human beings. But no ill effects will follow the transfusion of blood from a person of a different race or color. No personal or racial characteristics are transferred with it.

By ARTELL E. JOHNSON, M.D.

THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 1209.



In a blood transfusion, the bottle is turned upside down, and the blood trickles into an arm vein, without pain.

THE FOUNDATIONS OF MODERN CANADA

FROM 1759 TO 1850

IN the early dawn of a September morning in the year 1759 the French defenders of the fortress of Quebec looked out on a field which stood up the river from the city and found, to their surprise, a British army. For weeks the British had been trying to capture Quebec, and as summer drew towards autumn, it seemed that the besieging armies would be baffled. Now, however, on the Plains of Abraham, the forces under General James Wolfe were ready for battle. In the day of fighting which followed, the French armies were beaten, and the next day Quebec fell to the British. The power of France never revived in North America. When peace was made at Paris in 1763, Canada became an English colony.

For the 65,000 French-Canadian farmers in the valley of the St. Lawrence the change in 1763 was not great. The French soldiers and officials were replaced by English ones, and English merchants, for the most part from American colonies, took over the important business in Montreal and Quebec.

The Treaty of Paris in 1763 gave to England a great empire in America. From Florida to Hudson Bay, and from the Atlantic to the Mississippi River, the English were now masters.

The English assumed that the colony on the St. Lawrence River would become like the American colonies; and that it would be governed as the other English colonies were governed, with a royal governor, a council and an elected assembly.

At first, however, there was very little English settlement. Army officials and a few merchants, who established themselves for the most part in Montreal, were the only English to appear. Gradually the British

Courtesy, the Public Archives of Canada

The Peddler, by A. S. Scott, shows the farm family looking at the peddler's wares and listening to his news.

Government changed its mind and decided that Quebec should remain as a colony of French people within the Empire. This decision was made law in 1774 when Parliament in London passed the Quebec Act. This act stated that the civil laws of French-Canadian settlers were to remain in force, though English criminal law was adopted. Land was still to be held according to the feudal seigneurial system which had grown up in New France. The French Catholics of the colony were freed from the laws which elsewhere in the Empire prevented them from having any part in government, and the Catholic Church was given the right to collect tithes. Government was to be by a royal governor and an appointed council, without any elected assembly. The Quebec Act also enlarged the boundaries of Quebec and added to it a great region in the valley of the Ohio and Mississippi rivers.

THE THIRTEEN COLONIES REBEL AGAINST THE MOTHER-COUNTRY

The Quebec Act was passed at a moment when new troubles were appearing for the English in North America. The efforts of the British Government to organize their American empire and to secure money by taxing their colonies were leading rapidly to rebellion. The Quebec Act itself seemed to hem the English colonies in along the Atlantic; and other measures of the London government added to the anger of the Americans. In 1775 the American Revolution was under way, and by 1783 the thirteen colonies had won their independence and had become the United States.

The parts of British North America which remained after the American Revolution were the foundations of the Canada of today. First of all there was Nova Scotia, which had not joined in the Revolution, though many of its settlers had come from New England. Its commercial life was closely bound to that of England and there was a great naval base at Halifax. These were reasons which kept it within the Empire. Second, there was Quebec, whose French inhabitants had shown no interest in the Revolution, even when American armies had invaded Canada.

THE HUDSON'S BAY COMPANY OPENS UP THE WEST

The third area that was kept by England after the Revolution was the fur-trading domain of the Hudson's Bay Company. This reached from the shores of Hudson Bay to some unknown western limit—the Pacific Ocean had not yet been reached by land. The work of the Hudson's Bay Company and of other fur traders, who later pushed westward from Montreal, kept the western prairies as a part of British North America.

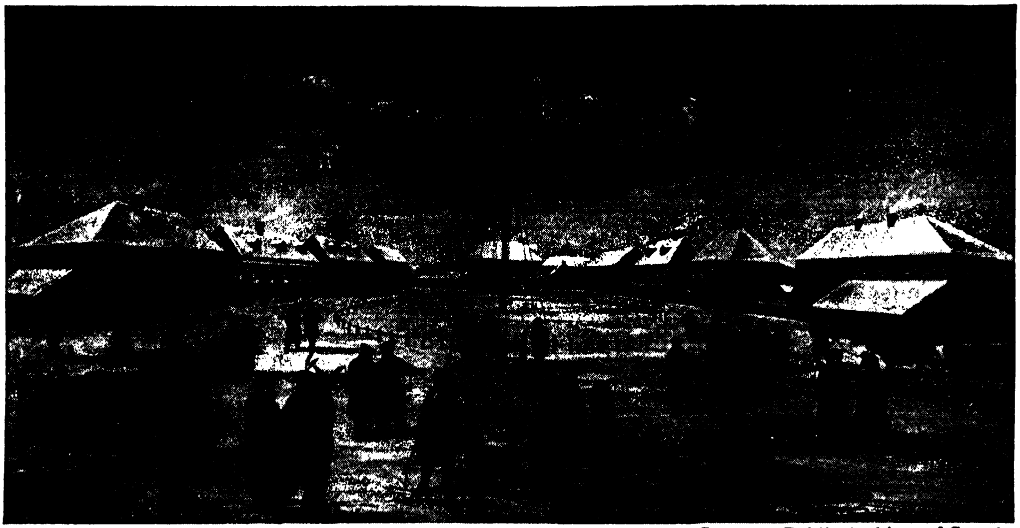
THE RIVALRY BETWEEN THE TWO GREAT FUR COMPANIES

Soon after the British conquest in 1759, it became clear that the old contest between Montreal and the Hudson's Bay Company for the control of the fur trade would continue. English and Scottish business men took over the organization of the fur trade in Montreal, and soon their canoes were penetrating into the far west. A good, though difficult, canoe route led to the western prairies. The large canoes, manned by French-Canadian *voyageurs,* were paddled up the Ottawa in the spring, full of supplies and trading goods. The route lay across the height of land from the Ottawa River by the French River into Georgian Bay, and from there through Lake Huron and Lake Superior to Fort William. There the goods were transferred to smaller canoes for the western part of the journey, which lay by way of the Rainy River system, Lake of the Woods and the Winnipeg River to Lake Winnipeg. From this point the Red, the Assiniboine, the Saskatchewan and, in the far north, the Peace and the Mackenzie rivers led out into the trading areas.

By carrying their trade into this region, the Montreal traders, who soon united in the North West Company, were challenging the Hudson's Bay Company. Soon a fierce competition developed. The two companies built posts side by side at important places on the main rivers and lakes, and sometimes the rivalry flared into violence.

THE SCOTTISH HIGHLANDERS COME TO THE WEST

In 1811 a shareholder in the Hudson's Bay Company, Lord Selkirk, made arrangements to place a settlement of Scottish Highlanders at Fort Garry, where the Red and Assiniboine rivers meet, and where the city of Winnipeg now stands. This colony lay across the path of the North West Company traders, who were afraid that they might be cut off from their trading grounds by such a settlement. They determined to destroy the colony, and very nearly succeeded in doing so. However, in 1821, the two companies joined forces under the name of the Hudson's Bay Company. Montreal ceased to be a center of the trade, which was afterwards carried on by way of Hudson Bay. For half a cen-



Courtesy, Public Archives of Canada

After the North West Company became a part of the Hudson's Bay Company, the trading post of Fort Garry was built where Winnipeg now stands. Here is a view of the inside of the fort. Note the Red-River cart at the left.

tury, the western prairies remained in the control of the fur traders.

Employees of the fur-trading companies opened up the whole western territory. The most famous of these were Alexander Mackenzie, Simon Fraser and David Thompson. Mackenzie followed the great river which bears his name to the Arctic Ocean in 1789, and later crossed the Rockies, by canoe, to reach the Pacific in 1793. Fraser found another canoe route to the Pacific down a river valley, the Fraser, which in modern times is the main railroad right-of-way. David Thompson's explorations opened up the Columbia River to its mouth.

The American Revolution completely changed the course of history for British North America. Perhaps the most dramatic sign of this change lay in the coming of the United Empire Loyalists. These were people who did not wish to stay in the new United States, but moved northward into the colonies which remained British. There were about 40,000 Loyalists in all. Most of these —some 30,000—came by sea to Nova Scotia. Many of these people were completely unaccustomed to the hardships of pioneer life, for they had lived in the seaboard cities of the colonies and had been lawyers and doctors and government officials—not farmers. They had to make a new start in life with only the few possessions they were able to carry with them. The Government gave them land, on which they had to clear away the forest and make log houses. Many new towns sprang up as centers for the Loyalists' settlements. The most important of them was Saint John at the mouth of the St. John River, where about 10,000 Loyalists were settled.

Another group of Loyalists found their way to Quebec, and from there along the St. Lawrence River to new land in the forests of the western river valley and on the shores of Lake Ontario and Lake Erie. Some of the western Loyalists crossed from United States territory at the Niagara River, and founded the first settlements in the Niagara Peninsula. Altogether about 10,000 Loyalists came to the St. Lawrence Valley and the Great Lakes. They were settlers of a rather different type from the Loyalists of the Maritimes, for most of them were pioneer farmers, accustomed to the hardships of life in the wilderness. They made the journey upriver from Quebec and Montreal in open boats, which had to be towed through the rapids. What few belongings they had they carried with them. A few preparations were made for them by the Government, but for the most part it was necessary for them to start their settlements from the very beginning, by cutting down trees and making log cabins.

After the Loyalists came, changes were made in the government of British North America. There were changes in Nova Scotia and Quebec. In Nova Scotia, a new colony was created on the St. John River where the largest group of Loyalists had settled.

Courtesy, Public Archives of Canada
Alexander Mackenzie, as he stood for the first time on the shores of the Pacific.

It was called New Brunswick, and later became one of the provinces of Canada. Prince Edward Island had already been separated from Nova Scotia, and for a time Cape Breton Island, too, was a separate colony.

In Quebec two provinces were created, Lower Canada and Upper Canada. Lower Canada was the French-speaking territory—the modern province of Quebec. Upper Canada was the area settled by the Loyalists; it reached from the edge of French settlement on the St. Lawrence River to the St. Clair River at Detroit. Today it is the province of Ontario. To Upper and Lower Canada the right to have a freely elected assembly was granted. In both provinces large areas were set aside as crown and clergy reserves, for the use of government and for the support of the church. Most of these changes were made by an act of the British Parliament—the Constitutional Act of 1791.

During the next fifty years the English settlements grew rapidly, especially in Upper Canada. It is not certain where all the people came from. Some were settlers from the United States, who found that good land was becoming scarce in western New York. A large part of the increase was a natural one, for pioneer families were large.

Some of the settlement was planned by leaders who were given tracts of land, and who brought people from Europe to live in their settlements.

A great wave of English, Irish and Scottish settlement came to North America and especially to Canada between 1820 and 1850. Times were hard in Europe and thousands of poor people came to find homes in the new world.

The journey to the new world was by no means easy. The passage was cheap, but it was long and dangerous. The fare for a poor immigrant was less than $10, but he brought his own food and bedding. The ships were often old vessels used to carry timber on the eastward journey, and the passengers were crowded into uncomfortable quarters below decks. The passage took many weeks, even with good weather, and sometimes sickness, "ship's fever," was added to the other dangers of the voyage. Some ships were lost in the stormy waters of the North Atlantic, and others were delayed or driven off their course.

When the immigrant arrived at Quebec, he had then to begin the long journey inland to the place where he was to settle. He traveled by boat up the St. Lawrence River; the roads were too primitive for regular use.

When the newcomer reached the end of his journey he faced the heavy task of making a farm out of the forest. First the trees had to be felled, and a cabin built. Usually the stumps were not pulled immediately, and the settler sowed his first crop by spreading the seeds among the roots of the trees. Gradually, year by year, the forest was pushed farther back, the buildings improved, the livestock increased. Almost everything used on the farm was made there, except for a few steel implements such as axes. Furniture and simple tools, candles and soap were made at home. Salt meat and vegetables were put down for the winter, and the maple trees in the wood lot were tapped each spring for their sugar.

Settlements usually grew up around some place where a tributary river ran into the

St. Lawrence or into one of the lakes, or at a point where a river could easily be dammed to supply water power for a mill. The busy water-wheel of the mill was a sign of a growing farming area, for its presence meant that enough farmers were growing wheat to support a miller, or that enough saw logs were being taken out of the forest for a timber industry.

HOW THE NEW LAND WAS DIVIDED AMONG THE SETTLERS

The land on which the settlers made their homesteads was given to them by the government. First surveyors marked out townships, and farms of roughly 100 acres were granted to farmers who would undertake to clear the land and put up buildings. Sometimes the settler chose a piece of land for himself before the government's surveyor had arrived. He then had to persuade the authorities to let him keep the land he had improved. The farms were not entirely free; the settler had to pay fees for the title to the land and to the surveyors. Sometimes there were great delays in securing a title, and a farmer would have to go ahead clearing his land before he was finally certain that it was his. The crown and clergy reserves were a great source of annoyance to the pioneers. These reserves would remain uncleared tracts of forest with no roads long after the surrounding country was settled.

GOVERNOR SIMCOE CALLS UPPER CANADA'S FIRST ASSEMBLY

The first governor of Upper Canada was Colonel John Graves Simcoe (1752-1866). He was an active man who did much to help the early settlers through the first stages of pioneer life. He built important roads in Upper Canada, one running along the shore of the lake, another running northward from York, later Toronto. Simcoe also called the first assembly in Upper Canada, which met in 1792. It was a small gathering, and its powers were not great, but it was the beginning of parliamentary government on the frontiers of Canada.

No new community can grow unless there is some local product which the settlers can sell. For Upper Canada and the Maritimes alike during this period, timber was the product. The forests were filled with excellent wood—maple, oak, elm, walnut and white pine.

The trees were felled and the branches and bark removed; the trees were then drawn to the nearest river and floated downstream. Once a larger river, like the St. Lawrence or the Ottawa, was reached, the timbers were made up into large rafts, strong enough so that they would hold together through the rapids. The men who built them rode on the rafts to Quebec, often pitching their tents or building rough huts directly on the timbers. At the height of the trade, hundreds of ships left each year from Quebec with Canadian timber for England.

The Maritime colonies also shared in the growth of commerce which came from the timber trade. In this area timber had a special use, for it was made into ships, which were then still made entirely of wood. Gradually a great shipbuilding trade grew in Nova Scotia and New Brunswick. Many of the people of these colonies were skilled seamen, and fishing continued to be important.

WATERWAYS WERE HIGHWAYS FOR THE SETTLERS

Water remained for many years the chief means of getting from one place to another in British North America. It was a long time before roads were built, and they were usually poor affairs, so dangerous in bad weather and so bumpy even when dry that they were useless for heavy traffic. The main line of travel for both passengers and freight lay along the St. Lawrence and Ottawa rivers. These waterways, however, were broken by dangerous rapids, so that heavy traffic could not pass. Canal building was the answer to this problem, and the 1830's saw many canals dug around the barriers in the rivers. Canals were costly, and it was years before the canal system was complete. Eventually, however, the farm products of Upper Canada, especially wheat, could be taken by water to Montreal, there to be put aboard ocean vessels for England.

THE LAST WAR TO BE FOUGHT ON CANADIAN SOIL

In 1812 war broke out between the United States and Great Britain. We tell you about this war elsewhere in our book. Canada became involved in the conflict.

The war lasted more than two years. In the Maritimes it was chiefly a naval war, but there was never much enthusiasm about it, because the ties, both economic and social, between the Maritimes and the New England states were very close.

In Upper and Lower Canada, the war took the form of active land fighting. The Americans also secured naval control of Lake Erie and partial control of Lake Ontario. For the Canadians, the chief task was to defend the main entrances to Canada, along the old

Richelieu River route, along the St. Lawrence west of Montreal, and at the Niagara River and at Detroit. Though American armies were able to cross the border at all these points, they were never able to establish themselves on Canadian soil. The Canadians under the leadership of British generals and with the help of British regular troops fought a number of defensive battles, the most important of which were at Queenston Heights, at Crysler's Farm, Châteauguay and Lundy's Lane. In the first of these battles, the British general, Isaac Brock, who had planned the defenses of Upper Canada and whose skill probably saved the province, was killed.

The war ended in 1814 with both sides withdrawing, and there were no changes in the boundary. In the settlement which followed, the foundations were laid for the friendly relations between Canada and the United States which have existed ever since. It is true that many questions had yet to be settled between the republic and the British North America provinces, but they have all been dealt with by peaceful and friendly means in the hundred and thirty-odd years since the War of 1812.

Courtesy, Chamber of Commerce, Hamilton

This appealing group portrays a Loyalist family. It is a monument to the Loyalists in Hamilton, Ontario.

The years before 1850 also saw the beginnings of English-Canadian cultural and social life in the English-speaking colonies. Schools and colleges were founded in many towns in this period—Dalhousie University, in Halifax; Mount Allison University; the University of New Brunswick; Queen's University, in Kingston; King's College (later to become the University of Toronto), Victoria and Trinity universities (later united with the University of Toronto); and another King's College, associated with Pine Hill and Dalhousie in Halifax. Newspapers were founded in all the provinces.

The important Canadian Protestant churches were established during this period, and two church leaders, Bishop John Strachan of the Church of England and Egerton Ryerson of the Methodist Church, were men of great importance in the early educational life of Upper Canada. Many Catholic settlers, especially from Ireland and the north of Scotland, also came to British North America during this period. A Canadian priest, Alexander Macdonell, brought a group of settlers from the Highlands of Scotland to the banks of the St. Lawrence, and remained in Upper Canada to become the first Catholic bishop in the province.

Besides coping with the problems of making towns and farm lands in the wilderness during these years, the settlers had to deal also with a very difficult political problem. The provinces were all British colonies, and the final authority in each was the governor who was appointed in the Colonial Office in London. He was assisted by an executive council made up of royal officials, such as the chief justice and the receiver-general and a few prominent citizens. This council was appointed by the governor, and together they were responsible for all the business of the colony. On the other hand, lawmaking and taxation were controlled by a colonial parliament called a legislature. This had two branches— a legislative council, appointed by the governor, and a legislative assembly, elected by the people.

The difficulty with this system lay in the fact that the people who were elected to the assembly often did not agree with the policies of the governor and his advisers. They could not force the governor to do what they wanted, but they could, and often did, refuse to vote the taxes which were necessary for the governor to carry on the business of the colony.

Gradually discontent mounted. The people generally disliked the men appointed by the governors. They thought land was often distributed unfairly. They disliked the fact that the Church of England enjoyed a position of privilege, though many of the settlers belonged to other churches. In Lower Canada, there were other causes of discontent as well, for there the government was made up for the most part of Englishmen, while the majority of the settlers were French.

In all the colonies there grew up a party of men, often called the Reformers, who wished authority to be transferred from the governor to the assembly. In Lower Canada the assembly fell under the leadership of Louis Joseph Papineau (1789-1871). In Upper Canada a Scottish newspaper owner, William Lyon Mackenzie (1795-1861) became leader of the Reformers. Both these men were led to adopt extreme positions, and in 1837 they turned to rebellion as a method of winning their aims. The rebellions, which broke out in both Upper and Lower Canada, were not very serious and did not last very long. In each colony, the governor was able to defeat the rebels, and very soon the fighting died out. Both Mackenzie and Papineau fled to the United States. The rebellion never spread to the Maritime Provinces, though there was a vigorous reform movement in those colonies.

The rebellion, in spite of its seeming failure, really had important results. The British Government sent the Earl of Durham to Canada with full power to find out the source of the trouble. Durham himself was a reformer in English political life, and he believed that colonies should be given as much freedom as possible. In Canada he found that the governors had been making many mistakes, and that there were indeed abuses which needed to be corrected. He also found that there was a group of moderate reform leaders in each colony who could be trusted. One of these, Robert Baldwin, in Upper Canada, had suggested that the governor should accept in his executive council only men approved by the colonial assembly. In this way, the governor's policies would be the people's desires, expressed through their elected representatives in the assembly. Durham wrote a report in which he suggested that this system, which is called Responsible Government, should be adopted.

This seemed a very revolutionary doctrine, for it meant that a governor would no longer do what the Colonial Office in London told him to do, but would always accept the advice of councilors supported by the colonial assembly. Durham made his report in 1839. It was almost ten years before his advice in this matter was finally accepted.

In the meantime the moderate reformers in the colonies had taken heart, and they began now to seek the changes which Durham had suggested. Upper and Lower Canada were joined together on Durham's recommendation into the province of Canada by the Union Act of 1840. Here a vigorous reform party emerged under the leadership of Robert Baldwin, of Toronto, and Louis H. La Fontaine, of Lower Canada. Together with the support of their followers, both French and English, they urged on the governors who followed Durham that government should be entrusted to men whom the assembly trusted. These governors, Sydenham, Bagot and Metcalfe, were able men who tried to govern the colony well, but they could not accept the idea that they must depend on their assembly. In Nova Scotia the same ideas of responsible government were being urged by the reform leader Joseph Howe.


A log church built by the pioneers.

Finally, in 1846, a new and liberal Colonial Secretary in England, Lord Grey, instructed the governors to choose advisers who had the confidence of the assembly, and he took special pains to send out governors who were prepared to do so. Within a few years, the reformers were at the head of the governments in all the colonies. Thus, in all matters of local importance, responsibility had been transferred to the citizens of the colony. Self-government for a colony had been put in practice, and the foundation laid for the modern British Commonwealth of self-governing nations.

Great progress had been made since the day in 1763 when Canada had passed from the hands of France and become a British colony. To the French settlers had been added an almost equal number of English-speaking settlers. The population of both French and English had increased, and by 1850 it numbered over two million. Settlement now reached from the Atlantic seaboard to Lake Huron, communications had been built, towns and cities founded, a growing trade established. Most important of all for the future life of the nation, the right of the people to govern themselves had been asked by the colonists and granted by the mother-country.

THE NEXT STORY OF CANADA IS ON PAGE 1482.

DEAN SWIFT'S GREAT SATIRE

A FEW years after Robinson Crusoe was published, one of the greatest satirical stories in our language appeared. This was Travels into Several Remote Nations of the World, the author of which called himself "Lemuel Gulliver." The first part appeared in 1726. It was written just like a book of real travel, but its purpose was to satirize the England of that time, to laugh at its follies. The story is extraordinary, and people liked it because it was so unusual. It has been a favorite with young folk for many generations, as the adventures it describes are so quaintly impossible that they are interesting quite apart from their inner meaning. The author was the Rev. Jonathan Swift, Dean of St. Patrick's, Dublin. Lilliput is meant for England. The war with Blefuscu about the eggs is meant to ridicule the stupid reasons nations had for making war.

GULLIVER'S TRAVELS

LEMUEL GULLIVER tells us that his father had a small estate in Nottinghamshire, and that he was the third of five sons. He was bound apprentice to an eminent surgeon in London. His father now and then sending him small sums of money, he laid them out in learning navigation. He believed that some day he would travel, and this knowledge would be useful to him. He did become surgeon successively in two ships, and made several voyages to the East and West Indies. His hours of leisure on these voyages were spent in reading the best authors. When he went ashore he observed the manners of the people and learned their language.

Gulliver afterward accepted an offer from Captain Prichard, master of the Antelope, who was making a voyage to the South Sea, and set sail from Bristol, May 4, 1699. They were driven by a storm to the northwest of Van Diemen's Land, where they were tossed on a rock. Six of the crew, of whom Gulliver was one, launched a lifeboat and got into it, but in about half an hour it was upset. What became of his companions he did not know, but he swam as fortune directed him. When he was almost worn out, he found himself within his depth, and so, throwing himself on the ground in weariness, Gulliver fell asleep at once. When he waked he was unable to move. His arms, legs, body and hair were fastened to the ground. A human creature not six inches high appeared on his chest. More were running over his body when he roared and frightened them off. An attempt to free his left arm brought a shower of tiny arrows which pricked like needles. He decided to remain quiet, and no more arrows were discharged. The tiny people built a platform one and a half feet high near Gulliver's head. From this a person of authority made an address. By signs Gulliver showed his hunger. He was given whole joints of meat which were about the size of birds' wings. The loaves of bread, each about the size of a rifle bullet, Gulliver ate three at a time. When his hunger was satisfied, he was given two barrels of wine, each containing 108 tiny gallons. He astounded the Lilliputians (as he discovered the name of the people to be) by drinking a barrel at a swallow.

After this Gulliver went to sleep and slept for about eight hours. The Lilliputians dabbed his face and hands with an ointment which removed all smart of their arrows.

By the emperor's orders the physicians had mingled a sleeping potion in the wine given to Gulliver. While drugged he was conveyed to the Lilliputian capital on an engine made by a small army of engineers and carpenters, and drawn by fifteen hundred of the emperor's largest horses. There was outside the capital an ancient temple, the largest in the kingdom. The great gate was about four feet high and two feet wide, and through this he managed to creep. To the portal of this temple he was for a time chained by his left leg.

Some hundred thousand of the inhabitants came out to view him, and his guards numbered ten thousand. He continued to lie on the ground of the temple for about a fortnight. Then the emperor caused a bed to be made for him, six hundred beds of the common size being used for this purpose. An imperial order was issued, obliging all the villages nine hundred yards round the city to provide the prisoner with food and drink. Payment for this was to be made from the imperial treasury. The allowance stipulated was sufficient for the support of 1,728 Lilliputians.

An establishment of six hundred domestics was also arranged for him. Further, three hundred tailors were appointed to make him a suit of clothes after the fashion of the country. The land appeared like a continuous garden, and the inclosed fields, which were generally forty feet square, resembled so many beds of flowers.

Proclamations were issued directing all who had beheld the Man-Mountain, as he was called in the language of the country, to return home and not to come within fifty yards of his house without license from the court. This was to prevent anyone's being hurt.

GULLIVER AT THE ROYAL PALACE OF LILLIPUT

One day the emperor desired Gulliver to stand up like the Colossus, with his legs apart. Between his legs marched the Lilliputian army. The troops so engaged numbered three thousand foot and a thousand horse.

At last, upon certain conditions, Gulliver was given his liberty, and was allowed to see the capital. The people had notice by proclamation of his design to visit the town. When he had finished his inspection, the emperor of Lilliput sent Gulliver a special invitation to visit the royal palace.

What follows is told in Gulliver's own words.

GULLIVER IN THE LAND OF LILLIPUT

THE emperor had a great desire that I should see the magnificence of his palace; but this I was not able to do till three days after, which I spent in cutting down with my knife some of the largest trees in the royal park, about a hundred yards distance from the city. Of these trees I made two stools, each about three feet high, and strong enough to bear my weight. The people having received notice a second time, I went again through the city to the palace with my two stools in my hands. When I came to the side of the outer court, I stood upon one stool, and took the other in my hand; this I lifted over the roof, and gently set it down on the space between the first and second court, which was eight feet wide. I then stepped over the building very conveniently from one stool to the other, and drew up the first after me with a hooked stick. By this contrivance I got into the inmost court; and, lying down upon my side, I applied my face to the windows of the middle stories, which were left open on purpose, and discovered the most splendid apartments that can be imagined. There I saw the empress and the young princes, in their several lodgings, with their chief attendants about them. Her imperial majesty was pleased to smile very graciously upon me, and gave me out of the window her hand to kiss. I did this as gallantly as possible.

One morning, about a fortnight after I had obtained my liberty, Reldresal, principal secretary for private affairs, came to my house attended only by one servant. He ordered his coach to wait at a distance, and desired I would give him an hour's audience; which I readily consented to, on account of his quality and personal merits, as well as of the many good offices he had done me during my solicitations at court. I offered to lie down, that he might the more conveniently reach my ear; but he chose rather to let me hold him in my hand during our conversation. He began with compliments on my liberty; said "he might pretend to some merit in it;" but however added, "that if it had not been for the present situation of things at court, perhaps I might not have obtained it so soon.

GULLIVER BOUND AND GULLIVER FREE

Gulliver had been driven ashore from a wreck on the coast of a strange land, which turned out to be Lilliput. As he lay asleep the Lilliputians, none of whom was bigger than one of Gulliver's fingers, secured him to the earth with numerous ropes and pegs. When he awoke and began to wrench himself free, he shook many of the little people off him like flies. They had to attack him with whole regiments of archers to make him lie quiet before they conveyed him, with infinite labor, to the capital of Lilliput.

It was no easy matter for Gulliver to accept the king's invitation to inspect the palace, as he could not step over the houses and walls without knocking some of them down. But at length, by making a stool out of some of the trees he found growing in the park, he stepped across without damaging the buildings. In order to look into the rooms in the upper stories he had to lie down in the great square of the palace. The queen looked out of the window and, smiling very graciously upon him, gave him her hand to kiss.

For," said he, "as flourishing a condition as we may appear to be in to foreigners, we labor under two mighty evils; a violent faction at home, and the danger of an invasion, by a most potent enemy, from abroad. As to the first, you are to understand, that for above seventy moons past there have been two struggling parties in this empire, under the names of *Tramecksan* and *Slamecksan,* from the high and low heels of their shoes, by which they distinguish themselves. It is alleged, indeed, that the high heels are most agreeable to our ancient constitution; but, however this be, his majesty has determined to make use only of low heels in the administration of the government, and all offices in the gift of the crown, as you cannot but observe: and particularly that his majesty's imperial heels are lower at least by a *drurr* than any of his court (*drurr* is a measure about the fourteenth part of an inch). The animosities between these two parties run so high, that they will neither eat, nor drink, nor talk with each other. How, in the midst of these intestine disquiets, we are threatened with an invasion from the island of Blefuscu, which is the other great empire of the universe, almost as large and powerful as this of his majesty. These two mighty powers have, as I was going to tell you, been engaged in a most obstinate war for six and thirty moons past. It began upon the following occasion. It is allowed on all hands, that the primitive way of breaking eggs before we eat them was upon the larger end; but his present majesty's grandfather, while he was a boy, going to eat an egg, and breaking it according to the ancient practice, happened to cut one of his fingers; whereupon the emperor his father published an edict, commanding all his subjects, upon great penalties, to break the smaller end of their eggs. The people so highly resented this law, that our histories tell us there have been six rebellions raised on that account; wherein one emperor lost his life, and another his crown. These civil commotions were constantly fomented by the monarchs of Blefuscu; and when they were quelled, the exiles always fled for refuge to that empire. It is computed that eleven thousand persons have, at several times, suffered death rather than submit to break their eggs at the smaller end. Many hundred large volumes have been published upon this controversy: but the books of the Big-endians have been long forbidden, and the whole party rendered incapable by law of holding employments. The enemy have now equipped a numerous fleet, and are just preparing to make a descent upon us; and his imperial majesty, placing great confidence in your valor and strength, has commanded me to lay this account of his affairs before you."

I desired the secretary to present my humble duty to the emperor; and to let him know that I was ready, with the hazard of my life, to defend his person and state against all invaders.

The empire of Blefuscu is an island situated to the northeast of Lilliput, from which it is parted only by a channel of eight hundred yards wide. I had not yet seen it, and upon this notice of an intended invasion, I avoided appearing on that side of the coast, for fear of being discovered by some of the enemy's ships, who had received no intelligence of me; all intercourse between the empires having been strictly forbidden during the war, upon pain of death, and an embargo laid by our emperor upon all vessels whatsoever. I communicated to his majesty a project I had formed, of seizing the enemy's whole fleet; which, as our scouts assured us, lay at anchor in the harbor, ready to sail with the first fair wind. I consulted the most experienced seamen upon the depth of the channel, which they had often plumbed; who told me that in the middle at high water it was seventy *glumgluffs* deep, which is about six feet of European measure; and the rest of it fifty *glumgluffs* at most. I walked towards the northeast coast, over against Blefuscu; where, lying down behind a hillock, I took out my small perspective glass, and viewed the enemy's fleet at anchor, consisting of about fifty men-of-war, and a great number of transports: I then came back to my house, and gave orders (for which I had a warrant) for a great quantity of the strongest cables and bars of iron. The cable was about as thick as packthread, and the bars of the length and size of a knitting-needle. I trebled the cable to make it stronger, and for the same reason I twisted three of the iron bars together, bending the extremities into a hook. Having thus fixed fifty hooks to as many cables, I went back to the northeast coast, and putting off my coat, shoes, and stockings, walked into the sea, in my leathern jerkin, about half an hour before high-water. I waded through with what haste I could, and swam in the middle about thirty yards, till I felt ground. I arrived at the fleet in less than half an hour. The enemy were so frightened when they saw me, that they leaped out of their ships, and swam to shore, where there could not be fewer than thirty thousand souls. I then took my tackling, and fastening a hook to the hole at the prow of each, I tied all the cords together at the end. While I was thus employed, the enemy discharged several thousand arrows, many of which stuck in my hands and face; and, besides the excessive smart, gave me much disturbance in my work. My greatest apprehension was for my eyes, which I should have infallibly lost, if I had not suddenly thought of an expedient. I kept, among other little necessaries, a pair of spectacles in a private pocket; these I took out and fastened as strongly as I could upon my nose, and thus armed, went on boldly with my work, in spite of the enemy's arrows, many of which struck against the glasses of my spectacles, but without any effect. I had now fastened all the hooks, and taking the knot in my hand, began to pull; but not a ship would stir, for they were all too fast held by their anchors, so that the boldest part of my enterprise remained. I therefore let go the cord, and leaving the hooks fixed to the ships, I resolutely cut with my knife the cables that fastened the anchors, receiving about two hundred shots in my face and hands; then I took up the knotted end of the cables, to which my hooks were tied, and with great ease drew fifty of the enemy's largest men-of-war after me.

The Blefuscudians, who had not the least notion of what I intended, were at first confounded with astonishment. They had seen me cut the cables, and thought my design was only to let the ships run adrift, or fall foul of each other; but when they perceived the whole fleet moving in order, and saw me pulling at the end, they set up such a scream of grief and despair as it is almost impossible to describe. When I had got out of danger, I stopped awhile to pick out the arrows that stuck in my face; and rubbed on some of the same ointment that was given me on my arrival, as I have formerly mentioned. I then took off my spectacles, and waiting about an hour, till the tide was a little fallen, I waded through the middle with my cargo, and arrived safe at the port of Lilliput.

The emperor and his whole court stood on the shore, expecting the issue of this great adventure. They saw the ships move forward in a large half-moon, but could not discern me, who was up to my breast in water. When I advanced to the middle of the channel, they were yet more in pain, because I was under water to my neck. The emperor concluded me to be drowned, and that the enemy's fleet was approaching in a hostile manner: but he was soon eased of his fears; for the channel growing shallower every step I made, I came in a short time within hearing, and holding up the end of the cable by which the fleet was fastened, I cried in a loud voice, "Long live the most puissant king of Lilliput!" The prince received me at my landing with all possible encomiums.

His majesty desired that I should take some other opportunity of bringing all the rest of his enemy's ships into his ports. And so unmeasurable is the ambition of princes, that he seemed to think of nothing less than reducing the whole empire of Blefuscu into a province, and governing it by a viceroy; of destroying the Big-endian exiles, and compelling that people to break the smaller end of their eggs, by which he would remain the sole monarch of the whole world. But I endeavored to divert him from this design by many arguments drawn from the topics of policy as well as justice; and I plainly protested, "that I would never be an instrument of bringing a free and brave people into slavery."

. . . .

The foregoing has been given in Gulliver's words. We shall tell in condensed form more of his story.

But because Gulliver protested against the Emperor's revengeful design for reducing the whole of the rival empire into a province and destroying the Big-endian exiles, he fell into disfavor.

Being informed of a design to accuse him of high treason, he made his escape to Blefuscu. Whence, by a lucky accident, he secured the means of reaching his own country again, and returned to England on April 13, 1702.

Like Robinson Crusoe, Gulliver had a passion for travel. On the twentieth of June following his return from Lilliput, he sailed for Surat, in the Adventure. About a year later this vessel was driven in an eastward direction, past the Molucca Islands. The ship being in need of water, the captain sent a party ashore in the long-boat, Gulliver being of the number. When they came to land, Gulliver wandered about a mile away from the sea.

Returning to the creek, he saw the men already in the boat, and rowing for life to the ship. He was about to holloa after them, when he observed a huge creature walking after them in the sea. But the men, having the start, escaped. Gulliver ran inland and up a steep hill which gave him a view of the surrounding country.

He found it fully cultivated. But what first surprised him was the length of the grass, which in those grounds that seemed to be kept for hay was about twenty feet high. He came upon a high road, so he imagined, though it served to the inhabitants only as a footpath through a field of barley! Here he walked for some time, but could see little on either side, it being now near harvest, and the corn rising at least forty feet. In a field he saw several giants with reaping-hooks.

Gulliver lamented his folly and willfulness in attempting a second voyage against the advice of all his friends and relatives. As he lay hidden in a ridge for terror, one of the reapers approached so near as to make him fear that he should be squashed to death under foot or cut in two with the reaping-hook. He screamed as loudly as he could. The reaper picked him up and examined him in surprise. Then he took the tiny stranger to the farmer, his master.

Gulliver was received well in the farmer's family, and made a pet of by the farmer's daughter. The farmer was advised to exhibit him for money. Finally, he was sold to the queen of the land, and had much conversation with the king, when he had mastered the language of the country.

Here Gulliver continues the story in his own words.

GULLIVER IN THE LAND OF BROBDINGNAG

HE desired the queen to order that particular care should be taken of me; and was of opinion that Glumdalclitch should still continue in her office of tending me, because he observed we had a great affection for each other. A convenient apartment was provided for her at court; she had a sort of governess appointed to take care of her education, a maid to dress her, and two other servants for menial offices; but the care of me was wholly appropriated to herself. The queen commanded her own cabinet-maker to contrive a box, that might serve me for a bed-chamber, after the model that Glumdalclitch and I should agree upon. This man was a most ingenious artist, and according to my direction, in three weeks finished for me a wooden chamber of sixteen feet square, and twelve high, with sash-windows, a door, and two closets, like a London bed-chamber. The board that made the ceiling, was to be lifted up and down by two hinges to put in a bed ready furnished by her majesty's upholsterer, which Glumdalclitch took out every day to air, made it with her own hands, and letting it down at night, locked up the roof over me. A nice workman, who was famous for little curiosities, undertook to make me two chairs, with backs and frames, of a substance not unlike ivory, and two tables, with a cabinet to put my things in. The room was quilted on all sides, as well as the floor and the ceiling, to prevent any accident from the carelessness of those who carried me, and to break the force of a jolt, when I went in a coach. I desired a lock for my door, to prevent rats and mice from coming in. The smith, after several attempts, made the smallest that ever was seen among them, for I have known a larger at the gate of a gentleman's house in England.

The queen became so fond of my company, that she could not dine without me. I had a table placed upon the same at which her majesty ate, just at her elbow, and a chair to sit on. Glumdalclitch stood on a stool on the floor near my table, to assist and take care of me. I had an entire set of silver dishes and plates, and other necessaries, which, in proportion to those of the queen, were not much bigger than what I have seen in a London toy-shop, for the furniture of a baby-house: these my little nurse kept in her pocket, in a silver box, and gave me at meals as I wanted them, always cleaning them herself. No person dined with the queen but the two princesses royal, the eldest sixteen years old, and the younger at that time thirteen and a month. Her majesty used to put a bit of meat upon one of my dishes, out of which I carved for myself, and her diversion was to see me eat in miniature; for the queen (who had indeed but a weak stomach) took up, at one mouthful, as much as a dozen English farmers could eat at a meal, which to me was for some time a very nauseous sight. She would crunch the wing of a lark, bones and all, between her teeth, although it were nine times as large as that of a full-grown turkey; and put a bit of bread in her mouth as big as two twelvepenny loaves. She drank out of a golden cup, above a hogshead at a draught. Her knives were twice as long as a scythe, set straight upon the handle. The spoons, forks, and other instruments were all in the same proportion. I remember when Glumdalclitch carried me, out of curiosity, to see some of the tables at court, where ten or a dozen of those enormous knives and forks were lifted up together, I thought I had never till then beheld so terrible a sight.

It is the custom, that every Wednesday the king and queen, with the royal issue of both sexes, dine together in the apartment of his majesty, to whom I was now become a great favorite; and at these times, my little chair and table were placed at his left hand, before one of the salt-cellars. This prince took a pleasure in conversing with me, inquiring into the manners, religion, laws, government, and learning of Europe; wherein I gave him the best account I was able. His apprehension was so clear, and his judgment so exact, that he made very wise reflections and observations upon all I said. But after I had been talking copiously of my own beloved country, turning to his first minister, who waited behind him with a white staff, near as tall as the mainmast of the Royal Sovereign, he observed, "how contemptible a thing was human grandeur, which could be mimicked by such diminutive insects as I, and yet," said he, "I dare engage these creatures have their titles and distinctions of honor; they contrive little nests and burrows, that they call houses and cities; they make a figure and dress in equipage; they love, they fight, they dispute, they cheat, they betray." And thus he continued, while my color came and went several times, with indignation, to hear our noble country, the mistress of arts and arms, the scourge of France, the arbitress of Europe, the seat of virtue, piety, honor, and truth, the pride and envy of the world, so contemptuously treated.

But as I was not in a condition to resent injuries, upon mature thoughts I began to doubt whether I was injured or no. For after having been accustomed several months to the sight and converse of this people, and observed every object upon which I cast my eyes to be of proportionable magnitude, the horror I had at first conceived from their bulk and aspect was so far worn off, that if I had then beheld a company of English lords and ladies in their finery and birth-day clothes, acting their several parts in the most courtly manner of strutting, and bowing, and prating, to say the truth, I should have been strongly tempted to laugh as much at them as the king and his grandees did at me. Neither, indeed, could I forbear smiling at myself, when the queen used to place me upon her hand towards a looking-glass, by which both our persons appeared before me in full view together; there could be nothing more ridiculous than the comparison; so that I really began to imagine myself dwindled many degrees below my usual size.

Nothing angered and mortified me so much as the queen's dwarf; who being of the lowest stature that was ever in that country (for he was not full thirty feet high), became so insolent at seeing a creature so much beneath him, that he would affect to swagger and look big as he passed by me in the queen's antechamber, while I was standing on some table talking with the lords or ladies of the court, and he seldom failed of a smart word or two upon my littleness; against which I could only revenge myself by calling him brother, challenging him to wrestle, and such repartees as are usually in the mouths of court pages. One day at dinner, this malicious little cub was so nettled with something I had said to him, that raising himself upon the frame of her majesty's chair, he took me up by the middle, as I was sitting down not thinking any harm, and let me drop into a large silver bowl of cream, and then ran away as fast as he could. I fell over head and ears, and, if I had not been a good swimmer, it might have gone very hard with me; for Glumdalclitch in that instant happened to be at the other end of the room, and the queen was in such a fright, that she wanted presence of mind to assist me. But my little nurse ran to my relief, and took me out, after I had swallowed above a quart of cream. I was put to bed: however, I received no other damage than the loss of a suit of clothes, which were utterly spoiled. The dwarf was soundly whipped, and, as a further punishment, forced to drink up the bowl of cream into which he had thrown me; neither was he ever restored to favor; for soon after the queen bestowed him on a lady of high quality, so that I saw him no more, to my very great satisfaction: for I could not tell to what extremity such a malicious urchin might have carried his resentment.

I was frequently rallied by the queen on account of my fearfulness; and she used to ask me whether the people of my country were as great cowards as myself? The occasion was this: the kingdom is much pestered with flies in summer; and these odious insects, each of them as big as a Dunstable lark, hardly gave me any rest while I sat at dinner, with their continual humming and buzzing about my ears. I had much ado to defend myself against these detestable animals, and could not forbear starting when they came on my face. It was the common practice of the dwarf, to catch a number of these insects in his hand, as school-boys do among us, and let them out suddenly under my nose, on purpose to frighten me, and divert the queen. My remedy was to cut them in pieces with my knife, as they flew in the air, wherein my dexterity was much admired.

I remember, one morning, when Glumdalclitch had set me in a box upon a window, as she usually did in fair days, to give me air (for I durst not venture to let the box be hung on a nail out of the window, as we do with cages in England), after I had lifted up one of my sashes, and sat down at my table to eat a piece of sweet cake for my breakfast, above twenty wasps, allured by the smell, came flying into the room humming louder than the drones of as many bagpipes. Some of them seized my cake, and carried it piecemeal away; others flew about my head and face, confounding me with the noise, and putting me in the utmost terror of their stings. However, I had the courage to rise and draw my hanger, and attack them in the air. I dispatched four of them, but the rest got away, and I presently shut my window. These insects were as large as partridges; I took out their stings, found them an inch and a half long, and as sharp as needles. I carefully preserved them all; and having since shown them, with some other curiosities, in several parts of Europe, upon my return to England I gave three of them to Gresham College, and kept the fourth for myself.

I now intend to give the reader a short description of this country, as far as I travelled in it, which was not above two thousand miles round Lorbrulgrud, the metropolis.

The country is well inhabited, for it contains fifty-one cities, nearly a hundred walled towns, and a great number of villages. To satisfy the curious reader, it may be sufficient to describe Lorbrulgrud. This city stands upon almost two equal parts, on each side the river that passes through. It contains above eighty thousand houses, and about six hundred thousand inhabitants. It is in length three *glomglungs* (which make about fifty-four English miles), and two and a half in breadth; as I measured it myself in the royal map made by the king's order, which was laid on the ground on purpose for me, and extended a hundred feet: I paced the diameter and circumference several times barefoot, and computing by the scale, measured it pretty exactly.

The king's palace is no regular edifice, but a heap of building, about seven miles round; the chief rooms are generally two hundred and forty feet high, and broad and long in proportion. A coach was allowed to Glumdalclitch and me, wherein her governess frequently took her out to see the town, or go among the shops; and I was always of the party, carried in my box; although the girl, at my own desire, would often take me out, and hold me in her hand, that I might more conveniently view the houses and the people, as we passed along the streets. I reckoned our coach to be about a square of Westminster-hall, but not altogether so high: however, I cannot be very exact.

Besides the large box in which I was

THE ARMY OF LILLIPUT MARCHES PAST

One of the most memorable parades in literature—the Lilliputian army marching between Gulliver's legs.

usually carried, the queen ordered a smaller one to be made for me, of about twelve feet square, and ten high, for the convenience of travelling; because the other was somewhat too large for Glumdalclitch's lap, and cumbersome in the coach; it was made by the same artist, whom I directed in the whole contrivance. This travelling closet was an exact square, with a window in the middle of three of the squares, and each window was latticed with iron wire on the outside, to prevent accidents in long journeys. On the fourth side, which had no window, two strong staples were fixed, through which the person that carried me, when I had a mind to be on horseback, put a leathern belt, and buckled it about his waist. This was always the office of some grave trusty servant, in whom I could confide, whether I attended the king or queen in their progresses, or was disposed to see the gardens, or to pay a visit to some great lady or minister of state in the court, when Glumdalclitch happened to be indisposed; for I soon began to be known and esteemed among the greatest officers, I suppose more upon account of their majesties' favor, than any merit of my own. In journeys, when I was weary of the coach, a servant on horseback would buckle on my box, and place it upon a cushion before him; and there I had a full prospect of the country on three sides, from my three windows. I had, in this closet, a field-bed and a hammock hung from the ceiling, two chairs and a table, neatly screwed to the floor, to prevent being tossed about by the agitation of the horse or the coach. And having been long used to sea-voyages, those motions, although sometimes very violent, did not much discompose me.

I was very desirous to see the chief temple, and particularly the tower belonging to it, which is reckoned the highest in the kingdom. Accordingly, one day my nurse carried me thither, but I may truly say that I came back disappointed; for the height is not above three thousand feet, reckoning from the ground to the highest pinnacle top; which, allowing for the difference between the size of those people and us in Europe, is no great matter for admiration, nor at all equal in proportion (if I rightly remember), to Salisbury steeple. But, not to detract from a nation to which, during my life, I shall acknowledge myself extremely obliged, it must be allowed, that, whatever this famous tower wants in height, is amply made up in beauty and strength; for the walls are near a hundred feet thick, built of hewn stone, whereof each is about forty feet square, and adorned on all sides with statues of gods and emperors, cut in marble, larger than life, placed in their several niches. I measured a little finger which had fallen down from one of these statues, and lay unperceived among some rubbish, and found it exactly four feet and an inch in length. Glumdalclitch wrapped it up in her handkerchief, and carried it home in her pocket, to keep among other trinkets; of which the girl was very fond, as children at her age usually are.

One day, Glumdalclitch left me on a smooth grass-plot to divert myself, while she walked at some distance with her governess. In the meantime, there suddenly fell such a violent shower of hail, that I was immediately, by the force of it, struck to the ground; and when I was down, the hailstones gave me such cruel bangs all over the body, as if I had been pelted with tennis-balls; however, I made a shift to creep on all fours, and shelter myself, by lying flat on my face, on the leeside of a border of lemon-thyme; but so bruised from head to foot, that I could not go abroad for ten days. Neither is this at all to be wondered at, because as nature in that country observes the same proportion through all her operations, a hailstone is nearly eighteen hundred times as large as one in Europe; which I can assert upon experience, having been so curious as to weigh and measure them.

. . . .

We must close the quotation to tell briefly what else happened to Gulliver.

After going through many adventures, he was in his box one day when it was caught up by a great bird, and carried out to sea, where it fell in the water. The box was seen by the captain of a ship. Thus it was that Gulliver was released and returned to England in 1706.

Gulliver in his later travels went to Laputa, a flying island inhabited by philosophers and astronomers. His last adventure brought him to the country of the Houyhnhnms, in which horses were the representatives of civilization, and men, under the name of Yahoos, were degraded beings of the lowest type.

THE NEXT STORY OF FAMOUS BOOKS IS ON PAGE 1421.

A Raphael fresco filling a lunette in the Vatican.

RAPHAEL AND HIS TIME

WHILE Michelangelo was working at his immortal frescoes and statuary, and attracting the attention of beauty-loving people to Rome, two other artists, also born in Florence, were continuing the traditions of the famous town. They were men who would have been unequaled leaders in a period less rich in art; had Leonardo da Vinci and Michelangelo never been born, Fra Bartolommeo and Andrea del Sarto would themselves, in the same generation, have made the name of Florence memorable.

During the two centuries in which Tuscan art was developing, painting as painting—that is to say, the technique of the art apart from the subject painted—had passed through a curious change. Let us review quickly this change, to which we have already given attention in the preceding chapters. We have seen Duccio seeking after more living forms, but not quite able to embody the sense of life in his painted shapes; then Giotto, with his more vigorous work presented in clear, water-color tones. Then came Fra Angelico and Botticelli, whose faults of technique we forgive for the sake of their spiritual and temperamental charms. After them Cosimo showed an advance in strength and sweetness, and Masaccio made men stop to think because he painted, with definite strokes, vigorous persons and definite situations. And Leonardo, with a technique both strong and pliant, was the first artist to introduce into painting what is called *chiaroscuro*—light and shade in color. The work of Fra Bartolommeo and Andrea del Sarto followed as a natural outcome of these changing styles.

Fra Bartolommeo, who lived from 1475 to 1517, stands out both as a wonderful colorist and as a remarkable master of composition. He built up masses of figures as an architect throws out buttresses and towers from a central body of stone. This faculty is shown in almost all the artist's work. There is the fine painting called The Virgin Appearing to St. Bernard, now in the Florence Academy, where the figures are piled up on either hand from an almost empty central space. In the picture called Madonna della Misericordia, in the gallery at Lucca, groups of people are arranged in a truly monumental fashion.

The painter-monk produced many works in his short lifetime—altar-pieces, frescoes, a great many smaller pictures, Holy Families and Madonnas. Raphael's attention was caught by a fresco of Bartolommeo's, painted in the hospital of Santa Maria Nuova in

Florence. Raphael was impressed by both the color and the composition in the monk's work, and sought to learn some of his secrets of technique.

Had Bartolommeo had even a small degree of the skill in delineation of character and individual beauty which Leonardo possessed, he would have been counted among the great masters. His genius lay in the grouping of his figures; the people he painted, beautiful shapes though they may be, lack vitality; and in his later work, in an effort to imitate the strong light and shade of Leonardo, he spoiled his own naturally clear and beautiful color.

THE MEN WHO MADE THE NAME OF FLORENCE FAMOUS FOREVER

A very different person was Andrea del Sarto, who lived from 1486 to 1531. In a way he was the rival of Fra Bartolommeo, and his technique and charm were such that he was known as the faultless painter. In a generation of geniuses Andrea was much admired—according to the later judgment of history, a little more than he deserved. When Michelangelo was in Rome talking to Raphael one day, he said, "There's a little man yonder in Florence who, were he employed on such great works as these, would bring the sweat to your brow." But we ourselves reserve such warmth of approval for Michelangelo's own work; the "faultless painter" leaves us pleasantly interested and admiring.

Andrea del Sarto had in his best work an extraordinary smoothness and sweetness. But he shows weakness in being imitative. He followed Leonardo's skillful blending of light and shade with color, but he had none of the great master's genius of insight into character; he aspired to Michelangelo's rugged grandeur, and simply formed a habit of making heavy draperies. His ideals were never lofty, for his mind had a tinge of commonness; but his painting, as painting, was exquisite. All his figures were bathed in a beautiful soft light.

ANDREA DEL SARTO SHOWS THE RARE SWEETNESS OF FLORENTINE ART

To study the work of this man is to realize how far Florentine art had gone in the journey away from archaism to sweetness and human freshness and lovableness. Religion still has a considerable place, but happiness has come into art, to stay, we hope, forever.

Two fine groups of Andrea del Sarto's —Charity and The Holy Family—are in the Louvre. But his work should be studied in Florence, where so much of it is treasured. There is a fresco of the Last Supper, at San Salvi, which attracts the eye even after looking at Leonardo's master-work on this subject; several frescoes in Santissima Annunziata, such as the Birth of the Virgin, show his skill in composition.

Like most Italian artists, Andrea del Sarto painted a number of Madonnas, and he stands out a little among his fellows in having created a new type of face for the mother of Christ. Two fine specimens are the Virgin in The Holy Family, in the Pitti Palace, and the Madonna delle Arpie, in the Uffizi. The faces in these pictures are characterized not so much by saintliness as by sweetness, charm, simplicity.

For most of them he used as a model his lovely and wayward wife, whose facial beauty was not the outward sign of a beautiful spirit. Whether we look at them from the point of view of the painter's father unhappy attachment for an unscrupulously selfish and hard woman, or from the point of view of beautiful portraiture, or as pictures of the Virgin, they claim our admiration and mark a stage in the countless repetitions of the little Jesus and his mother.

WANDERING ARTISTS WHO GAVE BEAUTY TO THE TOWNS AND VILLAGES

Another Florentine painter who was busy about this time was Bronzino. He lived from 1502 to 1572, and is chiefly remembered for his portrait work. In Florence, where more of his works are to be seen than anywhere else, there are some charming portraits of little princes and princesses, painted by Bronzino—the first independent portraits of children made by a Florentine artist.

It is the habit to speak of Italian art in various "schools" of painting—the Sienese, Florentine, Umbrian, Venetian. These are, however, merely broad definitions. We should not necessarily think that artists worked wholly in the town or state to which accident of birth or the style of their work allotted them. Quite a number of them were wandering artists, going from town to town to see the work of other men, intensely curious, and eager to share the ideas of their neighbors. They would undertake a piece of painting here, a fresco there, often finishing the work of some other man who had died.

The authorities of the towns and villages, generally speaking, were as eager to have their walls painted and buildings decorated as the artists were to do them. People cared intensely about beautiful things. A number of these artists never attained to any fame; some are what we might call half-great. Many well-known names appear as those of artists who worked here and there, going from town to town—Giotto, Fra Angelico, Gozzoli, Uccello, Filippo Lippi, Gentile da Fabriano, Piero della Francesca, Signorelli, Pinturicchio.

One of these, Gentile da Fabriano, who lived from 1360 to 1428, is known as the first painter of any merit of the Umbrian school. The artists of this little colony had much the same spirit as the Sienese: they were swayed more by feeling than by thought. Fabriano was what one might call a happy painter, loving to portray the joyous element in the life of the Middle Ages. Although his subjects are religious, his pictures really show knights and ladies, lovely dresses, flowers and plumes, pleasant fields and sunny skies. They sparkle with gold and color. His best-known picture is the Adoration of the Magi, in Florence.

THE TWO MEN WHO PREPARED THE WAY FOR RAPHAEL

After Gentile da Fabriano the men of the Umbrian school became indifferent, uninspired. A number of second-rate artists lived and worked in the district. Fiorenzo di Lorenzo is an Umbrian artist of this class. He was much influenced by the Florentines, and at one time in his life did some good painting in Perugia, the capital of Umbria. He is to be remembered chiefly through his two famous pupils Perugino and Pinturicchio, who, in their turn, prepared the way for the man who was the glory of Umbria, Raphael Santi (or Sanzio).

Perugino, who lived between 1446 and 1524, was the elder of the two by a few years. His real name was Pietro Vannucci. He is famous chiefly for his graceful, airy compositions and mastery of space management—qualities that belong to Umbria. There is a glow, a clear color in his work, a restfulness, a peace, which throughout a long lifetime of painting he never quite lost. For vigorous movement he had no aptitude whatever, but he made up for that lack by his remarkable restraint and delicacy.

There are pictures or frescoes by him in almost every gallery in Europe, and a great number in his native Perugia. Two of his most famous works are a triptych in the National Gallery, London, and the Madonna with Saints and Angels, in the Louvre.

"Pinturicchio" means "little painter." The artist's own name was Bernardino di Betto. He has all the grace of the Umbrians, but little vitality. Like his fellow-artists, he painted an enormous number of religious subjects, in which he shows prettiness without much strength.

THE ARTIST WHO CREATED A NEW AND LOVELY TYPE OF MADONNA

Like Andrea del Sarto the Florentine, Pinturicchio painted lovely women as Madonnas, and stands out in the history of Umbrian art as a creator of a new type of this eternal subject. There are some large compositions of Pinturicchio's in the Libreria of Siena and the Borgia Rooms of the Vatican which show that, like Perugino, had the artist only possessed vigor equal to his grace, he would have been numbered with the great.

It is strange that about Raphael, at one time the brilliant follower of these two Umbrian masters, the judgment of history has not yet been finally pronounced. A very great deal has been written about the "divine painter," and until the middle of the nineteenth century a kind of worship was given him. The men who know most about art to-day are trying to judge him on the merit of his work, apart from the traditions clinging to his name.

RAPHAEL REVEALS THE GREATNESS AND BEAUTY OF HIS ART

There is no doubt that Raphael was a very great artist, but not in the sense that Michelangelo and Leonardo da Vinci were great. He had no share in the grandeur, the Titan-like vigor of Michelangelo; he had none of the deep insight into men and women that make Leonardo's few remaining masterpieces treasures of all mankind. But he was the greatest illustrator, the greatest space composer, the world has ever known. He saw figures of men and women in masses as beautiful patterns against the sky or the landscape, against the pillars, arches and walls of a building. He had genius for shaping vast spaces and filling a picture in such a masterly way that, while it may contain scores of figures, it has a leisurely air—the leisureliness of time and eternity.

This, his peculiar greatness, the art of composition, was undoubtedly born in him; his styles of painting he owed to many men in turn. Raphael was extraordinarily receptive, sensitive to impressions, a born imitator; he could seize on the best in another man's work, thus drawing to himself, as to a magnet, the most alluring qualities of Italian art.

RAPHAEL'S WONDERFUL ACHIEVEMENTS IN A SHORT BUT BRILLIANT CAREER

In the year 1500, when Raphael was seventeen, he entered the studio of Perugino at Perugia, where Pinturicchio was head assistant. For four years he worked in the studio, very much influenced by the paintings of the two Umbrian masters. In 1504 he produced the masterpiece of his early manhood, The Marriage of the Virgin. This picture shows his growing genius for "piled-up" compositions, his sense of the beauty of space, his love for arched buildings as a background to groups. It is almost impossible to estimate the value of the space management of the famous painting. The group in the foreground would make a very different effect without the mounting steps in the middle distance, the domed temple surmounting the picture, the tiny figures quietly coming and going.

By this time Raphael's fame was established and he entered the years of crowded work that ended only with his death at the age of thirty-seven. Even allowing for the fact that his pupils and assistants helped largely in many of the pictures which bear his name, Raphael produced an astounding number of pictures and frescoes. His achievements are the more remarkable because he was something of a social "lion," the favorite of the great.

HOW RAPHAEL FOUND SCOPE FOR HIS GENIUS AT THE VATICAN

It soon became the fashion to talk about Raphael, admire him, follow him about. The inevitable result of this hero-worship was that the artist had to spend much time in society, away from his work.

After his period of work in Perugino's studio Raphael went to Florence for four years, and during that time fell under the influence of Leonardo da Vinci, Michelangelo and Fra Bartolommeo. While at Florence he painted a great number of his exquisite pictures of Mary and the Child, such as the Madonna in Munich. There is something of unearthly sweetness in these heads of Mary, something that appeals to the emotion and is saved from over-sweetness only by Raphael's exceeding grace.

In 1508 the artist was called to Rome by Pope Julius II, and from that time found it almost impossible to keep up with commissions for work which came to him. He was obliged in very many cases to content himself with making the cartoon for a picture, leaving his assistants to "paint it in," and then giving the finishing touches himself.

His great work, on becoming artist to the papal court, was the decoration of some of the Vatican apartments—the Stanze—and the Loggie of one of the courtyards. Here Raphael's genius at composition had full scope. When we consider the numerous pictures in the Stanze, it would seem that any one of them might almost have been the work of a man's lifetime. Hundreds of figures are grouped and painted, all looking as if they could not possibly have been placed anywhere else, and yet each subordinate to the magnificent whole.

THE PAINTER WHO BLENDED THE PAGAN WORLD AND THE CHRISTIAN STORY

You know that there are crowds of people in these pictures, but your eye seeks the one place and person, or two persons, it was the artist's intention you should seek; and that is the highest genius of figure management in a composition. The subjects of the Stanze were taken from stories of history, allegory and religion. In the Loggie are frescoes mainly from Old Testament history. They are affectionately known as Raphael's Bible, but we know now that the master himself did not do very much of this work.

There was something miraculous in the energy of this young man. In the midst of almost inexhaustible demands on his time he succeeded in finding leisure to paint some very fine portraits.

It is probable that as time goes on Raphael will be remembered chiefly for his Vatican pictures and his lovely Madonnas. By these he is forever set apart. No other painter has blended so marvelously the pagan world and the Christian story, or thus brought the spirit of the whole Renaissance to rest within one lifetime.

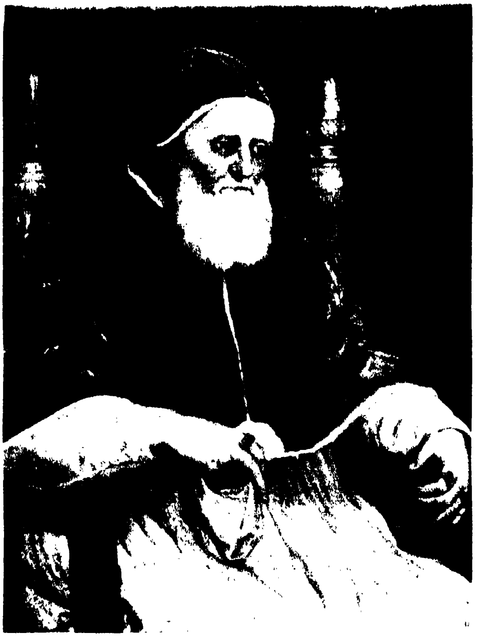
THE NEXT STORY OF THE FINE ARTS IS ON PAGE 1103.

PAINTINGS OF THE TIME OF RAPHAEL

THE MADONNA DEL GRANDUCA, BY RAPHAEL, IN THE PITTI PALACE, FLORENCE

THE SISTINE MADONNA, BY RAPHAEL, IN THE DRESDEN GALLERY

CATHERINE OF ALEXANDRIA, BY PINTURICCHIO, IN THE NATIONAL GALLERY, LONDON



POPE JULIUS II, BY RAPHAEL, IN THE NATIONAL GALLERY, LONDON

THE MADONNA AND CHILD, BY RAPHAEL, IN THE PRADO, MADRID

THE MADONNA AND CHILD, BY RAPHAEL IN THE PINAKOTHEK, MUNICH

LA BELLE JARDINIERE, BY RAPHAEL, IN THE LOUVRE, PARIS

THE HOLY FAMILY, BY RAPHAEL, IN THE PITTI PALACE, FLORENCE

FERDINAND DE MEDICI, BY BRONZINO, IN THE UFFIZI GALLERY, FLORENCE

THE GRAND DUCHESS ELEANOR, BY BRONZINO, IN DRESDEN

BALTHASAR CASTIGLIONE, BY RAPHAEL, IN THE LOUVRE

PIERO DE MEDICI BY BRONZINO NATIONAL GALLERY, LONDON

THE MADONNA OF THE CHAIR, BY RAPHAEL, IN THE UFFIZI GALLERY

THE VIRGIN AND CHILD, BY PERUGINO, IN THE LOUVRE, PARIS

ST. JOHN THE BAPTIST, BY ANDREA DEL SARTO, FLORENCE

RAPHAEL, BY PINTURICCHIO, IN SIENA CATHEDRAL

ST. JOHN IN THE DESERT, BY RAPHAEL, FLORENCE

The baptism of Virginia Dare, the first English child to be born in the New World, at the Roanoke settlement.

CHILD LIFE IN COLONIAL DAYS

YOU boys and girls who live in North America today will probably think the life of the children of two hundred years ago a very hard and dull affair. But though our colonial ancestors in their childhood days had fewer toys, fewer privileges and less freedom than the boys and girls of today, it is not at all certain that they were less happy. In this article we shall learn of the sharp discipline administered to naughty children by stern parents and schoolmasters; we shall hear how the tithing man rapped the heads of children who were restless in church and tickled their noses when they fell asleep during the four-hour sermon; we shall see boys and girls in school and at home, in the village meeting-house and at their sports.

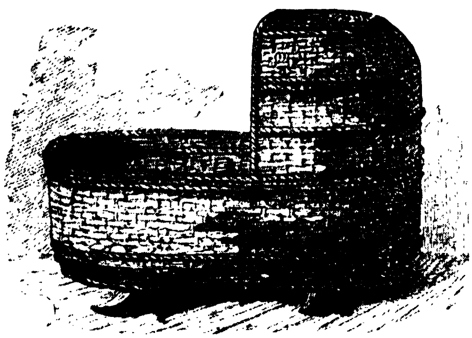
In these days much is done for children's happiness. The school is often the most costly building in the town; thousands of children's books are printed each year; toys are made by the million, and amusements of every kind are provided. This was not the case when the country was young. Then children were "expected to be seen and not heard," and they were expected also to obey without any question.

There is no doubt but that parents loved their children then as much as they do now; but fathers and mothers were afraid of spoiling their young ones by too much indulgence. In the earliest days of the colonies, life was hard for everyone, and children had to share the general hardships. Yet we know that these children were not unhappy; and we find that not all of them were good, in spite of the severe punishments. Let us see how these children lived and how their life differed from that of their descendants in our country today.

So far as we know, the first European child born in America was the Norseman Snorro Karlsefni, who was born about 1007. He went back to Europe when three years old, however, and so hardly counts as an American child. There were doubtless Spanish children born at St. Augustine, which is the oldest town in the United States; but the next child of whom we shall speak was the first English little one born in the New World. This was

Virginia Dare, born in 1587, on Roanoke Island, now a part of North Carolina. Sir Walter Raleigh was trying very hard to establish a colony in this region, which he called Virginia in honor of Queen Elizabeth, the Virgin Queen, and the little girl was named for the country. Before little Virginia was three years old, the colony disappeared, and no one knows to this day what became of its people. We shall tell in another place all that is known of the Lost Colony of Roanoke.

Years after this, in 1620, a small ship called the Mayflower was crossing a cold and wintry sea with a little band of Englishmen seeking homes in the new land. Two new baby boys had been added to their number; and almost everyone on board ship was crowding into the dark little cabin, eager to help the parents to choose names for the tiny fellows. It was at last decided that they should be called Oceanus and Peregrine. The first name is the Latin for ocean, and the second means wanderer. The names seemed to fit, as the children had been born on the ship during the wanderings of the Pilgrims on the ocean.



The cradle of the Mayflower baby, Peregrine White.

"Oceanus! Peregrine! What very odd names for children!" you exclaim. Yes, indeed, and very odd names many of the children were given who were born in New England in the days of long ago. Parents chose names from the Bible, or else gave the names of the Christian virtues to their children. Some showed the conditions under which the little ones had come into the world. Large families were the rule in those days, sometimes as many as ten or fifteen children. Many of them bore such names as Deliverance, Temperance, Hope, Patience, Truth, Faith, Isaiah, Jeremiah, Preserved and so on.

THE STRUGGLE FOR EXISTENCE BEGAN AT BIRTH

But if the names were strange, the manner of their bestowal seems far more so. "Half the Puritan children had scarce drawn breath in this vale of tears ere they had to endure an ordeal which might well have given rise to the expression, 'the survival of the fittest.' All were baptized within a few days of birth, and baptized in the meeting-house. We can imagine the January babe carried through the narrow streets or lanes to the freezing meeting-house, which had grown damper and deadlier with every wintry blast, to be christened, when sometimes the ice had to be broken in the christening bowl. It was a cold and disheartening reception these children had in the Puritan church; many lingered but a short time there. Indeed, from the moment when the baby opened his eyes on the bleak world around him, he had a Spartan struggle for his life." Those who survived were usually very hardy. As soon as a child was two or three years old, his small shivering feet were daily dipped into a tub of icy cold water to make them tough. Many parents for the same reason believed that their boys should wear shoes "thin enough that they may leak and let in ye water."

At first, in most of the colonies there was little regular education of the children. The boys learned at home how to read and write and the girls to sew, but there were no schools; the men were too busy making homes and providing food for their families to think of the matter. But in the hearts of our forefathers was a deep-seated reverence for education, and presently people began to build schoolhouses. Then here and there, wherever there were towns, schools were started. In Massachusetts every town of fifty families was compelled by law to keep a school for boys; but for some years nothing was said about girls. The buildings sometimes were small, uncomfortable log cabins; the books were few and tiresome, and the schoolmasters were often not good teachers. Yet nothing could weaken the ambition of the parents to have their children educated. "Child," said one noble New England mother of long ago, "if God make thee a good Christian and a good scholar, 'tis all thy mother ever asked for thee."

So the children, whether they wished it or not, were packed off bright and early each morning to the schoolhouse, with their spellers or their arithmetics tucked under their arms. The rules for one school in New England required school to begin at seven o'clock in summer and at eight in winter. The girls were sent when it was convenient for the mother to spare them from housework. The older boys and girls sat at rude desks made of boards resting on pegs driven into the floor, which was sometimes of earth. The younger pupils sat on blocks or benches of logs. Few of the seats had backs.

Usually the boys and girls began in a school kept by a woman in her own home. This was called a dame school. Then the boys were transferred to a school kept by a man; little attention was paid to the education of girls beyond reading and writing. In New England the ministers were often teachers as well. The same was true of some parts of the South. These ministers were usually college graduates, who taught Latin and Greek well, and were much respected. In other colonies the position of the teacher was lower. Once in New York the town council advertised for a man to act as clerk, serve as sexton of the church, ring the bell, dig graves, lead the singing in church and teach the children. Sometimes the teacher was a man who had failed at everything else he had tried. Often, however, he had a very good opinion of himself.

The appearance of one of the schoolmasters of "ye olden days" is thus described: "He wore a tabby velvet coat, the tails of which stood sometimes straight out. Inside the coat was a waistcoat of tremendous length, through which showed conspicuously the nicely starched ruffles of his white shirt. His knee breeches of velvet like his coat, were finished at the knee by large and shining silver buckles. With these in lustre, vied two more silver buckles which rested on the top of his clumsy shoes. Around his neck was wound, just once and a half, a stiffly ironed stock, which helped to keep his head stiff and straight, as became a teacher in his day. But, above all, his crowning glory was his

Courtesy of the National Life Insurance Company

The hornbook which the little girl is studying is made of paper or wood placed between two thin sheets of horn.

Three-year-old James Badger of Boston: painted 1760.

wig, the white powdered wig, combed straight back from his forehead, and hanging always in a nicely braided queue behind." The custom of wearing the hair in a queue lasted until the Revolution.

To modern boys and girls the children's clothes would seem every bit as odd as those of the schoolmaster. The girls were arrayed in stiff homespun linsey-woolsey petticoats and bodices. Linsey-woolsey was a rough cloth, half linen and half wool. About their throats they wore white kerchiefs and at their wrists white cuffs. The Puritan maidens wore demure little caps such as you can see in any picture of the Pilgrim mothers. The boys wore knee breeches, long waistcoats and heavy coats with wide pockets and wide turn-over cuffs. The children of well-to-do parents who were not Puritans frequently wore ruffles of fancy white linen at their necks and wrists.

Sometimes boys were sent away from home to a relative who lived near the school, and providing a suitable wardrobe was a difficult problem. One old lady who was boarding her grandson during the school term wrote home to his father in deep distress: "Richard weares out nigh twelve paires of shoes a year. He brought twelve hankers with him and they have all been lost long ago; and I have bought him three or four at a time. His way is to tie knottys at one end and beat ye boys with them & then to lose them & he cares not a bit what I will say to him."

School opened with prayer, after which the children began their reading, writing, spelling or arithmetic lessons, as the case might be. Paper was scarce and costly, and lead plummets were used instead of pencils. The children did their problems or copied their writing into notebooks made of foolscap paper sewed into book shape and carefully ruled by hand. "Among the thrifty Scotch-Irish settlers in New Hampshire and the planters in Maine, sets of arithmetic rules were copied by each child on birch bark."

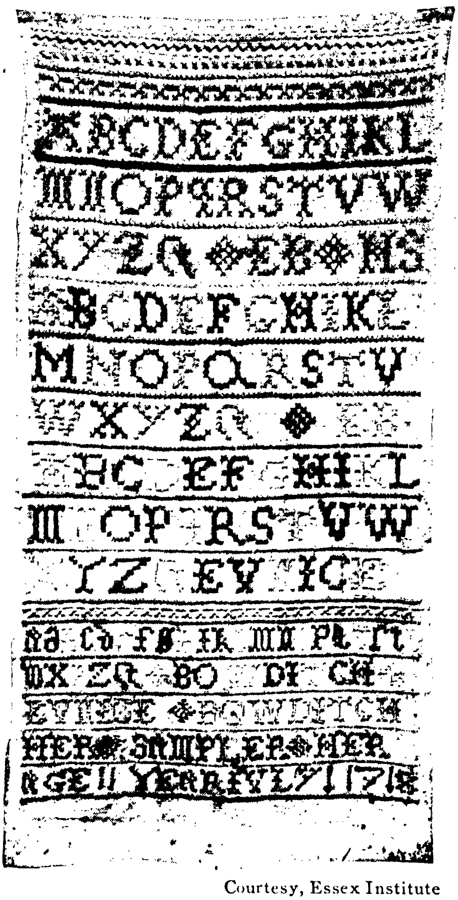
At eleven o'clock the bell rang, and the children, delighted to stretch their legs, and shouting to each other as they ran, scampered off home, not to return until one o'clock. Those who lived too far away brought their lunch, just as some children do now. The afternoon session lasted until four or five, and school closed, as it had opened, with prayer. On Wednesdays and Saturdays children learned and recited the catechism, or the prayers from the prayer book, in some colonies, especially in Virginia.

Pictures, courtesy, Metropolitan Museum of Art

Johannes de Peyster in 1621. This little Dutch boy later became a leading citizen of New Amsterdam.

"Spare the Rod and Spoil the Child," was the motto of nearly every parent and nearly every teacher. The discipline in the school was very severe. Boys who did not learn their lessons or were impertinent to their master were soundly flogged and the schoolroom continually resounded with the swish of the birch rod. Often, too, the stern fathers whipped their sons because they had been whipped at school. Children were taught to obey their parents according to the commandment, without arguing or objecting. An early law of Connecticut fixed the penalty of death upon any son who should strike his parent.

In the dame schools, as the schools kept for little folks by a woman were called, some of the methods of punishment were quite novel. The schoolmistress would go about among the benches and briskly tap the heads of idle children with a heavy thimble she always wore on her finger. Telling lies was punished by applying hot mustard to the tongue of the offender; whispering met the unpleasant fate of being gagged with a small wooden board; stupid children were made to stand or sit upon a tall dunce stool, and any child who was so wicked as to be guilty of stealing had his small fingers burned with red hot coals.



Courtesy, Essex Institute

A needlework sampler stitched by a little girl.

Among the modes of punishment were strapping tender hands with leather thongs, and pinching the ear-lobes and noses of naughty children with pieces of wood shaped like clothespins. In some of the schools, good and industrious children sometimes received such rewards of merit as a portion of a strawberry divided among three or four pupils, or had a red, pink or blue bow tied to their shoulders to wear home to show their proud parents. In schools where these were used a black bow was pinned upon a naughty child, with the usual consequence of a whipping administered at home.

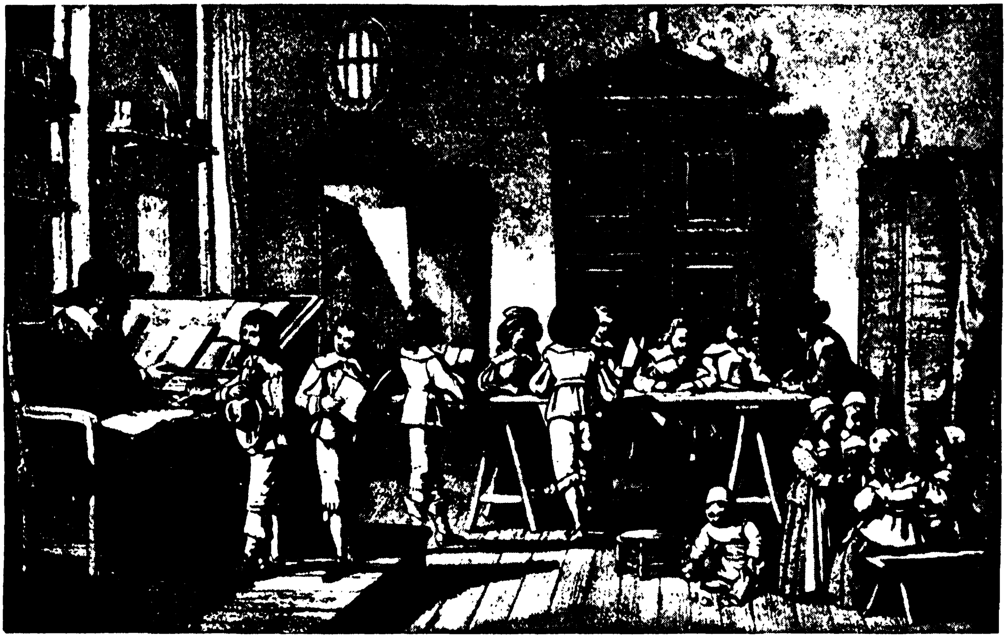
A writer of 1750 says, in commenting on his school days: "When I was three years old, I was sent to school to a mistress, where I learned to read with neat dispatch; in my fifth year, I was taken away and put to a writing master. In my seventh year, I flourished a tolerable hand and began my grammar. By the time I was fourteen I was considerably proficient in the Latin and Greek languages and was admitted into Harvard." Perhaps it was owing to the early age at which our ancestors were sent to school, and the fact that they entered college while mere boys, that corporal punishment (applied to the body) was much used in the higher educational institutions.

Students at college were often publicly thrashed. Among the rules of Harvard College which were published in the year 1660 was this:

"It is hereby ordered the president and fellows of Harvard College have the power to punish all misdeeds of the young men of their college. They are to use their best judgment and punish by fines or whipping in the hall publicly, as the nature of the offense shall call for."

That such punishment was not always wholly undeserved is shown by the following grim comment upon misdemeanors of students in that college:

"M——, H—— & W—— were expelled from college and their names cut out of the tables in the dining-room by order of the president of the college; this was done before all the fellows interested. It was because of the disorder and bad actions of these three young men towards Andrew Belcher. They killed Grandma Sell's dog and stole ropes with which to hang him. They hung him upon a sign post at night, as one of them afterwards confessed before the college authorities and before his comrades. And at the time it was not denied in any way; but two of the students afterwards had the third one say that after all what he had related was not true. Many great lies were told by all of them and especially by one. And there were many reasons for the belief that they committed these crimes."



Courtesy, New York Historical Society

A school for boys and girls of well-to-do burgher families of New Amsterdam in the late seventeenth century.

TEACHING PLANTATION CHILDREN IN THE SOUTH

In the South there were few towns, and most of the people lived on farms or plantations, often at some distance from neighbors. Therefore it was common for planters to employ tutors for their children. These private tutors were often of a much higher grade of intelligence than the teachers at the ordinary schools, as they were usually college graduates or at least had studied at college. Often the owner of a Southern plantation would hire a tutor for his sons and daughters and invite the parents on neighboring estates to send their children.

Here is an interesting extract from the diary of a young Princeton graduate, Philip Vickers Fithian, who went down to Virginia to be the tutor of the children of the wealthy Carter family in 1773.

"Monday, November 1st. We began school. The school consists of eight. Two of Mr. Carter's sons, one nephew and five daughters. The eldest son is reading Sallust; grammatical exercises and Latin grammar. The second son is reading English grammar and reading English writing, and ciphering in subtraction. The nephew is reading and writing as above: and ciphering in reduction. The eldest daughter is reading the Spectator, writing, and beginning to cipher. The second is reading now out of the spelling-book, and beginning to write. The next is reading in the spelling-book. The fourth is spelling in the beginning of the spelling-book. And the last is beginning her letters.

"In the morning so soon as it is light a boy knocks at my door to make a fire. After the fire is kindled, I rise, which now in the winter is commonly by seven or a little later. By the time I am drest the children commonly enter the schoolroom, which is under the room I sleep in. I hear them round one lesson, when the bell rings for eight o'clock (for Mr. Carter has a large good bell which may be heard for some miles, and this is always rung at meal times); the children then go out; and at half after eight the bell rings for breakfast, we then repair to the dining-room; after breakfast, which is generally about half after nine, we go into school, and sit till twelve when the bell rings, and they go out for noon; the dinner bell rings commonly about half after two, often at three, but never before two. After dinner is over, which in common, when we have no company, is about half after three, we go into school, and sit till the bell rings at five, when they separate till the next morning. We go into supper commonly about half after eight or at nine, and I usually go to bed between ten and eleven.

"Saturday, December 18. After breakfast, we all retired into the dancing-room and after the scholars had their lesson singly round, Mr. Christian very politely requested me to step a minuet; I excused myself, however, but signified my peculiar pleasure in the accuracy of their performance. There were several minuets danced with great ease and propriety; after which the whole company joined in the country dances; and it was indeed beautiful to admiration, to see such a number of young persons, set off by dress to the best advantage, moving easily to the sound of well performed music, and with perfect regularity, tho' apparently in the utmost disorder. The dance continued till two, we dined at half after three. Soon after dinner we repaired to the dancing-room again. I observed in the course of the lessons, that Mr. Christian is punctual, and rigid in his discipline, so strict indeed that he struck two of the young misses for a fault in the course of their performance, even in the presence of the mother of one of them. And he rebuked one of the young fellows so highly as to tell him he must alter his manner, which he had observed through the course of the dance to be insolent, and wanton, or else absent himself from the school."

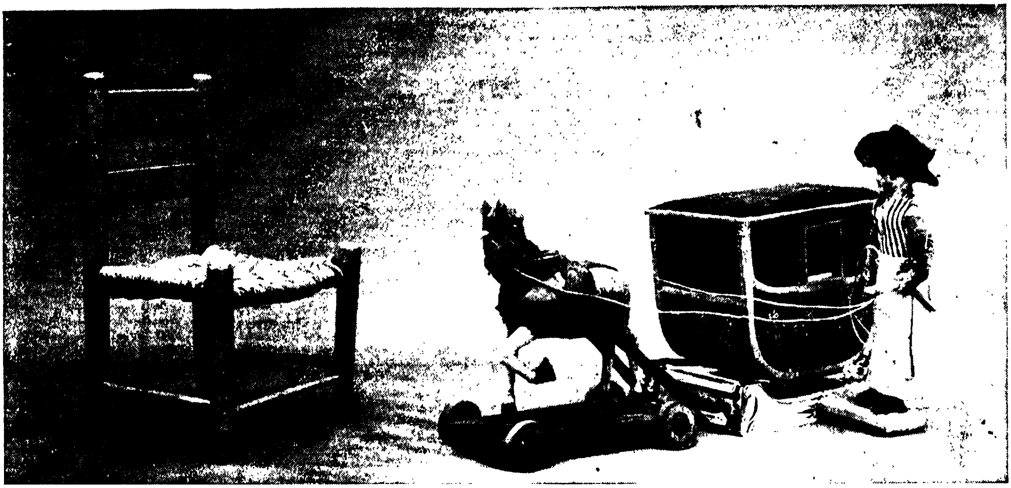
The number of people who could afford tutors was small, and the children of the smaller farmers in the South had poor opportunities of gaining an education. There were some good academies, but most of the children who went to school attended little neighborhood schools, which were badly taught.

Except where the parents were wealthy, the children at a very early age were expected to do their share of the house and farm work. Captain John Smith wrote of fishing before there were many children in New England: "He is a very idle boy who has passed the age of twelve years and cannot do as much; and a girl is very stupid who cannot spin a thread to make nets to catch the fish. What pleasure can be greater, when people are tired with work on shore, whether they have been

Culver Service

Lafayette visiting George Washington at Mount Vernon, a pleasant eighteenth-century Virginia country house.

planting vines, or building houses or ships, than to get recreation for themselves before their very doors, in their own boats upon the sea. There man, woman and child, each with a small hook and line, may take divers kinds of excellent fish at their pleasure. And is it not a pretty sport to pull up two-pence, six-pence, and twelve-pence as fast as you can haul and change a line? He is a very bad fisher who cannot take one day with his hook and line one, two or three hundred cods. These, dressed and dried, if they be sold here in New England will bring ten shillings for a hundred; or in England, more than twenty. If a man work but three days in seven he may get more than he can spend unless he is very wasteful."



Courtesy, the Metropolitan Museum of Art

American and Dutch colonial toys of the eighteenth century. Notice that the gaily painted carriage is mounted on sleigh runners instead of on wheels. Chairs like this one are made today, especially in the Allegheny region.

EVEN YOUNG CHILDREN SHARED IN THE WORK OF THE HOME

You must remember that many of the things which we now buy in the shops were then made at home. The mother then spun the wool or flax into thread, and wove it into cloth and made the clothes for the family. She knit the stockings and even made hats. She pickled and preserved, dried fruit, and even made the soap and candles for family use. In this she was of course helped by her daughters, who had their work given to them when very young.

The father was a farmer, and often carpenter, tanner, shoemaker and blacksmith as well. The boys had their work on the farm as soon as they were able to help. They took care of the animals, giving them water and food; chopped the wood for the great fireplaces, and tended the fires; brought in the corn and hay from the fields and put them away in the barn; and when they were old enough, plowed the fields. Such a state of things always exists in a new country, and in some parts of the United States has not entirely disappeared yet.

In New England the observance of Christmas Day was forbidden as "unseemly to ye spiritual welfare of ye community." William Bradford, governor of the colony of Plymouth, grimly commented upon the first Christmas.

"The day called Christmas Day, the governor called them out to work (as was used), but most of this new company excused themselves and said it went against their conscience to work on that day. So the governor told them that if they made it a matter of conscience he would spare them until they were better informed. So he led away the rest and left them; but when they came home at noon from their work, he found them in the street at play openly, some pitching the bar, and some at stool ball and such like sports. So he went to them and took away their implements and told them it was against his conscience that they should play and others work."

IN NEW ENGLAND SUNDAY WAS OBSERVED STRICTLY

"But," you perhaps are thinking, "there was at least one day of the week in which the children could be free from the discipline of parents or schoolmaster"—and you remember the many pleasant Sunday afternoons of your own life. But Sunday for the boys and girls of New England was a day of restraint. The Puritans brought with them to this country a fixed idea that the first day of the week, the Sabbath, should be strictly observed. Even in Virginia and New York, where the people were not so strict, there were rigid laws for the ordering of one's conduct on the Sabbath Day. "In Massachusetts the law provided that no person should be permitted to walk in the streets on Sunday, except in reverently going to church or returning from the services."

Both in the North and in the South it was the custom to have two or three religious services during a single Sunday, with a long recess at noon for dinner. In New England and some of the other colonies there were little houses or shanties built near the meeting-house, so that people might be kept warm and dry during dinner. These were called "noon houses." You can well imagine that the children did not always find Sunday a welcome day.

In the early history of the country it was thought wrong to have a fire in the churches on the Sabbath. A few delicate persons had footstools in which hot coals and ashes were placed, so that their feet might not freeze entirely, but all others were expected to endure the cold.

The Sabbath began in New England at sunset on Saturday afternoon, when all work was stopped and the children's play hushed to prepare their minds for the coming of the Sabbath. Next morning the whole family arose early. No work, except such as was absolutely necessary, was done. No hot meals were prepared. The dishes were left unwashed until Monday morning. Whether the weather was stormy or fair, the entire household, save the tiniest children and someone to mind them, set out for the meeting-house, sometimes several miles distant. In the earliest days, as they approached the meeting-house through the woods, their Bibles under their arms, the men often carrying their guns, they could hear the muffled beat of a drum through the Sabbath hush. It was the call to prayer.

When they entered the church, the children were separated from their parents, the boys going into one pew and the girls into another. The service was a long one, the sermon sometimes lasting three or four hours. Do you wonder that the boys got restless and the

A simple religious service in one of the colonies. In the early days of the settlements danger was never very far away. The men carried their guns with them even to church, in case of attack by hostile Indians.

QUAINT DOLLS FROM EARLY NEW ENGLAND

Some busy mother made this doll out of a hank of flax fiber from her spinning-wheel.

This prim and ladylike doll is made from the outer covering, or husk, of an ear of the maize, or native Indian corn.

All sorts of material were used to make toys. This doll is made of dried apples.

"Old Susan," a proud lady doll, made in Holland and sent to be the treasured possession of a little New York girl.

A Cape Cod rag doll which has no legs but can be placed in either a standing or sitting position. The doll's features were painted on its face with berry juice and charcoal.

Some little girl of long ago loved this rag doll whose plain but kind features were penciled on with charcoal. Her hair is charcoal too.

Center picture courtesy Museum of the City of New York: all others courtesy, the Wenham Museum, Wenham, Mass.

girls sleepy? But woe betide the unlucky child who chanced to close his eyes. Suddenly down would come the tap, tap of a knobby pole upon his head. It was the tithing man, whose duty it was to keep order during the church service. Now he tickled the face of a sleepy little girl with the fox-tail on the end of his pole, now he smartly rapped the skull of an unruly small boy.

STRICT RULES DID NOT MAKE ALL CHILDREN WELL-BEHAVED

That the boys were unruly is proven by the records of their time. One reads thus: "We of Medford do pass an order that all small boys who cut the seats in the meeting-house shall be persecuted." Tithing men and constables were appointed especially to watch over the "pue of ye wretched boys" to "see that they behave comlie, and use such raps and blows as shall be meet." Another record reads: "His majesty's Tithing man entered complaint against Jona and Susan Smith, that on the Lord's Day during Divine Service they did smile. They were found guilty and each was fined five shillings and costs."

In early days in New England the Sabbath ended at sunset on Sunday, twenty-four hours after it began. This custom grew out of the fact that the Jewish Sabbath, of which we read in the Bible, began at sunset. You know, of course, that the Jewish Sabbath begins at sunset on the day of the week which we call Friday.

There were Sabbaths when the snow was white and thick on the ground, and the air was crisp and clear, that proved a "temptation of ye Devile" to many boyish hearts, and they fell by the wayside and went "sleeing." This roused the deep wrath of the Albany authorities, and they passed a law forbidding such "unseemly wickedness."

"Whereas the children of the said city do very unorderly, to the shame and scandal of their parents, ride down the hills in the streets of the said city with small and great sleds on the Lord's Day . . . now for preventing the same it is hereby published and declared it shall and may be lawful for any constable in this city to take any such sled or sleds from all and any such boys and girls riding or offering to ride down any hill within the said city and break any sled or sleds in pieces."

Moreover, it was ordered that the officer seize the cloak or upper garment of the offenders and present them to the parents to be redeemed on the payment of a fine of five shillings, a considerable sum in those days.

CHILDREN PLAYED MANY GAMES THAT WE PLAY TODAY

The games played by the children were different in different sections of the country. At first the Puritan children were brought up to look upon wholesome games and frolic as deadly sin. Football, especially dear to boyhood hearts, was pronounced a game "wherein is nothynge but beastlye furie and exstreme violence." As the years went on, the people of New England grew more tolerant, and did not look so seriously upon childish play. During the fifty years before the Revolution the rules were not so strict. The Dutch settlers had many games. They were very fond of bowling on the grass. A little park in New York City, Bowling Green, is named for the game that was played there. The Dutch also played tick-tack, a complicated sort of backgammon, and trock, on a table somewhat like a billiard table, in which an ivory ball was struck under wire wickets with a cue. Coasting down hill became a popular sport. The sleds were low, with a rope in front, and were started and guided by a short stick. The children played with marbles, tops, hoops, kites, balls, even as do the boys and girls of today. Such familiar games as prisoner's base, hop-scotch, tag and leap-frog were well known. Running on stilts was a favorite diversion.

SOCIAL LIFE WAS GAY IN NEW YORK AND THE SOUTH

In the South, as in New York, good times were common. Dancing was considered a very important thing to know. Our forefathers, however, knew nothing of our modern dances, not even the waltz. The stately minuet, the quadrille, the Virginia Reel and a number of country dances were among their favorites. The young tutor, Philip Fithian, a bit of whose diary we have already read, writes thus of Virginia days: "Nothing is now to be heard of in conversation but the balls, the fox-hunts, the fine entertainments, and the good fellowship, which are to be exhibited at the approaching Christmas. Mr. Goodlet was barred out of his school last Monday by his scholars, for Christmas holidays, which are to continue till twelfth-day; but my scholars are of a more quiet nature, and have consented to have four or five days now, and to have their full holiday in May next.

"When the candles were lighted, we all repaired into the dancing-room; first each couple danced a minuet; then all joined as before in the country dances; these continued till half after seven, when at the proposal of several, we played Button, to get pawns for redemption: here I could join with them, and indeed it was carried on with sprightliness, and decency; in the course of redeeming my pawns I had several kisses of the ladies! Half after eight we were rung in to supper. The room looked luminous and splendid: four very large candles burning on the table where we supped; three others in different parts of the room; a gay, sociable assembly, and four well instructed waiters. So soon as we rose from the supper, the company formed into a semi-circlet round the fire, and Mr. Lee, by the voice of the Company, was chosen Pope, and the rest of the company were appointed Friars, in the Play called 'Break the Pope's Neck.' Here we had great diversion in the respective judgments upon offenders, but we were all dismissed by ten, and retired to our several rooms."

In the South the boys had much healthful out-of-door sport. They went hunting with their fathers or with the Negro men, and learned the habits of the birds and animals. They were taught to ride, to shoot and to fish, and, when they grew older, went fox hunting with their elders. To go hunting the 'possum or the coon at night was great sport, and every boy had his traps or snares for rabbits. Girls also were taught to ride, for many of the roads were so rough in the winter and early spring that carriages could not be used.

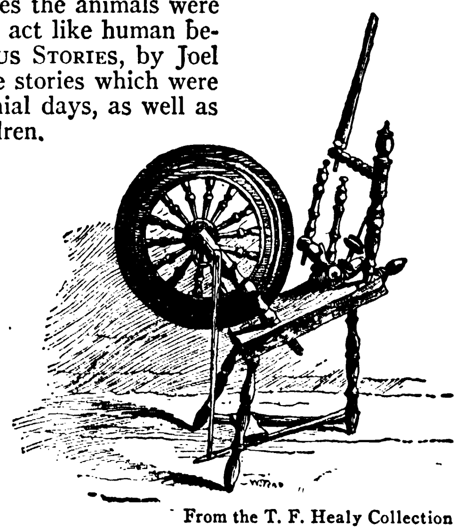
Many of the old Negroes were full of stories of beasts and birds, which had probably been brought from Africa with the slave-ships, though, of course, the animals were different. In these stories the animals were made to talk, think and act like human beings. The UNCLE REMUS STORIES, by Joel Chandler Harris, are the stories which were told to children in colonial days, as well as to their great-grandchildren.

There were other pleasant things in the life of the colonial child. In the seaport towns sweetmeats seem to have been plentiful. (The word candy was not yet common.) Ships brought sugar and molasses, chocolate and ginger. One thoroughly delightful colonial shop bore this quaint sign upon its door:

I have Sucket, Surrip, Grene Ginger and
Marmalade
Bisket, Cumfet, and Carraways as fine as
can be made.

Apparently such toothsome dainties were far more common in the colonies than in England, for one writer says that it was in these long-ago days that the foundation was laid for the "American sweet tooth—a wonder!" Then, too, the colonists learned very early to make maple syrup and maple sugar, and you may be sure that the children had their share of these. "Boys and girls who were fortunate enough to live in coast towns reaped the sweet fruits of their father's foreign ventures. When a ship came into port with eighty boxes of sugar candy on board and sixty tubs of rock-candy, poor, indeed, was the child who was not surfeited with sweets. There was a sequel, however, to the toothsome feast, a bitter dessert. The ship that brought eighty boxes of sugar candy also fetched a hundred boxes of rhubarb and ten of senna." And you may be sure the wise parents did not spare the bitter dose.

The value of a medicine was then judged according to its bitterness. Nowadays there is an effort to make all medicines tasteless or even pleasant to take. But in those days the sugar-coated pills, or the little gelatine capsules which conceal the bitter or nauseous dose had not been invented. Many of the medicines given were made from herbs such as tansy, thoroughwort, sage and pennyroyal. A mixture of sulphur and molasses was supposed to be good for the blood in springtime, and the other doses were hardly less unpleasant.



From the T. F. Healy Collection

Though it seems that the life of the children about whom we have just read was not very interesting, on the whole they were probably happier than children today. They did not have so many toys, and not so much was done for them, but they knew how to get pleasure out of simple things, and the simple pleasures are often the sweetest. They did not expect to have every whim gratified, but used their own skill and imagination.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 1039.

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Claude Bernard (with dangling glasses) demonstrating how the nerves act on digestion, in a rabbit.

MEN AND WOMEN OF SCIENCE

IV. THE NINETEENTH CENTURY

BACK in 1665, Robert Hooke (1635-1703), a brilliant and quarrelsome rival of Isaac Newton, had sliced a piece of cork (which, as you know, is part of the bark of a certain oak tree) and examined it with his crude microscope. He saw what looked like a collection of little boxes. He called these compartments cells because they resembled the "cells" of a honeycomb. What he really saw in the cork was only the dead cell walls; but Hooke also saw under his microscope lens the living contents in many other plant cells. A little later the Italian Marcello Malpighi (1628-94) and the English botanist Nehemiah Grew (1641-1712) also observed cells in plant tissues. These three men helped to lay the foundation for our knowledge of the minute (very small) structure of plants and animals. All three made beautiful drawings of plant tissues.

After the death of these scientists and of that observant Dutchman, Leeuwenhoek, there was little progress made in the study of cells for about a hundred years. At the end of the eighteenth century the French biologist M. F. X. Bichat (1771-1802) observed that the different organs of a human being, a dog or a tree, were built up of very different types of material. Since these different materials reminded him of woven cloth he called them tissues, from the French word *tissu,* the name of a rich cloth. So now we speak of muscle tissue, bone tissue, wood tissue, nerve tissue and so on.

Many scientists now began to recognize that each tissue was made up of a particular kind of cell. Discoveries came so fast that we can list only a few. The Frenchman Felix Dujardin (1801-62) clearly recognized in studying one-celled animals that there is a particular kind of substance always found in living cells and that this substance can move and carry on life functions. The Czech Johannes Evangelista Purkinje (1787-1869) named this substance protoplasm. The German Hugo von Mohl (1805-72) showed that we can easily distinguish between the sticky living protoplasm in a plant cell and the watery sap which is not alive, but which often occupies most of the space in a plant cell. He brought into common use the word protoplasm.

WE LEARN FROM THE ORCHID THAT EVERY CELL HAS A NUCLEUS

In the meantime, the Scot Robert Brown (1773-1858), who is called "the prince of botanists," discovered that all the living cells of the beautiful orchids he brought back from Australia contained a dense little body, which we know as the nucleus. Soon it was recognized that the nucleus is a very important part of every cell. The plural of nucleus is nuclei. Brown made other great discoveries, the most famous being the "Brownian movements." He noticed that when extremely small microscopic particles were observed in a liquid, the particles always seemed to be dancing or jumping in an irregular manner. We now know that this is because the particles are being bombarded by the constant movement of the molecules of the liquid.

Even before Brown saw nuclei in the smooth leaves of Australian orchids, one of the greatest of scientific theories, the one on which all our present-day biology is based, had been clearly stated by the French army surgeon Henri Dutrochet (1776-1847). This is the Cell Theory which states that: 1) All living things are made up of cells, or substances produced by cells (such as cartilage and bone; 2) All the life functions are actually carried on in the individual cells.

In 1824 Dutrochet published a work in Paris which included these ideas with excellent observations to support them. You might suppose that Dutrochet would soon have been recognized as one of the world's great scientists. Nothing of the kind happened. The biologists of Europe continued their investigations and in 1838 and 1839 (fifteen years after Dutrochet) two German scientists, Matthias Schleiden, a botanist (1804-81), and the zoologist Theodore Schwann (1810-82), each came out with the very same theory, with some fantastic errors added to it by Schleiden. The scientific world gave these two men great acclaim and the theory was presently adopted universally.

Many textbooks to this day give credit to Schleiden and Schwann for the cell theory; but when a group of American scientists gathered in 1939 to celebrate the 100th anniversary of the cell theory, they agreed that several other biologists, especially Dutrochet, deserved more credit than Schleiden and Schwann.

Max Schultze (1825-74), professor at the German university of Bonn, demonstrated the great similarity between the protoplasm of animals and that of plants. Thomas H. Huxley expressed Schultze's ideas when he called protoplasm the "physical basis of life." Rudolf Virchow (1821-1902), professor in Berlin University, carried the cell theory into the study of disease. His famous saying, *Omnis cellula e cellula* means "Every cell from a cell." Cells originate only by the division of cells already in existence. Two other German professors, Eduard Strasburger (1844-1912) and Walther Flemming (1843-1915), were among the many observers who worked out the strange and complicated manner in which living cells divide.

CLAUDE BERNARD, WHO WANTED TO WRITE PLAYS

The exceptional talents of the French biologist Claude Bernard (1813-78) were not confined to science, though he devoted most of his life to this field. Born in the village of Saint-Julien, the son of a small landowner, Bernard studied at a Jesuit school, then attended the college at Lyons. After a short time he left school to become a druggist's assistant; but spent his leisure hours writing a comedy. The play was produced with such success that the young author was encouraged to write an ambitious drama. He took this to Paris, and showed it to a leading dramatic critic. Happily for science, the critic advised Bernard to return to the study of medicine.

LOUIS NAPOLEON PROVIDES A LABORATORY FOR BERNARD'S RESEARCH ON DIGESTION

Still not more than twenty-one years of age, Bernard decided to follow this suggestion. In time he became an interne at the Hôtel-Dieu (public hospital) where he worked under François Magendie (1783-1855). That great physiologist was so impressed with Bernard's work that he made the young man his assistant. Later Bernard became professor of physiology at the Sorbonne. Handicapped in this post by the lack of a laboratory, in 1864 Bernard persuaded Emperor Louis Napoleon to furnish one. This Napoleon also built a laboratory in the Jardin des Plantes (the Botanical Garden in Paris) and established a professorship there. Bernard left the Sorbonne to accept this post in 1868. When he died, ten years later, he was given a public funeral —the first ever bestowed on a French man of science.

Bernard's special interest was in the action of the nervous system on digestion and on the sugar in the blood. He discovered dextrose sugar in the blood of starved animals, and his investigations proved that the liver was responsible. He demonstrated that when an animal is fed an excess of sugar, the liver stores the excess in the form of a starch-like substance which he called glycogen. The liver can then change the glycogen back into sugar and pass it into the blood stream as the body needs it. He identified and studied two secretions of the liver—its "external secretion" (bile poured into the intestine) and its "internal secretion" (sugar released into the blood). For many centuries scientists had felt that each organ might contribute something to the blood, but it was Bernard's work on glycogen that gave proper importance to this idea.

About two hundred years ago the Swedish scientist Carolus Linnaeus (1707-78) made the Latin words *homo* (man) and *sapiens* (having sense, or knowing) the scientific name for the human race. He used other Latin words for other living things. He called the dog *Canis familiaris* (*canis* being Latin for dog) and the cat *Felis domestica,* as the Romans called the cat *felis*. The lion he called *Felis leo* (lion cat) and the leopard *Felis pardus* (spotted cat) showing that these animals are closely related to the cat.

Ever since the days of Aristotle, scientists have been trying to get a satisfactory system for classifying animals and plants. If you don't think classification is important in science, think of the problem of finding a friend's telephone number if the names in the directory were not classified. True, Aristotle, John Ray and others had worked out ingenious schemes, but the books which described the kinds of animals and plants became more difficult to read as time went by. This was because, as more new species were discovered, scientists had to make the descriptions of them longer and longer, in order to tell one from another. The name of one kind of grass consisted of fifteen Latin words! Now, since there are about 4,500 species of the grass family, you can see that a simpler classifying method was needed.

Linnaeus persuaded the scientific world to give each species of animal and plant a double name. The second part indicated the *species,* such as domestic cat, or dog; the first name indicated the *genus*. A genus is a closely related group of species. The use of the two names together makes it possible for the scientist easily to find out what animal or plant is referred to. The plural of species is species. The plural of genus is genera.

As is usual with great discoveries, Linnaeus built on the work of former scientists, especially the Swiss Kaspar Bauhin (1560-1624) and the French botanist Joseph Pitton de Tournefort (1656-1708).

The father of Linnaeus was a poor clergyman who, like most Swedish peasants in those days, had no family name. He took the name Linné from a linden tree near his home. Later the young Carl Linné was raised to noble rank as a reward for his services to scholarship. Then he became Von Linné; but he is generally known by the Latin form

The Bettmann Archive

Linnaeus explaining his names for tropical plants.

By organizing the study of fossils, Cuvier gave science a new key to the story of ages long past.

of his Swedish name, Carolus Linnaeus.

Linnaeus classified all the species of plants and animals known in his day. He set them down according to species, genera, orders and classes. Your cat, for instance, is species *Felis domestica,* genus *Felis,* family *Felidae,* order *Carnivora* (flesh-eating), class *Mammalia* (mammals). Since then scientists have made many changes in classification, but many of the names introduced by Linnaeus are still in use.

SCIENTISTS ADD LUSTER TO THE COURT OF NAPOLEON I

Leopold Christian Frédéric Dagobert Cuvier (who is known to science as Georges Cuvier) was one of the most brilliant of the scientists who glittered with stars and metal braid at the court of the great Napoleon. He was a favorite of Napoleon, and he was just as accustomed to having his own way in the field of science as Napoleon was on the field of battle and in politics.

Cuvier was born in 1769 of French parents in a town then belonging to the German state of Württemberg. As a boy he was sent to a German school where officials and army officers were trained. Cuvier's only language was French, but during his first term he mastered German and earned high marks for courses given in German. He was a young man when the French Revolution broke out. At the time when the chemist Lavoisier was led to the guillotine by the Revolutionists, Cuvier was working for a wealthy family in Normandy as a private tutor.

CUVIER SHOWS THE RELATION BETWEEN FOSSILS AND LIVING PLANTS AND ANIMALS

Cuvier carried on the work of Linnaeus and greatly improved the classification of animals. But even more important was the fact that he was the first to make systematic studies comparing the remains of extinct animals (fossils) with the structure of existing species. Now, although fossils had been known since the time of the ancient Greeks, and many observers had understood that they were really the remains of extinct animals, there were still people in Cuvier's time who thought they were mere "freaks of nature."

Cuvier showed that some of the fossils were very similar to living types, and that others were very different. More than anyone else he deserves credit as the founder of paleontology, the study of extinct animals. Cuvier laid great stress on what he called the principle of correlation of parts. From the earliest times, of course, people have recognized that if human footprints are found they must have been made by a man and not by a kangaroo or an antelope. But Cuvier pushed the principle much further than this "detective story" sort of application. Given a piece of feather, he explained, we know it must have come from a bird. Furthermore, we know that a bird is constructed on a certain plan, with a beak, scales on the feet and the other bird characteristics. From small portions of fossil bones, Cuvier was often able to predict many details about what the structure of the extinct animal was. When more complete remains were discovered, it was usually found that Cuvier had been right.

In spite of his great achievements, Cuvier made a few serious errors. Due to his great fame people accepted his errors as truths, and so he actually managed to hold back the advance of science in some fields.

JEAN BAPTISTE DE MONET LAMARCK, SOLDIER AND SCIENTIST

Twenty-five years before Cuvier another French boy was born whose ideas about the classification of animals and about how new species arise were much closer to those held by modern scientists than the views of Cuvier. He was Jean Baptiste de Monet Lamarck (1744-1829). Lamarck was as unskilled in diplomacy and in knowing how to get along with emperors and kings as Cuvier was skilled in these very useful accomplishments. Furthermore, he wrote badly; Cuvier wrote well. Both were great research scientists, but Cuvier was also a brilliant teacher. Even in his academy uniform Lamarck did not look particularly important; Cuvier looked like a very distinguished person indeed, with an air of cool authority.

Lamarck came from a family of soldiers. He was the eleventh child of his parents. His father sent him to a Jesuit college to study for the clergy, but when his father died, La marck bought a broken-down horse and trotted this melancholy animal toward the German frontier (the Seven Years' War was going on), joined the French army and in his first battle distinguished himself for bravery. When all the officers in his company had been killed Lamarck took command and refused to fall back, though the rest of the army was retreating.

Culver Service

The great zoologist, Lamarck.

His military career was ruined when a comrade injured his neck in a practical joke. Now unfit for military service, he went to Paris to study medicine. Studying drug-producing plants he became fascinated by the beauty and variety of vegetable life. After about nine years work he wrote a Flora (a scientific description of plants) of France. This work won Lamarck wide recognition as a botanist. Later he was invited to help reorganize a famous natural history institution, now known all over the world as the Jardin des Plantes; and he became a member of the staff.

When Lamarck was fifty the institution shifted him from work in botany to work in zoology. He soon became the world's greatest authority on the classification of invertebrates, animals without backbones. Studying the anatomy of hundreds of animals, he came to the conclusion that new species resulted from the gradual change of previous species, as a result of the use and disuse of parts and the influence of the surroundings. For example, he assumed that the giraffe's ancestors once had a neck no longer than that of other browsing animals, but by continual stretching, generation after generation, the long neck of the modern giraffe finally developed. This idea is not accepted by scientists today.

However, all biologists agree that in any class or order of life simpler species occurred as a rule earlier than more highly organized species. Did the more complicated species descend from the earlier, simpler ones? That has been one of the most sharply debated questions in the history of science. Lamarck's theory was not regarded as very important in his lifetime. In fact, there was laughter at the court of Napoleon as Cuvier described any "new folly" of Lamarck. (A theory, in science, is a statement of a natural law as yet unproved.)

Cuvier thought that several times in the past there had been great catastrophes, wiping out vast populations of living things at one time. He thought of these catastrophes as something more terrific and awe-inspiring than anything that could be observed on the earth today. Lamarck strongly disagreed. Naturally, thought the cultivated people of the day, the eccentric Chevalier Lamarck must be wrong.

Now a school of geologists grew up which maintained that the very same processes that had built up mountains, worn down granite rocks and caused lands to sink under the sea in the past were still at work and could be observed. This view is universally accepted now, and scientists are convinced that mountains are rising, rocks are forming and coastlines are changing now in exactly the same way as they did ages ago.

JAMES HUTTON, PHYSICIAN AND GEOLOGIST

James Hutton (1726-97), a Scotch doctor, was the first to make a definite statement of this theory. He proved that in some places granite and other igneous rock had been forced up from below through breaks in the rock above it. His work was carried on by William Smith (1789-1839), an English canal engineer. As with Hutton, geology was mainly a hobby to Smith, but he worked out the story of English rocks so well that many of the names he applied to rock formations are still used. He showed that certain rock layers have each a particular series of fossils. In other words, when certain rocks formed the upper crust of the earth certain species were living. Since these species are not found in certain other rocks, they were probably not in existence when (and where) the other rocks were laid down.

The geologist who finally demolished Cuvier's theory of catastrophes was another Scot, Sir Charles Lyell (1797-1875). His parents sent him to Oxford to study law, but Lyell was far more interested in the problem of how the Highlands of Scotland came to have their wild rocks and jagged coasts. He was greatly influenced by Smith and Lamarck (although he rejected Lamarck's theory). Since Lyell, geologists are universally agreed that titanic mountains like those of Colorado or British Columbia, the twisted and tortured layers of rock we see in many parts of the world, the fantastic sculpturings of the Grand Canyon and great caves under the earth's surface were all caused by the same forces we can observe today.

One of the most distinguished of Cuvier's pupils was the English paleontologist, Sir Richard Owen (1804-92). A paleontologist is a man who studies ancient forms of life. Owen's early ambition was to go to sea as a ship's doctor, but while he was waiting for an opening in the navy he was placed in charge of the natural history collections of the Royal College of Surgeons; and that task changed his career. He dissected hundreds of animals and spent years on an investigation of the teeth of mammals. In 1856 Owen became director of the Natural History Department of the British Museum. Following Cuvier's example, Owen was able (as expert paleontologists are today, of course) to predict the general structure of an extinct animal from a comparatively small fossilized portion.

Once Owen was sent a fossilized leg bone of a bird from New Zealand. Nothing else was sent but this queer bone, some thirty-four inches long. From this single bone (and his own wide knowledge) Owen pictured and described the giant Dinornis, a great wingless bird, twelve feet high. Since then many remains have been found in New Zealand and it is clear that Owen's restoration was substantially correct. The moa (as it was called

The Bettmann Archive

In this quiet study, Charles Darwin worked on ideas which were to cause an explosion in the world of science.

by the native Maoris) apparently became extinct not more than a few hundred years ago. Owen, like Cuvier and Linnaeus, believed that species do not change.

The scientific world still believed that species do not change, that every species of animal and plant had been separately created. Scientists did not agree on whether all species had been created in the very remote past or whether some had been created very much more recently than others. The notion of Lamarck (and of a few before him) that present-day animals and plants are the descendants of other species was regarded as nonsense.

ERASMUS DARWIN HELPS TO PAVE THE WAY FOR HIS MORE FAMOUS GRANDSON

Erasmus Darwin (1731-1802), a friend of Priestley, was a doctor and also a scientist and a poet, who wrote long poems with strange titles like "The Loves of the Plants" and "The Origin of Society." He worked out a theory much like that of Lamarck on the origin of new types of living things. His son Robert was also a doctor and Robert Darwin's son, Charles Darwin, brought forward a new theory about the many species of life on earth. It is called the Darwinian Theory.

INTEREST IN ALL NATURE BEGINS AT AN EARLY AGE FOR CHARLES DARWIN

Charles Darwin was born in Shrewsbury, England, in 1809. He did not distinguish himself in school, in fact, he later wrote that his teachers thought him "a very ordinary boy, rather below the common standard in intellect." But Charles Darwin was already an amateur naturalist. He was an enthusiastic collector of minerals. He wanted to collect insects, but he and his sister decided it was not right to kill harmless insects for that reason.

At Edinburgh University, where he studied medicine, he made no greater success than he had in school. The lectures were dull, he wrote, except the ones on chemistry, but he found the operating clinic far worse. Anesthetics had not yet been discovered, and young Darwin found that he could not endure to watch the sufferings of patients during the operations. It was evident Darwin was not going to be a surgeon.

Next his parents sent him to Cambridge University to study for the clergy. Darwin at first thought that this time his education would be a success, but after three years at Cambridge, he decided that he was wasting his time. Yet at each university Darwin had accomplished something important; he had become the intimate friend of men who loved nature and knew much about it.

When Darwin was twenty-two he was allowed to go as naturalist on a scientific trip, on a government sailing ship, the Beagle. It was planned to explore the southern coasts and lands of South America for two or three years. Actually the voyage took five years and the ship went around the world before it returned to England. In those five years Darwin learned things that no professor in all of the universities of Europe could have taught him. He collected birds, reptiles, insects, fish, barnacles and plants. In Brazil he saw armadillos scurrying through the woods, and sloths hanging upside down in trees. Later he noticed that the fossil Glyptodon of Argentina resembled a giant edition of the armadillo and that the enormous extinct Megatherium was constructed like the sloth, but fitted for tearing great branches off trees rather than for hanging upside down in them. In Tierra del Fuego he saw naked savages apparently quite comfortable in freezing rain.

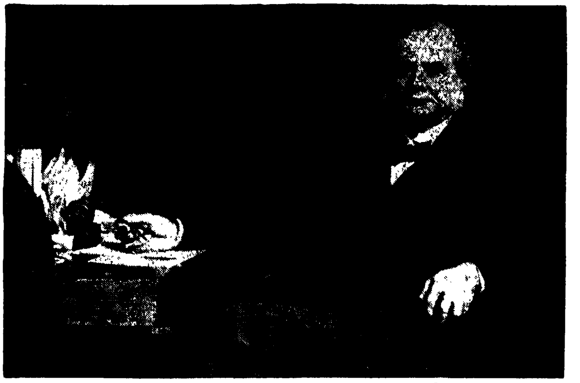
The book Darwin read most often on the Beagle was Lyell's PRINCIPLES OF GEOLOGY. And as he sailed from tropical forests to desert shores and from one green Pacific island to another, he wondered. Why were certain types completely absent from regions where they would certainly thrive if they were introduced? Why did beautiful and fertile islands like New Zealand have almost no mammals? Why had so many species of the past disappeared and been succeeded by other types?

HOW SCIENTISTS DISAGREED ABOUT THOSE CURIOUS SEA CREATURES—BARNACLES

When the Beagle returned to England in 1836 Darwin wrote a fascinating journal of his travels. For the next eight years Darwin worked on barnacles, the curious sea creatures whose shells encrust piers and sea walls, and which used to coat the bottoms of ships. Linnaeus, Cuvier and Owen had said that one species never changed into other species; that each species had been created distinct from every other and that it remained distinct. If that is so, thought Darwin, why can not scientists agree as to the number of species of my barnacles? What some say is a mere variety, others claim is a distinct species, or even genus. Why? (Varieties are groups of differing individuals in a species. For example, the tailless Manx cat is a variety of the domestic cat species.)

Darwin finally began to believe that the various species of plants and animals are the result of gradual changes during many generations. Lamarck had held a similar belief. But Lamarck's idea was that new forms resulted from the use and disuse of parts and the direct effect of the environment. Darwin was not satisfied that this fully explained the changes.

An essay, On Population, by the English clergyman Thomas Malthus (1766-1834), fired the spark in Darwin's mind. Population, claimed Malthus, tends to increase at a much greater rate than food supply; Malthus feared that in the future there would be an acute competition between men for the necessities of life. Darwin wondered if a principle like this ran throughout nature. In other words, since all living things tended to increase so rapidly, there would not be food or space enough on the earth if all of their descendants survived. Darwin was greatly impressed by the varieties of pigeons, the pouters, fantails, homers and the wild rock-dove which still haunts the wilder coasts of Europe. Darwin knew that most of these varieties had resulted from the pigeon breeders *selecting* the birds which showed desirable characteristics for breeding.



Brown Brothers

Thomas Huxley, whose sparkling lectures on science opened the gates of this fascinating subject to everyday people.

In 1842 Darwin wrote out a brief statement of the theory he had formed to account for the origin of species by *natural* selection. The main points are these:

1. Overproduction. Plants and animals produce far more offspring than can survive. One elm tree may produce hundreds of thousands of seeds. One oyster may produce ten million eggs.
2. Variation. No two living things are exactly alike.
3. Struggle for Existence. Since more living things are produced than can survive, a sort of struggle goes on among them. This does not necessarily mean that they go after each other with tooth and claw. The struggle may express itself in the ability to grow faster or to endure difficult conditions better.
4. Survival of the Fittest. (Natural Selection.) Since there is endless variation some organisms are better fitted for the struggle for existence than others. "Fittest" does not necessarily mean largest or strongest. A big animal which needs a large amount of food may be less likely to survive when food is scarce than a smaller creature.
5. Heredity. Darwin believed that the descendants of the "fit" organisms would inherit the qualities which made their ancestors fit, and gradually new species would arise, well-adapted to their environment and very different from their remote ancestors.

Darwin had married soon after the return of the Beagle and had bought a house in the country where he spent the rest of his life. During nearly all of his long life he was ill, so that he could work only a few hours a day. In 1858 a letter came to Darwin from the steamy jungles of the Malay Archipelago. It was from the young naturalist, Alfred Russel Wallace (1823-1913), who earned his living collecting strange butterflies and birds.

The letter was like a bombshell for the sickly Darwin. Wallace had also read Lyell and Malthus and in the leech-infested and orchid-resplendent forests of the East Indies he had worked out the very same theory as Darwin, argument for argument. And he wanted Darwin to get *his* theory published!

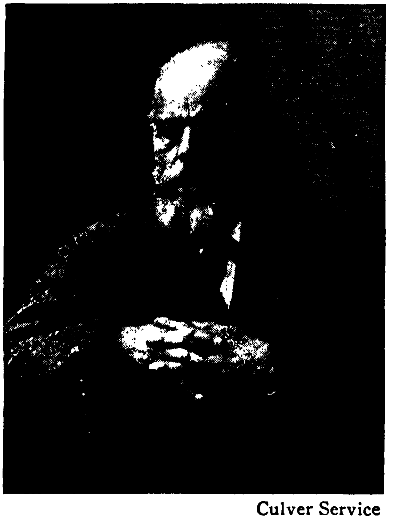
Scientists are human. Most of them have just as great an appetite for fame as poets, military commanders and high-school athletes. Sometimes there have been weird squabbles over priority. But this time both Darwin and Wallace acted with the greatest modesty. On the great Lyell's advice, Wallace's paper was read at the Linnaean Society along with a short essay by Darwin. Next year, 1859, Darwin's book, THE ORIGIN OF SPECIES, was published.

The English philosopher Herbert Spencer (1820-1903) had been working on the same problem. Like Darwin, Spencer suffered from ill health most of his life, but whereas Darwin had inherited enough money from his parents to live very comfortably, Spencer was very poor. For ten years he worked as a railroad engineer and then as a journalist. When he was forty he set out to write a great work of philosophy in ten volumes, to gather together and explain the principles of all the fields of knowledge. Spencer gave himself twenty years to complete his great work. It actually took him thirty-six years.

When THE ORIGIN OF SPECIES was published in 1859, the greatest scientific controversy in history followed. Interest was so great that the publisher sold the entire first edition on the first day. Many men of science ridiculed Darwin's theory; many attacked it as irreligious. Today, almost a hundred years later, Darwin's theory is accepted by many scientists, questioned by others, accepted with reservations by still others.

The American botanist Asa Gray, the English botanist Sir Joseph Hooker (1817-1911) and the English scientist Thomas Henry Huxley (1825-95) were the first to come out in favor of the new theory. Huxley, unlike Darwin, loved a debate and a good fight.

Like Darwin and Spencer, Huxley suffered from wretched health, and like Spencer, he was poor as a boy. As a young doctor he made a cruise on the ship Rattlesnake much like Darwin's on the Beagle. He was 5 feet 11 inches tall; the height of his cabin was 4 feet 10 inches, which gave him quite a problem. For many months in the broiling sun on the seas east of New Guinea, Tom Huxley sweated and dissected jellyfish and planned to overthrow the Cuvier classification.



Culver Service

August Weismann, student of heredity.

In later life Huxley became the most popular lecturer on science of his time, attracting great crowds because he could make even the structure and history of a piece of chalk interesting and important. Because Huxley was such a successful champion, Darwin's theory received a great deal more attention than it otherwise would have had. Actually, in Darwin's time, men knew very little about heredity. Even today the study is still in its infancy.

Without the handicap of defective eyesight, August Weismann (1834-1914) might never have made his name outstanding in the study of heredity. Born in Frankfort on the Main, Germany, he received his degree in medicine at Göttingen; then practiced medicine at Frankfort. But he was so much interested in pure science that at the age of thirty he went to Giessen to study zoology and a few years later was appointed professor of zoology at Freiburg, a position he held for more than forty-five years. For some time he devoted himself to the study of flies, but as his eyesight became impaired, it grew impossible to work extensively with the microscope. He turned his attention to wider biological matters, and the problem of heredity became his greatest interest. He put forward a theory of heredity which had its basis in the *continuity of the germ-plasm.* This theory denied the inheritance of acquired characters. (A blacksmith's children are not born with strong arm muscles, for instance, or a dancer's children with strong leg muscles, since the blacksmith and the dancer were not born with this muscular strength, but acquired it.) Weismann said that the offspring of two individuals are descendants not from the body cells, but from the germ cells.

Before Weismann, most biologists had assumed that acquired traits and the effects of use and disuse were inherited (for example, the wings of flightless birds show the effect of disuse). Weismann cut off the tails of generation after generation of rats. But the baby rats always had normal tails, just as if nothing had happened to their ancestors.

If the history of science were told in pictures, you might not attach much importance to one which showed a young man working in a monastery garden. Yet such a scene illustrates the early stages in some of the outstanding biological discoveries of all time, having to do with the fundamental laws of inheritance. Today they are known as the Mendelian Laws in honor of the monk who worked in a garden in search of knowledge.

Gregor Mendel was born in 1822, the son of a poor Austrian farmer. His brilliant mind made him dissatisfied with the mere tilling of the soil, and he entered a monastery. At the monastery of Brünn, Austria (today known as Brno, Czechoslovakia), besides teaching, he found time to carry on experiments in plant-breeding. For his experiments he used peas.

THE STORY OF MENDEL'S WORK ON HEREDITY IS PUBLISHED IN AN OBSCURE MAGAZINE

For eight years Mendel worked, observing the results of his plant-breeding, and keeping a most complete record of all data connected with his experiments. Then, in 1866, he wrote the story of all he had learned about inheritance. It was published (under the title Research upon Hybridization) in a small and little known periodical devoted to the subject of natural history. (Hybridization of plants means producing a new generation from two unlike parents. Another word for this is crossing. The new generation is called a hybrid.) Shortly after publishing his paper on hybridization, Mendel gave up teaching and research to become abbot of the monastery. He died in 1884, and even his close associates had not the slightest idea that he was leaving to the world principles that one day would do much toward solving the riddles of heredity.

For thirty-four years Mendel's findings lay forgotten, gathering dust on library shelves, while other scientists struggled to shed light on the very problems with which his work dealt. In 1900 three biologists, De Vries, Tschermak and Correns, all happened to come across them, and recognized their true worth. Republished and widely acclaimed, they started a whole new chain of experiments.

THE "DOMINANT" AND "RECESSIVE" TRAITS IN THE MENDELIAN LAWS

Mendel chose to work with plants because they were easier to obtain in large quantities, and easier to manage than animals. His system was to cross peas that belonged to the same species, but differed from each other in one character, such as color or shape of the seed, or the height of the plant. If he crossed a pure yellow-seeded plant with a pure green-seeded plant the first hybrid generation resulting from this cross-breeding all had yellow seeds. The characteristic which showed up in the hybrid offspring was called "dominant." The character that did not show up Mendel called "recessive." When the hybrids produced offspring, the recessive character appeared in a certain proportion which today is known as the *Mendelian ratio.* (We explain the Mendelian Laws at some length, and with pictures, elsewhere. See Mendel, in the Index.)

After Mendel's paper had been published for the second time, his fundamental principles of heredity were extended to other plants and to animals. His work has made possible the breeding of better wheat, corn and other plants; improved strains of horses, dogs and other animals have been produced; and knowledge of the way heredity works in the human race has been greatly increased. This does not mean that Mendel's Laws are the answer to all problems of heredity. Many mysteries still exist and many discoveries are still to be made. But the primary laws as established by Mendel remain the key to inheritance.

A COMMON WEED GIVES HUGO DE VRIES ANOTHER IDEA ABOUT THE RISE OF NEW SPECIES

One of the three men who discovered Mendel's writings in 1900 was the Dutch botanist Hugo de Vries (1848-1935). A common American weed whose light-yellow blossoms brighten our roadsides in autumn gave De Vries an idea of the greatest importance in heredity and evolution. The weed was the evening primrose which had escaped from a garden and was growing in an uncultivated field.

De Vries found that these evening primroses did not always breed true—that is, even when both parents were alike, the next generation sometimes showed changes. New varieties appeared; and some of these new types would "breed true," that is, their offspring would be like the strange parent plants, not like the grandparent plants. As De Vries expressed it, a species seemed to be "exploding" into new varieties, or even new species.

De Vries called these rather large changes mutations. He decided that these sharp definite mutations were the important things in bringing about new species—and not the very small variations, going on for generations, which Darwin had thought most important.

FRANCIS GALTON PROVES THAT NO TWO SETS OF FINGERPRINTS ARE ALIKE

Born at Birmingham, England, in 1822, into a distinguished scientific family (he was a grandson of Erasmus Darwin and cousin of Charles Darwin) Francis Galton's own case is frequently given as evidence in favor of his theory that intellectual ability tends to be inherited.

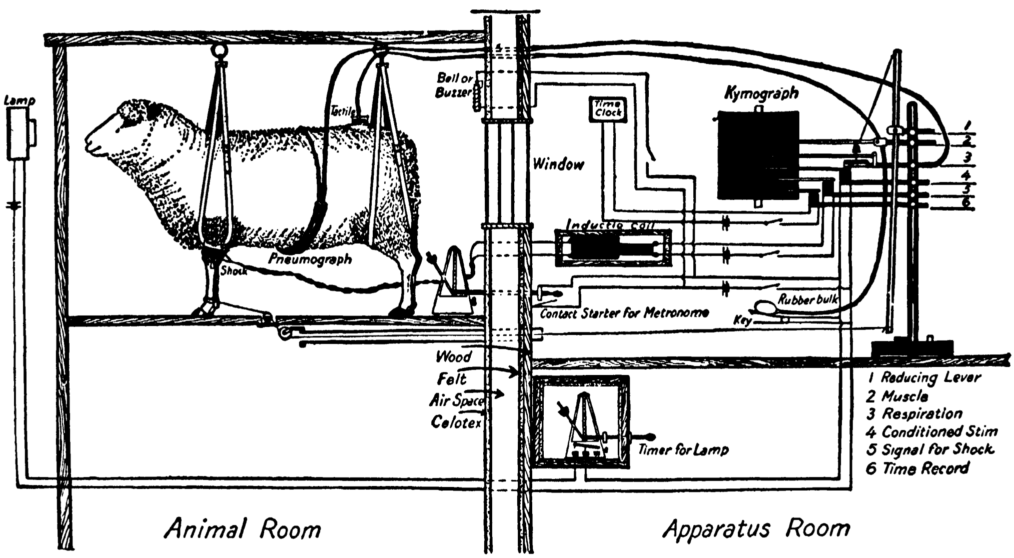
For a while Galton gave his attention to meteorology, the study of weather. He originated ideas which are now the basis of weather forecasting. In his mid-thirties he became interested in anthropology, and, inspired by Darwin's ORIGIN OF SPECIES he devoted himself to the study of heredity. Galton was one of the first to appreciate fully the value of keeping careful accounts in biological experiments.

Among Galton's most important contributions was the demonstration that the ridges on the balls of fingers are individual and permanent in character. In other words, every person's fingerprints are different from all other fingerprints; and the markings on a person's fingers remain the same from the cradle to the grave. Galton showed how these markings could be employed for the identification of criminals.

Galton was knighted in 1909. He died in 1911. Among his important writings are HEREDITARY GENIUS, NATURAL INHERITANCE and FINGER PRINTS.

Born in the district of Ryazan, Russia, the son of the village priest, Ivan Pavlov (1849-1936) was destined to become one of the world's outstanding physiologists. He first studied science at the University of St. Petersburg (now Leningrad). After being graduated as a doctor, he went to Germany where he studied physiology. That science was emerging from a long, unprogressive period. This was chiefly due to advances in chemistry and physics. The new knowledge in these fields was helping to explain many things about the workings of the body.

Pavlov's first achievements were on the physiology of blood circulation. In his experiments he found the same handicaps under which fellow-scientists labored—that is, when studying the reactions of an animal to a certain stimulus, it was almost impossible to keep other stimuli from affecting the animal at the same time, and thus confusing the experiment. Pavlov strove to remove all confusing interference. He had special laboratories constructed, arranged so that the animals under observation did not even see the experimenters; and he carried out numerous experiments under absolutely uniform conditions.

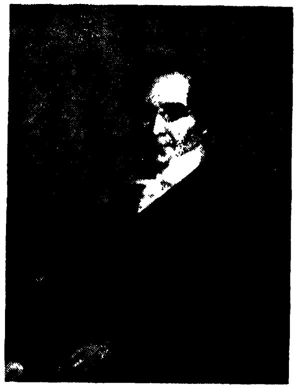


A Pavlov apparatus for the study of reflex responses. At the same instant the lamp flashes, a weak electric shock is applied to the sheep's foreleg, which makes the animal pull its leg up. After a period in which light and shock always come together, the sheep will pull its leg up on sight of the light only.

Pavlov devised methods for studying the process of digestion. He measured accurately the flow of saliva in the mouths of dogs, and recorded the manner in which a hungry dog's mouth "watered" when he was shown food. If a bell was rung every time food was shown, in time the animal's mouth would water at the sound of a bell, even though no food was produced. The production of saliva when food is taken into the mouth is an automatic response called an inborn reflex. Since Pavlov had substituted a new stimulus for the inborn one while still getting the same response, he called the new reflex a conditioned reflex. Pavlov found that conditioned reflexes could be produced in babies as easily as in dogs.

In one experiment Pavlov caused dogs to go through something like a nervous breakdown. A conditioned reflex was established in a dog by feeding it after showing it a circle of light. When the dog was shown an ellipse it got no food. Being shown the ellipse didn't disturb the dog. The animal paid little attention to it.

Baron Justus von Liebig.



Joseph Louis Gay-Lussac.

Then Pavlov started changing the shape of the ellipse. Day after day he made the ellipse more like a circle. At first the dog paid no attention. But one day, when the shape was such that it was very difficult to tell whether it was an ellipse or a circle, the dog took a look at the spot of light, and suddenly howled, struggled and remained nervous for days.

Building on Pavlov's work, scientists have decided that much of the behavior of both human beings and lower animals is conditioned behavior.

HOW GAY-LUSSAC AND AVOGADRO HELPED TO EXPLAIN THE BEHAVIOR OF GASES

Soon after Dalton announced the atomic theory, the French chemist Joseph Louis Gay-Lussac (1778-1850) made a series of experiments with gases. He made a strange observation about the volumes of gases which would combine with each other and of their combinations (when these were gases). Here are some of his results:

1 volume of nitrogen + 1 vol. oxygen = 2 vols. nitric oxide
2 volumes of hydrogen + 1 vol. oxygen = 2 vols. water vapor
1 volume of nitrogen + 3 vols. hydrogen = 2 vols. ammonia

His conclusion, which we call Gay-Lussac's Law, states: *When gases react, their relative combining volumes and the volume of the product, if it is a gas, can be expressed by small whole numbers.*

An Italian scientist, Amedeo Avogadro (1776-1856), professor at Turin University, found the explanation of the puzzle. Avogadro's law states that *equal volumes of all gases under the same conditions of temperature and pressure contain the same number of molecules.* How does this account for one volume of nitrogen combining with three volumes of hydrogen to form two volumes of ammonia? Avogadro assumed that a molecule of each of the most common gases that combine contains two atoms.

Now suppose 1,000 molecules of nitrogen combine with 3,000 molecules of hydrogen. Each molecule will split into its two atoms, giving 2,000 atoms of nitrogen and 6,000 atoms of hydrogen. Each nitrogen atom will combine with three hydrogen atoms, forming 2,000 molecules of ammonia, NH_3.

This reasoning was found by later scientists to be correct, though chemists did not generally accept Avogadro's hypothesis when he put it forward in 1811. During the next forty years great confusion prevailed about the terms atom and molecule. Some chemists referred to atoms of water in the same way they spoke of atoms of oxygen. Water is not an element but a compound of oxygen and hydrogen. Its smallest unit is not an atom, but a molecule. In 1860, Stanislao Cannizaro (1826-1910), an Italian, revived Avogadro's hypothesis and also his definition of a molecule, which is now included in every chemistry book: *A molecule is the smallest part of either an element or a compound that has the properties of that substance.*

Scientists once believed that live animals and plants had the power to make many substances which could never be duplicated in the laboratory. Such substances, like sugar, starch and proteins and many other foods, poisons and pigments were thought to be the product of a mysterious "vital force." Even the great Berzelius thought that the chemical laboratory could never imitate the sugar-cane plant in manufacturing an organic substance like cane-sugar.

A pupil of Berzelius was the first to prepare an organic compound in the laboratory. For a year an angular, thin-faced German youth, Friedrich Woehler (1800-1882), had worked in Berzelius' laboratory in Stockholm. In 1828 Woehler synthesized (produced chemically) urea from the chemical ammonium cyanate. Previously urea had been known only as an animal waste product.

Woehler's friend, Baron Justus von Liebig (1803-73), was not born a baron, but was the son of a poor storekeeper of Darmstadt, Germany. After attending two universities he worked in Paris in the laboratory of Gay-Lussac. When only twenty-one he became professor of chemistry at the University of Giessen, and there he started the first really thorough laboratory training in chemistry given by any college.

Before the time of Liebig, farmers knew that farmyard manure and other organic matter would enrich the soil. Liebig showed that artificial chemical fertilizers could be used just as well. The modern fertilizer industry which uses ground-up rocks of the proper types is largely due to Liebig.

The friendship between Woehler and Liebig was something like that between Schleiden and Schwann. Woehler was a most amiable and reasonable person, humorous and artistic, and he did his best to keep his friend out of the endless quarrels that Liebig delighted in.

Chemists picture molecules as composed of atoms arranged in a definite pattern. Each atom has a valence, that is to say, a certain ability to combine with other atoms, as you read in the story of Atoms. It is as if each atom had a certain number of hands and to be "satisfied" had to have each of these clasped by a hand from some other atom. Hydrogen has a valence of 1, or one hand. Oxygen has a valence of 2, or two hands. The formula for water is H_2O; that is, one atom of oxygen and two atoms of hydrogen make a molecule of water. We can picture the water molecule as H-O-H. Carbon generally has a valence of 4. When carbon combines with hydrogen to form methane gas, the formula is CH_4. Our picture is

$$\begin{array}{ccccc} & & H & & \\ & & | & & \\ H & - & C & - & H \\ & & | & & \\ & & H & & \end{array}$$

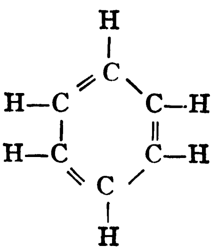
Ethylene gas has the formula C_2H_4 and chemists have decided its structure is:

$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & - & C & = & C & - & H \end{array}$$

In this case we have two carbon atoms joining each other with two hands. Chemists call this double joining a double bond.

In 1825 Faraday separated benzene, a colorless, combustible liquid from fish oil. Chemists found the molecule of benzene to have 6 carbon atoms and 6 hydrogen atoms. The formula was C_6H_6. Before reading on, see if you can figure out how these atoms are arranged.

Forty years after the discovery of benzene no one had been successful in working out the pattern of the benzene molecule. The German chemist Friedrich Kekulé (1829-96) had been baffled for years. One evening he dozed before his fireplace, still haunted by the benzene problem. He dreamed of atoms —and snakes. Suddenly one snake seized hold of its own tail and snakes and atoms whirled mockingly. Kekulé woke with an inspiration. By morning he had worked out the benzene molecule's structure. It was like a *ring,* as if each carbon atom were a snake biting the tail of the one before it:



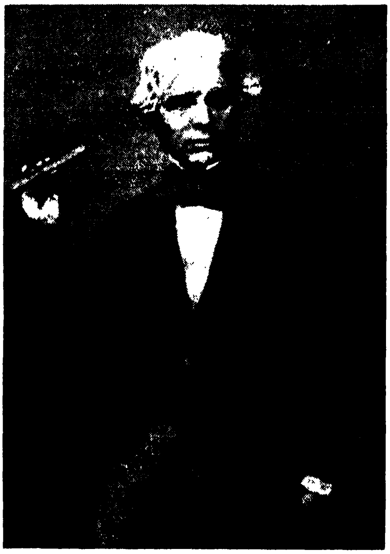
Thousands of compounds are now known to be built on such ring structures.

Dimitri Ivanovitch Mendeleef (1834-1907) was born in Siberia, the seventeenth child of a Russian father and a Tartar mother. While Mendeleef was still a student his doctor gave this frail blue-eyed Siberian only six months to live. But in a few years he had stamina enough to write a 500-page textbook in sixty days. At thirty-two he was a full professor in the University of St. Petersburg.

In a separate article, elsewhere in our book, we give you the Periodic Table of the elements. This table was Mendeleef's great achievement. He noticed that if the elements were arranged in the order of their atomic weights, every seventh element *repeated* many of the physical and chemical characteristics of the element seven spaces before it. By means of his table Mendeleef predicted the discovery of elements which had never been heard of—and he told accurately what their properties would be when they were found! Later the new elements were discovered. Their properties were found to agree with Mendeleef's predictions.

Since Mendeleef's day a whole new family of elements, the inert gases (so-called because they rarely react with other elements) were discovered. These include helium (used for lifting airships), argon, krypton and xenon. A new eighth group, called the zero group, had to be made for them in the Periodic Table.

A great deal of work in chemistry is done with substances in solution, that is, dissolved substances. Most often they are dissolved in water. The chemistry of living things is concerned largely with solutions, since only dissolved substances can pass through a cell membrane. Thomas Graham (1805-69) found that substances could be divided into two classes according to how they acted when dissolved in water. Crystalline substances, such as most salts, pass freely through membranes when dissolved. But many substances, such as gelatin, do not dissolve entirely in water, and can not, therefore, pass through a membrane. This latter class of substances Graham called colloids. Colloids make mud stick together, especially mud from soil that contains a great deal of clay.



Michael Faraday, holding a bar magnet.

The Dutch physicist J. H. van't Hoff (1852-1911) worked on osmotic pressures (such as occur when plant cells absorb water). He showed that these pressures were similar to those exerted by gases. Van't Hoff's friend, the Swede Svante Arrhenius (1859-1927), formulated one of the great theories of chemistry while he was still in college. He tried to tell his professor about it but the professor was not interested.

When Arrhenius presented his thesis to the University of Uppsala it was given the lowest mark that could be given without rejecting it. Yet the theory he advanced, the ionization theory, is generally accepted today. Arrhenius' theory assumes that the molecules of salts, bases and acids break up into electrically charged *ions* when dissolved in water, and that it is the ions which carry electric currents through solutions. Ions are electrically charged atoms. Plain atoms, as you know, are electrically neutral, having balanced negative and positive electricity. Ions have somehow lost this perfect balance. Some of them are positive, some are negative.

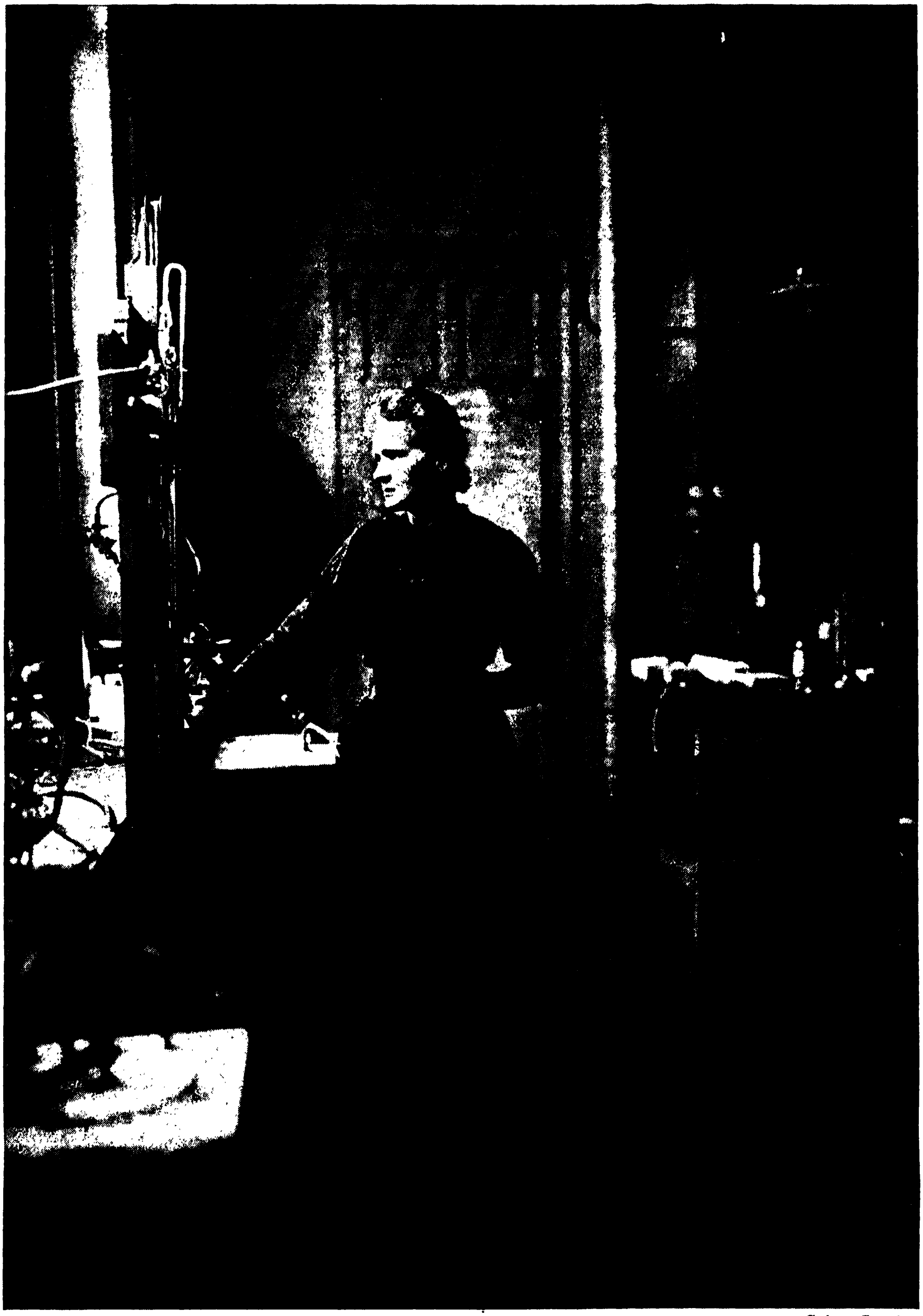
We come now to the story of radium, discovered in 1898 by Marie and Pierre Curie. Of course, this discovery, like most others in science, depended on the earlier discoveries of men of many different countries. For example, there was Sir William Crookes in England. "That certainly is a peculiar glow," we can imagine him saying as he watches one of his newly discovered cathode-ray tubes. "I wonder what causes it."

Then there was Professor Wilhelm Konrad Röntgen in Munich. He observed that even when a Crookes' tube was covered with black paper (through which no light could pass) something which affected a photographic plate did come through. What could this unknown something be—an invisible ray? "I'll call them X rays," said Röntgen. It was an accident which made him famous. One day in 1895, he found that photographic plates inside a desk drawer had been blurred by these X rays which had passed right through the desk. Instead of throwing these spoiled plates away, he developed them. To his amazement, the perfect image of a key appeared on one of them. But no key had been in the drawer. Oh yes, he remembered, there had been a key on top of the desk! The key was photographed right through the desk by these remarkable X rays. Thus, at the age of fifty, fame caught up with Röntgen. What a practical discovery this turned out to be. A very short time afterward X rays were used by a doctor in the United States to locate a bullet imbedded in a wound.

HENRI BECQUEREL, PIONEER PHYSICIST IN THE WORK ON RADIOACTIVITY

Next we jump to Paris. Here is Antoine Henri Becquerel, professor of physics. His father before him had been professor of physics, and his grandfather also had been a well-known physicist — scientists both. Henri was interested in phosphorescent sub-

MARIE CURIE, CO-DISCOVERER OF RADIUM



Culver Service

Madame Curie proved that women can make as great a contribution to science as men. With her deep feeling for suffering humanity, it must have comforted her to see radium used to combat disease.

stances; substances which, after being exposed to sunlight, continue to glow of their own accord when placed in the dark. What made them glow? Were they giving off rays similar to those strange X-rays of Professor Röntgen? Becquerel was going to find out. In February, 1896, Professor Becquerel announced that a certain uranium compound was able to affect a photographic plate through black paper. Did something come out of the compound and pass through the paper? Later he showed that whatever came out of the uranium compound could pass through metals also. At this point Becquerel dropped his work on these strange compounds, and turned to other research. However, he had done enough to give the Curies their start toward the discovery of radium.

YOUNG PIERRE CURIE FINDS HIS LIFE-WORK IN EXPERIMENTAL PHYSICS

Pierre Curie was the son of a French doctor. For three generations before his birth in 1859, the Curies had been men of intellect, interested in science. Pierre was no exception. He showed his ability early, for by the time he was sixteen he had already obtained his university degree in science. Together with his brother Jacques, who was also interested in experimental physics, he discovered that electricity could be produced by squeezing certain crystals—the so-called piezoelectric effect. This discovery, and further work along the same lines, gave the two brothers a reputation in other countries, although they were not well known in France. At any rate, 1894 found Pierre director of research at the Paris School of Physics and Chemistry. Here a Polish girl, Marie Skladovska, came in the hope of finding a place to carry on her experimentation.

MARIE SKLADOVSKA CURIE—WIFE, MOTHER AND GREAT SCIENTIST

Marie Skladovska had had a hard life. She was born in Warsaw on November 7, 1867, during a period when Poles were persecuted by their foreign rulers. Her father, a school teacher, earned just enough to make ends meet; and although Marie wanted to study more than anything else, she found it necessary to go to work. From the ages of seventeen to twenty-two she worked as a governess. All this while, she skimped and saved, and finally, in 1891, she set out for Paris to study at the famous Sorbonne.

She lived alone in an unheated garret, on three francs (about sixty cents) a day. Some days she went without food. But always she applied herself to her work. In 1893 she was graduated from the Sorbonne with honors in physics, and in 1894, with honors in mathematics. What now? Fortunately, an industrial research job opened for her, a study of the magnetic properties of various types of steels. She began this work at the Sorbonne, but the laboratory was crowded. On the advice of a friend, she went to the Paris School of Physics and Chemistry. Here she met Pierre Curie, the director of research—and these two scientists were married on July 26, 1895.

STRANGE RAYS IN URANIUM ORES GIVE THE CURIES THEIR FIRST CLUE

A new period began in the life of Marie, now Madame Curie. She divided her time between her studies and housework. In 1897, a daughter, Irene, was born. However, Marie did not neglect her work at the laboratory. She had been fascinated by Professor Becquerel's discovery that uranium ores give off mysterious rays. What is the nature of these rays? This was to be the subject for her research. Using electrical equipment (which had been invented by Pierre and Jacques Curie) to measure the strength of the rays, she concluded that the more uranium in an ore, the greater the radiation. Marie suggested the word "radioactivity" to describe this peculiar behavior.

But there was something strange. A piece of an ore from Austria, pitchblende, gave off radiation far greater than the amount of uranium in the ore should produce. Could this be an error? She repeated her test again and again. Each time the same result. Could there be a new element here; an unknown element; an element far more powerful in its radiation than uranium? This was the middle of 1898. Pierre gave up his own work and joined forces with Marie. Together, in July, 1898, after intensive work, they announced the discovery of a new radioactive element, which Marie named polonium in honor of her birthplace. In December of 1898, a second new element, radium, was announced.

TEDIOUS LABOR ON TONS OF PITCHBLENDE YIELDS ONE TINY GRAM OF RADIUM

Scientists are skeptics. They would not accept the existence of these new elements until enough was produced to see, to weigh, to measure. Now began the tremendous task of working over tons and tons of pitchblende ore to get the tiny fraction of radium which it contained. One tiny gram of radium—six tons of ore to get it! Finally, in 1902,

With this apparatus, developed by Alexis Carrel, organs can be kept alive outside the body. Fluids circulate through the tissue, supplying it with oxygen and food and carrying off waste products.

the proof of the existence of radium was so strong that science could no longer deny it. What precious stuff it was—one ounce was valued at $4,000,000. In 1903, the Nobel Prize in physics was divided among Henri Becquerel and Marie and Pierre Curie for their work on radioactivity.

Life and work went on for the Curies. Another daughter, Eve, was born in 1904. Things were easier now. They had a well-equipped laboratory to work in. Pierre was now a professor at the Sorbonne. Suddenly tragedy struck. In 1906, Pierre was run down by a heavy cart, and killed instantly. Marie did not give up. Her studies of radium continued. In 1911 she was again honored with a Nobel Prize, the only person ever to receive this award twice. Honors came to her by the score. In 1921, and again in 1929 she came to the United States, each time to receive a gram of radium as a gift from the women of America.

But radium left its mark on Madame Curie. In 1934 she became ill. Perhaps long exposure to the penetrating rays of radium had caused the disease, pernicious anemia. Death came on July 4, 1934.

Sir Isaac Newton had rejected the wave theory of light put forward by Huygens. Early in the nineteenth century the English scientist Thomas Young (1773-1829) and the Frenchman Augustin Jean Fresnel (1788-1827) put the theory into modern form which was generally accepted. Young succeeded in calculating the wave-lengths of light of different colors. Now scientists are able to tell that various elements are present in the sun by analyzing the sun's light.

Before the examining board at Cambridge University stood an eighteen-year-old boy, who was competing for the highest prize in mathematics. As the examination ended, and the boy left, one examiner whispered to a second, "You and I are just about fit to mend young Thomson's pen."

This brilliant youngster, born in 1824, was William Thomson, second son of a professor of mathematics at Glasgow University. At ten he had already passed the entrance examinations for Glasgow University. At sixteen, he enrolled at Cambridge, and when his work there was complete, he went to Paris for further study. Paris was a center for advanced scientific work.

In 1846, when William was twenty-two, he became professor of natural philosophy at Glasgow. There he remained for the next fifty years. Thomson was not a "natural born" teacher, but he was a remarkable mathematician and experimenter. Fortunately for the world, his teaching at the university took up only part of his time, and he was able to devote himself to many of the problems in physics which confronted scientists of the time. For example, there was the new field of thermodynamics.

Since the days of Count Rumford, it had been known that mechanical work sets free heat. How is this heat created? Around 1840, Von Mayer and Joule answered this question. The heat is not created; it is merely energy which has been changed from some other form to heat. "Energy can not be created or destroyed," they said (each in his own words), "it can merely be changed from one form to another." Who were Von Mayer and Joule?

ROBERT VON MAYER'S SOLUTION OF AN OLD PROBLEM GOES UNNOTICED

Julius Robert von Mayer (1814-78) was a German doctor who spent his spare time trying to find out how much mechanical work a given amount of heat could perform. In 1842 he published a short article in a German scientific magazine announcing that he had calculated the answer. In 1845 he published another article describing his experiments. Poor Robert von Mayer. His work went completely unnoticed.

In the meantime, James Prescott Joule (1818-89), an English brewer, was also investigating the same question. In 1843 he published an article announcing that he had worked out this so-called "mechanical equivalent of heat." He stated that 778 foot-pounds of mechanical work released the heat needed to raise the temperature of one pound of water one degree Fahrenheit. The work of Joule, too, went unnoticed.

JOULE'S CALCULATIONS ON ENERGY ARE APPLIED BY WILLIAM THOMSON

This is where William Thomson entered the picture. In 1849 he called attention to Joule's work, and pointed out the importance of the idea that the same energy is used time and time again, without ever being used up. Thomson applied this knowledge to such questions as the age of the earth and whether our universe, like a huge clock, is gradually running down. Together with Joule, he tried to find out why an expanding gas got cooler—an apparent loss of energy without work.

Unfortunately, Thomson overlooked Von Mayer's work completely. As the ideas of conservation of energy and the mechanical equivalent of heat came to be generally accepted, Joule got all the credit, and Von Mayer, who insisted on his share of honor, got only abuse. Finally, in despair, Von Mayer tried to commit suicide by throwing himself out of a window. Fortunately his injuries were not fatal, and he lived to see the day when in 1862, John Tyndall, lecturing at the Royal Institution, gave public recognition to the contribution of Robert von Mayer in the field of thermodynamics.

THE ATLANTIC CABLE IS MADE POSSIBLE BY INVENTIONS OF THOMSON

Thomson did not devote himself to theoretical problems alone. He invented many devices of practical importance, such as a ship's compass which is unaffected by the magnetism of the ship itself. He made possible the laying of the Atlantic cable by inventing a device to measure the depth of the ocean. He made possible the use of the cable by inventing special devices to record and make intelligible the weak signals which crossed the ocean.

Honors were heaped upon him. In 1892 he was raised to the peerage, and under the name of Lord Kelvin he continued his scientific work until 1907, when he died. He was buried in Westminster Abbey next to Sir Isaac Newton.

VON HELMHOLTZ APPLIES HIS KNOWLEDGE OF PHYSICS TO THE HUMAN BODY

Herman Ludwig Ferdinand von Helmholtz is a long name. But the list of contributions which this German army doctor made to science is far longer. Born in 1821, he studied medicine only because his father convinced him that he could make a living more easily as a doctor than in experimental physics, his first love. Later this combination of medical training and ability in physics enabled him to apply physical measurements to life processes.

One of his earliest contributions was the application of the law of conservation of energy to living things. He showed that an organism resembles a machine depending for its activities on a source of energy, the burning (oxidation) of food. Later he studied sight and sound. He invented the ophthalmoscope so that he could see the living retina of the eye. He made studies of the ear, and the quality of tones. His conclusions were applied to the improvement of tone quality in the piano.

Before his death in 1894, Von Helmholtz had made more than two hundred separate contributions to the various fields of science. Indeed, his investigations covered the whole field of science, from physiology to mechanics. He was an empiricist, that is, he believed that all knowledge is founded on experience, acquired or inherited.

By THOMAS GORDON LAWRENCE, and Others.

THE GREAT BIOLOGISTS OF THE NINETEENTH CENTURY

J. B. M. Lamarck (1744-1829), French. Held that new species were formed as a result of use and disuse of parts and the inheritance of acquired characteristics.

Georges Cuvier (1769-1832), French. Famous for his studies of comparative anatomy of different animals and his work with fossils.

Alexander von Humboldt (1769-1859), German. Wrote magnificent descriptions of tropical vegetation. Founded science of physical geography.

M. F. X. Bichat (1771-1802), French. Showed that organs are made of different tissues.

Robert Brown (1773-1858), Scotch. Called attention to nucleus of cell. Discovered Brownian Movement of microscopic particles.

Henri Dutrochet (1776-1847), French. Clearly stated the cell theory, giving evidence to support it, applying to both animals and plants.

Johannes Evangelista Purkinje (1787-1869), Czech. Named protoplasm.

Felix Dujardin (1801-62), French. Recognized importance of protoplasm. He called it sarcode.

Matthias Schleiden (1804-81), German. Established the cell theory as applying to plants.

Richard Owen (1804-92), English. Made many excellent dissections; published many works on comparative anatomy and paleontology. Opposed Darwin's theory of origin of species.

Hugo von Mohl (1805-72), German. Made popular the cell concept and the term protoplasm.

Louis Agassiz (1807-73), born in Switzerland, became an American. Collected evidence to show existence of Ice Age in past. Great teacher of zoology.

Charles Robert Darwin (1809-82), English. Developed the theory of natural selection to account for the origin of new species.

Theodore Schwann (1810-82), German. Made an excellent statement of the cell theory. He worked mostly with animal tissues.

Claude Bernard (1813-78), French. Showed that liver changes sugar to glycogen (animal starch) and glycogen to sugar. Greatly advanced the study of digestion.

Herbert Spencer (1820-1903), English. Coined the phrase "survival of the fittest." Although he was a philosopher rather than a scientist, he had a great influence on scientific thought.

Rudolf Virchow (1821-1902), German. Extended the cell theory into the study of disease.

Gregor Mendel (1822-84), Austrian. His researches laid the foundations for the science of heredity, which is consequently often referred to as Mendelism.

Louis Pasteur (1822-95), French. Developed the germ theory of disease. Demolished the theory of spontaneous generation. Showed that fermentation is due to living organisms. Discovered pasteurization (for milk, beer, etc.) and Pasteur treatment for rabies. (See also Index.)

Francis Galton (1822-1911), English. Showed the importance of the ridges on finger tips (fingerprints).

Alfred Russel Wallace (1823-1913), English. Independently worked out the theory of natural selection.

Max Schultze (1825-74), German. Showed the great similarity between protoplasm of plant and animal cells.

August Weismann (1834-1914), German. Produced evidence against the inheritance of acquired characteristics. Developed the idea of the "continuity of the germ plasm," meaning that the protoplasm that forms the offspring is handed down from one generation to another.

Hugo de Vries (1848-1935), Dutch. Maintained that new varieties are produced by sudden definite and inherited changes in the germ plasm, which he called mutations.

Ivan Pavlov (1849-1936), Russian. Physiologist. Discovered the conditioned reflex. Winner of Nobel Prize in medicine, 1904.

Edmund Beecher Wilson (1856-1939), American. Leading authority on the structure of the cell.

William Bateson (1861-1926), English. Made important studies on heredity.

Sir Charles Sherrington (1861-), English. Leading authority on functions and working of nervous system. Winner of Nobel Prize in medicine, 1932.

Charles B. Davenport (1866-1944), American. Made wide study of eugenics, the science of improving hereditary qualities.

PHYSICAL SCIENTISTS (CHEMISTS, PHYSICISTS, Etc.)

Thomas Young (1773-1829), English, and **Augustin Jean Fresnel** (1778-1827), French. Put the wave theory of light into modern form.

André Marie Ampère (1775-1836), French. Made the fundamental discovery which led to the invention of the telegraph. The ampere, the unit of current, is named for him.

Amedeo Avogadro (1776-1856), Italian. Stated that equal volumes of all gases under same conditions of temperature and pressure contain same number of molecules.

Hans Oersted (1777-1851), Danish. Discovered that a magnetic needle is affected by the presence of a current-carrying conductor.

Continued on following page.

Joseph Louis Gay-Lussac (1778-1850), French. Showed that gases combine in simple proportions by volume.

George Simon Ohm (1787-1854), German. First to state the mathematical relationship between current resistance and electromotive force. The unit of resistance is named for him.

Michael Faraday (1791-1867), English. Discovered electromagnetic induction and the laws of electrolysis. Many other scientific contributions.

Sir Charles Lyell (1797-1875), English. Helped establish the fact that rocks are being laid down today by the very same processes which formed them millions of years ago.

Joseph Henry (1799-1878), American. Independently discovered electromagnetic induction.

Friedrich Woehler (1800-82), German. Synthesized urea, first organic compound to be made artificially.

Christian Doppler (1803-53), Austrian. Discovered the "Doppler Effect," the fact that the pitch of a sound coming from an approaching or receding body is altered.

Justus von Liebig (1803-73), German. Advocated the use of inorganic compounds as fertilizers for soil.

Thomas Graham (1805-69), English. Distinguished between crystalloid and colloid substances.

Matthew Fontaine Maury (1806-73), American. Studied climate, winds, ocean currents. His charts were used by sailors of all countries.

Robert Bunsen (1811-99), German. Invented the spectroscope; and also made popular the Bunsen burner, which is used in all gas stoves and chemistry laboratories.

James Dwight Dana (1813-95), American. Great geologist.

Julius Robert von Mayer (1814-78), German. Independently worked out the mechanical equivalent of heat.

James Prescott Joule (1818-89), English. Discovered the mechanical equivalent of heat. This means that a certain amount of heat can result in a certain amount of work; and a certain amount of work can result in a certain amount of heat.

Jean Foucault (1819-68), French. Showed that light travels less rapidly in water than in air. He measured the speed of light, obtaining the figure of 185,150 miles a second.

John Tyndall (1820-93), Irish. One of the greatest popularizers of science. Studied glaciers and various effects of light.

Sir William Dawson (1820-99), Canadian. Geologist; made important studies of fossil forests of the coal-measures (rocks of the period when great coal deposits were formed).

Herman Ludwig von Helmholtz (1821-94), German. With Joule, Thomson and Von Mayer, helped to establish the law of conservation of energy.

William Thomson, Lord Kelvin (1824-1907), British. Devised the absolute temperature scale. Secured universal acceptance of the principle of the conservation of energy.

Stanislao Cannizaro (1826-1910), Italian. Revived Avogrado's hypothesis.

Marcellin P. E. Berthelot (1827-1907), French. Important work with explosives. Opposed the belief that only living things could form organic compounds.

Friedrich Kekulé (1829-96), German. Great organic chemist.

James Clerk Maxwell (1831-79), Scottish. Stated the electromagnetic theory of light. First to show the similarity between different forms of radiation (light, heat waves, etc.).

Sir William Crookes (1832-1919), British. His work with the "Crookes tube" paved the way for the discovery of X-rays.

Dimitri Ivanovitch Mendeleef (1834-1907), Russian. Arranged the chemical elements in a periodic table. Predicted the discovery of new elements.

Josiah Willard Gibbs (1839-1903), American. Discovered the Phase Rule, which has been of the greatest importance in theoretical chemistry and in the study of solutions and metal alloys.

Wilhelm Konrad Röntgen (1845-1923), German. Discovered X-rays. Winner of Nobel Prize in physics, 1901.

Henri Moissan (1852-1907), French. First to obtain the most active gaseous element, fluorine. Made artificial diamonds. Winner of Nobel Prize in chemistry, 1906.

Antoine Henri Becquerel (1852-1908), French. First to show radioactivity. Won Nobel Prize in physics, 1903, with the Curies.

J. H. van't Hoff (1852-1911), Dutch. Showed that osmotic pressure in solutions resembles gas pressure. Winner of Nobel Prize in chemistry, 1901.

Albert Abraham Michelson (1852-1931), American. Made the most accurate measurement of the speed of light to date—186,508 miles a second. In the famous Michelson-Morley ether-drift experiment, he showed that no evidence could be obtained for the existence of the "ether," a mysterious substance which had been imagined to permeate all space. Won Nobel Prize in physics, 1907.

Hendrik Antoon Lorentz (1853-1928), Dutch. Built up an electric theory of matter before J. J. Thomson's discovery of the electron. His work formed the basis for Einstein's first theory of relativity. Winner of Nobel Prize in physics, 1902.

Heinrich Hertz (1857-94), German. First to show that long electromagnetic waves (radio waves) exist.

Svante Arrhenius (1859-1927), Swedish. His theory states that molecules of salts, acids and bases break up into electrically charged particles, called ions, in water solution. Winner of Nobel Prize in chemistry, 1903.

Pierre Curie (1859-1906), French, and **Marie Curie** (1867-1934), Polish. Discovered and isolated radium. Winners of Nobel Prize in physics, 1903, with Becquerel. Latter won Nobel Prize in chemistry, 1911.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 1227.

SEALS, SEA LIONS AND WALRUSES

THE seals and their relatives are flesh-eating mammals, carnivores, that have taken up a life in the sea and feed on the abundant animal life of its waters. They took to the sea so long ago and have changed so much to swim and catch fish that they are put in an order of their own, the Order Pinnipedia, or fin-footed mammals. They are mostly large in size, ranging from a little bigger than a dog to the great elephant seals, which may reach twenty feet in length.

If you look at one of these fin-footed mammals you can see the many ways in which they are suited for their life in the water. They are streamlined in shape, not so perfectly as most fishes or as the whales, but much better than land mammals. Their limbs are short, but the hands and feet are large and paddle-like—the front flippers of a sea lion are almost like the wings of a bird. On land they are slow and clumsy; the limbs are not suited for walking or running. The ears of these water mammals are small or not visible; their nostrils can be closed by muscular valves to keep the water out, and their large eyes are shaped to be most useful under water.

Although the fin-footed mammals get their food from the sea, all of them come ashore or climb on ice-cakes to rest, and for the birth of their young. The newly born young ones can not swim and must learn to do this and the other things a life in the water requires.

The fin-footed mammals are most abundant and most varied in the cold waters of the North and Far South; in the tropics there are only a few kinds and most of these are rare and very local in distribution. Those living in cold waters are kept warm by a blanket of fat, or blubber, inside the skin. All these animals are warm-blooded, and if they did not have a warm fur coat or fatty blanket they would feel the cold.

Sea lions are better able to move about on land than the members of the other two families; the walruses and true seals. Their flippers can be pulled under the body and are used in their clumsy, rolling gallop, helped by a vigorous jerking of the body. For a short distance they can go about as fast as a man running, but they soon become exhausted. When the sun is hot, the sea lions on shore often use the flippers, both front and hind ones, as fans.


Press Association, Inc.
A young fur seal of the Pribilof Islands, Alaska.

These animals swim gracefully with their wing-like front flippers and a rolling motion of the whole body; they go almost as fast through the sea as a bird in the air. Few fish can swim faster than they can. The waves breaking on the rocks have no terrors for the sea lions; they dive into the boiling surf of a storm as readily as into a calm sea. They can swim long distances. Some members of this group pass months in the open sea, far from land. Members of this family have outside ears.

Among the sea lions and fur seals the males (bulls) are much larger than the females (cows). Each bull tries to get a large harem of cows, usually ten to fourteen but sometimes as many as a hundred. The males come to the breeding grounds (rocky shores or islands) first, and fight for the best stations. Once established, a bull has to stay on guard, or another bull would take his station; so the males remain on shore, fasting for several months.

It is a terrible experience to see two bull

New York Zoological Society

California sea lion, lazily sunning itself before a group of youthful admirers. This animal is a marvelous swimmer, and the most violent surf holds no terrors for it; it can get about fairly well on land also. The sea lion is very intelligent and can be taught to perform many amusing tricks. It is often seen in circuses.

sea lions fight. They gallop towards each other, bellowing and roaring, their small heads tossing and their massive necks and bodies writhing. Often it is largely bluff; one of the bulls gives way and is chased shamefully by the victor. But just as often they fight, shoulder to shoulder, each striving to sink his great dog-teeth in the face or neck of the other. Both receive gashes that would kill a man, until one of the combatants has enough punishment and runs away. Scars of these fights are always found on old bulls, but the encounters are rarely fatal to them. Now and then, however, a young pup fails to get out of the way and is crushed under one of the bulls.

The cows come to the rookery, as the home rocks of sea lions are called, a week or so after the males; they do not seem to have much choice of mates, for they are the prizes of the victorious bulls. Soon after coming ashore, the mothers each give birth to a pup, which is open-eyed and covered with hair. About two weeks later the young ones learn to swim, but they stay close to shore until they are several months old.

The "seal" that is known to almost everyone, the trained seal of the circus, belongs in this family. These intelligent animals learn to balance balls on the end of the nose with all the skill of a human juggler and their cheerful barks seem to say they are enjoying the game.

This is the best known sea lion, the kind usually seen in zoos and circuses. It is found along the shores of the Pacific, from Mexico to northern California and on the Asiatic side as well. It is small compared with some of its relatives, but old males reach about nine feet in length and weigh six hundred pounds; the females are several feet shorter and weigh three or four hundred pounds. These animals are usually dark, dull brown, but old bulls may be almost black. The old bulls have high foreheads while cows and younger males are almost flat from the nose to the back of the head. The high brow is not due to an increase in the brain, but to the enlarged jaw muscles and the bony crests to which they are attached.

The sea lion of the northern Pacific, from California and the Japanese Islands to the Bering Sea, is much larger than the other members of this family. Old bulls are about thirteen feet long and weigh well over a thousand pounds. When they reach the breeding grounds in the spring their color is reddish brown with darker neck and limbs; they fade to a golden brown and then in the late autumn grow a new coat, darker than ever. They are not very active on land, but they are extraordinary climbers, getting up to the top of slippery rocks that would be difficult for a skilled mountaineer. Although large numbers are killed by the Eskimos and

Siberian natives for food and for their skins to make boats and shoes, the northern sea lions, sturdy and very fertile animals, are still decidedly abundant.

The Southern sea lion was first seen when Magellan sailed along the coast of Patagonia and through the straits that now bear his name. It occurs on the coasts of South America from the Rio de la Plata and Peru southwards, and on the Falkland and Galapagos islands. The latter islands are almost on the Equator, but the water around them is cold because the cold Humboldt Current flows there. The Southern sea lion has a kind of mane, better developed in the males than in most of the other species, and the ears are smaller than in other sea lions. It is a little larger than the California sea lion. Males are a rich brown, while the females are paler and grayer, and both have dark flippers. These sea lions were once numerous but they were hunted down by sealers for their hides and fat so that only a small number remain and many of their old breeding grounds are empty.

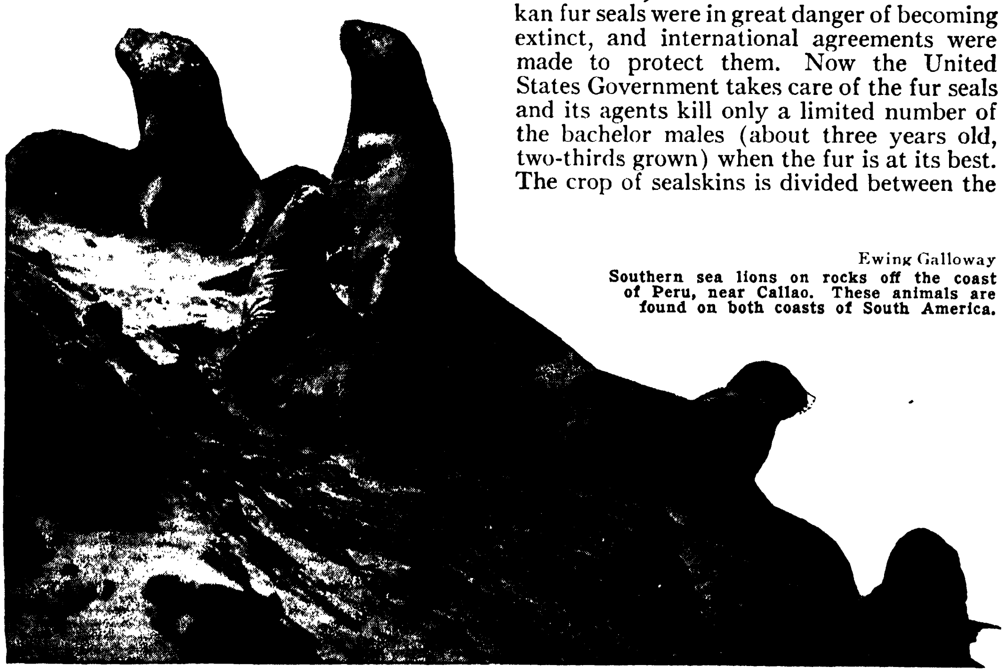
The adult males of the Australian sea lion have a white "wig" although females and young males are entirely brown. For years they were thought to be two species because of this difference in appearance. This sea lion is found along the southern shores of Australia and about halfway up the east coast.

Hooker's sea lion is found on the Auckland Islands, south of New Zealand. It is grayish brown in color and has a flattened head and rather long muzzle. Little is known of its habits.

Fur seals, sometimes called sea bears, are sea lions that have a dense, soft undercoat of fur. While the sea lions we have been describing are sleek-looking, their hair is coarse, with little or no underfur, and their skins are used for leather. The fur seals, or sea bears, are sought for their fur which makes the beautiful and long-wearing sealskin coats.

Sealskin was once so desired and the fur seals were so numerous and easily killed that a period of great slaughter followed the discovery of the various species and their home islands and shores. In the early 1800's there were millions of Northern fur seals and in the next hundred years millions were killed. They were butchered on their island homes, and when they were far out at sea ships used to follow the herds, shooting and spearing them. People were so greedy that they often killed more than they could properly care for, and many hides were spoiled by the time the ships reached home.

Around 1900 it was realized that the Alaskan fur seals were in great danger of becoming extinct, and international agreements were made to protect them. Now the United States Government takes care of the fur seals and its agents kill only a limited number of the bachelor males (about three years old, two-thirds grown) when the fur is at its best. The crop of sealskins is divided between the



Ewing Galloway
Southern sea lions on rocks off the coast of Peru, near Callao. These animals are found on both coasts of South America.

countries whose ships formerly killed seals in the open sea: the United States, Russia, Canada and Japan.

The fur is prepared by scraping the inner side of the skin to loosen the long hairs (long hairs have deep roots and when these are cut the hairs fall out, leaving the short-rooted fur still solidly attached). The fur is dyed. In recent years there has been less demand for sealskin, because muskrat pelts, treated in the same way, make an excellent, cheaper fur, known as Hudson seal.

A South American fur seal taking its ease.

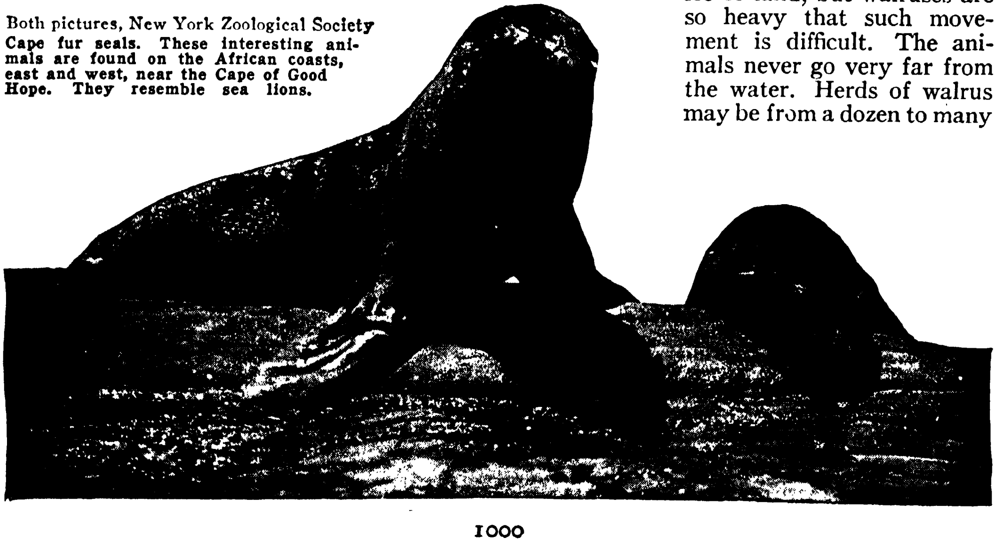
The Northern fur seal is the best known of all the many seals and the most valuable. Alaska was purchased from Russia for about $7,000,000, but the royalties on sealskin have more than repaid the American government. This fur seal has a very short face, in contrast to the longer muzzles of the Southern species. Old males are almost black above, with grayish shoulders, while the females are paler and grayish. Both sexes have reddish brown undersides. The largest fur-seal bulls weigh about 500 pounds and are about six feet long; the cows weigh only about 100 pounds and measure about four feet from nose to tail.

There are five species of the Southern fur seal. They look more like the sea lions, and several have so little fur that they are of small value economically. One species lived north of the Equator, along the coasts of Mexico and on the Pacific islands near by; it is now found only on Guadalupe Island, off Lower California. Two fur seals are Australian, ranging along the south and east coast respectively. Another is found on the Galapagos Islands and along the coasts of southern South America, while the last occurs on the African coasts near the Cape of Good Hope.

The huge, wrinkled walruses live in the extreme northern Atlantic and Pacific oceans, well equipped for bitter cold, never going much south of the Arctic Circle nowadays. Those found in the Pacific are slightly different from the ones that live in the Atlantic side, but no other mammal is likely to be mistaken for a walrus. It has a great, bulky body (a large walrus weighs about 3,000 pounds) and a small head. The ear opening is present, but there is no pinna, or outside ear. The great dagger-like tusks, reaching a length of about 30 inches, are present in both sexes but are larger and heavier in the bulls. The coloration is dull brownish; in young animals the body is thinly covered with brownish hairs, but the old walruses are nearly naked except for the stiff, bristly mustache. The hindfeet may be turned under the body to support it and are used in movement on the ice or land, but walruses are so heavy that such movement is difficult. The animals never go very far from the water. Herds of walrus may be from a dozen to many

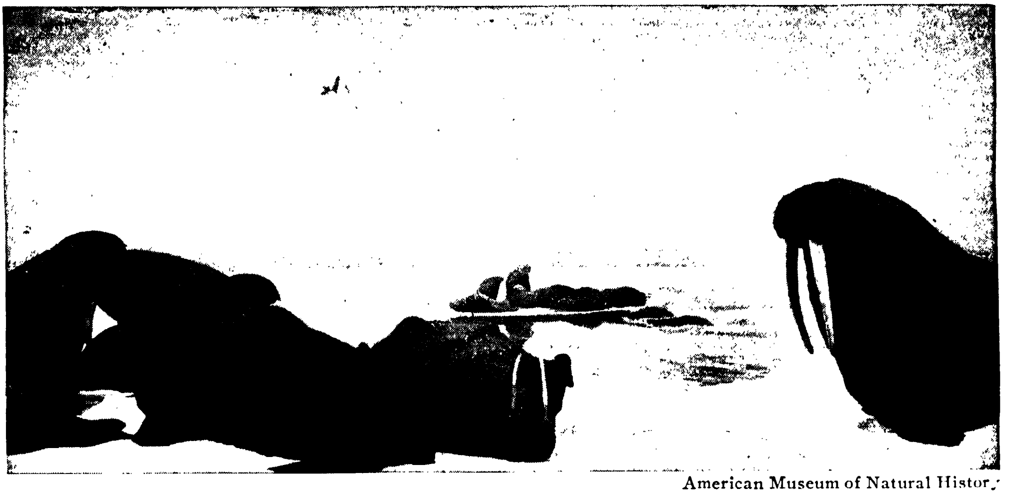
Both pictures, New York Zoological Society

Cape fur seals. These interesting animals are found on the African coasts, east and west, near the Cape of Good Hope. They resemble sea lions.



hundreds in size and the animals often sleep in a confused pile. Even though the walrus has no fur coat, it is kept warm by a thick layer of blubber, or fat, under the skin.

Walruses feed on clams and other shellfish found on the bottom of the northern seas. They dive at least 180 feet below the surface, raking the clams from the bottom with their tusks. The peg-like cheek teeth are used to crush the shells and then the shellfish is swallowed, shell and all. The tusks are also used as grappling hooks when the animal climbs upon the ice, and as weapons in self-defense or in fighting for a mate. Sometimes a hunted walrus turns on the hunters' boat, charging through the sea like an elephant through the jungle. If it reaches the boat the great tusks drive through the planks as if the boat were made of paper.



American Museum of Natural History

Walrus group. These bulky animals feed on shellfish found on the bottom of the sea. They often dive more than a hundred feet in search of clams, which they rake from the bottom with their long, dagger-like tusks.

Killer whales often attack even the larger walruses and young animals may be preyed on by the polar bears, but the bears usually prefer less dangerous hunting, since the old walruses defend their young. Man is the chief enemy of the walrus. For thousands of years the natives hunted walruses for food and for the skins from which to make boats. In spite of the danger, Eskimos in skin kayaks (canoes) used to attack the walruses with harpoons. Now the weapon is generally a rifle, which is safer for the hunter but more destructive, especially since walruses sink when dead and many are lost. White men have slaughtered hundreds of thousands of these great sea animals for the ivory of their tusks, for their skins, which make good leather, and for their fat. There was great danger that the walruses might be exterminated, but now a certain amount of protection is given to them.

The true, or earless, seals (sometimes called hair seals) have their hind legs and feet stretched out in line with their bodies, so that they can not be used to support the body on land, and the forelimbs are so short as to be of little help for this purpose or for walking. The seals must wriggle along, moving chiefly by the action of the body. They seldom go more than a few feet from the water and many kinds come out only on ice, which is easier to slide around on. All mother seals must come out of the water to give birth to their young ones. Seal babies can not go into the water for several weeks or they would drown, and after that time they have to learn to swim. The fur of adult seals is short, coarse and bristle-like, but newborn young ones of some species have long, soft fur, usually pure white in color.

The cold seas of the North and South are the regions where seals are most common and where most kinds can be found. However, this family is represented in the warm seas by three species, all rare to-day. Most seals are smaller than the sea lions, but one, the elephant seal, may be eighteen to twenty feet long.

In the Arctic regions of America and eastern Asia, the Eskimos and Siberians depend on seals for much of their food and clothing.

New York Zoological Society

A baby walrus—an inhabitant of the northern Atlantic. The walrus is a fine swimmer but is slow on land.

The skins make water-resisting and long-wearing clothes and the fur, although not so good as that of the fur seal, is warm. Since about the year 1700 white men have hunted seals, using the skins for leather and the fat for oil. At the height of the sealing industry about a million seals were taken each year and many more were killed and lost. Even in recent years, when the herds had been greatly reduced, nearly a quarter of a million were killed each year in the North Atlantic. Killer whales, polar bears, sharks, and, in the Antarctic, other seals also prey on these sea mammals.

The harbor seal, or spotted common seal, is best known to most of us. It is yellowish gray or brown and occurs in the coastal waters, at the mouths of rivers and harbors from the Carolinas and Spain in the Atlantic, and in the Pacific from Mexico and Japan north to the Arctic. It is small, about four feet long, and both sexes are alike in size and color. Harbor seals do not go far from land, nor do they migrate like some of the other kinds. The females come ashore on rocky islands or shores for the birth of their young and are often found in small herds.

The ribbon seal is brown with bright bands of yellow around the neck, shoulders and rear part of the body. Females are less brightly marked than the males. This is a rare seal, found in the Aleutian Islands and on the coast of Alaska, where the natives prize the skins for their best clothes.

The ringed seal looks very much like the harbor seal and is about the same size. It has a pointed muzzle and is blackish gray or brown, with small whitish or yellowish rings or blotches. It is an inhabitant of the colder seas, from Newfoundland and the Aleutian Islands northward. The young are born on ice-floes.

The harp, or Greenland, seal is larger than its relatives. Adults may be six feet long and weigh 700 pounds or more. The males are white or yellowish white, with a broad band of brown or dull black across the shoulders and down the sides and with a blackish mask over the face. The females have a less complete pattern or lack it entirely. The young are white and keep the long, soft fur of their birthday for about two weeks; it is this fur that is valued by the sealers.

In the early spring the harp seals go north to the great ice-floes of the Arctic Ocean. Great schools of the seals travel together, swimming eight or ten miles an hour. The females reach the ice first and climb out on the floating pieces. When the floes freeze solid the seals make holes in the ice, which they keep open to go back and forth.

Soon after the mothers arrive each has a little baby seal; these babies are left on the ice while the mother catches fish in the sea. The mother seal's milk is very rich and the young ones grow quickly; in two weeks they become four or five times as large as they were at birth. If the baby seal is knocked off the ice by storms, its mother swims under it and helps it back on the ice. In spite of this care many babies are drowned in bad storms. It is still a marvel to all who have studied seals that the mother can come back from the trackless sea two or three times a day to her own baby when thousands of other babies are on the great ice pack.

The male seals arrive after the young ones are born and play and fight in the open water near the ice, climbing on the ice now and then to rest or sun themselves. After nursing their babies for a couple of weeks, the mother seals seem to tire of their duties and go off with the successful males. The young ones lie quietly for a few days, living on the fat they have stored up and changing to the adult fur. When the change of fur is completed the young seals venture into the sea. At first they are not very expert, but they soon learn to swim and dive, and to catch shrimps and, later, fish.

The number of seals, even after years of hunting, that come to the ice-floes in certain places is hard to believe. More than half a million are thought to be in a herd that spends the winters off Belle Isle, Newfoundland, while many larger herds occur elsewhere in the northern seas.

Scientists have been puzzled by the seals in the Caspian Sea and Lake Baikal in Siberia. These bodies of water have no connection with the oceans and the only close relatives of these seals are found in the Far North. Perhaps the seals had a more southern distribution and the Siberian seas may have then been connected with the oceans. We can be sure the seals never traveled so far overland; they do not usually go more than a few yards from the sea, although a seal once escaped from captivity and traveled thirty miles across land.

The gray seal is a large species, the males reaching nine feet or more in length. It is silvery gray or may have a yellowish tinge, with dim spots on the back and sides. Although it is rare on the American side of the Atlantic, it is much more common on the northern coasts and islands of Europe. Gray seals are shy and haul out (climb out of the sea) on rocky shores where the wind will carry warning of their enemies. At the least disturbance the seals slide into the water.

The bearded seal should perhaps be called the "mustached" seal, for its name comes from the large tuft of long bristles on each side of the muzzle. This seal may be ten

Fish and Wildlife Service, U.S. Dept. of the Interior

A young hair seal of the Aleutian Islands, Alaska. The hair seal is also called the true or earless seal.

Wide World photo

A baby hair seal. Its long, soft fur, pure white in color, will become short and coarse as it grows older.

feet in length and usually is yellowish gray, darker on the back than on the sides. It is at home in the Arctic seas.

The three monk seals make their homes in warm places. One species lives in the Mediterranean and Black seas, another in the Caribbean and the third in the Pacific, around the Hawaiian Islands. The monk is moderately large (about eight feet in length) with brownish gray back and white undersides. The head is small for such a stout body. Monk seals are quite rare, chiefly because they were hunted for the oil that could be obtained from their abundant fat.

The leopard seal is the best known of the Southern forms and is perhaps the fiercest of the fin-footed mammals. It often preys on its smaller relatives, especially on their young ones, and on penguins. Males generally reach a length of some ten or twelve feet. In color the leopard seal is yellowish gray with dark spots above and dull yellow on the underside. It is found from the Falkland Islands, Patagonia, New Zealand and Australia, south to the ice of the Antarctic.

Acme photo

A baby leopard seal. The animal is so called because of its spotted fur. The male sometimes reaches a length of twelve feet.

The crab-eating seal is seven or eight feet long and is not spotted, except for a few light spots on the sides. It feeds largely on the small shrimp-like animals so abundant in the southern seas, on the edge of the ice-pack. The teeth act like sieves to strain out these small crustaceans.

Weddell's seal is about nine feet in length. It has cone-like front teeth, with which it saws through the ice that thickly and permanently covers the Antarctic bays in which these seals live. The young are born near the end of the Southern winter and the mother seals must go into the water under the ice to catch their food (fish), and must come back on the ice to nurse their babies.

Ross's seal, a rare species about four and a half feet long, is the most streamlined of all seals, but it has a swollen throat, like a goiter. It is olive in color; it is lighter and

American Museum of Natural History

California sea elephants. The sea elephant is a huge beast, sometimes as much as twenty feet long, with a circumference of twelve feet around the thickest part of the chest. The male is much larger than the female.

tawny on the underside, while the sides are marked by narrow, slanting bars.

The male of the crested or hooded seal has a strange bladder-like nose, which can be blown up to nearly double the size of its head in front of the eyes. These seals reach a size of about eight feet in length and weigh about 600 pounds. They are found in the pack-ice of the North Atlantic and the nearby Arctic, usually living in small herds or individual families and staying far from the coasts. Crested seals are fiercer than other Northern seals; they frequently charge the hunter and fight to protect their young.

The great sea elephants are given this name not only because of their large size (the males are sixteen or eighteen or even twenty feet long), but also because of the strange proboscis of the males, like the shortened trunk of an elephant. This odd nose hangs limply as a rule, but when the seal is excited it can be inflated and extended.

Unlike most of the true seal family, the elephant seals are polygamous, that is, they have a number of wives. One or two old bulls will lay claim to a beach and prevent other males from landing, while they welcome a number of cows. The males often show fight when men come among them, but the cows, which are hardly half as long as their mates, are passive. The young ones are almost black when born, while the color of adults is a slaty brown.

The story of how the elephant seal was brought nearly to extinction is a sad one. The big males were fat enough to produce more than 200 gallons of oil and men hunted them without mercy. The Northern elephant seal, once found along the coast of California and Mexico, was thought to be completely exterminated, but a herd of several hundred does still live on Guadalupe Island, off the coast of Lower California. The Southern elephant seals were found on most of the islands of the far South Atlantic. Only a pitiful remnant of the herds remain, but if they can be given protection the sea elephants will come back. Let us hope they will, for they are magnificent sea mammals.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 1126.

POEMS ABOUT BIRDS

Illustrated by Roger Vernam

To A Waterfowl

By WILLIAM CULLEN BRYANT (1794-1878)

WHITHER, midst falling dew,
While glow the heavens with the last steps of day,
Far, through their rosy depths, dost thou pursue
Thy solitary way?

Vainly the fowler's eye
Might mark thy distant flight to do thee wrong,
As, darkly painted on the crimson sky,
Thy figure floats along.

Seek'st thou the plashy brink
Of weedy lake, or marge of river wide,
Or where the rocking billows rise and sink
On the chafed ocean-side?

There is a Power whose care
Teaches thy way along that pathless coast,—
The desert and illimitable air,—
Lone wandering, but not lost.

All day thy wings have fanned
At that far height, the cold, thin atmosphere,
Yet stoop not, weary, to the welcome land,
Though the dark night is near.

And soon that toil shall end;
Soon shalt thou find a summer home, and rest,
And scream among thy fellows; reeds shall bend,
Soon, o'er thy sheltered nest.

Thou'rt gone, the abyss of heaven
Hath swallowed up thy form; yet, on my heart
Deeply hath sunk the lesson thou hast given,
And shall not soon depart.

He who, from zone to zone,
Guides through the boundless sky thy certain flight,
In the long way that I must tread alone,
Will lead my steps aright.

The Eagle

By ALFRED, LORD TENNYSON (1809-1892)

HE clasps the crag with crooked hands;
Close to the sun in lonely lands,
Ringed with the azure world, he stands.

The wrinkled sea beneath him crawls;
He watches from his mountain walls,
And like a thunderbolt he falls.

The Sandpiper

By CELIA THAXTER (1835-1894)

ACROSS the narrow beach we flit,
One little sandpiper and I,
And fast I gather, bit by bit,
The scattered driftwood bleached and dry.
The wild waves reach their hands for it,
The wild wind raves, the tide runs high,
As up and down the beach we flit,—
One little sandpiper and I.

Above our heads the sullen clouds
Scud black and swift across the sky;
Like silent ghosts in misty shrouds
Stand out the white lighthouses high.
Almost as far as eye can reach
I see the close-reefed vessels fly,
As fast we flit along the beach,—
One little sandpiper and I.

I watch him as he skims along,
Uttering his sweet and mournful cry.
He starts not at my fitful song,
Or flash of fluttering drapery.
He has no thought of any wrong;
He scans me with a fearless eye:
Staunch friends are we, well tried and strong,
The little sandpiper and I.

Comrade, where wilt thou be to-night
When the loosed storm breaks furiously?
My driftwood fire will burn so bright!
To what warm shelter canst thou fly?
I do not fear for thee, though wroth
The tempest rushes through the sky:
For are we not God's children both,
Thou, little sandpiper, and I?

Robert of Lincoln

By WILLIAM CULLEN BRYANT
(1794-1878)

MERRILY swinging on brier and weed,
  Near to the nest of his little dame,
Over the mountain-side or mead,
Robert of Lincoln is telling his name:
  Bob-o'-link, bob-o'-link,
  Spink, spank, spink;
Snug and safe is that nest of ours,
Hidden among the summer flowers.
    Chee, chee, chee.

Robert of Lincoln is gayly dressed,
Wearing a bright black wedding-coat;
White are his shoulders and white his crest.
Hear him call in his merry note:
  Bob-o'-link, bob-o'-link,
  Spink, spank, spink;
Look, what a nice new coat is mine,
Sure there was never a bird so fine.
    Chee, chee, chee.

Robert of Lincoln's Quaker wife,
Pretty and quiet, with plain brown wings,
Passing at home a patient life,
Broods in the grass while her husband sings:
  Bob-o'-link, bob-o'-link,
  Spink, spank, spink;
Brood, kind creature, you need not fear
Thieves and robbers while I am here.
    Chee, chee, chee.

Modest and shy as a nun is she;
One weak chirp is her only note.
Braggart and prince of braggarts is he,
Pouring boasts from his little throat:
  Bob-o'-link, bob-o'-link,
  Spink, spank, spink;
Never was I afraid of man;
Catch me, cowardly knaves, if you can!
    Chee, chee, chee.

Six white eggs on a bed of hay,
Flecked with purple, a pretty sight!
There as the mother sits all day,
Robert is singing with all his might:
  Bob-o'-link, bob-o'-link,
  Spink, spank, spink;
Nice good wife, that never goes out,
Keeping house while I frolic about.
    Chee, chee, chee.

Soon as the little ones chip the shell,
Six wide mouths are open for food;
Robert of Lincoln bestirs him well,
Gathering seeds for the hungry brood.
  Bob-o'-link, bob-o'-link,
  Spink, spank, spink;
This new life is likely to be
Hard for a gay young fellow like me.
    Chee, chee, chee.

Robert of Lincoln at length is made
Sober with work, and silent with care;
Off is his holiday garment laid,
Half forgotten that merry air:
  Bob-o'-link, bob-o'-link,
  Spink, spank, spink;
Nobody knows but my mate and I
Where our nest and our nestlings lie.
    Chee, chee, chee.

Summer wanes; the children are grown;
Fun and frolic no more he knows;
Robert of Lincoln's a humdrum crone;
Off he flies, and we sing as he goes:
  Bob-o'-link, bob-o'-link,
  Spink, spank, spink;
When you can pipe that merry old strain,
Robert of Lincoln, come back again.
    Chee, chee, chee.

The Skylark

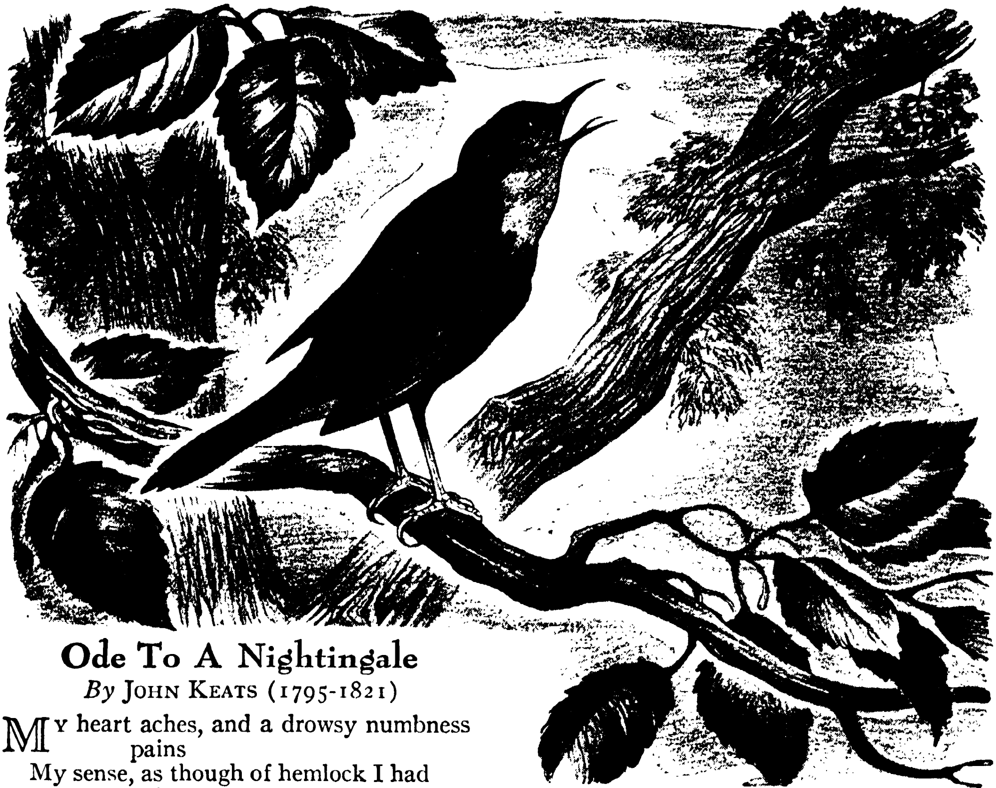
By JAMES HOGG
(1770-1835)

BIRD of the wilderness,
  Blithesome and cumberless,
Sweet be thy matin o'er moorland and
    lea!
  Emblem of happiness,
  Blest is thy dwelling-place—
O to abide in the desert with thee!

  Wild is thy lay and loud,
  Far in the downy cloud,
Love gives it energy, love gave it birth.
  Where, on thy dewy wing,
  Where art thou journeying?
Thy lay is in heaven, thy love is on earth.

  O'er fell and fountain sheen,
  O'er moor and mountain green,
O'er the red streamer that heralds the
    day,
  Over the cloudlet dim,
  Over the rainbow's rim,
Musical cherub, soar, singing, away!

  Then, when the gloaming comes,
  Low in the heather blooms
Sweet will thy welcome and bed of love
    be!
  Emblem of happiness,
  Blest is thy dwelling-place—
O to abide in the desert with thee!



Ode To A Nightingale

By John Keats (1795-1821)

My heart aches, and a drowsy numbness pains
My sense, as though of hemlock I had drunk,
Or emptied some dull opiate to the drains
One minute past, and Lethe-wards had sunk:
'Tis not through envy of thy happy lot,
But being too happy in thy happiness,—
That thou, light-wingèd Dryad of the trees,
In some melodious plot
Of beechen green, and shadows numberless,
Singest of summer in full-throated ease.

O for a draught of vintage, that hath been
Cooled a long age in the deep-delvèd earth,
Tasting of Flora and the country green,
Dance, and Provençal song, and sunburnt mirth!
O for a beaker full of the warm South,
Full of the true, the blushful Hippocrene,
With beaded bubbles winking at the brim,
And purple-stainèd mouth;
That I might drink, and leave the world unseen,
And with thee fade away into the forest dim:

Fade far away, dissolve, and quite forget
What thou among the leaves hast never known,
The weariness, the fever, and the fret,
Here, where men sit and hear each other groan;
Where palsy shakes a few, sad, last gray hairs,
Where youth grows pale, and spectre-thin, and dies;
Where but to think is to be full of sorrow
And leaden-eyed despairs;
Where Beauty cannot keep her lustrous eyes,
Or new Love pine at them beyond to-morrow.

Away! away! for I will fly to thee,
Not charioted by Bacchus and his pards,
But on the viewless wings of Poesy,
Though the dull brain perplexes and retards:
Already with thee! tender is the night,
And haply the Queen-Moon is on her throne,
Clustered around by all her starry Fays;
But here there is no light,

Save what from heaven is with the breezes blown
Through verdurous glooms and winding mossy ways.

I cannot see what flowers are at my feet,
Nor what soft incense hangs upon the boughs,
But, in embalmèd darkness, guess each sweet
Wherewith the seasonable month endows
The grass, the thicket, and the fruit-tree wild;
White hawthorn, and the pastoral eglantine;
Fast-fading violets covered up in leaves;
And mid-May's eldest child,
The coming musk-rose, full of dewy wine,
The murmurous haunt of flies on summer eves.

Darkling I listen; and, for many a time
I have been half in love with easeful Death.
Called him soft names in many a musèd rhyme,
To take into the air my quiet breath;
Now more than ever seems it rich to die,
To cease upon the midnight with no pain,
While thou art pouring forth thy soul abroad
In such ecstasy!
Still wouldst thou sing, and I have ears in vain—
To thy high requiem become a sod.

Thou wast not born for death, immortal Bird!
No hungry generations tread thee down;
The voice I hear this passing night was heard
In ancient days by emperor and clown:
Perhaps the self-same song that found a path
Through the sad heart of Ruth, when, sick for home,
She stood in tears amid the alien corn;
The same that oft-times hath
Charmed magic casements, opening on the foam
Of perilous seas, in faery lands forlorn.

Forlorn! the very word is like a bell
To toll me back from thee to my sole self!
Adieu! the fancy cannot cheat so well
As she is famed to do, deceiving elf.
Adieu! adieu! thy plaintive anthem fades
Past the near meadows, over the still stream,
Up the hill-side; and now 'tis buried deep
In the next valley-glades:
Was it a vision, or a waking dream?
Fled is that music:—Do I wake or sleep?

To A Skylark

By Percy Bysshe Shelley
(1792-1822)

Hail to thee, blithe spirit!
Bird thou never wert,
That from heaven, or near it,
Pourest thy full heart
In profuse strains of unpremeditated art.

Higher still and higher,
From the earth thou springest
Like a cloud of fire;
The blue deep thou wingest,
And singing still dost soar, and soaring ever singest.

In the golden lightning
Of the sunken sun,
O'er which clouds are bright'ning,
Thou dost float and run;
Like an unbodied joy whose race is just begun.

The pale purple even
Melts around thy flight;
Like a star of heaven
In the broad daylight
Thou art unseen, but yet I hear thy shrill delight.

Keen as are the arrows
Of that silver sphere,
Whose intense lamp narrows
In the white dawn clear,
Until we hardly see, we feel that it is there.

All the earth and air
With thy voice is loud,
As, when night is bare,
From one lonely cloud
The moon rains out her beams, and heaven is overflowed.

What thou art we know not;
What is most like thee?
From rainbow clouds there flow not
Drops so bright to see
As from thy presence showers a rain of melody.

Like a poet hidden
In the light of thought,
Singing hymns unbidden
Till the world is wrought
To sympathy with hopes and fears it heeded not:

Like a high-born maiden
In a palace tower,
Soothing her love-laden
Soul in secret hour
With music sweet as love, which overflows her bower:

Like a glow-worm golden
In a dell of dew,
Scattering unbeholden
Its aerial hue
Among the flowers and grass, which screen it from the view:

Like a rose embowered
In its own green leaves,
By warm winds deflowered,
Till the scent it gives
Makes faint with too much sweet these heavy-wingèd thieves:

Sound of vernal showers
On the twinkling grass,
Rain-awakened flowers,
All that ever was
Joyous, and clear, and fresh, thy music doth surpass.

Teach us, sprite or bird,
What sweet thoughts are thine:
I have never heard
Praise of love or wine
That panted forth a flood of rapture so divine.

Chorus hymeneal,
Or triumphal chaunt,
Matched with thine would be all
But an empty vaunt—
A thing wherein we feel there is some hidden want.

What objects are the fountains
Of thy happy strain?
What fields, or waves, or mountains?
What shapes of sky or plain?
What love of thine own kind? what ignorance of pain?

With thy clear keen joyance
Languor cannot be:
Shadow of annoyance
Never came near thee:
Thou lovest; but ne'er knew love's sad satiety.

Waking or asleep,
Thou of death must deem
Things more true and deep
Than we mortals dream,
Or how could thy notes flow in such a crystal stream?

We look before and after,
And pine for what is not:
Our sincerest laughter
With some pain is fraught;
Our sweetest songs are those that tell of saddest thought.

Yet if we could scorn
Hate, and pride, and fear;
If we were things born
Not to shed a tear,
I know not how thy joy we ever should come near.

Better than all measures
Of delightful sound,
Better than all treasures
That in books are found,
Thy skill to poet were, thou scorner of the ground!

Teach me half the gladness
That thy brain must know,
Such harmonious madness
From my lips would flow,
The world should listen then, as I am listening now.

Overflow

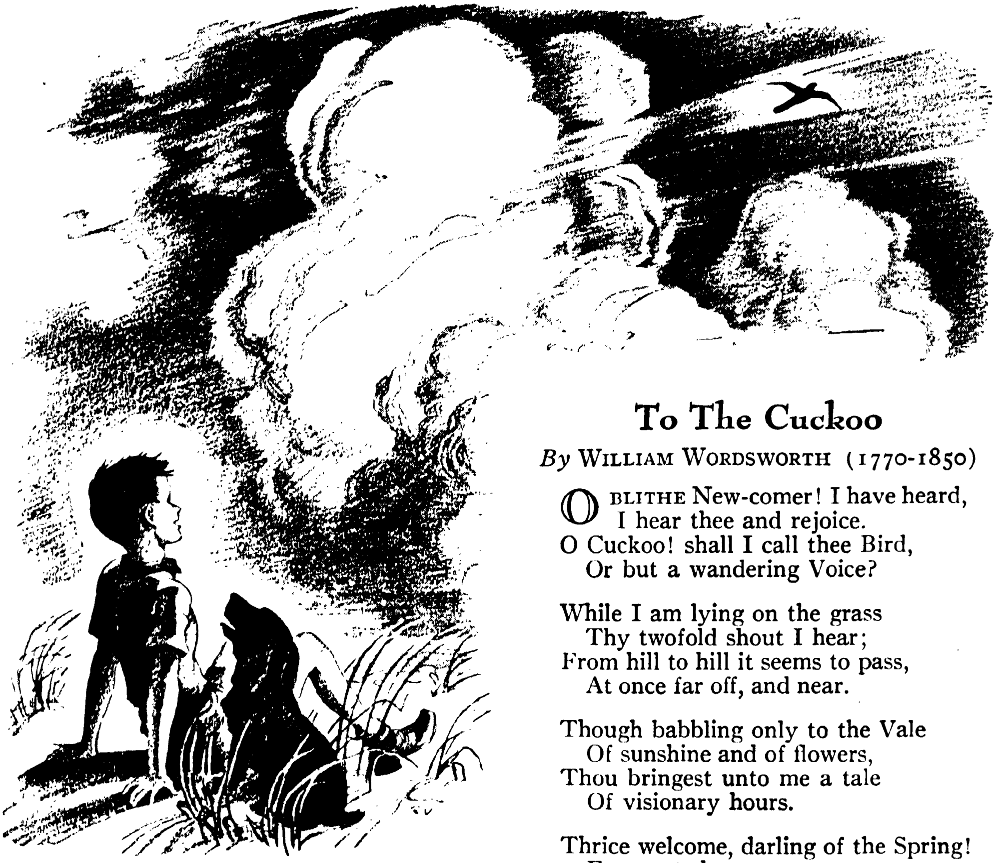
By John Banister Tabb
(1854-1909)

Hush!
With sudden gush
As from a fountain, sings in yonder bush
The Hermit Thrush.

Hark!
Did ever Lark
With swifter scintillations fling the spark
That fires the dark?

Again,
Like April rain
Of mist and sunshine mingled, moves the strain
O'er hill and plain.

Strong
As love, O song,
In flame or torrent sweep through Life along,
O'er grief and wrong.



To A Skylark

By William Wordsworth
(1770-1850)

Ethereal minstrel! pilgrim of the sky!
Dost thou despise the earth where cares abound?
Or, while the wings aspire, are heart and eye
Both with thy nest upon the dewy ground?
Thy nest which thou canst drop into at will,
Those quivering wings composed, that music still!

Leave to the nightingale her shady wood;
A privacy of glorious light is thine;
Whence thou dost pour upon the world a flood
Of harmony, with instinct more divine;
Type of the wise who soar, but never roam;
True to the kindred points of Heaven and home!

To The Cuckoo

By William Wordsworth (1770-1850)

O blithe New-comer! I have heard,
I hear thee and rejoice.
O Cuckoo! shall I call thee Bird,
Or but a wandering Voice?

While I am lying on the grass
Thy twofold shout I hear;
From hill to hill it seems to pass,
At once far off, and near.

Though babbling only to the Vale
Of sunshine and of flowers,
Thou bringest unto me a tale
Of visionary hours.

Thrice welcome, darling of the Spring!
Even yet thou art to me
No bird, but an invisible thing,
A voice, a mystery;

The same whom in my school-boy days
I listened to; that Cry
Which made me look a thousand ways
In bush, and tree, and sky.

To seek thee did I often rove
Through woods and on the green;
And thou wert still a hope, a love;
Still longed for, never seen.

And I can listen to thee yet;
Can lie upon the plain
And listen, till I do beget
That golden time again.

O blessèd Bird! the earth we pace
Again appears to be
An unsubstantial, faery place;
That is fit home for Thee!

THE NEXT POEMS ARE ON PAGE 1135.


The loveliness of the wild foxglove, which produces a million seeds in a summer.

FLOWERS AND FRUITS

THE purpose of the flower is to produce seeds, and seeds are young plants just beginning their careers. We saw that in the picture-story of a buttercup on page 510.

But we have already seen that the flower first makes spores—little spores called pollen-grains and big spores that develop into embryo-sacs. The transformed leaf-structures that make the pollen-grains are the *stamens,* and the transformed leaf-structures that make the embryo-sacs are the *carpels.* A male cell in the pollen-grain fertilizes an egg-cell inside the embryo-sac. One of the uses of a flower is to bring it about that the pollen-grains are scattered, and that some are dusted on to the stigma, or carpel-tip.

The poet Goethe was one of the first to see clearly that a flower consists in ordinary cases of four tiers, or whorls, of different leaf-structures which have been changed for different purposes. It is nature's way to make apparently new things out of old things, and the flower consists of four whorls of transformed leaves. These are:

1. The sepals which protect the bud ana steady the blossom.
2. The petals which shelter the more important parts and also attract insect-visitors.
3. The stamens that make pollen.
4. The carpels that make embryo-sacs, within each of which there is an egg-cell.

That the parts of a flower are transformed leaves may be seen in a case like the water-lily, where the green sepals pass quite gradually into white petals, and these into yellow stamens. It is sometimes difficult to tell where one stops and the other begins. When flowers become double, it generally means, as when a wild rose becomes a garden rose, that what should have developed into stamens have sunk back into parts nearer leaves—the parts we call petals. One sometimes finds a Canterbury bell in which the whole flower has become a crowded tuft of green leaves. This may happen when a plant is too well fed; it ceases to be floral and becomes more leafy. It will be understood that sepals and petals are nearer to leaves than are stamens and carpels, which are leaf-structures transformed in connection with spore-forming or seed-forming.

"You will find," Mr. Ruskin said, "that all plants are composed of two parts:

> The leaf and the root, one loving the light and the other darkness; one liking to be clean, the other to be dirty; one liking to grow for the most part up, the other for the most part down; and each having faculties and purposes of its own. But the pure one which loves the light has, above all things, the purpose of being married to another leaf, and having child-leaves, and children's children of leaves,

to make the Earth fair for ever. And when the leaves marry they put on wedding-robes, and are more glorious than Solomon in all his glory, and they have feasts of honey, and we call them flowers."

This is finely said, but we should be careful to notice that stamens are not really *male* parts, nor the carpels *female* parts. They are spore-making organs, and the spores are made in the pollen-sacs and ovules. So when a flower has stamens only and another carpels (with ovules) only, it is better to call them *staminate* and *pistillate* flowers, rather than male and female flowers.

THE WAY POLLEN IS CARRIED ABOUT FROM FLOWER TO FLOWER

The pollen-grains are of different colors and shapes and sizes, but they are usually yellow and dry; and we may speak of them as grains of golden dust. What is important is that they should reach the usually moist and sticky tip, or stigma, of the pistil. There each sends out a delicate pollen-tube which contains the male cell, and makes its way down the interior of the carpel to reach the egg-cell within the embryo-sac, which is within the ovule, which is within the ovary! The union of the male cell and the egg-cell is called fertilization; it is the beginning of a new individual life. But the dusting of the tip of the pistil with pollen is called *pollination,* and it is brought about in one of three chief ways.

Sometimes, as in grasses and sedges, alders and birches, oaks and elms, the pollen is carried by the wind from flower to flower. This is the oldest method, which lasted for ages; but it is very wasteful. Thus, in the pine forests there is sometimes so much pollen that it is borne up by the wind like clouds of smoke, and when it sinks to the ground—as much of it does—people talk of a sulphur shower.

THE BUSY BEE PAYS ITS CALL IN THE GARDEN

The second method, which is seen in most flowering plants with notable blossoms, is by means of insects or some other flower-visiting animals. The visitors, such as bees, come for the sake of the nectar and the pollen itself; and the color and fragrance may be useful advertisements. They get dusted with pollen and land some of this on the pistil of a neighboring flower of the same kind, for they often pay many visits one after the other to the same species. If the bumblebee is visiting, let us say, aconite one forenoon, it will keep to aconite for a while, so that the pollens are not so much mixed as one might expect.

It has been shown that various insects can distinguish different colors, and not only colors but different degrees of brightness; and it is likely that in the course of their individual experience they learn that the colors and brightness of certain flowers mean plenty of nectar and pollen. As we say, they learn to *associate* certain flags of color with certain feasts of honey. The same applies to the fragrance of some flowers; it appeals to the sense of smell, which is very keen in some insects, such as bees. Some odors that are repulsive to us are attractive to insects, and thus we find that some flowers with an evil smell are eagerly sought by certain flies, which lay their eggs in them and bring about pollination in so doing. In South America many flowers are pollinated by humming-birds, and even the slow-going snails may dust pollen on the flowers they visit. This happens, for instance, in the little golden saxifrage of damp woods.

HOW NATURE PROTECTS THE SEED OF THE PLUM AND CHERRY

In a small number of plants, such as the common pea and the wheat, self-fertilization occurs. The pollen-grains from the stamens of a flower land on the stigma of the same flower, and send out their pollen-tubes. It is interesting to note that in some cases where pollen-grains pass from stamens to stigmas of the same flower they do no useful work, for they do not send out pollen-tubes. Such are some of the doings of the flower; let us consider the fruit.

The fruit consists of the ripe seed-box or seed-boxes, to which may be added some extra parts, such as an expanded flower-stalk, as in the rose-hip; or a fleshy flower-stalk and green sepals, as in the strawberry. When we use the word fruit we think at once of something juicy, but we cannot separate dry fruits from soft fruits, and even the fruiterer's shop window shows many dry fruits.

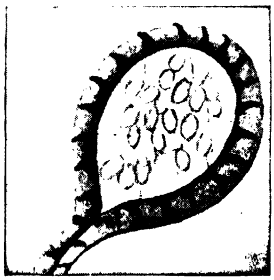
If we look at such a common kind of fruit as a plum or a cherry, we distinguish at once the firm outer skin, the juicy pulp and the stone. The last contains the seed, or kernel. As it is hard and woody, it protects the very young plant inside from being digested in a bird's food-canal or

STORY OF A FERN'S MILLIONS OF SPORES

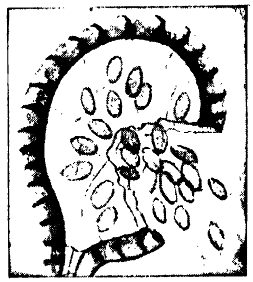
1. This is part of the upper side of a frond of a male shield fern. In one year this fern will scatter millions of spores.

2. The under-surface of part of a frond dotted with little spore cases called sporangia.

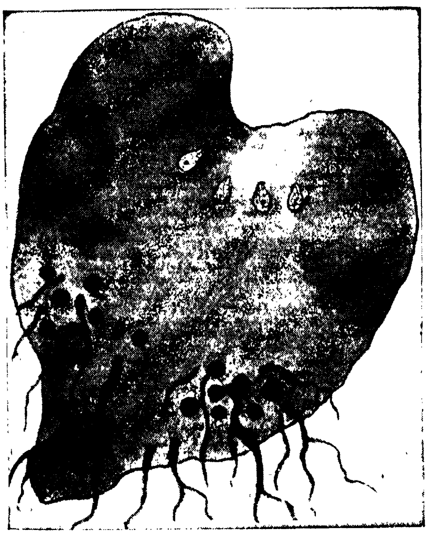
3. Part of the frond magnified to show spore cases, some with their wax-like covering.



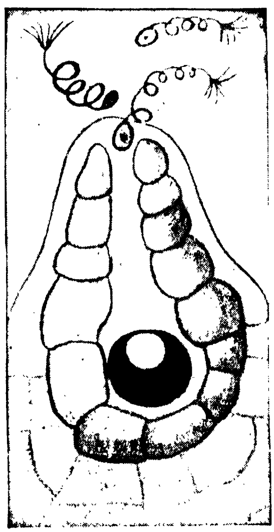
4. An unripe case with the spores inside before the wall bursts to release them.



5. A spore case discharging the spores, which are carried away by the wind.



6. The spore falls to the ground, where it swells and bursts. It sends down a rootlet and forms a thin flat green expansion called the prothallium. At the top are the egg-bearing organs; below, sperm-bearing organs.



7. Enlarged view of egg-bearing organ. The spiral bodies with tufts of hair called cilia are sperms and seek the egg-cells.

8. After being fertilized the egg begins to grow. It draws nourishment from the prothallium, and develops roots.

frost-bitten in the soil. It also keeps the seed from sprouting too soon. The use of the juicy pulp, which is sheer loss to the plant, is to attract birds and beasts that eat the fruit but at the same time scatter the seeds.

The outer skin prevents the fruit from drying in the sun, and it keeps out bacteria and molds unless it is in some way broken. Everyone knows how quickly a plum goes bad if the skin is pierced by a bird's peck or a wasp's bite. The "going bad" means that bacteria have got in at the wound.

There are three great kinds of dry fruits and two great kinds of soft fruits. The first set of dry fruits includes the box-fruits (capsules), which liberate the seeds by bursting or gaping or opening in some way, as in the case of pea-pods, turnip-fruits and poppy-heads. The second set, known as splitters, divide into pieces, each inclosing a seed which is not liberated till it sprouts in the ground. We see this kind of fruit in all the members of the hemlock order, in mallows and in plants like the white dead-nettle. Thirdly, there are all sorts of nuts and nutlets, which do not split or liberate the seed till the time of sprouting. These may be illustrated by hazel-nuts, by green fruits of the buttercup and by grains of wheat.

HOW STRAWBERRIES, RASPBERRIES AND FIGS ARE FORMED

The soft fruits are either stone-fruits, with the seed inside the hard innermost layer, as in plum, peach and cherry, or berries which have the seeds imbedded in a juicy pulp, as in grapes, gooseberries and currants. The hard thing in a cherry is the stone; the hard thing in a mistletoe berry is a seed. So, looking backward, we have box-fruits, splitters, nuts, stone-fruits and berries. To these, however, must be added a number of difficult fruits. A strawberry is a collection of tiny yellowish nutlets on the rounded red surface of the fleshy top of the flower-stalk. A raspberry is a collection of little stone-fruits perched on the soft, conical tip of the stalk. More complicated is the fig, where a whole group of fruits, each from a separate flower, is inclosed in a fleshy cup.

The uses of the fruit are all bound up with the seeds. Some fruits protect the seeds from frost and seed-eating enemies; some attract the attention of fruit-eating birds and mammals. That is profitable when the visitors do not digest the seeds; some scatter the seeds by explosion or by forming parachutes; and some prevent the seed from sprouting too quickly in the ground. These are the ordinary uses of fruits, but perhaps they may be more clearly understood if we keep in mind the following facts. They are the principal points to remember in studying the whole subject of the development of fruits of every sort and kind.

THE SUGAR-FACTORY WORKING INSIDE A GREEN PLANT

1. Fruits are usually built up of transformed leaf-structures, or carpels, which naturally tend to dry and die. This throws light on the splitting of dry fruits.

2. Many juicy fruits are rich in sugar, and the green plant is a sugar-factory. It is natural that after the nectaries of the flower close up—having played their part in attracting insect-visitors—there should be a redirection of the surplus sugar into the fruit.

3. Many soft fruits have at least seventy-five per cent of water. This must come, of course, from the soil, and we can understand better how it can be spared if we remember that the leaves are no longer using or losing so much water.

4. Seeds are rich in nitrogenous food-stuffs of great value as nourishment which form a legacy for the next generation. But what is in the fruit is not handed on, and is so much loss to the plant. We understand, therefore, why the fruits contain comparatively little in the way of protein, but often much in the way of sugar, which is less nourishing.

5. Everyone is familiar with the great difference between an unripe apple or plum and a ripe one. This is due to the chemical changes of ripening, such as fermenting starch into sugar, making ethers and oils of fine fragrance, and also in many cases making coloring matter, as in the apple's rosy cheeks.

FRUIT AS A LINK BETWEEN PARENT AND SEED

6. As we have just said, the treasures of fruits, so precious to man in apple and orange, grape and banana, and scores of other cases, represent so much loss to the plant, but in some plants the fruit is the link between the parent and the developing seeds which are laying up stores for the growing time.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 1083.

Beauty and the Beast

A RICH merchant had three daughters. The two elder ones were cross and ugly, but the youngest daughter was so sweet and lovely that she was called Beauty. There came a day when the merchant lost nearly all his money. He had to sell his grand house and go to live with his daughters in a little cottage. He was too poor to keep any servants, but Beauty willingly undertook all the work of the house, and even tried to find excuses for her lazy sisters when they stayed in bed till quite late in the morning and allowed her to wait on them all day long.

One day, while the merchant worked in his garden, a letter was handed to him. He opened it and learned that if he could go to a distant town he would be able to obtain work. Overjoyed at his good fortune, the merchant embraced his daughters, and prepared to set out.

"What shall I bring you when I return?" he asked Beauty.

"I want a new dress," cried both the elder daughters before Beauty could answer.

"I will bring you the best that I can afford, my daughters," replied the merchant. "And you, Beauty, what would you have?"

Beauty knew that it pained her father to feel that he no longer had the means to buy costly presents for his children, so she said quietly:

"A rose, father, just a beautiful rose, if you can find one," thinking that such a present would cost him nothing.

So the merchant set out, and after traveling for a whole day reached the town to which he was journeying, and received his orders for work. The following day he prepared to return, but he had not gone far when, to his dismay, he discovered that he had taken the wrong turning. He was in the midst of a huge forest, and knew it was very unlikely that he would meet anybody of whom he could inquire his way.

After he had tried for many hours to find the right path, a terrible storm arose, and the merchant, in despair, climbed up into a tree in the hope of finding a light to guide him to some house. Sure enough, he saw a light and, regaining the ground quickly, he leaped upon his horse and was soon before the gates of a magnificent castle.

He climbed up a tree and saw a light in the distance.

For a moment he waited, but as nobody appeared, he dismounted and strode up the

Beauty and her father had scarcely finished eating their dinner when the Beast appeared in the doorway.

steps. The house was brilliantly lighted from top to bottom, and on every side were signs of wealth and luxury.

The merchant passed through the great hall blazing with lights, and found himself in a large room. In the centre stood a table loaded with good things, and the merchant, being very hungry, sat down and ate a good meal. When he had finished, he began to feel very sleepy. Opening a door at the end of the room, the merchant found himself in a comfortable bedroom. He undressed and got into bed, and soon fell asleep.

In the morning, to his intense astonishment, he found a new suit of clothes in the place where he had left his old ones. He thought this strange, but he put them on and made his way to the dining-room, where he found breakfast awaiting him.

When he had finished an excellent meal, he rose and wandered out into the garden. The flowers were magnificent, and the sight of a lovely rose tree reminded him of his youngest daughter's request. Stooping, he cut a lovely bud and placed it in his coat. Just then he heard a noise, and looking up, found himself face to face with the ugliest man he had ever seen, for, though he had a man's body, the face was that of a beast.

The merchant shuddered.

"Ungrateful man!" roared the Beast. "Did I not feed you when you were hungry, and shelter you for the night? And yet you repay me by robbing me of my flowers. Ingratitude is a sin I cannot pardon; in an hour from this time you must die!"

"Forgive me, I pray you!" cried the merchant, falling on his knees. "I did but pick a rose for my daughter, and could I have found you sooner, I would have thanked you for all your kindness."

After some pleading, the Beast consented to forgive the poor man if he would promise to send in his place the first living thing he saw on returning to his home; and the merchant, thinking that this would be his dog, who always ran to welcome his master long before anyone else had heard his footsteps, promised, and departed.

To his horror, his first sight as he drew near the house was Beauty.

"Oh, what a beautiful rose!" she exclaimed, kissing him.

"Alas!" replied the poor man sadly, "you little know how dear it has cost me." And drawing her to him, he led her into the house and told her the whole story.

"I must return to the Beast, and die," he said. "What you will do when I am gone, my poor children," he concluded, "I do not know, but I can not break my promise."

"But you are not going," declared Beauty bravely, "for I shall go instead." And in spite of everything that the merchant could say, Beauty insisted on having her own way.

And so the next day they both set out for the castle, where they found a splendid supper awaiting them. They sat down to eat, and had scarcely finished when the Beast appeared. He looked at Beauty, and Beauty lifted her eyes and saw him. She shuddered and moved closer to her father. "What a dreadful man!" she was thinking. "I do hope he will kill me quickly."

But the Beast did not want to kill one so gentle, and he told Beauty's father that if he would go home and leave the maiden behind, no harm should befall her.

So the merchant rode sadly away, and Beauty was left alone in the huge castle. But the Beast scarcely went near her all day, and when night came, he showed her a beautiful little room, which he told her was hers. Sure enough, on the door was written: "Beauty's room," and inside was everything she could wish for. That night Beauty dreamed that a fairy came to her and bade her be not afraid, for she was quite safe.

The next morning she rose early and wandered through the gardens, but not one single person did she see. When she felt hungry she went to the dining-room, where she met the Beast.

"Do you think me very ugly?" asked the Beast.

"Well—yes," replied Beauty. He spoke so gently that she felt quite sorry for him.

The Beast sighed and left her. The next day she met him again.

"Will you marry me, Beauty?" said the Beast.

"Oh, no, no, no!" cried Beauty, for much as she pitied him, she could not bear the thought of marrying him, and the Beast went away looking very unhappy.

Soon after this, Beauty looked into a magic glass and saw that her father was very ill. The next time she met the Beast she begged to be allowed to visit her home.

"If you go away, it will kill me," said the Beast; "but rather than see you unhappy, I would bear any pain. Go, but you must return in a week."

At parting the Beast gave her a magic ring which would take her home and bring her back again when she wished to return, and Beauty was surprised to find how sad the parting with the great, ugly creature made her.

Her father was so rejoiced to see his daughter alive and well that he quickly recovered, and Beauty was so happy to be at home again that she forgot all about her promise to the Beast. The week slipped by, and then another, until one night Beauty dreamed that the Beast was dead. She burst into tears and awoke. She dressed quickly, and with the aid of her ring was soon back again in her little room in the palace.

She ran out into the gardens, and there, by the fountain, the Beast lay in a swoon. Beauty threw some water upon his face, and presently he recovered. When he saw her, he smiled.

"I could not live without you," he said faintly, "and so I tried to starve myself to death."

"Oh, you must not die!" cried Beauty, wringing her hands. "I will marry you, dear Beast, indeed I will. It is surely better to be kind and gentle than to have a handsome face; and indeed I love you."

As she spoke a wonderful change came over the hideous Beast, and even as she looked he was transformed into a young and handsome prince.

Beauty was so astonished that she could scarcely believe her eyes. Taking her hand, the young man explained that a wicked fairy had cast over him a spell, which could not be removed till some gentle girl should promise to marry him, ugly as he was.

Beauty's father was overjoyed to hear the good news, but the disagreeable sisters were as jealous as they could be, and said such unkind things to Beauty at the wedding that the Prince turned them into statues, and placed one at each side of the palace gates, where they stand still and cold, to this day.

The Riddle of the Sphinx

From THE AGE OF FABLE, *By* THOMAS BULFINCH

LAIUS, king of Thebes, was warned by an oracle that there was danger to his throne and life if his new-born son should be suffered to grow up. He therefore committed the child to the care of a herdsman with orders to destroy him; but the herdsman, moved with pity, yet not daring entirely to disobey, tied up the child by the feet and left him hanging to the branch of a tree. In this condition the infant was found by a peasant, who carried him to his master and mistress, by whom he was adopted and called Œdipus, or Swollen-foot.

Many years afterwards Laius, being on his way to Delphi, accompanied only by one attendant, met in a narrow road a young man also driving in a chariot. On his refusal to leave the way at their command the attendant killed one of his horses, and the stranger, filled with rage, slew both Laius and his attendant. The young man was Œdipus, who thus unknowingly became the slayer of his own father.

Shortly after this event the city of Thebes was afflicted with a monster which infested the highroad. It was called the Sphinx. It had the body of a lion and the upper part of a woman. It lay crouched on the top of a rock, and arrested all travellers who came that way, proposing to them a riddle, with the condition that those who could solve it should pass safe, but those who failed should be killed. Not one had yet succeeded in solving it, and all had been slain. Œdipus was not daunted by these alarming accounts, but boldly advanced to the trial. The Sphinx asked him, "What animal is that which in the morning goes on four feet, at noon on two, and in the evening upon three?" Œdipus replied, "Man, who in childhood creeps on hands and knees, in manhood walks erect, and in old age with the aid of a staff." The Sphinx was so mortified at the solving of her riddle that she cast herself down from the rock and perished.

THE NEXT STORIES ARE ON PAGE 1034.

Philip Gendreau, N. Y.

A fishing fleet in the harbor at Concarneau, Brittany, in northern France.

THE CONTINENT OF EUROPE

EUROPE is the second smallest continent, with an area of about 4,000,000 square miles; only Australia is smaller. If you look carefully at the map, you will see that Europe is hemmed in by the sea on every side, except where it is joined to Asia. It is, therefore, really a peninsula—that is, a body of land that is nearly surrounded by water.

In the far north we find the Arctic Ocean and the White Sea, which is a branch of the Arctic Ocean. On the west Europe is bordered by the broad Atlantic Ocean and its two arms—the North Sea and the Bay of Biscay. In the south there are the Mediterranean Sea and the smaller seas that branch off from it—the Tyrrhenian, Adriatic, Ionian and Ægean. Farther to the west we find the Black Sea, which is connected with the Mediterranean, and the Sea of Azov, a branch of the Black Sea.

Europe is a close neighbor of two continents—Asia and Africa. Europe is joined to Asia along a boundary line that extends from the Arctic Ocean to the Caspian Sea. The two continents are also connected by the broad belt of land between the Caspian and Black Seas. They almost meet again at the narrow straits—the Bosporus and the Dardanelles—through which the Black Sea flows into the Mediterranean. Europe and Africa face each other for a distance of almost 2,000 miles across the great Mediterranean Sea. They almost touch at the Strait of Gibraltar, at the western end of the Mediterranean Sea.

Europe has a number of large peninsulas. In the far north is the Kola Peninsula, lying between the Arctic Ocean and the White Sea. The big Scandinavian Peninsula, in the northwest of the continent, looks like the head of a spirited horse—a horse which is about to gobble up little Denmark.

The Scandinavian Peninsula covers an area of about 300,000 square miles. It is separated from the near-by peninsula of Denmark, to the south, by the two straits called the Skagerrak and the Kattegat. To the southeast there is the stormy Baltic Sea; farther to the north, the Gulf of Bothnia.

In the southwestern part of the European continent is the more or less square-shaped land mass that we call the Iberian Peninsula; it includes Spain and Portugal. After passing into the Mediterranean Sea, we come to the long, narrow, boot-shaped Italian Peninsula. East of Italy there is the large Balkan Peninsula, which includes Rumania, Bulgaria, Yugoslavia, Albania, Greece and European Turkey. The Crimean Peninsula, in the Black Sea, is attached to the mainland by a narrow isthmus.

Because of all these peninsulas, to say nothing of numberless bays and inlets and gulfs, the coastline of Europe winds in and out every which way. It is astonishingly long—50,000 miles in all. To give you some idea of what this figure means, we need only point out that Africa, which is three times as large as Europe, has a coastline of 16,000 miles.

A number of large and important islands lie off the coast of Europe. Chief among these is Great Britain, which is separated from the French mainland by the narrow English Channel. We all know that Great Britain, which is divided into the three regions of England, Scotland and Wales, is the centre of one of the greatest empires the world has ever known.

To the west of Great Britain lies Ireland, the Emerald Isle. To the north, off the Scottish coast, are the Hebrides Islands; still farther to the north are the Orkneys, the Shetlands and the Faroes. The large and picturesque island of Iceland lies some 500 miles northwest of Great Britain. Though Iceland touches the Arctic Circle, it is by no means the northernmost of Europe's isles. Far within the Frigid Zone, north of Russia, we find Spitsbergen and also Novaya Zemlya, which is made up of two islands.

The Balearic Islands, in the Mediterranean, lie off the eastern coast of Spain. Farther east, off the western shores of Italy,

Philip Gendreau, N. Y.

A scene in the Carpathian Mountains, a chain in central Europe. There are several peaks in this range that are more than 8,000 feet high. The section is rich in minerals. Agriculture is carried on in the high plains. The sturdy mountain sheep have thick fleece which helps them to endure the crisp airs of the high altitudes.

are Corsica and Sardinia, separated from one another by a comparatively narrow strait. A still narrower strait separates Sicily from the toe of the Italian boot. Crete, the cradle of a long-vanished civilization, lies southeast of Greece. North of Crete, between Greece and Asia Minor, are the Ægean Islands.

A considerable part of the European continent is mountainous. The mighty Alps are the centre of a great system of mountains in southern Europe. The Alps extend from the French Riviera, in the southeastern corner of France, in a northerly and then an easterly direction. They cover a part of southeastern France, northern Italy and southern Germany, and nearly all of Switzerland. They reach their loftiest height in Mont Blanc (15,781 feet). Other tall peaks of the Alps are Monte Rosa (15,217 feet), the Matterhorn (14,780 feet) and the Jungfrau (13,671 feet).

Branching off southward from the Alps are the Apennines, which form a sort of spine running the length of Italy. To the southeast, the Alps are connected with the Balkan Mountains and the Pindus range of Greece. West and northwest of the Alps lie the Cévennes, the Jura and the Vosges mountains; north and northeast, the Harz, Thüringer and Bohemian mountains and the Erzgebirge. Somewhat farther east, the Carpathian range forms a semicircular belt, nearly 800 miles long and, in certain places, 250 miles wide. It partly incloses the vast and fertile plain of Hungary.

Far to the north of all the ranges that we have just named lie the Kjölen Mountains, which extend for 900 miles along the great Scandinavian Peninsula. Scotland and northern England are mountainous. So is the Iberian Peninsula, in the southwest of the continent. Along the northern end of this peninsula, barring it from the rest of Europe, we find the snowy Pyrenees. Another lofty range of the Iberian Peninsula is the Sierra Nevada, which hugs the Mediterranean coast in the south of Spain.

The Ural Mountains serve as a boundary between Europe and Asia; they seldom reach over 5,000 feet in height. In the southeastern corner of Europe are the Caucasus Mountains, extending from the Black Sea to the Caspian. The Caucasus Mountains are about 940 miles long and vary in width from less than 60 to more than 130 miles.

Philip Gendreau, N. Y.

A flock of mountain goats at Gstaad, in Switzerland, with a snow-capped Alpine peak in the background. The Swiss put every possible foot of ground to use.

Europe has few active volcanoes. The largest of all is Mount Etna, on the island of Sicily. It rises to a height of about 10,750 feet; the circumference at the base is something like ninety miles. Etna has erupted many times and it has brought about great destruction. In the year 1169 A.D. it overwhelmed Catania and buried 15,000 persons in the ruins.

Mount Vesuvius, which lies ten miles southeast of the great Italian seaport of Naples, is only about 4,000 feet high—less than half as high as Etna—but it has done as great damage as its southern neighbor. The most famous of all the eruptions of Vesuvius was that of 79 A.D., in the days of the Roman Empire, when Pompeii and Herculaneum were buried under ash and lava.

In the southwest of Iceland we find Hekla (or Hecla), a cone-shaped volcano with three snow-clad peaks. The loftiest of these peaks, Keklufjall, is 5,110 feet high. Hekla has not erupted so often as Etna or Vesuvius. Furthermore, since there are no settlements to speak of in its vicinity, its eruptions have not been destructive.

Though there are many mountainous areas in Europe, the greater part of the continent is level or comparatively level. A great plain, occupying about two-thirds of Europe's land area, stretches from west to east. It includes part of France, western and northern Bel-

This map of Europe shows the chief mountain ranges, the most important rivers and the great inland seas.

gium, Holland, the northern provinces of Germany and the greater part of European Russia. In Holland and northern Germany, this plain is generally only a few feet above the surface of the sea. Sometimes it is at sea level or even slightly below sea level and it must be protected from the inroads of the sea by means of strong dikes.

In northern Russia the plain becomes a rolling, mossy expanse, known as the tundra. In the southeastern part of European Russia we find the flat, treeless areas which are called steppes (from the Russian word *stepi,* meaning heath). These steppes are very fertile in some areas, where the soil is rich. Other areas are covered with rough grass and shrubs during the short spring season, but this vegetation is dried up by the fierce heat of summer. In the winter the steppes become dreary wastes of snow.

The great plain that we have just described is not the only low-lying territory of

Most of Europe's rivers flow north and west.

Europe. There are lowlands in many areas of Portugal, Spain, southern France, Italy, Hungary, Greece and European Turkey.

Europe has many rivers famed in song and story. The longest of all is the Volga (2,400 miles), which drains an area of more than 500,000 square miles. This mighty stream, which flows into the Caspian Sea, is navigable almost from its source. West of the Volga we find its neighbor, the Don (1,125 miles), which at one point in its course is only fifty miles from the Volga. The Don empties into the small Sea of Azov.

Still farther west the Dnieper (1,400 miles) and the Dniester (800 miles) flow into the Black Sea. The largest river to empty into this big sea is the Danube (1,725 miles), the second longest river in Europe. It rises in the Black Forest of Germany, north of the Alps, and flows through Germany, Bohemia-Moravia (Czechoslovakia), Hungary, Yugoslavia, Bulgaria and Rumania. The "beautiful blue Danube," as the stream has been called, drains an area of something like 300,000 square miles.

THE RIVERS THAT FLOW INTO THE MEDITERRANEAN SEA

The most important European rivers that empty into the Mediterranean are the Rhone, in France, and the Ebro, in Spain. The Po, an Italian river, flows into the Adriatic Sea, an arm of the Mediterranean, after watering the fertile Lombard Plain in the northern part of Italy.

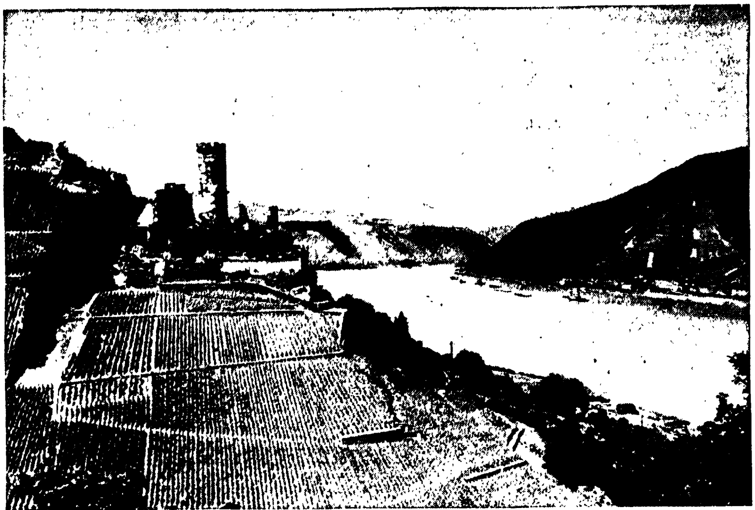
The Guadalquivir, the Tagus and the Douro, rivers of the Iberian Peninsula, flow into the Atlantic Ocean; so do the French rivers of the Garonne and the Loire. The Seine, which divides in two parts the great French city of Paris, empties into the English Channel.

The North Sea receives the waters of the Rhine (700 miles), one of the most beautiful rivers in the world. Along its course one finds numberless mountains, valleys, islands, rich fields, vineyards and medieval castles. The navigation of the Rhine is extremely important, particularly for western Germany. The Elbe River also empties into the North Sea.

The Oder, the Vistula, the Niemen and the Düna rivers flow into the Baltic Sea. The Düna is sometimes called the Western Dvina. The Northern Dvina, which is also known simply as the Dvina, empties into the White Sea, about twenty-five miles below the port of Archangel (Arkhangelsk).

WATER POWER FROM TUMBLING RIVERS OF MOUNTAINOUS SECTIONS

The rivers of Europe have contributed much to the prosperity of the continent. Many of them are excellent highways of commerce and offer safe and economical routes for the transportation of goods of all kinds. Other rivers, tumbling down from mountain heights, provide abundant water power, which is used chiefly nowadays to generate electricity. Norway, Sweden, Finland, Switz-



Ewing Galloway, N. Y.

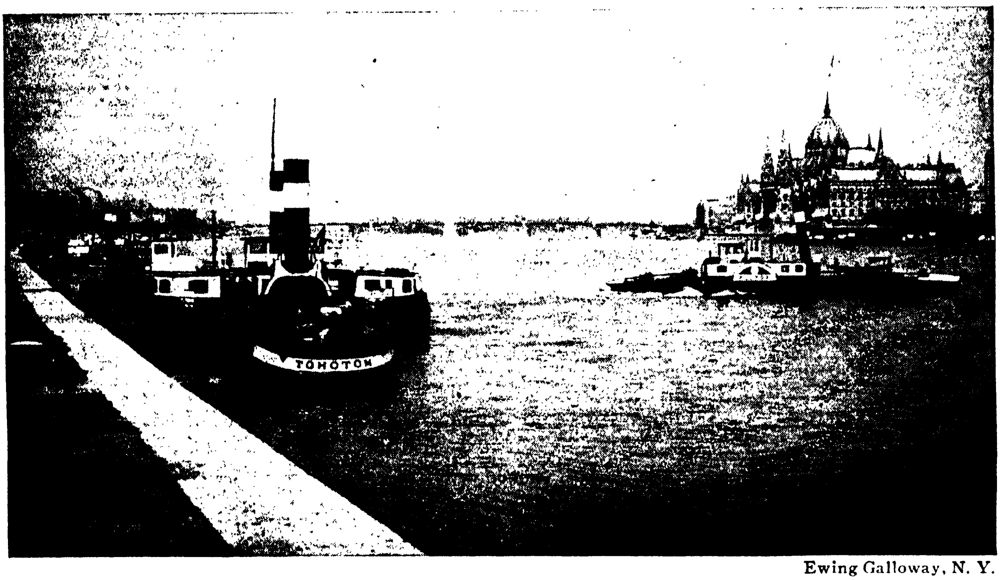
A medieval castle on the Rhine in Germany, almost surrounded by terraced vineyards, a scene that has not changed very much through hundreds of summers. The Rhine and the Elbe rivers are Germany's busiest waterways.

erland, Germany, France, Italy and Spain—all have fine water-power developments.

The lakes of Europe are quite small, compared to those of the Americas or of Africa. They may be divided into two groups—northern and southern. The northern lakes stretch from west to east across the Scandinavian Peninsula and Finland. The lakes of Finland, numbering some 40,000 in all, form a complicated network and cover a considerable area of that small country. To the east of these lakes lie Lake Ladoga, which is between Finland and Russia, and Lake Onega, in Russia.

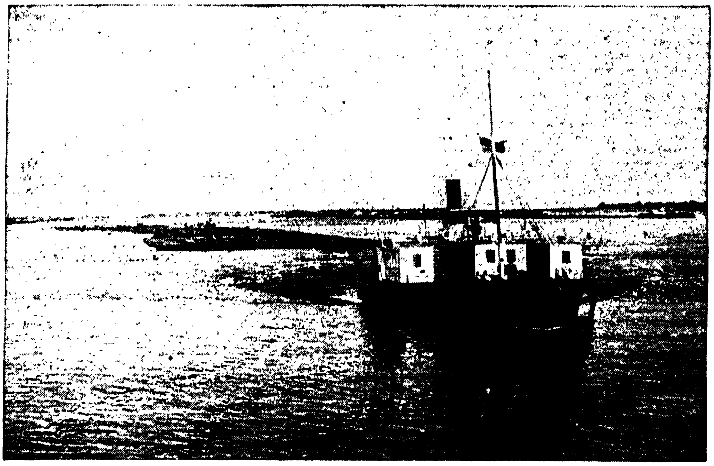
The southern lakes of the European continent extend along both sides of the Alps. North of that range we find Lakes Geneva, Neuchâtel, Thun, Lucerne, Zurich and Constance. The most important lakes on the southern side of the Alps are Maggiore, Como, Lugano, Iseo and Garda.

Geology, the science that deals with the history of the earth, teaches us that the continents acquired their present form only after a series of great changes. In what is now the European continent these changes consisted chiefly in the formation and, later, the destruction of one vast mountain system after another. As each of these chains gave way in its turn, parts of it would sink be-



Ewing Galloway, N. Y.

Boats on the Danube, tied up along the wharves at Budapest. The Parliament Building is at the far right.



Ewing Galloway, N. Y.
A tugboat on the Volga River, in the Soviet Union, towing a raft of logs.

neath the waves. At one time the sea covered the valley of the Rhone, the Alps Mountains and the Hungarian plain. On the other hand, the dry land once extended north and northwest as far as the Faroe Islands and perhaps even as far as Iceland.

Within what geologists would call "recent times," the climate grew colder all over Europe. Great sheets of ice, known as glaciers, began to form in northern Europe and moved slowly southward. They scooped up the soil in their steady advance and brought about great changes in the basins of lakes and the courses of rivers. When the ice sheets withdrew at last, Europe had acquired its present form.

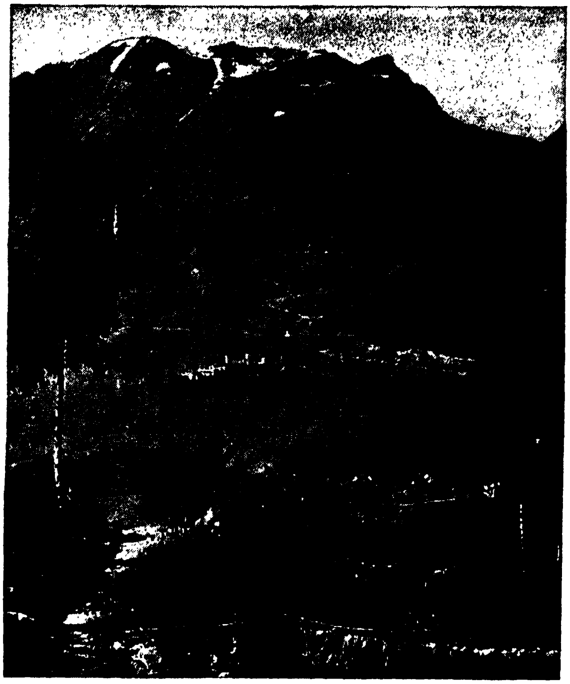
Most of Europe lies within the Temperate Zone. None of it is in the tropics, while only its northernmost areas lie above the Arctic Circle. The climate is particularly favorable in the British Isles, the western parts of France and Germany and the southwestern part of Norway. These areas feel the effects of warm ocean currents and Atlantic winds that blow from the southwest. Here the winters are mild, while the summers are not too hot. There are greater extremes of temperature as we advance toward the east, and these extremes become particularly great in European Russia.

In the northern half of Europe rain is fairly well distributed throughout the year; in winter the rain is apt to turn to snow. In the regions along the Mediterranean Sea it rains most often in the wintertime. Comparatively few districts in Europe suffer from lack of rainfall. Consequently there are no deserts that can compare with those of Asia, Africa and North America.

The vegetation of Europe ranges from mosses and lichens, found in the frozen north, to such warm-weather plants as the sugar-cane, the date-palm and the fig tree. In Scandinavia and Finland there are great forests of fir, birch, pine and spruce. Farther south we find the oak, the beech, the maple, the elm, the chestnut and a great many other trees.

Cereals, especially wheat, rye, barley and oats, have been widely cultivated for a very long time. In the last few centuries root crops like potatoes, turnips, beets and parsnips have also become very important. The vine is found in many districts. Olives, oranges, lemons, apricots, figs, almonds, sugar-cane and rice flourish in certain parts of southern Europe. Industrial crops (those not used for food, but in indus-

Ewing Galloway, N. Y.
Part of Lake Lugano is in Italy and part in Switzerland.



Ewing Galloway, N. Y.
•Norway has some of the most inspiring scenery in all Europe. Here is a view of Geiranger Fiord, with the majestic peak of the Saathorn rising from the far bank.

try) include flax, hemp and tobacco. The cork oak yields its bark to produce cork in Spain and Portugal.

Europe is rich in minerals that are useful to man. There are great coal deposits in Great Britain, Belgium, France and Germany. Iron is to be found in these countries and in Sweden, Norway and Spain as well. Copper ores are abundant in the Ural Mountains of Russia and in certain districts of Germany and Spain. Spain is also noted for its deposits of mercury, lead and wolframite. Great oil-fields are to be found in European Russia, Albania and Rumania. The sulphur deposits of Sicily are famous; so are the platinum deposits of Russia.

Precious metals, such as gold and silver, are not very abundant in Europe. Silver is found, to be sure, in a number of places, but generally only in small quantities. The richest silver mines are in Spain, Norway and Germany. Gold is quite unimportant. It is found chiefly in Transylvania, an area that has been fiercely disputed between Hungary and Rumania for many years.

The advance of civilization in Europe has not completely driven out wild animal life. The most important flesh-eating animals are the bear, the wolf, the fox and the lynx. The deer is particularly well represented among plant-eating animals. The European members of this family include the reindeer, the elk, the red deer and the roebuck.

Rabbits are found in many places. The ibex, a wild goat, and the chamois, a goat-like antelope, dwell in the mountains of the south. Wild boars, once common in Europe, now survive only in a few areas. Domestic animals include cattle, sheep, swine, horses, mules and donkeys.

The largest birds of the European continent are the eagle, the owl and the raven. We also find the house sparrow, the wood pigeon, the grouse, the thrush, the finch, the kingfisher and other members of the bird family. Many European birds go south with the coming of cold weather.

There are various species of snakes in Europe, but the only poisonous kind is the viper, found in a number of different places. Frogs and toads are common. So are insects; butterflies and beetles are particularly well represented.

The northwestern seas of Europe are filled with great quantities of fish —including herring, mackerel, cod and salmon. Farther to the south, tunny and sole are plentiful. Oysters and other shellfish are taken in various areas. In the many rivers of the continent one finds fresh-water fish such as perch, carp, pike, roach and bream.

Little Europe, with 480,000,000 inhabitants, ranks second among the continents in population; it has more people to the square mile than any other continent. Almost all Europeans belong to the Caucasian or white race, although some of them have traces of Mongolian blood.

It is generally agreed that the people of Europe form a number of different groups. Learned men, however, do not agree about just what these groups are. Some think that Europeans should be classified according to their appearance. For example, in one famous system long-headed people with blue eyes and fair hair form one group; round-headed individuals with hazel eyes and light chestnut hair form another; persons with dark eyes and dark hair, still another.

Other scholars prefer to group the peoples of Europe according to the languages that they speak. They point out that people who speak the same tongue are apt to have similar traditions and a similar background of learning. A group of this kind is apt to be far more closely knit than one whose members have only blue eyes or blonde hair or tallness in common.

On the basis of language the races of Europe fall into a few main groups. The most important of these are the Teutonic, Slavic and Latin. The Teutonic peoples dwell in the western and northwestern areas of the continent. They include the Germans, Dutch, Flemings, English, Danes, Swedes and Norwegians. The languages they speak belong to the Germanic group.

To the east of the Teutonic peoples are the Slavs. The Russians, the Poles, the Czechs, the Serbians, the Croatians and the Bulgarians all belong to this race. The Slavic languages that they speak differ greatly from the Germanic languages in grammar and in word-forms.

In certain southern areas of Europe we find the Latin peoples—the Italians, French, Spanish and Portuguese, among others. They are descendants of peoples who once dwelt in the great Roman Empire and who spoke Latin, the language of the Empire. The tongues they speak to-day—Italian, French, Spanish, Portuguese and so on—represent different developments of Latin. The Greeks, who also live in the south of the continent, are related to the Latin peoples by both blood and language.

In the western part of Europe—in Ireland, Wales, Scotland and the province of Brittany in France—we find large numbers of Celts. The old Celtic languages have by no means disappeared; many Celts, however, speak only the language of the country in which they happen to live.

The people that we have just named—the Teutons, the Slavs, the Latins, the Greeks and the Celts—use tongues belonging to the Indo-European group. The languages called Finnish, Lapp, Hungarian, Estonian and Turkish all belong to the Ural-Altaic family of languages, first spoken in the Asiatic lands near the Ural and Altai mountains. The peoples speaking these languages—the Finns, Lapps, Hungarians, Estonians and Turks—were originally related to the Mongolian races of Asia. However, there has been so much inter-marriage with Caucasians that in certain cases the Mongolian strain has practically disappeared.

In southwestern France and northwestern Spain we find the Basques. We do not know from where these people came or how they are related to the other European races. Their language, too, has puzzled scholars for many years. About the only point on which they all agree is that the Basque tongue is one of the most difficult in the world.

Finally there are the Jews, who belong to the so-called Semitic group—a group that also includes the Arabs. Jews are to be found in every country of Europe. In the days of old their language was Hebrew—the tongue in which most of the Old Testament was written. Nowadays Hebrew is still used in religious rites, but it is not often used as an everyday language by European Jews. Many of these Jews speak Yiddish, which is a dialect of German. Others speak neither Hebrew nor Yiddish, but only the language

British Official Photo

England is a manufacturing and trading centre, sending her products to the far corners of the world. This is a railroad freight yard in an English industrial city. Freight cars stretch as far as eye can see, waiting to be marshaled into trains.

of the land in which they dwell.

By far the most important religion in Europe is Christianity. The Roman Catholic faith, Protestantism and the Greek Orthodox Church are all well represented. Roman Catholicism flourishes particularly in the Latin nations of France, Belgium, Spain, Italy and Portugal, as well as in Ireland, Poland, Czechoslovakia and Lithuania. Protestantism is strongest in Great Britain, Germany, the Scandinavian countries, Finland, Estonia and Latvia. The Greek Orthodox Church finds its chief support among the Russians, Yugoslavs, Bulgarians, Rumanians and Greeks.

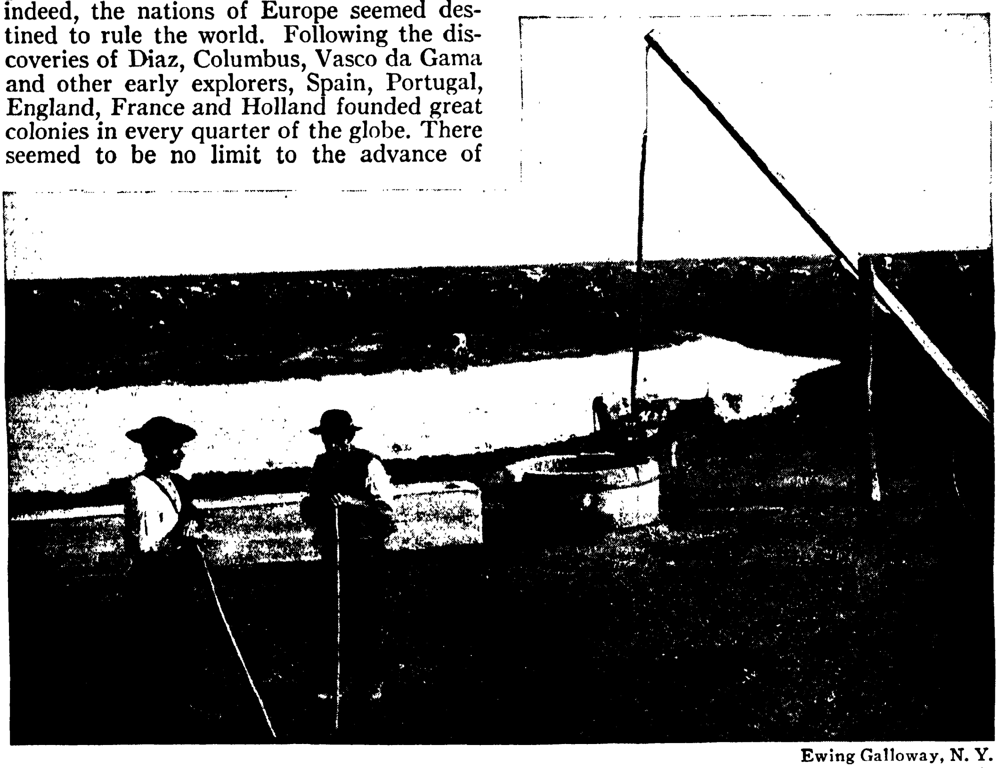
Almost 10,000,000 Europeans follow the Jewish faith; as we have pointed out, they are scattered all over the continent. Mohammedanism has a number of supporters in European Turkey and in other parts of the Balkan Peninsula. Mohammedans are also to be found in the Crimean Peninsula.

From an early time the European continent has played an important part in the great drama of human history. At one time, indeed, the nations of Europe seemed destined to rule the world. Following the discoveries of Diaz, Columbus, Vasco da Gama and other early explorers, Spain, Portugal, England, France and Holland founded great colonies in every quarter of the globe. There seemed to be no limit to the advance of European influence among the nations.

To-day the dream of European mastery over the world is a thing of the past. The nations of Europe have withdrawn from most areas of the New World, following the rise of the United States and the independent Latin-American countries. No large area in the New World is now the possession of a European state. Canada, to be sure, is a member of the British Commonwealth of Nations; but her position is that of a free and independent nation, which chooses to belong to that union. Various European powers still have big holdings in Asia; but the cry of "Asia for the Asiatics" is becoming stronger as time goes on.

Yet Europe still exercises great influence among the peoples of mankind. Unless we know something about the various European countries—their history, literature, industry and so on—we can not have a satisfactory idea of the march of human progress. We tell you about these countries in other chapters of The Book of Knowledge.

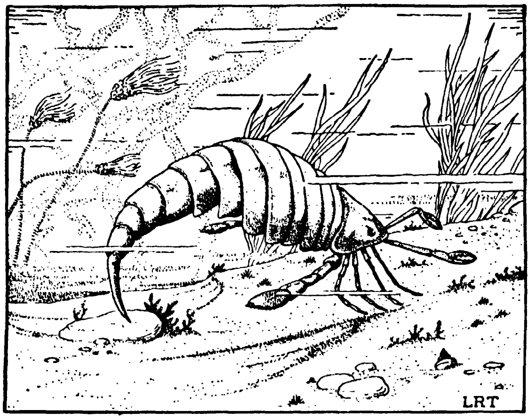
THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 1191.



Ewing Galloway, N. Y.

The plains of Hungary are often called Europe's granary. Livestock as well as grain are raised there. This cattle ranch is tended by men wearing the quaint old peasant costumes of the region. Water for the cattle is drawn from the well and poured into the pond, with the aid of the primitive wooden well-sweep.

THE WORLD IN THE ORDOVICIAN AND SILURIAN PERIODS



A Silurian eurypterid, ancestor of the modern scorpion.

As we have seen, the animal life of the Cambrian seas began to be more elaborately formed towards the close of the period. In the following period, the Ordovician, life advanced still further, although animals with backbones did not appear yet, and all life was still confined to the water. This period takes its name from an ancient tribe, the Ordovices, who, centuries ago, lived in Wales, where Ordovician rocks are fully exposed to-day.

During the Ordovician period, the trilobites still flourished. However, they were no longer rulers of the seas. Their place was taken by greatly increased numbers of cephalopods, the ancestors of the modern pearly nautilus, snail and octopus. The cephalopods became the largest, most powerful animals that lived in the waters of the Ordovician seas.

The shells of the early cephalopods were straight and looked something like ice-cream cones. Some of them were as long as fifteen feet. In time, some of these shells began to be slightly curved, and during the Ordovician period, many of them became coiled and even twisted to look very much like pretzels.

In addition to the cephalopods, a great variety of other shell-fishes lived during the Ordovician period. The most important of these were the snails, and the modern snail is very little different from these early forms. Some of the Ordovician snail shells looked very much like the shells of the cephalopods. The soft bodies within the shells were quite different, however. The brachiopods, or lamp shells, increased in number and began to take on more elaborate forms.

One of the chief things for us to remember about this period is that it was one during which thick layers of limestone were formed throughout the world. The vast numbers of shell-fishes in the Ordovician seas took lime from the water to use in building their shells. When they died, the shells settled to the ocean floor in great masses, along with lime-containing sea plants. With the aid of pressure and certain chemical reactions in the water itself, the remains of the dead shell-fishes and plants in time became solid masses of limestone. This same rock-forming process is going on to-day. Limestone formed in the far-off Ordovician period now furnishes us with building stones, cement, fertilizer, and many other commercial products. Sometimes it contains valuable ores.

Towards the close of the Ordovician period, what is now the North American continent began to rise from beneath the seas. Some parts of the land were squeezed so hard during this process that they buckled up to form mountain ranges. With the increase of land areas, there was a like decrease in the size of the areas covered by water. This great continent-making process marked the end of the Ordovician period of the earth's history.

The next period, the Silurian, is named for an ancient Celtic tribe, the Silures, who lived along the borderland of England and Wales. It was in this region that the rocks of this period were first studied.

The beginning of the Silurian period was marked by the sea flowing back over much of the land formed in the Ordovician period. Spreading down from the north, the waters formed an inland sea over what is to-day middle western United States. An island-like area from Alaska to California and another from Massachusetts to Florida formed the boundaries of the great sea.

THE BEAUTIFUL CORAL FORMATIONS INCREASED TREMENDOUSLY

The Silurian climate was warm and moist, although towards the end of the period it became very dry over wide regions. The warm, shallow waters were ideal for the growth of sea life. The trilobites began to decline in numbers and the cephalopods ruled the oceans. The corals, another kind of undersea life, really began in the Cambrian period, but they showed a tremendous increase during the Silurian period.

The corals are tiny animals that join together to form colonies in which many thousands of individual corals live. The skeletons of corals are on the outside of the animals and form the walls of the colonies. Many of our warmer seas to-day contain quantities of these beautifully colored and lacelike coral masses.

Although lovely to look at, the corals are really deadly animals of the sea, for their mouths are ringed with waving tentacles. When any small form of life has the misfortune of drifting too close to these tentacles, it is seized and carried to the hungry mouth of the coral.

During Silurian times these coral colonies grew and grew until they formed regular islands, or atolls, and reefs, just as they continue to do to-day. After the passage of millions of years, these vast coral colonies were turned into limestone.

CHICAGO IS BUILT ON CORAL-FORMED LIMESTONE

The city of Chicago rests upon a deposit of Silurian, coral-formed limestone that reaches eastward to the Appalachians, southward through the Mississippi valley, westward to Oklahoma and Iowa, and northward to the shores of Hudson Bay. The limestone over which the great Niagara Falls pours is an extension of this same deposit upon which Chicago stands. Since coral reefs only occur in tropical regions, we know that this vast area must have had a very warm, moist climate in Silurian days.

It was during the Silurian period that the first animal to breathe air and live upon land made its appearance. This animal was the scorpion, a relative of the trilobites, although it looked quite different. The scorpion did not make a sudden appearance, but probably developed slowly from a creature called the eurypterid. The eurypterid may have grown from trilobites that moved into shallow water to escape the cephalopods. Here, in the shallow waters along the shores, the eurypterid learned to breathe air.

WHAT THE FIRST AIR-BREATHING CREATURE LOOKED LIKE

The body of the eurypterid was divided into a head and stomach region and a jointed tail to which was attached a poisonous stinger. Jointed legs and a pair of strong pincers extended from the head. Some of these creatures reached a length of ten feet. The eurypterid has died out, but his descendant, the scorpion, still exists, although he is a great deal smaller.

In the Silurian period also we find the first fishes, queer-looking creatures covered with bony armor. This first fish is called cephalaspis, meaning "spiny head." His appearance was a very important step upward in animal development, for it was the beginning of animals with a backbone. We must remember that the Silurian period is remarkable chiefly for the appearance of the Vertebrata — backboned animals — and fishes. To be sure, the first backbone was composed only of a tough thread of gristle extending throughout the length of the animal's body, but in time it was replaced by bone.

The streamlined form of the bodies of the earliest fishes leads scientists to believe that fishes originated in the rivers and not in the seas. A long, narrow body strengthened by a backbone is perfectly suited for swimming against the strong currents of swift-flowing rivers.

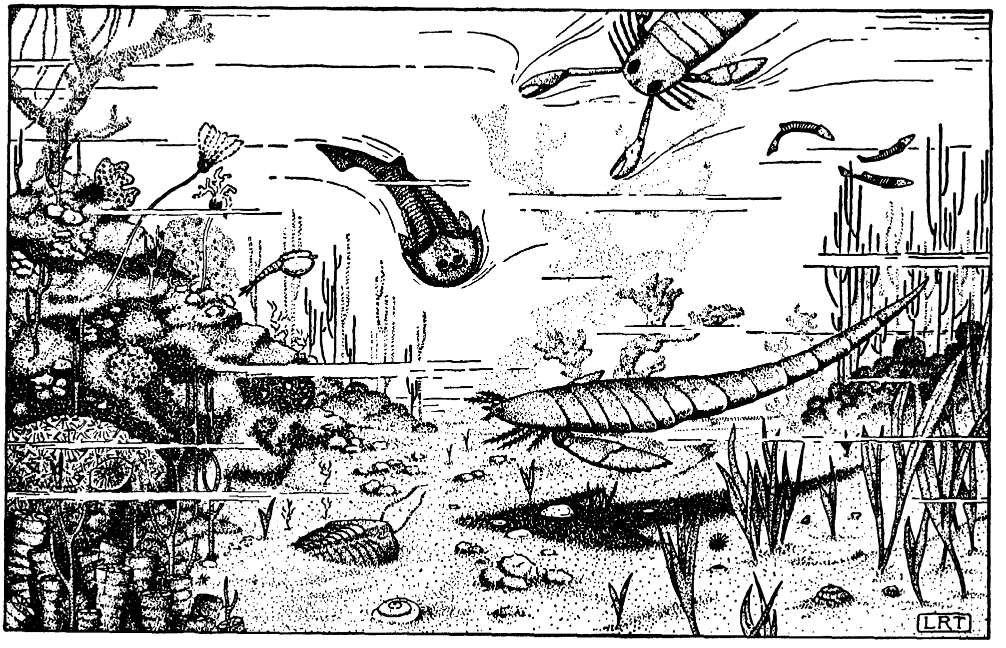
In addition to the animals of which we have spoken, an immense number of others inhabited Silurian waters. Brachiopods still flourished and cephalopods were to be found in great numbers. Animals called crinoids and cystideans grew stalks and spent their lives attached to rocks. Their tentacles, floating in the currents, picked bits of food from the passing water.

THE SEAS DREW BACK AND MOUNTAIN RANGES FORMED

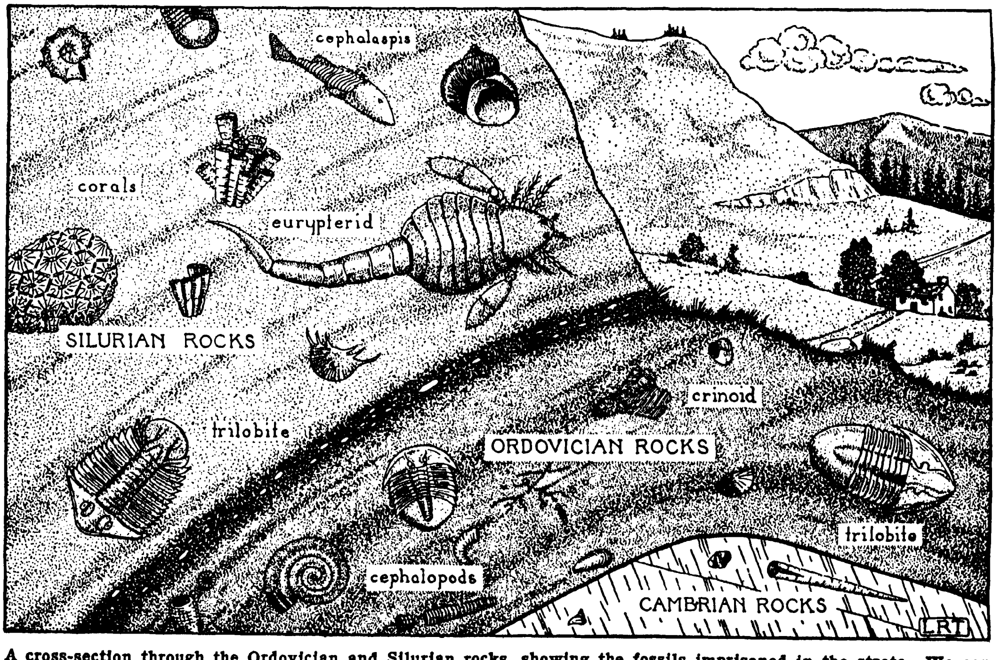
Once again, near the close of the Silurian period, North America began to become dry land as the seas slowly drew back. Mountains were raised in Alaska, in some of the Arctic islands, and in Greenland. In Europe, the great range of the Caledonian Mountains was formed at this time, and extended from Scandinavia through Scotland, Wales, France and Spain to the Sahara desert in Africa.

THE NEXT STORY OF THE EARTH IS ON PAGE 1175.

IMAGINARY VIEW OF THE SILURIAN



A view of undersea life as it must have been during the Silurian period. Note the abundance of corals, the jointed eurypterids, the earliest fish and the trilobite half buried in the sea bottom.



A cross-section through the Ordovician and Silurian rocks, showing the fossils imprisoned in the strata. We can see that animal life is becoming more and more elaborate as the earth grows older.

MARTHA

> **STORIES FROM OPERAS**
>
> OPERAS are dramatic works set to music. They are usually built upon spectacular plots, so that scenery and costumes are important, as well as the action of the story. Often, too, there is opportunity for fine dancing. The music includes orchestration, choruses, and vocal parts for all the chief characters in the story. It is a good thing to know the story of an opera before attending a performance, or before listening to it on the radio, for when we are familiar with it we can follow the music with more understanding and pleasure. In this article are the stories of Verdi's AÏDA, Flotow's MARTHA and Wagner's THE MASTERSINGERS OF NUREMBERG.

ONE bright spring day, during the reign of Queen Anne of England, a maid of honor to the Queen, the Lady Harriet, sat looking dismally out the window of the palace. She was dressed in rich brocades and velvets; on her fingers were rings worth a king's ransom. She had beauty, youth, friends and wealth, but she was unhappy because the formal life of the court was stupidly uninteresting. Her faithful friend, Sir Tristram, was a good-natured but dull sort of fellow, never quite able to understand her. Her favorite attendant, Nancy, was a sprightly girl, full of the joy of life. These two were her closest companions.

On this particular morning, Nancy tried to dispel Lady Harriet's gloom by telling her amusing stories of the fair being held in the town that day. It was the annual occasion when the farmers came to town to hire serving maids for the coming year. The girls in their best dresses danced happily on the green, and tried to secure good employment by telling of all the things they could do.

Lady Harriet impulsively decided to go to the fair, dressed as a serving wench. Nancy must accompany her and Sir Tristram, too, disguised as country folk. It was great fun at first, watching the farmers choose maids. Some could cook and some could sew, others could spin and weave, tend the poultry, work in the garden and even sow and reap in the fields. One by one the girls were chosen by the farmers who bound the bargain by giving a shilling to each as a token of acceptance.

Into the crowd burst Nancy, Sir Tristram and the Lady Harriet. A countryman named Plunkett and his handsome young foster-brother Lionel, attracted by the girls' happy temperament, hired them for a year, and not understanding that the matter was legally binding when they accepted the shilling, the girls in fun agreed. Their laughter turned to fear, however, when they tried in vain to break away. Unwilling to cause a commotion, and bring their escapade to the Queen's attention, they went quietly with the farmers, having lost Sir Tristram in the crowd.

At the home of Plunkett and Lionel they were ordered to perform menial tasks, and, naturally, failed at all of them, but the men were lenient with their mistakes. Lionel found himself more and more attracted to Lady Harriet, or Martha, as she called herself; and Plunkett saw much to admire in Nancy.

Lionel, alone for a few moments with Martha, begged her to sing for him, and she sang the mournful but lovely LAST ROSE OF SUMMER. So touched was the young farmer by the girl's beauty and charm that he begged her to be his wife, vowing to "raise her to his station," and only the entrance of Nancy and Plunkett saved her from laughing uproariously at such an offer.

Night came, and the two masqueraders stole softly out of the farmhouse and down the dark road toward the palace. Imagine the astonishment of the farmers next morning when they found their new servants gone! They searched everywhere—everywhere, that is, but in the Queen's palace!

Weeks passed. Plunkett and Lionel still looked for the runaways, and hoped to bring them back, for they had fallen in love with the strange maids. And what of Nancy and the Lady Harriet? Very sad these two had grown. They could not forget their adventure with the farmers, for truth to tell, they, too, had fallen in love. One day a royal hunt was arranged and, surprisingly enough, the four friends met in the forest. Lionel, overjoyed to see Martha again, made the most desperate and enthusiastic love, to her profound embarrassment, especially when Sir Tristram wandered in upon the scene. The good knight, mistaking the situation, fell upon Lionel and called for help and the poor young farmer

MERRYMAKERS AT THE COUNTY FAIR

was captured and led away to prison.

Lady Harriet was heartbroken, for she felt she had brought this trouble upon the man she loved. But happiness was in store for both. It was discovered that Lionel was in reality no farmer boy but Sir Lionel, son of the mighty Earl of Derby, and Lady Harriet's superior. He was released from prison and given his rightful place at court. He forgave Lady Harriet the deception she had practised upon him and when they were married he did in truth, "raise her to his station," as he had promised.

Nancy and Plunkett found happiness together and so the two runaway maids were restored to their masters, after all.

AÏDA

EGYPT and Ethiopia were at war and the Egyptian king, in his beautiful palace in Memphis, was troubled. He must send a powerful army out to meet the Ethiopian forces, and he knew not what general to put in command of his soldiery. He summoned the High Priest, Ramphis, and asked him to consult the Oracle of Isis. "Choose Radames!" said the Oracle. "He is the bravest soldier of them all!"

Radames was indeed a courageous fighter, and burning with love for his country. He longed to prove his valor, and to shine before the court, especially before the ladies in the court, and in particular before a slave girl, the lovely Aïda, who served the princess, Amneris.

Aïda was, unhappily, an Ethiopian, taken captive by the Egyptians and forced to wait upon the princess. She was lonely and unhappy in Memphis and only her love for Radames made life bearable.

Neither he nor Aïda gave a thought to the Princess Amneris, who loved Radames with a secret jealous love, and hated the beautiful captive maid who had won his heart.

The arrival of a messenger to announce that Amonasro, the Ethiopian leader, had invaded Egypt, hastened Radames' departure with his army. Aïda was in despair, for Amonasro, the king, was her father and now the two who were dearest to her in all the world were fighting desperately.

In the deadly struggle it was Radames and the Egyptians who won. Amonasro was captured and put in chains, and the victorious army moved amid the cheers and acclamations of the people to the palace at Thebes, there to receive the thanks of the King. What suitable thanks could the grateful monarch bestow upon Radames? Wealth, honors, these were not enough. His own daughter Amneris should be the prize accorded to the mighty victor. Amneris, told of her father's plan, happily agreed to it; yet there was one flaw in her joy—her jealousy of Aïda, whom she determined to humiliate still further.

In joyous excitement the soldiers arrived and the captives were dragged into the great hall with their leader Amonasro. When Aïda saw her father she cried out, but he warned her with a look not to disclose to the enemy the fact that he was the Ethiopian king. The captives were ordered to be put to death, but at Amonasro's plea for mercy, seconded by Radames, all were permitted to go free except Amonasro. Thus father and daughter were held as slaves in exile.

Preparations for the royal marriage were almost complete. Aïda and Radames planned one last interview. Aïda, first at the tryst, met her father who said that his forces were rearming to take up the struggle once more. If they but knew the road the Egyptian soldiers were planning to take out of Thebes, victory would this time be in the hands of the Ethiopians, Amonasro would recover his throne and Aïda could marry her lover. This happy outcome was in Radames' power. Would he tell Aïda the road of march? When Radames came to the meeting-place, Aïda begged him to tell the secret. She begged in vain. Dearly as he loved her, he could not be a traitor, but as they talked, the name of the road slipped past the barrier of his lips and Amonasro lurking in the shadows, heard.

Someone else had heard—Amneris, listening jealously. Shrieking imprecations upon the traitor, she summoned the soldiers and the high priests, who took Radames prisoner, and killed Amonasro. Aïda escaped.

Tried and convicted of treason on the charge of Amneris, and his own admission, Radames was condemned and led away to be buried alive in the stone crypt under the altar of the God of War. As the last stone was dropped into place Radames saw in the shadows of his tomb another figure. Aïda had come to die with him. Separated in life, these two were joined in death; and as the priests before the altar chanted the ritual of the dead, and Amneris sobbed out to the gods a plea for forgiveness, Radames and Aïda entered the kingdom of the immortals.

THE MASTERSINGERS OF NUREMBERG

In the old German town of Nuremberg, a group of twelve mastersingers prepared a great contest. Singers were invited to compete for membership in the group, and the best singer in the Grand Competition was to win as a prize the beautiful Eva, daughter of the rich Herr Pogner. Many suitors loved Eva, chief among them the ill-natured Beckmesser, marker for the Mastersingers, and Sir Walther von Stolzing, a strange knight who had recently come to the town and had fallen deeply in love with Eva. She loved him in return, but her father's word was pledged to give his daughter to the best singer.

Walther resolved to try for the prize. He knew little of the formal art of singing and in the preliminary trials he won the hatred of Beckmesser, the Mastersinger whose duty it was to mark down on a slate the errors made by the contestants as they sang. When Walther's turn came, Beckmesser scratched so noisily and viciously upon the slate that the singer was confused and the judges had no fair chance to hear him. Only one judge, the best musician of them all, the cobbler Hans Sachs, perceived, even through the tumult, that here was a singer who broke the artificial rules of the day but had true music and poetry in his heart and his voice.

Hans Sachs was outvoted and Walther's name was not entered in the list of competitors for the next day. Eva, saddened, sought comfort from Hans Sachs who lived across the way, but he had no solace to give her. Night fell, and the stupid Beckmesser came with his lute to serenade beneath Eva's window, just as she was stealing off down the dark road with Walther. Hans Sachs, knowing their elopement would only cause more trouble, prevented it, and forced Walther to spend the night in his humble cottage, while Eva returned to her father.

Next morning Walther sang for Hans Sachs a strangely beautiful melody that had come to him in a dream. Enchanted, the cobbler wrote it down and promised Walther that he would have his chance to sing it in the Grand Competition that day.

While Walther was dressing for the event, Beckmesser arrived and saw the song lying on the table. As it was in Sachs' handwriting he assumed that the cobbler had composed it. Sachs offered him the melody to sing "if he could learn it in time" and Beckmesser went off confident that now, with his fine voice and Hans Sachs' song he would surely win Eva.

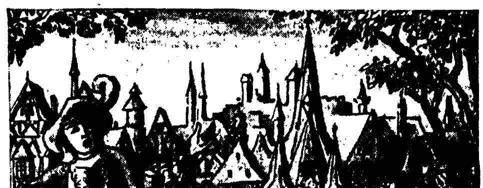
Boldly he stepped forth before all the people, at the Grand Competition. Arrogantly he started to sing the new ballad, Walther's song. But the words were not clear in his memory and even the music escaped him. He made comical mistakes. The people laughed him off the platform.

Then out stepped Walther von Stolzing. There was silence as he lifted his head and began to sing his beautiful love song to Eva, and deeper silence reigned as his voice soared free above the crowd, in a very ecstacy of melody. When he had finished the applause thundered up to heaven.

"He has won!" shouted the people.

Herr Pogner crowned the kneeling youth with laurel, and over his head slipped the golden chain of the Mastersingers. Then, taking him by the hand, he led the knight to the prize, Eva, his love.

THE NEXT STORIES ARE ON PAGE 1088.



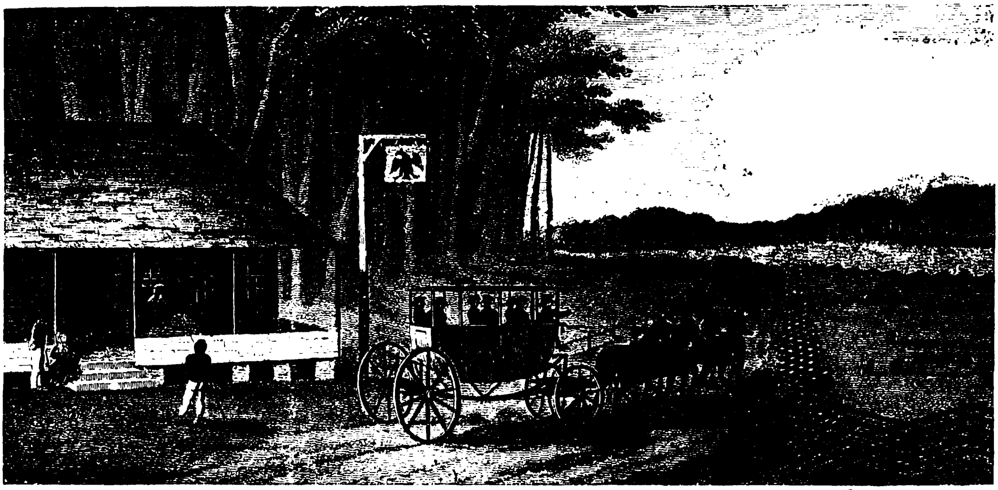

TWO GREAT CITIES IN COLONIAL TIMES

From an old print

Charleston Harbor at about the time of the Revolution. St. Michael's Church is at the left and St. Philip's Church at the right. In the middle is the old Exchange, where, in 1774, the Charlestonians stored the taxed tea to keep it from being sold. During the Revolution British troops occupied the building, but they never knew that the Americans had hidden 10,000 pounds of gunpowder in a secret room in the basement. It was also used as a prison.

From an old print

The old State House in Philadelphia, on Chestnut Street between Fifth and Sixth streets, about the middle of the eighteenth century. This is the building that we now know as Independence Hall; where the Continental Congress met, where the Declaration of Independence was drawn up and where the Liberty Bell was rung. It was built as the State House, or seat of government, of the colony about 1735. The tower was added in 1750.



From an old print

Colonial inns and stagecoaches were rather crude. From the eagle on its sign we can tell this inn's name.

THE THIRTEEN COLONIES ON THE EVE OF THE REVOLUTION

YOU have read about the founding and settling of the thirteen colonies, in the article beginning on page 543. Now we shall tell what these colonies were like just before the Revolution. There were three groups; New England, which included Massachusetts, New Hampshire, Connecticut and Rhode Island; the Middle colonies, New York, New Jersey, Pennsylvania, Delaware and Maryland; and the Southern colonies, Virginia, North and South Carolina and Georgia.

The western boundaries of most of the colonies were supposed to reach clear to the Pacific Ocean, but really very little was known of the lands west of the Mississippi River. Most of the settled area clung to the coast and the navigable rivers that flowed into the Atlantic. One reason for this was that the rivers and the sea were the best, and almost the only, highways. The roads were rough and muddy, and there were few of them, so that land travel and transportation was difficult and slow. There were wagons and carts, and some rich people had coaches made for them in England. While there were a few stagecoaches, most people traveled on horseback or on foot if they could not travel by water. In this way the people had pushed the frontier back to the foothills of the Allegheny Mountains, but in only a few places had settlers penetrated beyond the mountain wall.

Farming was the chief occupation in all the colonies, because people had to produce their own food and many other necessities. All of the plowing, sowing, cultivating and harvesting was done in the primitive ways that had been used for thousands of years, for no labor-saving machinery had then been invented. On the frontier, and among the poorer farmers in the East, the farmer and his family had to do everything themselves. Well-to-do farmers in the North had indentured servants, a class of people that we shall tell about later, and the planters of the South had slaves, but all of them had to make many things that farmers to-day can buy. Tools, soap, tallow candles, shoes and other clothing were often made on the farm; and the spinning, weaving and dyeing of cloth, with home-made vegetable dyes, kept the women of most rural households busy from early morning until dark.

MASSACHUSETTS INCLUDED MUCH OF WHAT IS NOW MAINE

Massachusetts, the northernmost colony, included most of what is now the state of Maine. In 1770 this colony had over 300,000 people, most of them born in America of

Much of the land that the colonies claimed, and sometimes quarreled over, was still unexplored.

English stock. There were many farms in the colony, as well as many towns along the rivers and the coast.

The kind of farming that was done in Massachusetts was not the sort in which slaves could be used to advantage, so that slavery never got a real start there. A few slaves, Negro or Indian, were to be found in many communities, but these were usually house servants or tradesmen's helpers. There were a great many indentured servants, white persons who sold their services for a term of years in return for food and shelter and a sum of money to be paid when their time was up.

One feature of colonial farm life which we must not overlook was the traveling merchant or peddler. These men, many of them traveling on foot with packs on their backs, wandered through the colonies, turning up even in the most remote backwoods settlements. Some of them were shoemakers or tinkers or cabinetmakers. Others sold wonderful remedies for any and all illnesses, and many carried stocks of trinkets, ribbons, pins and needles and other small wares. They also brought news of the outside world and gossip of the neighborhood, and they were usually welcomed by the people who lived far from towns and shopping centres.

Fishing, shipbuilding and shipping had grown to be important industries in Massachusetts before the Revolution. The light, shallow-draft sailing vessels of those days could enter harbors and sail up rivers that would be far too shallow for the ships of to-day, so all the little coastal towns of Massachusetts were able to share in the shipping trade with the other American colonies and with the West Indies. Hundreds of whaling ships sailed from these ports every year to bring back the oil which lighted the lamps and had so many other uses before petroleum was discovered.

Each town had its local industries, among them weavers' and blacksmiths' shops, sawmills and flour mills, run by water power from the river, shipwrights, makers of barrel hoops and staves, rope-walks, harnessmakers' shops, clockmakers, ship-chandlers, and shoemakers. Steam power and electricity were not yet in use, and except where wheels could be turned by running water, all power was furnished by the muscles of men or animals. The craftsmen and small tradesmen had their shops and workrooms in their own houses, and even the wealthy merchants and shipowners lived very near their yards and counting-houses, or offices.

Each little town had its church, and the pastor was an extremely important person in the community. Each town had its school, for as early as 1647 the Massachusetts Bay Colony had made a law that every fifty families must support a teacher, and that for every 100 families there must be what we would call a high school. Reading, writing, spelling, simple arithmetic and English grammar were the chief studies of the younger children, and Latin and Greek of the older ones. (See the article on Child Life in Colonial Days, beginning on page 965.)

What was true of the smaller towns was also true of Boston, the capital city of the colony, where the royal governor lived. By the time of the Revolution, Boston had a population of about 20,000, and was second only to Philadelphia in size. It was a busy commercial centre as well as the seat of government. There one saw wealthy merchants and small tradesmen, lawyers like John Adams, political writers like Samuel Adams, craftsmen like Paul Revere and many learned preachers. Boston was not then the centre of culture that it became in the nineteenth century. Its music still consisted largely of hymns and its literature of sermons and political arguments—sometimes in prose and sometimes in verse, but all very, very long. There were no theatres until after the Revolution, for the Puritan dislike of play-acting was still strong. One art which received a great deal of encouragement was that of portrait painting. People liked to have pictures of themselves and their families. Besides really fine painters, such as John Singleton Copley, there were many who did very poor work but who must have satisfied their customers. Some painters would travel around the country, like peddlers, working for board and lodging if they could not get money. Sometimes such painters would carry a stock of portraits already painted except for the face. This they would fill in with the features of any person who would buy the picture.

In near-by Cambridge was Harvard College, the most important institution of higher learning in Massachusetts, and the oldest in the English colonies. Harvard was originally intended, as most of the colonial colleges were, to educate young men for the ministry, and in the time of which we are speaking, just before the Revolution, it was still mainly a theological seminary. Latin, Greek and Hebrew were a very important part of its teaching program. Anyone who wanted to study to be a physician or a lawyer did so in the office of a doctor or a lawyer, and not at a college. Not all of the graduates of Harvard became preachers, however. Some of them taught school, some of them went into business or studied law or medicine after they left college.

Social distinctions had always been strong in the Massachusetts colonies, as in most of the other colonies. In Puritan Boston clergymen received much deference, as did high government officials, elders in the churches, rich people and the more highly educated people. The descendants of the earlier settlers considered themselves more aristocratic than the people who had come to the colonies later. While these distinctions grew less as time went on, they still existed at the time of the Revolution. In the Harvard catalog of 1772, the students were arranged according to the social rank of their families. The main divisions of rank were — gentlemen, yeomen (small farmers), merchants and mechanics. The term "gentlemen" seems to have included well-to-do and well-educated people of various callings.

Boston, with its girdle of waterways and its narrow, crooked streets, was full of contrasts. Many of the streets were merely dirt tracks, though some were paved with cobblestones. The dwellings ranged from shacks to mansions. Many of the more substantial houses were built of brick, though some were wood, and the Palladian style of architecture that we now call Georgian, or colonial, was fashionable.

The people who lived in the finer houses

From an old print

This picture of Boston Harbor in 1768 shows a very different shore line from what you would see to-day. Much of it has been filled in, and streets and buildings cover areas where ships used to anchor. In the picture State Street, which begins at the old State House, extends out in the water; now it is surrounded by land.

From an old print

Boston's famous Old State House, which was built in 1713.

had fine furniture, delicate chinaware, silverware and most of the luxuries that the period knew. The china, wallpaper, fine carpets and hangings and much of the furniture and silverware were imported from England. Some of them were very likely smuggled in from the French and Spanish ports with which the colonials were forbidden to trade direct. Boston and other colonial towns had skilled craftsmen who produced beautifully made tables and chairs and other articles of furniture, and these, too, were to be seen in the homes of the well to do. The celebrated English furniture designers of the period published books of their designs, and much of the better American-made furniture was copied from these books. Silversmiths flourished in Boston and other colonial cities as early as the year 1700, and so great was the demand for their wares that some of them got quite rich.

Most of the people dressed in simple, practical clothing, usually of homespun cloth; home-tanned leather provided jackets and high boots for men in the country districts. Women wore large hoods and long cloaks in cold weather. The pioneers had quickly adopted the Indian moccasin for general wear, and these were still worn in frontier communities. Shoemaking, however, became an important industry in Massachusetts early in the seventeenth century. There were shoemakers among the first settlers in the colony, and the General Court in Boston even made laws regulating the quality, prices and wages in the trade. By the time of the Revolution even the most remote settlements in Massachusetts were visited by shoemakers. In wet or snowy weather the women wore clogs or pattens (thick wooden soles strapped to the regular shoes) to keep their feet dry. Rich people imported fine shoes and other clothes, and almost all townspeople had some imported clothes for "best."

Cooking was done in great fireplaces with built-in ovens. Candles furnished most of the light: tallow dips for the poorer people and beeswax for those who could afford them. Crude little oil lamps of Dutch origin, called betty lamps, had been used by the Pilgrim Fathers, and these were still used by many people at the time of the Revolution. They were made of pewter, brass, and sometimes of silver.

Many of the things which we have told you about the life of the people of the Massachusetts colony were equally true of all the other colonies. As we come to the different colonies we shall point out the ways in which customs and conditions differed.

NEW HAMPSHIRE'S COASTAL TOWNS AND INLAND FORESTS

In 1775, the colony of New Hampshire had a population of nearly 73,000. The most thickly settled area was on the coast, around the four original towns of Portsmouth, Dover, Exeter and Hampton.

On the eve of the Revolution, Portsmouth had been the seat of government for nearly a century. It was a small town but an important shipbuilding and shipping centre and its wealthy merchants had built lovely Georgian houses surrounded by flower gardens. If you go to Portsmouth to-day you can still see many of these houses. Some of them have a space on the roof with a railing around it called the Captain's Walk, or the Widow's Walk. Here many a shipowner or captain's wife used to gaze out over the harbor, watching for ships that might never return.

Ships from Portsmouth carried lumber from the inland forests to Spain and Portugal and the West Indies. Dried fish was another export article, and in the winter small ships carried English and West Indian goods to Virginia and the Carolinas and brought back corn and pork. There was a great deal of travel between Portsmouth and Boston, and in 1761 a stagecoach route was started between the two cities.

Most of the people in New Hampshire at this time were Congregationalists, or Puritans. In Portsmouth, however, the Anglican church (Church of England) was established, and around Londonderry there were many Irish Presbyterians who had come to the colony to escape the oppressive rule of the English Church in their native land. These people were spinners and weavers of linen, and they brought a new industry to New Hampshire. There was a small iron industry in the colony, but it suffered from a lack of experienced ironworkers. The mother country's policy was to discourage any industries in the colonies that conflicted with her own, so New Hampshire's linen, iron and wool industries did not have much of a chance.

Most of the people of the colony lived very plainly. The houses usually were of the one-story and attic type, built close to the earth and with the chimney in the middle. Every house had its spinning-wheel, and most of the people wore homespun clothing. Hardly anyone outside a few of the older towns had carriages. People who had horses rode horseback, and one would often see a husband and wife riding on the same horse, the wife sitting on a sort of cushion, called a pillion, placed behind the saddle. Sleds or sleighs were used in the winter, sometimes drawn by oxen. Most people walked.

Education was not so well looked after in pre-Revolutionary New Hampshire as in Massachusetts. The laws of the colony required schools of some kind, but it was left to the different towns to provide their own. In 1771, Governor Wentworth told the Assembly that nine-tenths of the towns had no schools at all, or had teachers who could scarcely read and write themselves. There were, however, a few excellent academies, and one of these, Phillips Exeter, founded in 1781, is to-day one of the most famous schools in the United States. When Harvard College was founded, the New Hampshire towns were connected with Massachusetts, and money was given by Dover, Portsmouth and Exeter to help support the college. Dartmouth College, at Hanover, New Hampshire, graduated its first class, four students, in 1771. One of the graduates was the son of Governor Wentworth. The Governor had a seventy-five-mile road built through the forest from Wolfeborough to Hanover so that he could go to his son's graduation in comfort.

CONNECTICUT HAD MANY KINDS OF MANUFACTURES

Like the other colonies, Connecticut grew most of its own food on the farms clustered around its tiny villages, but trade and in-

From an old print

This colonial kitchen has an oven built in the fireplace, and a crane to hang pots and kettles over the fire.

dustry started early and formed the chief occupations of the people. At the time of the Revolution "Yankee notions" made in Connecticut were carried by peddlers throughout the thirteen colonies. These articles included tinware, brassware, nails, pins and many other small wares. The Connecticut craftsmen were very clever, and often got ideas for new gadgets from drawings made by the customers themselves.

Many ships were built in the colony, iron and copper were mined and worked, silversmiths, coppersmiths, clockmakers and paper mills flourished. So many hats were manufactured at Wethersfield that the English hatters complained that they were losing the trade of the colonies.

From New London the whaling fleet set out every year, and Connecticut ships carried onions from around Wethersfield, tobacco from Windsor, oak barrel staves, cattle and hides to the Indies and the Southern colonies. They also found the slave trade profitable.

Connecticut started out in 1642 with an excellent system of free, compulsory education, consisting of elementary and Latin grammar schools, but during the eighteenth century the system was somewhat neglected. Yale College at New Haven was founded in 1718.

Altogether, the people of Connecticut lived busy lives on their farms and in the many villages. In most of the villages the houses were built around a central green, or common. The houses were of wood or stone or even of brick, and each village had its little church and its blacksmith's forge.

RHODE ISLAND, A COLONY WHICH HAD COMPLETE RELIGIOUS LIBERTY

Rhode Island was in many ways different from the other New England colonies. For one thing, it was the only one in which complete religious liberty for everyone was established by law. Roger Williams, who founded the first settlement at Providence in 1636, had left Massachusetts in order to escape religious persecution, and he welcomed people of all faiths.

By 1774 the entire colony had a population of 58,000, many of whom were engaged in some kind of commerce. During the first half of the eighteenth century Newport and the other Rhode Island towns had become rich in the shipping trade. They shipped wool to France and brought back linen; horses, beef, butter, cheese and flour were sent to the West Indies in exchange for sugar and indigo; and dried fish were traded for the wines and salt of southern Europe. There was another form of trade that was not so admirable, but which was very profitable, and this was the slave trade. Many of the New England ports were engaged in the slave trade, but Newport seems to have been the most important. Ships would leave port laden with rum and other articles and sail to Africa, where the cargoes would be traded for slaves. Then they would sail to the sugar islands of the West Indies and trade the slaves for sugar and molasses. This cargo would be taken back to Newport to be sold or made into rum.

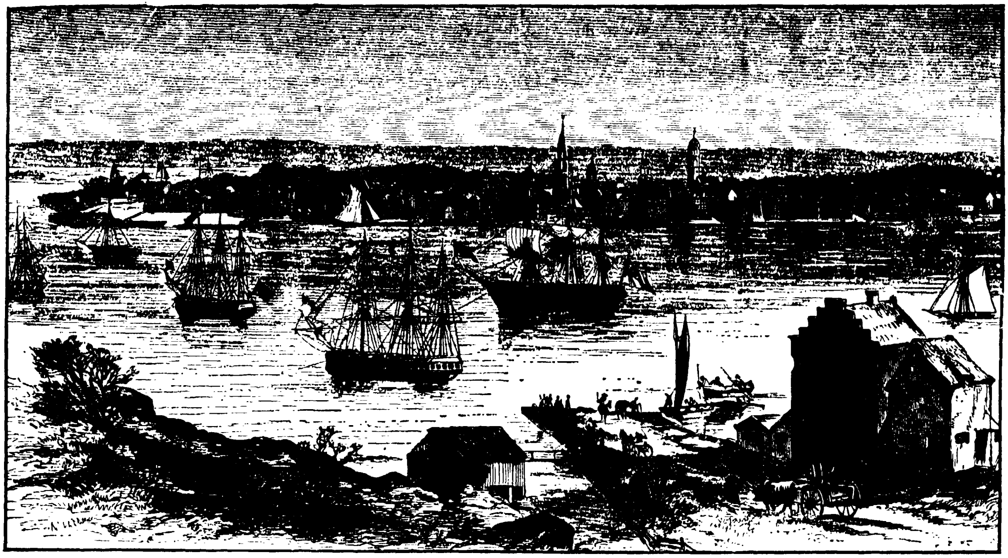
Newport was a well-built city with paved streets, and in 1761 had 888 houses and 439 warehouses and stores. Many people from Charleston, South Carolina, spent the summers in this northern city, and there was a great deal of social life, including theatrical entertainments. The shops sold all kinds of lovely things from Europe and the Orient.

When the British Parliament began to enforce the laws which taxed articles imported into the colonies, the great shipping trade of Rhode Island was ruined, but a large smuggling trade sprang up. For many years before the Revolution, privateers, smugglers and even pirates were familiar sights in the towns and harbors of the colony.

NEW YORK, THE COLONY WHICH ONCE BELONGED TO THE DUTCH

If New England was mainly populated by English people, the Middle colonies had drawn settlers from many other countries, and New York had perhaps the greatest variety of all. Colonial New York consisted of three regions, all entirely different from one another. There was the city at the lower end of Manhattan Island, even then a colorful place of many languages. Along the Hudson River as far as Albany were the rich farms and great estates of the Dutch and English landowners. From Albany, along the Mohawk Valley to the Indian country in western New York, was the frontier. Here were the little settlements of pioneers; people from the other colonies, Scotch-Irish and Scotch, English and many Germans from the Rhine and Bavarian Palatinates.

In the peaceful years just before the Revolution, these settlers were comparatively free from the fear of Indian raids. At Johnstown, northwest of Albany, Sir William Johnson and his Scotch settlers lived. Sir William was the royal commissioner to the



From an old print

New York City in 1750, viewed from the Brooklyn side of the East River. Note the flat-bottomed ferry boat, with sails and oars, starting its trip across the river, and the ox-drawn cart in the foreground.

Six Nations and all the other northern Indians, and so great was the friendship that the Indians felt for him that it meant much to the peaceful settlement of the region.

Albany was a crossroads on the great route to Lake Champlain and Montreal, and the route to the West. It was still a Dutch city, with cobbled streets and high-gabled brick houses, but there were also Georgian houses like that of General Philip Schuyler outside the city. It was a busy commercial centre, for ships came up the Hudson and exchanged their cargoes for the products of the farm land near by and for the furs brought down from the north.

New York City had a population of about 15,000 at this time. It was not so important a seaport as Boston or Philadelphia, but even then it was a regular beehive of commercial activity. It had newspapers, a theatre, a chamber of commerce and many taverns where the merchants of the town gathered to discuss business and politics. Politics were very much disturbed in New York for years before the outbreak of the Revolution. The city was the capital of the province, the Assembly met there and the royal governors held their court there; but as early as 1765 the Sons of Liberty were organized, and riots and protests greeted every move of the government. King's College, which is now Columbia University, was chartered in 1754, and built with money raised by holding a lottery. It had been hoped by the authorities that King's College would help to keep down the growth of "republican tendencies" among the youth of the city, but they were disappointed. The students, among them young Alexander Hamilton, were among the foremost of the agitators for liberty.

The fine brick houses of the English-Dutch merchant aristocracy were all down around the Bowling Green, or within a few blocks of it, and the owners of these homes did not have to go very far to reach the waterfront, where the bowsprits of the ships arched over the stone pavement, and the smell of tar and salt water filled the air. The rich people had fine carriages and beautifully furnished houses, and carried on a pleasant, but rather stately, social life. One of the most delightful social customs, in the opinion of Colonel George Washington, who visited there, was the New Year's Day reception held in many homes. Skating parties on the pond above the city, sleighing parties into the country, and dancing parties made the winter gay. In the summer most of the wealthy people moved to their country homes.

NEW JERSEY'S RICH FARMS AND PROSPEROUS VILLAGES

If you will look at the map, you will see that New Jersey lies between the Hudson, or North River, as the Dutch explorers called it, and the Delaware, or South River. On the

From an old print

This Delaware classroom was like most colonial schools. While one boy recites his lesson, another one is eating an apple behind his slate, and a boy who did not prepare his lesson is being punished by having to stand in a corner and wear a dunce's cap while he studies. One boy seems to have a toothache, but looks quite cheerful.

Hudson is New York City, and on the Delaware is Philadelphia. This has had an important influence on the life of New Jersey, for it early caused New Jersey to develop its agriculture in order to feed these two great cities. Long before the Revolution, Benjamin Franklin said that New Jersey was like a cider barrel tapped at both ends. Wise old Ben Franklin meant that New Jersey was drawn politically as well as in an agricultural way between the two great colonial cities. Nevertheless, New Jersey had a rich, busy life of its own.

Settled by New Englanders, Quakers, Dutch, Swedes, Scotch-Irish, Huguenots and Palatine Germans, New Jersey was a real melting-pot long before that word had been invented to describe the United States. The people lived mostly on small or moderate-sized farms, or in villages like Princeton, Camden and Perth Amboy. Local industries flourished in the towns, and because the farms were so near to New York and Philadelphia, the farmers could buy many articles that farmers in the frontier regions had to have made at home.

Slavery had been introduced by the early Swedes and Dutch, but slaves were not greatly needed on the farms of that region. Most of the farm labor in New Jersey—and indeed in most of the northern and middle states—consisted of indentured servants. An indentured servant was a man or woman who contracted to work a number of years for food, shelter and a small sum of money paid when the time was up. Many thousands of poor or unfortunate people in England, Scotland and Germany were able to come to the colonies by entering into such an agreement beforehand. Some of them, called "redemptioners," signed an agreement to work for a specific person before they left the Old Country. Others, called "free-willers," would make an agreement with a ship captain to take him or her over to the colonies and sell his or her services after the ship arrived in port. Sometimes dishonest ship captains cheated these unfortunate people, who were ill protected by the laws.

The people who came over to the colonies in this way included many skilled craftsmen, as well as rough, unskilled laborers. Tutors, seamstresses, even artists and musicians who were poor and in debt chose this form of temporary slavery in order to get to the New World and get a second chance in life. A typical term of service was four years, with $25 in pay at the end. Some of these people became discouraged long before their term was up; some ran away to the frontier, others went to the bad, but most of them lived to be independent citizens whose descendants to-day should be proud of them.

These, then, were the people who worked on the farms and in the shops of New Jersey and other colonies. They were among the people who listened with rapture to the sermons of the Methodist preacher George Whitefield, when he spoke to thousands on his tours of the colonies in the first half of the century, and they were among the people who rose to protect their new country at the beginning of the Revolution.

Two famous colleges were founded in New Jersey in the eighteenth century: the College of New Jersey, first at Newark and, in 1752, at Princeton; and Queen's College, later called Rutgers, in 1766. On the whole, the people of New Jersey were prosperous, thrifty and industrious, whether they lived in the towns or on the farms, in cottages or in great manor houses.

PENNSYLVANIA, WHERE AMERICAN INDEPENDENCE WAS BORN

Pennsylvania, like New York, combined the industrial development of the North with the agricultural development of the South, yet it was different from either. You have learned how William Penn wished to have religious freedom in his colony. This religious and civic freedom caused Pennsylvania to have more different races and religions than any other colony. There were Dutch, Swedes, English, Scotch, Germans, Welsh, Irish, Scotch-Irish and Swiss.

Philadelphia, the capital of Pennsylvania and the largest city in the colonies, was mainly a Quaker city, though before the Revolution it contained many people of all the nationalities we have named. The Quakers were sober and industrious, and became prosperous merchants and bankers. The other colonists brought with them many arts and crafts from their European homes, including printing and type-founding, bronze-working, silversmithing and the making of fine optical work and watches. Fine furniture and silver made in Philadelphia before the Revolution is to be seen in our great museums to-day; and at the period of which we write, the city was quite as beautiful as any other colonial city, and far cleaner than most of them.

It was to Philadelphia that young Benjamin Franklin went from Boston to make his fortune as a printer. It was as a Philadelphian that, in 1753, he was made joint postmaster-general for the colonies, with William Hunter of Williamsburg, Virginia. Most of the work and planning was done by Franklin, and he created a network of postal riders and postmen from Massachusetts to South Carolina. You may guess how difficult this was when we tell you that it took three weeks to send a letter and get a reply between Philadelphia and Boston, and that there were only three mails a week between Philadelphia and New York. Philadelphia was a great shipping port, perhaps the greatest in the colonies, and was a city of wealth and culture.

Outside the Philadelphia region, the Pennsylvania colony was settled as far as the Susquehanna Valley, and beyond as far as Pittsburgh. The German farmers cultivated the rich farms around Lancaster and York; and the Scotch-Irish in the West went their independent way, helping greatly to push the colony into the Revolution when that time came. One thing that we must tell you about the Swiss colonists is that they were the makers of those fine rifles which were called Kentucky rifles because they were used by the men who opened up the "West," as it was called.

DELAWARE, A LAND OF BUSY WATERWAYS

Tiny Delaware was at this time a smiling land of small farms where corn and wheat, hay and livestock were raised. The population of the colony in 1775 was estimated at about 37,000. Some years before that a writer stated that Dover and Lewes each had 100 houses, New Castle 250 and Wilmington 260. There were no large seaports, but ships were built by the Quakers at Wilmington, and trade (including smuggling) flourished on the Delaware River and on the creeks. On the Brandywine and the Christina, near Wilmington, there were paper mills and flour mills, and grain was brought to the mills in wagons from neighboring sections of Pennsylvania and Maryland. In New Castle and on the Christina River there were many busy forges where iron was worked.

Delaware was the subject of colonial wrangling clear up to the end of the Revolution. Both Maryland and Pennsylvania claimed her, while Delaware herself preferred to be an independent colony.

MARYLAND, A LOVELY LAND WITH A TROUBLED HISTORY

Maryland, as you know, had originally been founded by Lord Baltimore as a refuge for English Catholics, but with religious freedom for all other Christians. This happy state of affairs had not lasted long, however. The Puritans made trouble, the colonial government of Virginia tried to seize Maryland territory, and finally, in 1694, the British Government had taken the colony away from the Lords Proprietors. The Church of England was then established there, Catholics were no longer allowed to vote, and other Protestant sects were deprived of many civil rights.

By the eve of the Revolution, Maryland had about 300,000 people. The capital of the colony was Annapolis, which had been founded in 1649 by Puritans driven out of Virginia. Baltimore was not founded until 1735, and at the time of which we speak had only 7,000 people, but it was a flourishing port which exported the products of the colony and of Virginia. In the eastern counties of Maryland, life was much like that in the tidewater region of Virginia, which we shall tell about later. There were large estates and beautiful manor houses, some of which may still be seen to-day.

The colony almost surrounded Chesapeake Bay, and great wealth came from the export of the products of the Susquehanna Valley in Pennsylvania, as well as from Maryland. The oysters and other seafood of this region, and the products of its fertile soil gave Maryland even in those days a reputation for delicious food and fine living.

VIRGINIA, OLDEST OF THE THIRTEEN COLONIES

The four Southern colonies, Virginia, North and South Carolina and Georgia, had grown along different lines from the New England colonies. This came about partly because of their geography and climate, and partly because of the type of settlers that they attracted. We know that the early settlers of Massachusetts came there to set up their own form of religion and government. The early settlers of Virginia, on the other hand, came largely because they wanted land. Of course, as all these colonies grew, people came to them for many different reasons, but the influence of the original settlers continued to be felt for centuries.

On the eve of the Revolution the difference between the life of the Southerners and that of the New Englanders was strikingly clear. New England was a region of towns, and its people were chiefly engaged in trade, commerce and manufacturing. Farming was carried on to feed the people and to provide certain raw materials, but other activities provided the wealth of the section. In the learned professions, the ministry was the most important. In the South it was quite the other way around. Agriculture was the source of wealth and there was little commercial or industrial life, and law and politics were the chief interests aside from the land.

We have said that the geography of the Southern colonies had a great deal to do with the way they developed. If you look at the map you will see that these four colonies are divided from north to south into three parts: the Tidewater, or lowlands near the coast, the Piedmont, or rolling foothill country in the middle, and the Allegheny mountain region. In all four colonies the first settlements were made in the Tidewater, and that was where the aristocratic plantation life was most firmly established.

In the Virginia tidewater the people were mostly of English descent, but early in the eighteenth century a great number of Scotch-Irish families had settled in the broad Shenandoah Valley that lies between the Blue Ridge and the Allegheny Mountains, and had also mingled with the English in the Piedmont. These people were more democratic than the people of the Tidewater. They were mostly Presbyterians and did not like having to pay taxes to support the Established (Episcopalian) Church. They regarded education as extremely important, and they were independent in their political ideas. Some of them had large estates, but there were many more moderate-sized farms and not so many slaves. It was this part of Virginia that produced Thomas Jefferson, Patrick Henry, John Marshall and James Madison, and when the Revolution came there were very few Tories to be found there.

Virginia had about 500,000 white people in 1775, and possibly 175,000 slaves. Down in the Tidewater, tobacco was the great crop, and life was centred in the great plantations along the Potomac, the Rappahannock, the York and the James rivers. Here the planters and their families lived in a great deal of luxury, for the tobacco produced on their thousands of acres was in great demand in England. Most of the planters were cultivated people, but they were also fond of social gaiety and liked to ride and hunt and attend horse races and cock fights. They visited back and forth a great deal, and strangers were always welcomed and encouraged to make long visits. The children of a planter's family were educated at home until the sons were old enough to go away to school or college. Some of them were sent to William and Mary College at the capital, Williamsburg, some were sent north and some went to England. The daughters usually finished their education at home. (See Child Life in Colonial Days, page 965.)

The planter and his wife were not idle people, however, for even those who had managers and overseers had to devote much time to the details of plantation life and to the comfort and welfare of their slaves. Fine clothes and furniture were brought over from England, but the clothing for the slaves and many other articles were manufactured right on the home plantation.

The rivers of the Tidewater were broad highways along which English and Dutch ships sailed right up to the private wharf of the plantation, to load up with hogsheads of tobacco in exchange for manufactured articles and luxuries from Europe or articles from the northern colonies and the West Indies. The laws, as we know, forbade any but English or colonial ships from trading with the colonies, but there was absolutely no way to enforce these laws completely. Because the ships could come to the very doorstep of the plantation, so to speak, there was no merchant class in Virginia except for small storekeepers in the towns. Most of the planters had agents in London or Bristol to whom they shipped their tobacco, and through whom they ordered whatever merchandise they desired, from coaches to sewing needles. This system held back the development of manufacturing in Virginia, and it also had other defects. The planter had to take whatever prices the English merchants offered, and he had to pay whatever prices they asked for the goods that they

From an old print

Virginia planters loved to have company, and here we see a family welcoming friends who have come to make them a visit. Note the coachman's smart livery and cocked hat, and the lady's maid carrying a large bonnet-box.

shipped to him. Besides this, the planter was sometimes cheated by his agent across the ocean. In spite of the wastefulness and inefficiency of this system, the planters preferred it to the Northern system of selling and buying through merchant middlemen at home.

The planters did not spend the entire year on their plantations. When the House of Burgesses was in session at Williamsburg, almost everyone who could spent the season there. Many of the planters were themselves members of this legislative body and all of them were keenly interested in politics. Moreover, Williamsburg was a very gay place during the sessions. The royal governor held court there and many of the planters owned town houses there. Parties, balls and entertainments of all sorts and of a lavish nature were held. Theatrical troupes offered plays, concerts were held, and political discussion raged continuously. The Tidewater people were very fond of cards and dancing, and one of the royal governors wrote to a friend with great satisfaction that "there is not an ill dancer in my government." Thomas Jefferson, George Washington and many other famous Virginians of the Revolutionary period danced and played cards and attended plays at Williamsburg.

With so many well-to-do customers at hand, it is not surprising that merchants and craftsmen, some from the other colonies and even from London filled the shops with their wares and took orders for special articles. Besides the planters' families, many well-to-do people from the Piedmont and even from the Shenandoah Valley came to Williamsburg for the legislative session. The capital's all-year-around population was little more than 3,000.

The capital was also the great educational centre of the colony. William and Mary College, founded in 1693, was the second oldest college in the thirteen colonies. It was there that the Phi Beta Kappa Society was founded in 1776, and it was the first American college to offer a law course.

Most of the other towns in Virginia were like Williamsburg on a less ambitious scale. Most of them were county seats and market towns, and their seasons of bustle and gaiety occurred when the courts were in session. Richmond, on the James River, just where the Piedmont and the Tidewater meet, had only 1,800 people when it became the capital of Virginia during the Revolution. It had started as a mill and warehouse in 1733.

Where the Piedmont ends and the land drops down and becomes the Tidewater, all of the rivers flowing toward the Atlantic have to drop too, and so, all up and down the Atlantic coast, from New York to Georgia, there is what is called a fall-line, where the rivers drop down to the coastal plain. In those days, before the coming of steam and electricity, grist mills were built at these points, so that the farmers' grain could be ground by great water-wheels. These were followed by other kinds of mills, and almost always a town grew up near by, using the falls for power, and the river below the falls as a highway to the coastal region.

NORTH CAROLINA, A LAND OF STURDY FRONTIERSMEN

In North Carolina the principal industry was agriculture, but it was an agriculture quite different from that of Virginia and South Carolina, for there were few large estates. The policy of the colonial government was to limit land grants to 640 acres, whereas some of the Virginia planters owned as much as 175,000 acres of land. This meant that North Carolina became a region of small and moderate-sized farms, except for a few large plantations near the coast.

On the eve of the Revolution there were 300,000 white people in North Carolina, and about 40,000 slaves. Most of the people lived on farms or plantations. There were not many towns, and the only one with more than 1,000 people was Wilmington, the main seaport. The climate and soil of North Carolina vary so much that it is possible to grow within its borders almost anything that will grow between Massachusetts and Georgia. In colonial days the chief crops grown for export were tobacco, corn, peas, beans, potatoes and some indigo. A great deal of livestock and lumber was exported, besides salt pork and beef. Rice, cotton, fruits, hemp and flax were grown for home use.

The fall-line is quite far back from the seacoast in North Carolina, and the rivers and streams were used for transportation. In some places ocean-going ships could come up the rivers, but on many streams flatboats and huge log canoes were used to ship produce to the coast. Because many North Carolina rivers flow down through South Carolina, the people who lived on these rivers shipped their produce through Charleston. Pamlico and Albemarle sounds, with their winding inlets and sheltered coves, were great places for pirates. The famous Captain Teach, or Blackbeard, became such a menace to life and trade that in 1718 the royal governor sent a naval vessel to look for him and kill him.

A large part of the settlers of North Carolina came from the other colonies: Virginia, Pennsylvania and even New England. Then there were English, Moravians from Germany, and, especially in the Cape Fear region, exiled Highland clansmen from Scotland, who had fought for Bonny Prince Charlie in 1745. There were many Scotch-Irish from the north of Ireland. Many of these people lived on the frontier, west of the fall-line, and they were a different type of people from the ones near the coast, for they were true pioneers. It was they who furnished the hunters, Indian-fighters and settlers who followed Daniel Boone and other leaders across the Alleghenies into "the West" during and after the Revolution. Western North Carolina typified the great frontier belt of the colonies, which stretched from western Pennsylvania and Virginia to Northern Georgia.

Here the people of the "backwoods" lived in log cabins or in log forts. They were largely cut off from trade and communication with the seacoast settlements and cities, and they were also almost free from the rule of the colonial governments and authorities. They formed their own local governments and militia companies, and elected their own officers and officials. Every man and boy old enough to carry a rifle owned one, and used it to kill game for food and to fight Indian raiders. These frontiersmen were almost all native-born Americans. The families of most had been American for several generations. They were a religious people, and whenever they established a new settlement they built log churches and schools. Andrew Jackson was a native Carolinian. Daniel Boone moved there as a boy, and from there started his westward trek.

We have particularly mentioned the frontiersmen of North Carolina, but the same kind of people and the same kind of life existed for a thousand miles up and down the western edge of the colonies. The frontier was an extremely important part of colonial life, and it was the frontiersmen who, during the Revolution, won all that great territory between the mountains and the Mississippi River.

SOUTH CAROLINA, A LAND OF TROPICAL SPLENDOR

The richest of all the colonies before the Revolution was South Carolina, and the heart of South Carolina was Charleston. In 1773, Josiah Quincy of Boston wrote that Charleston was "beautiful and in many respects magnificent," and "far surpassed anything I ever saw or expected to see in America." Situated on a narrow peninsula where the Ashley and Cooper rivers flow together into the Atlantic, the city was the third largest seaport in the colonies. The white population was about 15,000, and there were at least that many slaves. For many miles along the coast and up the tidal rivers there were great plantations where rice, indigo and sea-island cotton were grown. Charleston was the capital of the colony and the centre of political, social and cultural life. All of the rich planters had town houses there, and many of them spent quite as much time in the city as they did in their plantation homes.

From an old print

Early settlers in the Carolinas hoeing corn.

Indigo and rice were in great demand in England, and it has been estimated that the export of these products in the year 1768 amounted to one-third of the total exports of all the thirteen colonies. In 1775 the value of the rice and indigo exported from Charleston was $5,000,000. It is easy to see, therefore, why South Carolina was such an important colony.

Besides the English settlers, large numbers of Scotch and French Huguenots made up the population. There were also many Englishmen from Barbados in the West Indies, some Portuguese Jews, and about 1,200 French people whom the British had forced to leave Acadia in 1755.

If you were to go to Charleston to-day you could still see some of the stately old houses with their romantic walled gardens, and some of the public buildings which were built long before the Revolution. St. Michael's

Church, built in 1752, still stands, and so does the statue of William Pitt, the British prime minister, with its arm shot off by British guns during the Revolution.

Charleston's Dock Street Theatre was the first permanent theatre in the colonies, and play-going was a popular diversion. There were horse races and a great deal of private entertaining; but Charlestonians were interested in the arts as well as in purely social enjoyment. There was a library, founded in 1748, and concerts were held regularly by the St. Cecelia Society. Although Charleston society was brilliant and gay, it has been said that there was a strictness and seriousness about it that was more like Boston than like tidewater Virginia. This is believed to have come from the strong Scotch and Huguenot influence. These people were public-spirited and founded a number of charitable societies. One was the St. Andrew's Society, founded by Scotchmen in 1720, and another was the Huguenot's Two-Bit Club, so named because each of the members had to give two bits (a bit was an eighth part of a "piece-of-eight" or Spanish silver dollar). That they were public-spirited in another way was shown when, in 1774, Charleston established a chamber of commerce.

A free school had been established in Charleston in 1710. Later, about 1733, when the Up-Country (the Piedmont region) had begun to be settled, the Assembly provided that every parish having 100 families should have a school. The schools were supported partly by the government in order to give free schooling to ten poor children in each parish. The majority of the people were able to pay their share of the school expenses, and the wealthier people had private tutors. Many sent their sons to Scotland or England to school.

As in Virginia and North Carolina, the Up-Country was settled chiefly by thrifty German farmers and religious, strong-minded Scotch-Irish. After the Battle of Culloden (1745), many exiled followers of Bonny Prince Charlie settled in the highlands of South Carolina.

GEORGIA, THE YOUNGEST OF THE THIRTEEN COLONIES

The youngest of all the thirteen colonies was Georgia, which was not founded until 1733, when General Edward Oglethorpe brought 114 settlers to the mouth of the Savannah River. In the ten-year period before the Revolution, the population of Georgia was about 75,000, most of whom lived near the seacoast. Savannah was the capital and leading town, while Augusta, more than 200 miles up the Savannah River, on the South Carolina border, was a frontier outpost. After the close of the French and Indian Wars, the boundaries of the colony had been extended west to the Mississippi River, but the lines dividing Georgia from Louisiana and Spanish Florida were still vague.

At the time of which we speak, Georgia was beginning to prosper greatly. Agriculture was the chief occupation of the people. Rice was grown in the coastal region around Savannah, and this and cattle and hides were important exports. Wheat, corn, sweet potatoes and yams were grown on the farms farther back from the coast. Slavery had been forbidden in the colony of Georgia at first, but the settlers had found that without slave labor they could not sell their products cheaply enough to compete with the slaveholding colonies around them. Therefore, in 1749 the government permitted slavery to be introduced into Georgia. Cotton was introduced in the same year, but it was not until after the Revolution that it began to be an important crop.

When Georgia was founded, the trustees of the colony, over in England, had provided plants, seeds and equipment for the growing of wine-grapes, flax for making linen, herbs for medicines, olives and mulberry trees for the cultivation of silkworms. It was hoped that Georgia might take the place of the countries of Europe as a source of wine, linen, silk and so on. The attempt failed, however, partly because the climate and soil were not suited to some of these products, and partly because of the high cost of the experiment.

Before the Revolution all of these difficulties were past. The region about Savannah, which was most prosperous, had as yet few large plantations, and the small ones flourished. Savannah, being the only large seaport below Charleston, became a gay, busy city, with a large West Indian trade. It had a theatre and a society that was brilliant indeed for a city that had so recently risen out of the wilderness. Georgia had originally been settled by English people who were poor and unfortunate, and by Scotch, German Lutherans, Swiss and Italian Protestants and Portuguese Jews. All of these nationalities went to make up a strong and brilliant stock when combined with the older native stock from the other colonies.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 1157.

THE WONDER OF A BOOK

A BOOK is one of the marvels of the world. Perhaps a newspaper is more wonderful still, because a newspaper comes and goes almost in an hour, and yet it has in it the work of thousands of men. Your father buys a newspaper for a few cents, and throws it aside when he has read it; yet that paper is something like a miracle, for it may have had its first beginning in a tree. Paper is made from pulp, which is made from many things such as rags, flax, hemp, straw, grass and jute. The greater part of the paper made for newspapers and books, however, comes from trees, which had lived and helped to make the world beautiful for many years.

The pictures on the following pages show us how a book is made, from the time the words are written on paper until it is ready for us. But it is not possible to give any idea in pictures of the great work and thought that go to make a book. Men must think about it, and write their thoughts on paper; and no pictures can show us how many men have been thinking for years and years about the things set down in our book. We can see the men cutting down trees; we can see the men making paper; we can see the printers at work. But the real thought that makes a book can never be seen.

What men think is written to-day in books, just as what men have seen is painted in pictures. Nothing has been able to stop the men who write books. Kings have tried to stop them, great tyrants have burned their books, and writers have been tortured by fire, but nothing can ever destroy the power of writing or stop the growth of books. They are the only things that live forever; because, although one book may perish, new copies are made.

At first men painted or carved pictures and signs on bones and wood and bark and stone; then they made bricks of clay and stamped inscriptions on them; then they carved their hieroglyphics on the walls of temples. The Egyptians were probably the first to invent a kind of paper, and the word papyrus was the name of the bulrush from which they made it. It is probable that the ark in which the little Moses was placed by the river's brink was made of this bulrush.

The papyrus was not really paper as we know it now. It was simply the pith of the plant pressed together. We really owe our modern paper to the ingenious Chinese. Originally the Chinese wrote on bamboo boards, or on a tissue of silk, but in the first century of the Christian Era, or perhaps before, a clever Chinese succeeded in making paper of bark and hemp and rags.

We do not know when the first piece of real paper was made, but there is an extraordinary story of the oldest paper documents which have come to light. It carries us away to the ruins of the Chinese Wall which stretch across the desert sands of Turkestan. They have been explored by Sir Aurel Stein, who went out for the British Museum to trace the cities lost under Asian sands. Here and there along the ancient wall stand the ruins of old watch-towers, and in a heap of rubbish in one of these towers Dr. Stein and his workers made a wonderful discovery.

They found wooden tablets with Chinese inscriptions, a strip of silk paper with writing on it, and bundles of letters on actual paper made from bark and rags. The letters were in an unknown tongue, but the language has since been translated, and evidence convinced Dr. Stein that these three kinds of writing were deposited in the tower about the same time. The date is fixed by the writing on the wooden tablets, which are dated in the actual year of the birth of Christ. Here, in this ruined tower, three civilizations seem to have met, and the first three kinds of writing materials lay side by side. These letters are the oldest pieces of paper known. The oldest paper document known before went back to about a hundred years after Christ; these take us back, perhaps, a century earlier.

HOW PAPER WAS BROUGHT TO EUROPE

The paper the Chinese made in those days was made chiefly from the bark of the mulberry tree—the tree that silkworms feed on. In that first century, however, China was little known, and for about seven hundred years Europeans learned nothing about paper. By accident paper-making found its way to Europe. It happened in this way: In A.D. 751 the Arab governor of Samarkand, a city in Central Asia, captured some Chinese paper-makers who were with a Chinese army. These men instructed the Arabs, and the Arabs, in their career of conquest, introduced the invention into Europe.

Now, what was the secret of the Chinese paper? They mashed up the bark of the mulberry so that the woody fibres were broken up and pulled apart. The tiny fibres were then allowed to sink through the water on a grating, where they formed a kind of tangled felt-work which could be compressed into a thin sheet. Roughly speaking, that is the principle on which the Chinese made paper, and though paper-making has been improved, the principle remains the same. All modern paper consists of a deposit of vegetable fibres. Not only wood, but any vegetable fibre, may be used. About four hundred different kinds of woody fibre have been tried at one time or another. The fibres now chiefly in use are cotton, linen, straw, wood and esparto grass.

THE AMAZING POWER IN THE WORLD OF STARCH AND CELLULOSE

Vegetable fibre consists of a substance called cellulose, and, apart from its uses in paper-making, cellulose is a very interesting natural product. No man has ever succeeded in manufacturing it. It is manufactured in green leaves by the sun, and were there no green leaves of plants, there could be no white leaves of paper.

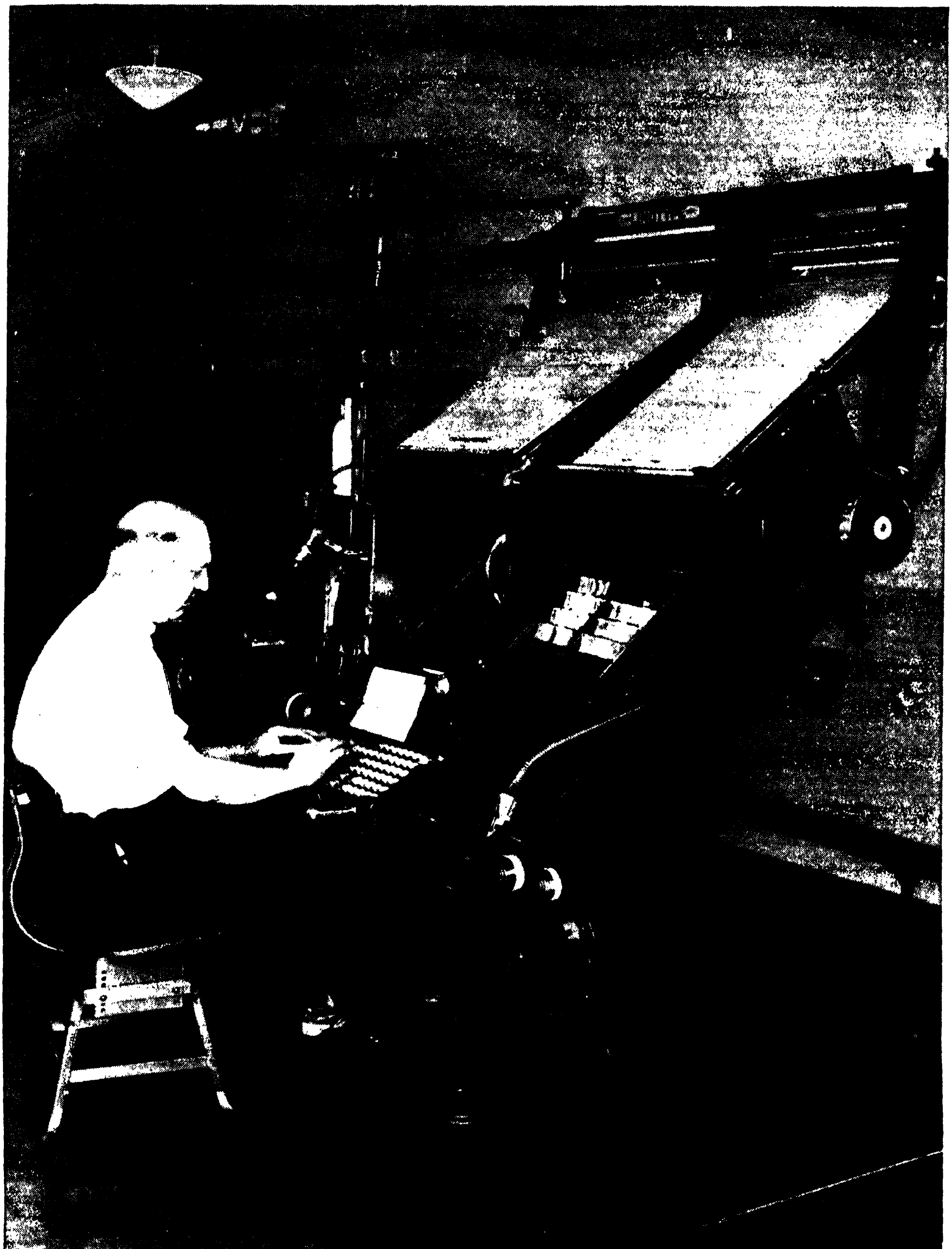
If a chemist were asked what is the most important substance in the world, he might answer Starch, because starch is the material out of which all flesh is made, and the chief fuel of the fire of life, which gives energy to all living creatures. If he were asked what is the next most important substance in the world, he might say Cellulose, because cellulose, with ink on it, is the most important fuel in the furnace of the mind and the soul of man. We tell of it on page 2747.

Now to return to our paper-making. Paper was brought from China to Samarkand, and was carried to Europe. Toledo, in Spain, was the first place in Europe to practice the art. That was in the eleventh century. In the thirteenth century the art reached Italy, and in the fourteenth it arrived in Germany, but not till the fifteenth century did it reach England, and not till the eighteenth was paper made in England in any great quantities or with any great skill. At first European paper was made almost entirely of rags, and even still rags are used, but now the main raw material is wood, and some large newspapers have their own forests. It makes one's brain reel to think of mighty forests turned into sheets of white paper covered with the thoughts we write.

THE LITTLE INSECT THAT SHOWED MAN HOW TO MAKE PAPER

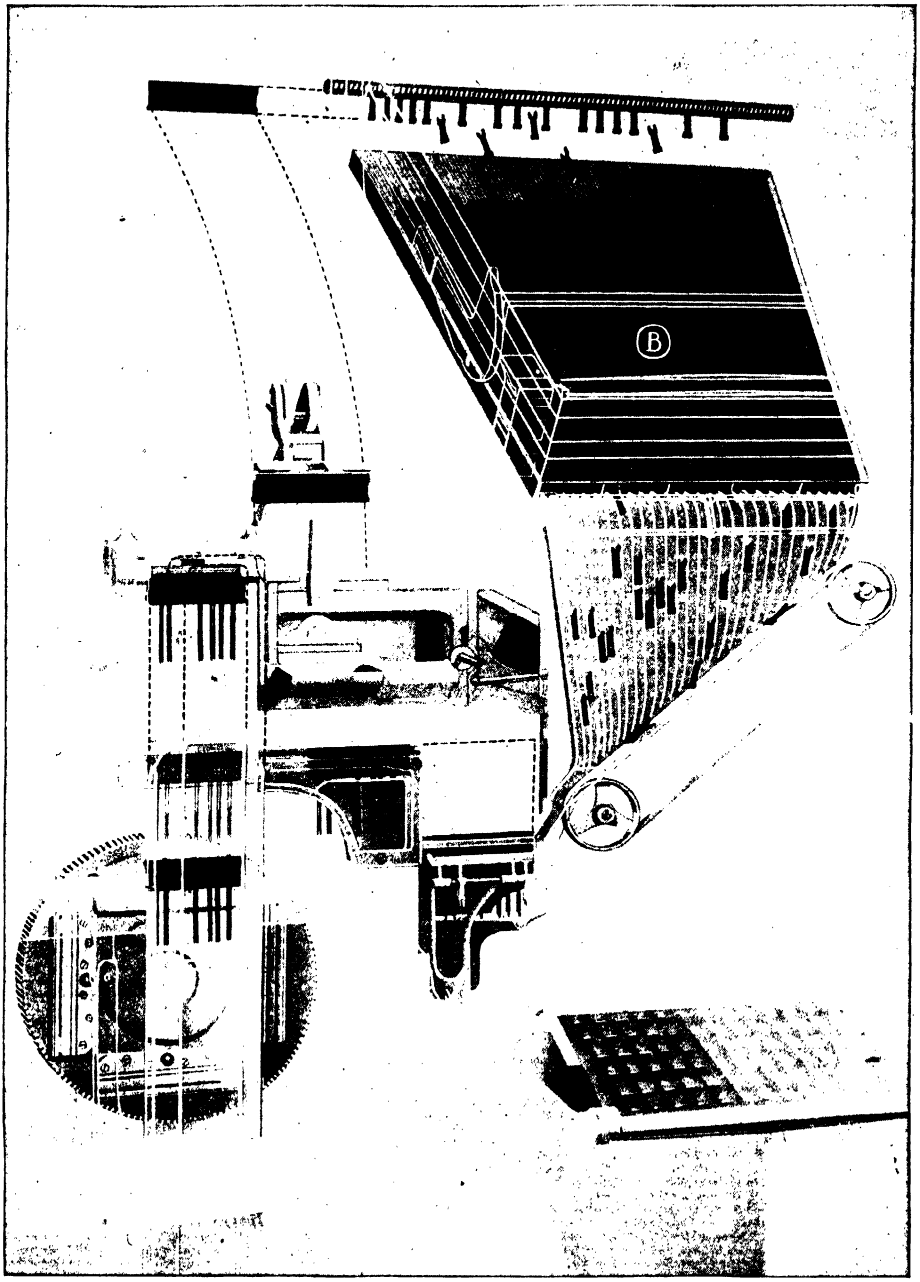
Thousands of years before man discovered how to utilize wood in this way (many thousands of years before the Chinese paper-maker) a little insect, really the first paper-maker, had been making a paper nest out of wood. The wasp's nest is really a wood-paper, for it is made of paper manufactured from wood, and it was this nest that suggested the modern methods of making paper from wood-pulp. When Solomon advised the sluggard to go to the ant, he might also have advised the paper-maker to go to the wasp. No one thought of going to the wasp

THE BEGINNING OF A BOOK



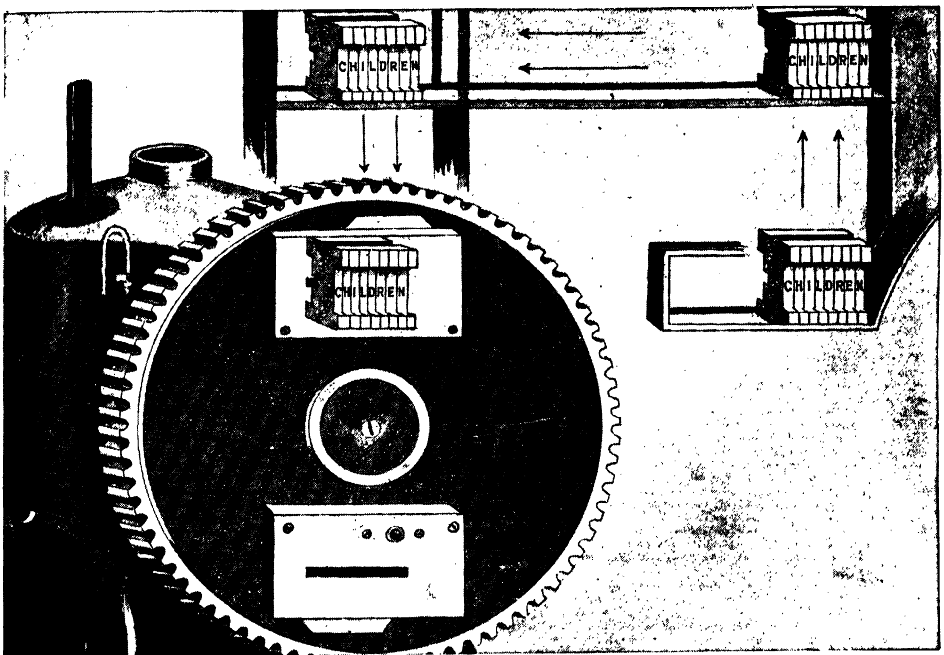
Courtesy, Mergenthaler Linotype Co.

When the writer has set down his thoughts on paper, and the editor has prepared it for the printers, it is then passed on to be set up in type. This machine, the linotype, is one of the most wonderful things in printing. It almost thinks. By pressing down keys as we do at a typewriter or a piano, the man at this machine sets the words in metal lines. Almost as fast as a man can think, the linotype puts his thoughts in solid metal. The machine, which was invented by Ottmar Mergenthaler, is called a linotype because it sets up lines of type.

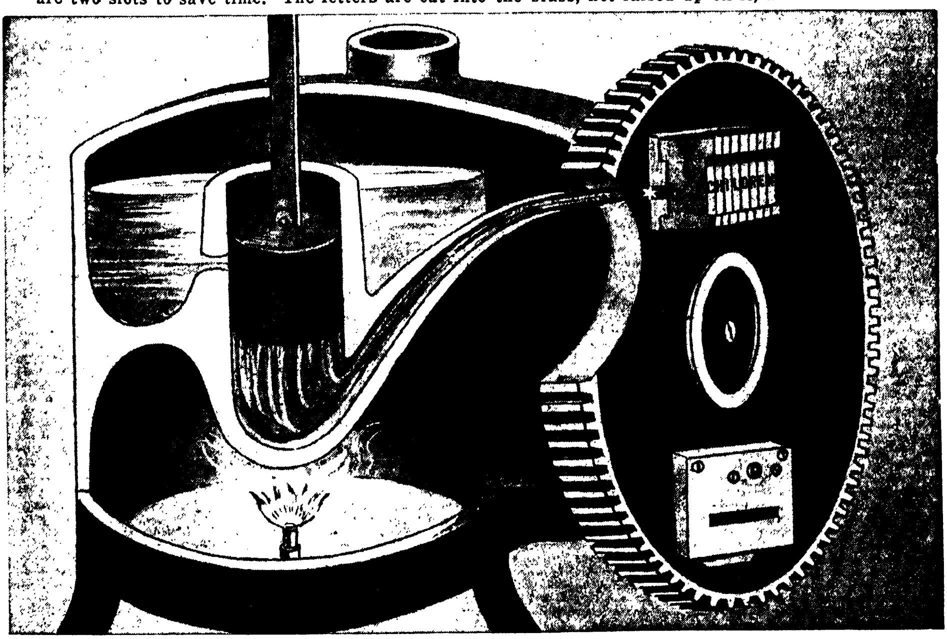


This picture shows how the little pieces of brass (called matrices), which shape the type, move in a linotype machine. When a letter in the keyboard A is struck, a matrix with that letter drops from the magazine B, and slides down to the assembling-elevator C. When a line of matrices is finished it is carried to a mold a little to the left and filled with melted type metal, and a line of type is cast. These matrices then go to the distributor-bar D. When a matrix reaches the proper place on the bar it drops down into the magazine, ready to be used again. Three lines are in motion simultaneously, one being set, one being cast, and one being distributed.

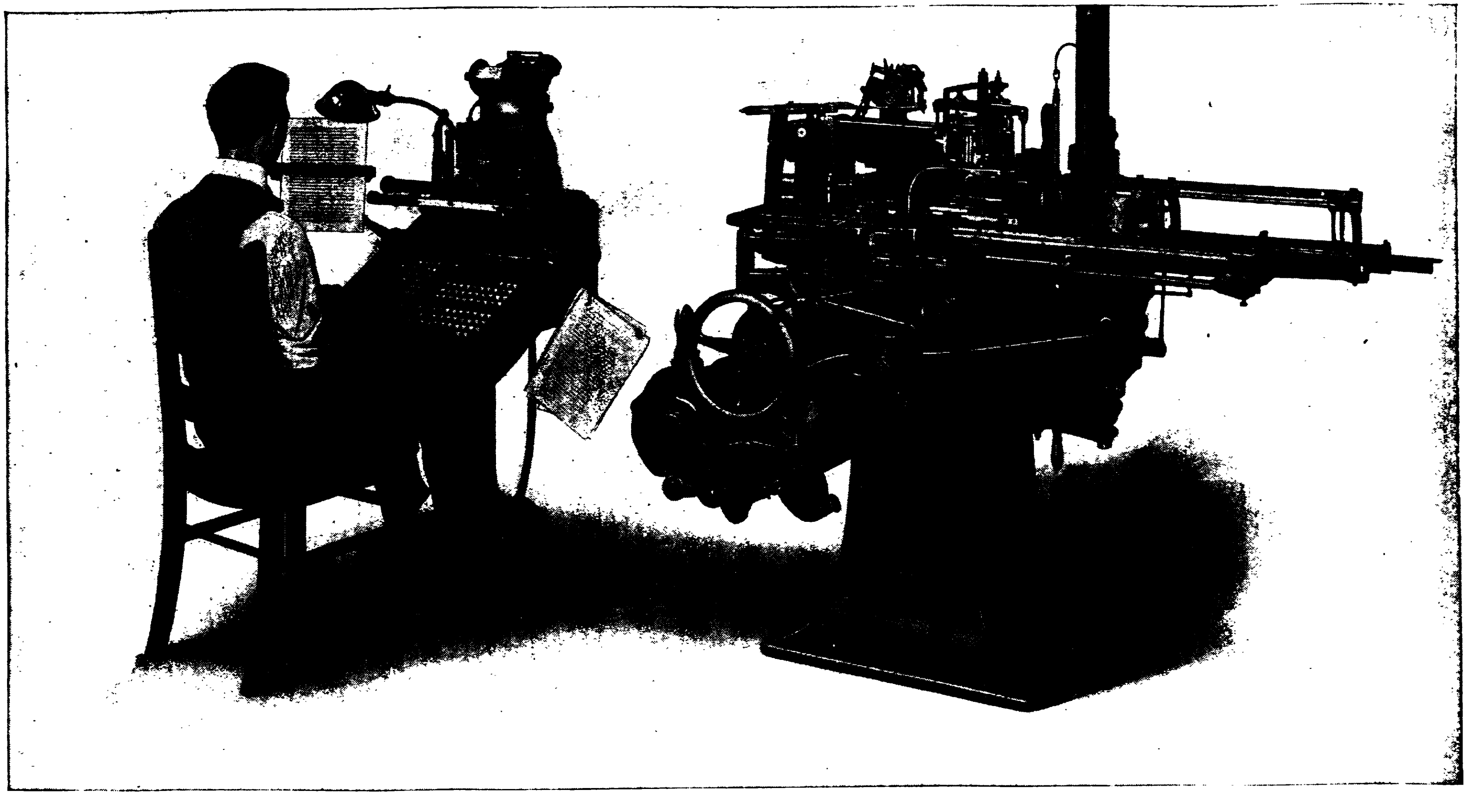
HOW THE WORDS ARE SET IN METAL



The brass letters are carried automatically from their box till they rest against a slot in this wheel. There are two slots to save time. The letters are cut into the brass, not raised up on it, and form molds.


The letters are cut on both sides, so that one line of letters is close to the slot. When this line is ready, a heavy punch comes down into the molten metal and forces it into the slot. The place is marked in the picture by a star, and the vessel is shown as if it were cut in two. When the line of letters is cast, the unused metal rushes back, the wheel turns, bringing the empty slot into position, and the brass pieces and the newly cast line are carried away by an iron band.

THE MONOTYPE KEYBOARD AND TYPE-CASTING MACHINE



The Monotype Type-Setting Machine consists of two separate and distinct units—a keyboard and type-caster. Each of these units is complete within itself, and they work as partners to produce type in lines. The man in the picture is operating the keyboard, which is arranged like a typewriter. Each time he strikes a key, a hole is punched in a paper ribbon (shown in the top of the picture). The perforated ribbon is placed in the type-casting machine at the right, where type is made from molten metal. The position of the holes in the paper ribbon controls the selection of characters made at the type-casting machine, so that the type corresponds to the characters which were struck at the keyboard; the paper ribbon also fixes the width of each individual type as it is cast, and determines the size of the spaces which are cast between words to fill the line completely. After each line of type is cast it is automatically placed on a galley, from where, when the galley is full, it is taken to be made up into pages.
Lanston Monotype Machine Company

till 1765, when a priest of Ratisbon, named Schaffer, began to experiment with wasps' nests and sawdust and wood-shavings, and succeeded in making excellent wood-paper. His experiments were continued by a Dutchman named Koops, and by a Saxon weaver called Keller, who in 1844 made considerable quantities of paper from wood-pulp. The first manufacturers of paper from wood-pulp ground the wood into sawdust, but the resulting paper was poor. Some chemical processes for making pulp were invented, and these have proved so successful that now wood is the chief material in paper-making. You may read about paper-making in the article called Pulp and Paper (see Index).

TREMENDOUS FORESTS ARE MADE INTO PAPER EVERY YEAR

Whole forests must be converted into pulp, for if we take land planted with trees nine inches thick, it would require a forest of forty million acres in extent to supply pulp even for one year's paper. The area covered by all the paper in the world must be enormous. Forty million acres of forest for five million tons of pulp! One ton of wood-pulp will make over three acres of paper, 210 tons of pulp will paper a square mile. The annual output is about eight million tons, enough to paper almost 40,000 square miles. The paper made in one year, therefore, would make a path over a mile wide all the way round the world. If all the paper were in the form of a tape an inch broad, it would reach many times the distance to the sun.

THE WONDERFUL TYPESETTING MACHINE WHICH SEEMS TO THINK

Suppose one of our authors has written a story for you. It comes on paper to that astonishing machine that almost seems to think—the linotype. A man sits in front of it and taps down the keys, as on a typewriter. As he taps a key a letter cut out in brass falls down into a little space. The next letter slips beside it, and the next, and the next, until a line of letters lie side by side, all cut in reverse into the brass matrices, so that in another moment, when they are carried by steel fingers to a slot to have molten metal pumped into them, a solid metal line is made, with the letters all standing up on the surface. There may be a thousand lines in one of our stories set like that, line by line, until it is complete. This process of typesetting by machinery is called "machine composition."

While the linotype is one of the supreme inventions of our time, wonder on wonder is to come. When a great many copies are to be printed, the metal of these cast lines of type would wear out; or it might be that the printing must be done on plates which are curved instead of flat. Therefore, there is a process of duplicating these type pages.

First a sheet of metal is covered with stiff wax which is shaved down until it is about one-eighth of an inch thick, with a smooth, flat surface. This is placed to face the type in a molding press which squeezes the type into the wax. When the type is removed there remains a perfect impression of it in the wax.

The mold is now dusted and polished with very finely powered graphite and then placed in a solution containing copper (sometimes nickel is added, too) through which a current of electricity is passed. We tell you of the process of electroplating, for that is what it is called, on page 1307. The result is that a thin sheet of metal forms on the wax mold. By softening the wax in hot water, this shell can be removed and its surface will be a perfect duplicate of the original type which was molded in the wax.

But this shell is too thin to be handled very much. It is strengthened by "backing up" with melted type metal. We now have a printing plate which is called an electrotype and printing can be done directly from it just as it could from the original.

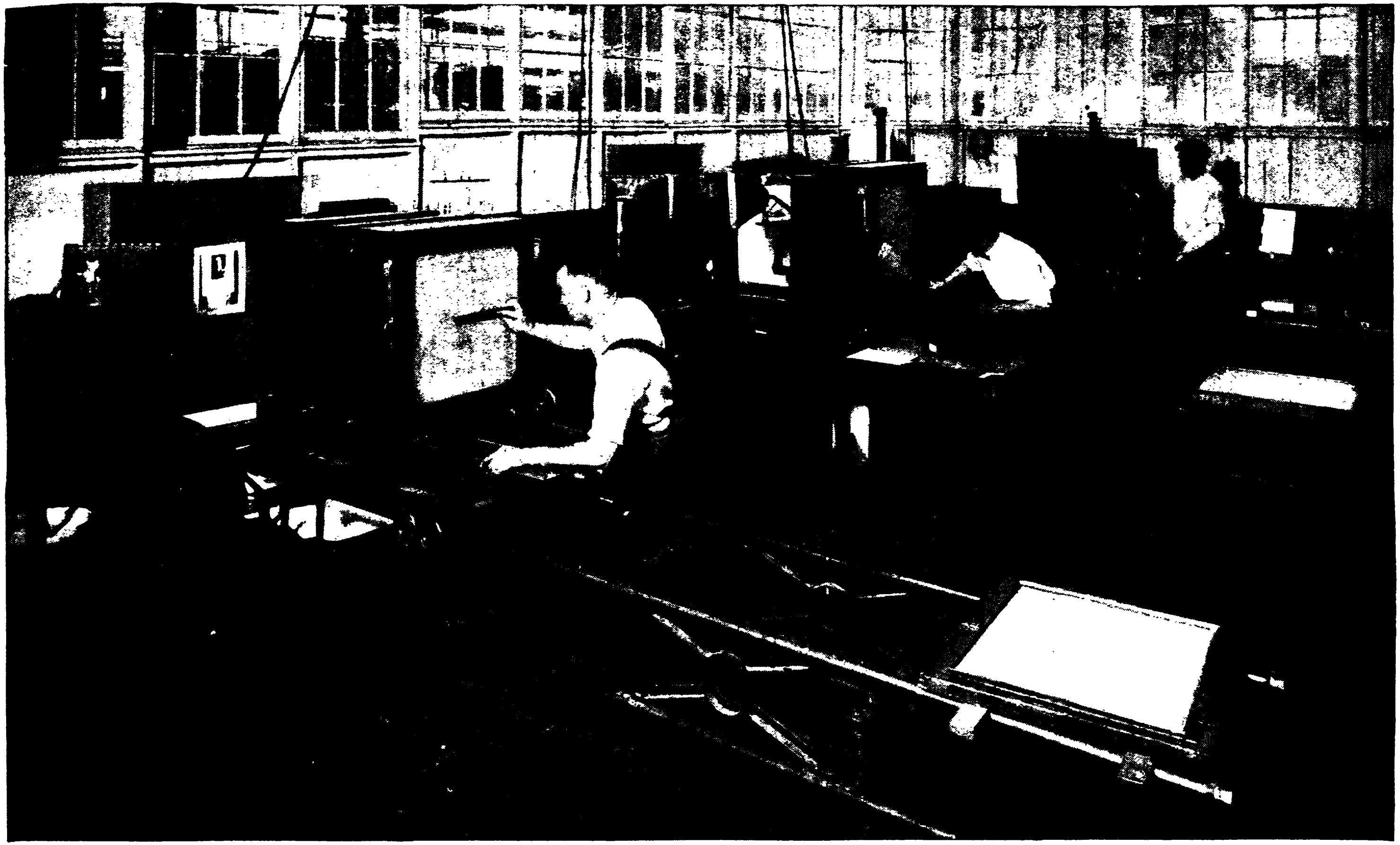
So much for the pages that have nothing on them but printing. Now let us see what happens when we wish to make a picture page. Most of the pictures in a book come from two sources. They are either drawn by an artist or else they are reproduced from photographs.

Suppose we consider those that have been drawn especially for a story to illustrate an important scene or an interesting character. The artist's drawing may be a line drawing done with black ink on clear white paper or it may be a wash drawing showing variations of tones, but the process for making a line drawing is simpler. We shall take that to the engraver first and see how it is made ready for printing.

The line drawing is placed before a special camera and photographed, just as you are posed before a photographer when you are having your picture taken. From the negative, a print is made, not on paper as your photograph is, but on a metal plate.

Before making the print, however, the metal plate has been prepared by coating it with a solution that makes it sensitive to

MAKING PICTURES TO ILLUSTRATE A BOOK



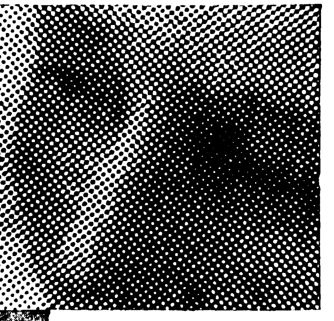
Courtesy, Haddon Craftsmen

This illustration shows us how halftone cuts are made. The photograph, or "original" as it is called, can be seen on the left with the strong light shining on it. It is having its picture taken by a special camera. In front of the photographic plate has been placed a fine glass screen, so fine that the copper plate will be covered with tiny dots. Because of these dots, the reproduction is printed in tones of gray, like this one, and hence the name "halftone."

A LINE CUT AND A HALFTONE

Courtesy, Tanner's Council of America

Notice the difference between this illustration of ancient Moorish bookbinders and the one below. This one is a line cut made from an artist's drawing. No glass screen was used in the process of photographing the "original" so it is reproduced in clear-cut black and white just as the artist drew it with his pen.



This picture is a reproduction of a famous painting in the Metropolitan Museum of Art in New York, called "Young Woman with a Water Jug" by the Dutch artist, Jan Vermeer, who lived from 1632 to 1675. It is printed here from a photo-engraving made by the halftone process from a photograph of the painting. We tell you about this process on page 1066. At the right is shown a portion of the face covered with little dots as it looks when you see it through a magnifying glass. Notice how the dots vary in size.

PREPARING THE STORY IN METAL FOR THE PRINTING PRESS

Courtesy, Haddon Craftsmen

In the background we see compositors making up pages by combining lines of type or cuts of illustrations, or perhaps both, into individual page units. In the foreground a compositor, known as a stonehand, is locking up a page in a steel frame called a chase. Before the story is printed, to avoid errors, a proof is pulled by passing an ink roller over the type and pressing a sheet of paper down upon it. This is read by the proofreaders.

Courtesy, Haddon Craftsmen

Proofs of text pages as well as those with pictures are taken to the readers. Every page must be corrected several times before it is printed and the reader is supposed to be a man or woman who neither makes mistakes nor lets other people's mistakes pass. Proof is also sent to the author, who reads it, too, and when it seems that every error has been found it is ready to be plated.

light. The negative is now placed in front of this sensitized plate and a powerful light is then turned on it. What happens is that the light penetrates the transparent parts of the negative and acts on the treated plate in such a way that these parts will not dissolve and can be made to resist acid.

The parts of the plate not affected by the light are, of course, the dark places on the negative, that is, the clean white paper on which the picture itself was drawn. The solution can be washed away from those parts exposing bare metal.

The reason for this is that the plate is next put into an acid bath. Acid, as you know, eats metal and so it eats into the parts of the plate that have not been protected. When this process is finished, the picture stands up in relief like the letters on a rubber stamp. This eating-away process is called "etching" and a plate that is produced from a line drawing is a line etching, or a line plate. In printing, the ink comes in contact with the part that is raised and the design is transferred to paper. Comic strips in the newspapers are made in this way as well as many of the illustrations in this book.

Now suppose it is a wash drawing or a photograph that is to be used. Like the line drawing, it is placed before the camera. In front of the camera plate, however, is a glass screen, crossed with fine lines, something like a window screen, except that it is very much finer, in fact so fine that it gives the appearance of tiny dots, and the negative of the photograph is covered with these minute dots.

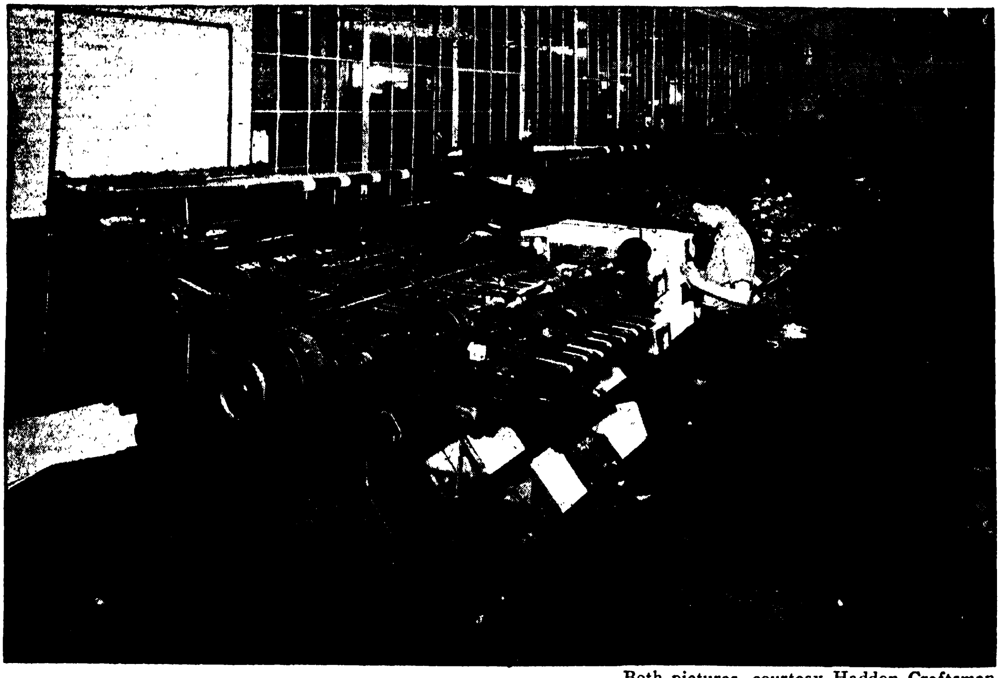
It may seem strange that a perfectly clear photograph is made into a negative with dots, but these dots play a very important part. In printing the negative on the metal plate, which has been prepared with the sensitizing solution, the strong light prints the dots, and protects them, but the solution between the dots washes away, leaving the metal exposed, to be etched.

When the acid eats the metal between the dots, it leaves them standing like so many hills with flat tops. When it comes to printing on paper, the ink clings to the tops of the dots and is transferred to paper, by the printing pressure, just as with a line plate.

But perhaps you are wondering why it is necessary to make all these little dots. Why couldn't the plate be made just like the plate for the line drawing? The line drawing, we remember, had definite black lines drawn on white paper and, when the plate was made, these same black lines were put upon paper. A photograph or wash drawing does not have definite lines. It has, instead, many shades

PRINTING AND FOLDING A BOOK

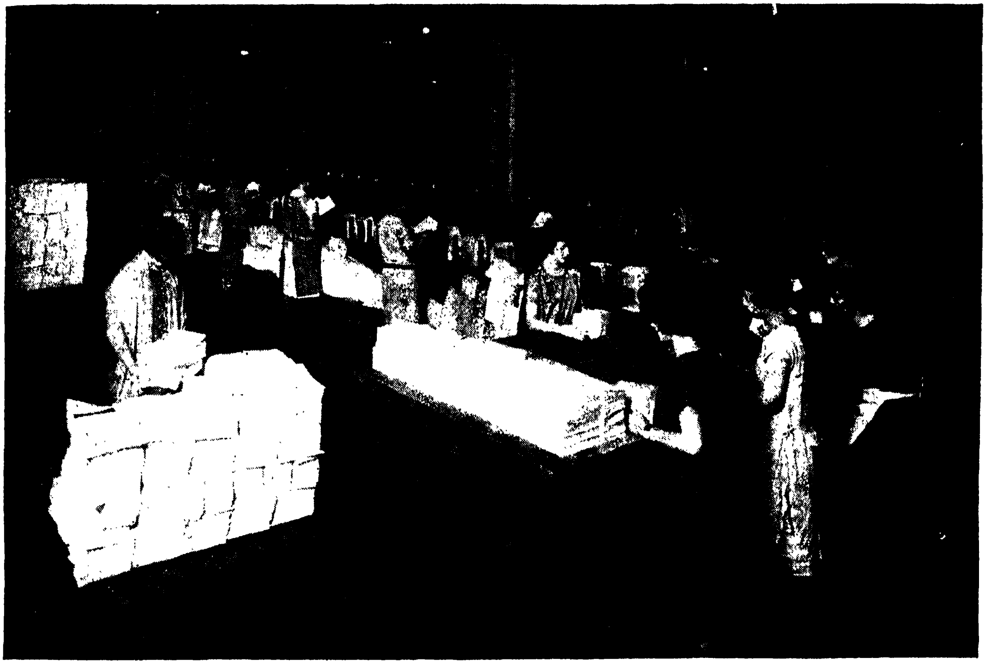
When the plates are in position and the printing press started, sheets of paper are pushed forward automatically.



Both pictures, courtesy Haddon Craftsmen

The large printed sheets are brought to these marvelous machines which fold them to the size of a page.

GATHERING AND SEWING A BOOK



The girls in the background are placing the sections of a book into a gathering machine.

Both pictures, courtesy Haddon Craftsmen

When a book is complete, the sections are sewed together, the edges are trimmed and it is ready to be bound.

Courtesy, Haddon Craftsmen

The covers have been made and here the lettering is being stamped on them. Next, the sections of the book, which have been sewed together, will be placed within the covers and fastened there so cover and book will not fall apart. Besides strengthening and protecting books, covers also serve to adorn them.

of gray color and it would not be possible to reproduce them on paper by the same method.

Let us see why the dots are important. The openings in the fine mesh screen used in the camera were uniform in size, but the amount of light in the photograph causes them to vary on the negative and consequently on the paper where it is printed. For instance, you notice in the little inset illustration on page 1063 that the places around the eyes, which are darkest, have smaller white spaces while the light places along the top of the nose have larger ones. If you were to examine the dress with a magnifying glass you would see that the white spaces are so minute as to make the dress seem solid color. The variations of black and white produced by screening cause the picture to have many shades of gray, or tones of gray. The plate is known as a halftone.

Perhaps you have noticed that there are also other illustrations—some in brownish color like the picture section of the Sunday newspaper. These are called rotogravure. They are not always brown. Black, blue or green ink may be used for printing. (See pages 1109-12). The difference between a picture made by the halftone process and the rotogravure process is mainly in the method of preparing the metal plate. Instead of allowing the acid to eat around the design, the picture itself is eaten by the acid, leaving the plate similar in appearance to a sand picture that has been scraped out of wet sand. When the ink is applied, it is squeezed into the hollowed-out places in the plate by pressure from a long, thin, steel blade, which also cleans all excess ink from the surface and the picture is then transferred to paper.

The most attractive of all pictures, however, are those printed in color, but that is a complicated process, for it is necessary to make several metal plates instead of one. Perhaps you have thought that the inks were mixed to the right colors and then printed just as the colors in your paint box are mixed and then applied to the paper. It is not so easy as that.

Let us look at the picture on page 851. This, you can see, is printed in two colors—red and black. The engraver has made two plates. The etching process here is most important for the one plate is made so that all parts except the red are etched out; that is, the plate is so prepared that only the red parts will be printed; the other is made with all but the black parts etched out and it will print only black. After a sheet of paper has been printed with the red design, it is printed over again so that the black plate makes its impression.

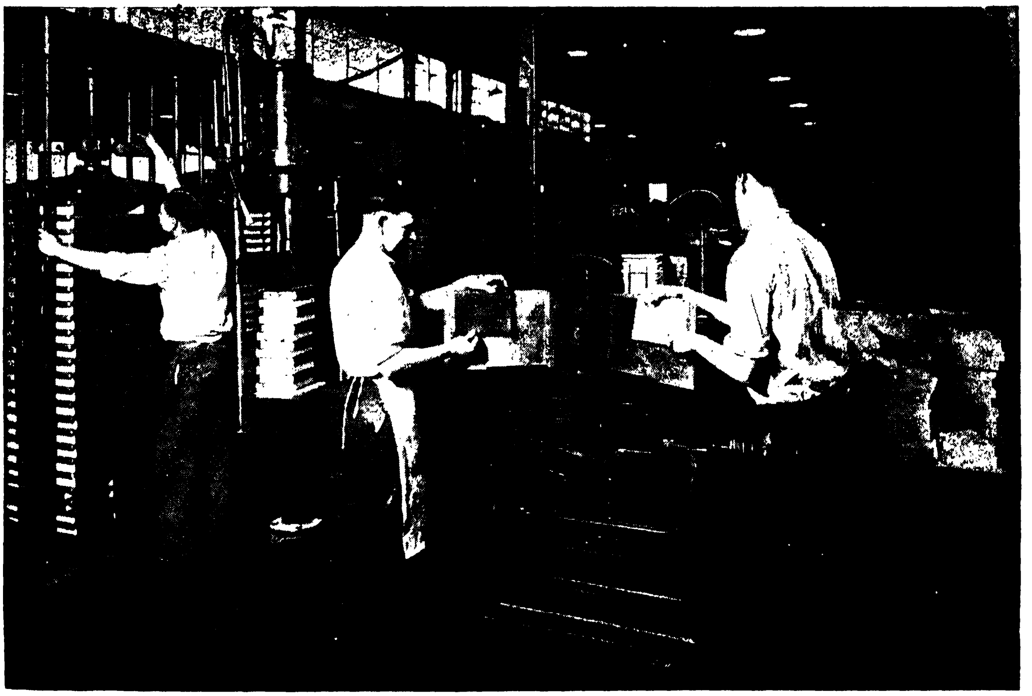
If a picture is to be printed in four colors, a plate must be made for each. Yellow, red, blue and black are the colors usually employed, and by means of printing one on the other, it is possible to get many other colors and shades of colors. A green field, for instance, is made by printing in yellow, then in blue. Not only is the combining of the colors important, but etching the plates for color printing requires a great deal of knowledge and experience.

Electrotype plates may be made for picture plates just as they are for text pages and then they are ready for the printing press, which is described on pages 3381-96.

The pages of a book are not printed one at a time, but the plates are arranged and locked together so that several pages are printed on one side of a large sheet of paper. Then the sheet is turned and the backs of these pages are printed. Thirty-two pages of this book are printed on one side, and the same number on the other, so that one of the large sheets of paper makes sixty-four pages. For other books, the number may differ and may be as small as two for a large book or as great as 128 for a very small one.

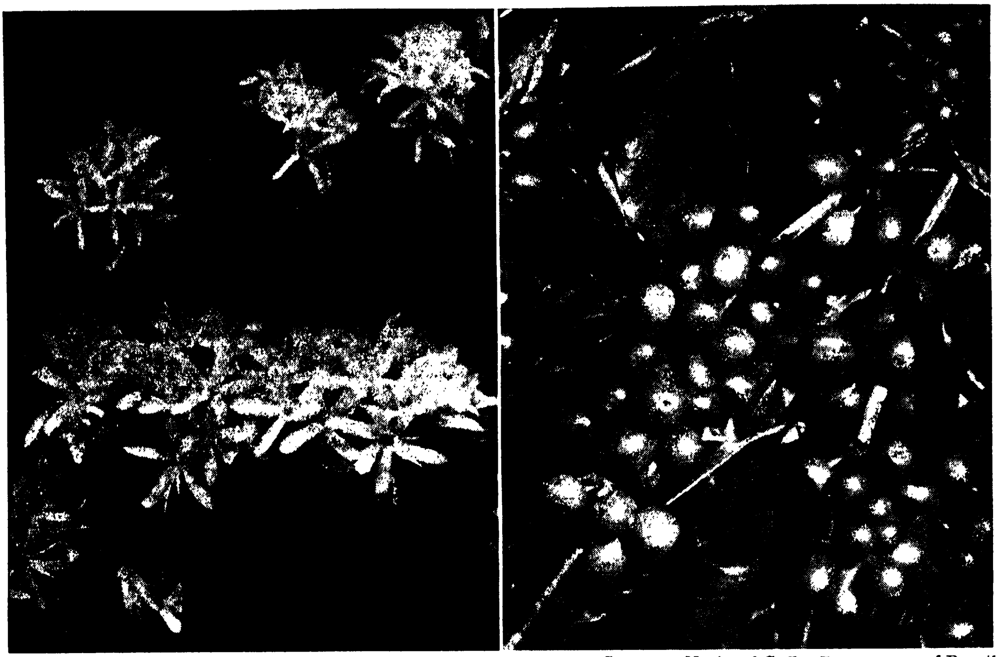
Large piles of printed sheets are next taken to the bindery where a huge machine takes up the task of folding. You can see how this part of the work is done by taking a sheet of paper, folding it in half, and then in half again. Put a pin in the crease. Now you have a small booklet, which represents a form or signature. A signature is really a printed sheet folded to page size.

As a book is made up of several signatures, they must now be "gathered" to make up the whole volume. When the volume is completed, it is pressed heavily to lessen the bulk, then stitched along the back and pressed again, the edges are trimmed and it is ready for its casing or cover of cloth, leather fabric or real leather. A final squeeze in a pressing machine (see the picture below) and the book is ready to be packed and shipped.



Courtesy, Haddon Craftsmen

Here the completed books are being placed in their covers and then pressed in the hydraulic presses at the left. The work of making a book is almost done, and soon copies will be shipped to all parts of the country.



Courtesy, National Coffee Department of Brazil

Seven months after blossoming (left) the coffee tree is ripe (right). The crop is one to twelve pounds per tree.

COFFEE AND CHOCOLATE

YOU know that millions of people all over the world have one or more cups of coffee every day. However, there is a substance in coffee called caffeine which keeps some people from sleeping. For this reason, children are better off without it. Here we shall tell you how coffee comes to the table.

Just when people began to drink coffee we do not know, but at least five hundred years ago it was well known in Abyssinia. From there its use spread to Persia and other countries in the East, and Europeans brought back stories of the wonderful drink. About 1554 "coffee houses" were opened in Constantinople, and soon other European cities had them. By 1675 there were several in London, and King Charles II ordered them to be closed because people talked politics while sipping the fragrant beverage and "spread abroad divers false, malicious and scandalous reports, to the defamation of His Majesty's government, and to the disturbance of the peace and quiet of the nation."

This order made the people of London so angry that the King found it wise to withdraw it, and the coffee houses became more popular than ever.

Soon coffee became known and liked all over the world. It is typical of the romantic history of trade that this little bean, which had for so long been known only in a few remote spots, should become in a short time one of the important articles of world commerce. Today, more than four billion pounds of coffee are produced each year.

Nations differ very much in the amount of coffee they drink and in the way in which they prepare the drink. It is not surprising to learn that the United States uses more coffee than any other nation, but according to population Holland drinks most. The people of Norway, Sweden, Germany and France are also fond of coffee. On the other hand, the people of the British Empire drink more tea than coffee, except in South Africa, which was originally settled by Hollanders. In proportion to population Canada drinks more coffee than does Great Britain, but tea is very popular there too. Most Western

Harvesting the coffee berries. The harvesting season in South America lasts from April until August. These trees may live for fifteen years or more.

peoples like their coffee strong but clear, while Oriental nations and many South Americans like it thick and black, almost like a syrup.

The coffee plant is an evergreen shrub which may grow as high as twenty feet, but is seldom allowed to become more than six or eight feet in height. It flourishes in warm countries all over the world. From Africa it was taken to Arabia, then to India and to the islands of the Pacific and Indian oceans. Coffee from Arabia is called Mocha. Mocha and the coffee grown in Java are highly prized. The New World, however, produces more than the Old. In 1697 coffee was introduced into the West Indies from Java, and from there it was introduced into South America. Both seeds and living plants were brought to the Portuguese colony of Pará, on the Amazon River, in May, 1727. A Portuguese officer, Francisco de Mello Palheta, obtained them from the governor of Cayenne, French Guiana. Today coffee is grown in the West Indies, Mexico, and Central America and in the countries of the northern half of South America. Two-thirds of the world's coffee is grown in Brazil. We shall tell you how coffee is grown there.

Pictures, courtesy National Coffee Department of Brazil

The first step in cleaning the berries: tossing them to get rid of chaff, twigs and other impurities.

Courtesy, National Coffee Department of Brazil

The berries are spread out under the hot sun, on wide drying grounds, and heaped up under canvas each night. When they are quite dry the thin outer membrane is broken and the silver skin that surrounds each bean is removed.

Inside the berry is a sweet yellowish pulp. Inside this are two beans wrapped together in a parchment covering. Each bean has its own inner wrapper of silver skin.

Coffee grows on many kinds of land, but in Brazil the gentle slope of a hill or mountain about two thousand feet above the sea is preferred. Trees are planted in rows, and begin to bear when three or four years old. They reach their full strength in their sixth or seventh year and continue till they are fifteen or more years old.

Following the beautiful fragrant white flowers, fruits resembling small, elongated cherries appear along the twigs. These are often called coffee berries. They ripen six or seven months after the flowers appear, and generally contain two coffee beans with the flat sides together. Each bean is covered with a "silver skin," and the two are held together by a thin membrane. These beans, or seeds, are surrounded by a sweet yellow pulp covered by a thin skin which turns dark red when ripe. The crop does not appear all at one time, for the shrubs bear flowers and ripe fruit at the same time, and the berries are picked several times in a season. One kind of coffee bean is nearly round, and the berry contains only one bean. Not very much of this is grown.

When the berries are picked they may be treated by the wet or the dry method. In the wet process, the berries are raked and shoveled in water until clean and soft. Then they are carried by a stream of water through a machine which breaks the skins and rubs off much of the pulp, but does not break the thin membrane which holds the two beans together. This loose pulp and the skins are carried away by the water.

When the remaining pulp has become soft and loose, the berries are dried. The traditional method of spreading them out in drying yards and turning them over with a kind of rake takes about ten days. On the most modern "fazendas," or estates, artificial heat is used and the drying process can be completed in twenty-four hours. When very dry and brittle the berries are run through machines which break the membrane and also remove the silver skin.

In the dry process, the pulp is not removed by water, but the whole berry is allowed to become very dry. Pulp, membrane and skin are removed together, in the way described above. When all the pulp and chaff have been removed, the beans go to a separator, which separates the beans of different sizes. They are then packed in bags and are carried, by mules, by rail or boat to the coffee market. There they are again sorted, and beans from different plantations are often mixed to make a desired blend, since the coffee grown on different kinds of land differs somewhat in flavor. Next the bags go to coffee dealers in different parts of the world, who sell some of this green, or unroasted, coffee without any further treatment. Sometimes they mix beans from different parts of the world in order to get a particular flavor.

When the beans have been cleaned and dried, they are graded according to size by machines, and then packed in bags.

Many years ago people always bought their coffee by the bag, green, roasted it in a pan or oven, and then ground just enough for their needs every time they made coffee. Even today some people who are very particular about the taste of their coffee do their own grinding. They say that coffee loses

Pictures, courtesy National Coffee Department of Brazil

Bags of coffee in a warehouse, waiting for shipment. Each contains 132 pounds. Brazil leads the world as a grower, producing nearly two-thirds of the entire coffee supply. The United States is by far the largest consumer.

some of its flavor if it is ground more than a few minutes before it is used.

Most of us, however, buy our coffee already ground and packed in airtight cans ready for use. The grayish green beans have already been roasted, and under the influence of heat have increased in size and become a rich golden brown. Roasting must be done very carefully, or the coffee will be spoiled. The degree to which it is roasted makes a difference in the flavor of the coffee. Some people like it roasted to a very dark color, others like it medium or light.

Not all peoples use the bean of the coffee. The leaves of the plant make a drink which is stronger in caffeine than that made from the beans. It is not very pleasant to the taste but the people of the island of Sumatra, in the Dutch East Indies, are very fond of it. In some parts of the Orient coffee is prepared from the whole berry, which has been roasted, pulp and all, or from the dried pulp alone. Others boil the green beans a long time to make a drink.

Coffee is prepared for drinking in several other ways in different countries and in different kitchens. Some people boil the ground coffee; others use some sort of pot or percolator in which the coffee is not placed in the water, but the boiling water is allowed to drip or bubble through the ground coffee.

Coffee is often used as a flavoring in candies, cakes, ice cream and other sweets and many people who do not care to drink coffee like it as a flavoring in various foods. Sometimes coffee-flavored foods are called "mocha" icing, or custard or candy, as the case may be. This name has come down to us from the days when the finest obtainable coffee came from Mocha in Arabia.

CHOCOLATE

COFFEE is not the only one of our favorite beverages that comes from the warm tropical lands: cocoa, or chocolate, is another, and it was given to the Old World by the New. It is difficult for most of us to imagine a world in which there was no chocolate candy, and in which all of the chocolate pies, puddings, cakes and drinks that we like so much were quite unknown, yet such was the benighted state of Europe until the year 1528. In this year Cortes, the conqueror of Mexico, introduced into Spain a delicious beverage, made from crushed *cacahoatl* beans, which he had enjoyed at the court of Montezuma, the Aztec Emperor. This drink was called *chocolatl* by the Aztecs. The name of the bean, *cacahoatl,* was shortened to *cacao* by the Spanish, and this was later corrupted to *cocoa,* the name by which it is known to the trade today. The botanical name of the plant, selected by the great Linnaeus, is *Theobroma,* "food of the gods."

Courtesy, Brazilian Government Information Bureau
Cocoa comes from the seeds of a tropical evergreen tree. The pods grow from the trunk on small stems.

Chocolate soon became a favorite drink in Europe, though for a long time only the rich could afford it. Not until 1828 was it discovered that candy could be made from it. In that year a Dutch manufacturer decided that the chocolate drink would be improved if some of the natural fat, or "cocoa butter," were taken out. After pressing the butter out of the roasted beans, he experimented further, and found that, by mixing a limited amount of the butter and some sugar with the dry cocoa, and cooking the mixture, he could get a solid substance that was exceedingly good to eat. This was the beginning of our enormous chocolate candy industry. Shortly after the American Civil

Underwood and Underwood

The cocoa pods are gathered when ripe, and cut open with sharp knives. Inside is a sweet pulp, pinkish in color, with twenty to thirty hard seeds clustered in the center, in rows, like those of a watermelon. The seeds are from six-tenths to one inch long.

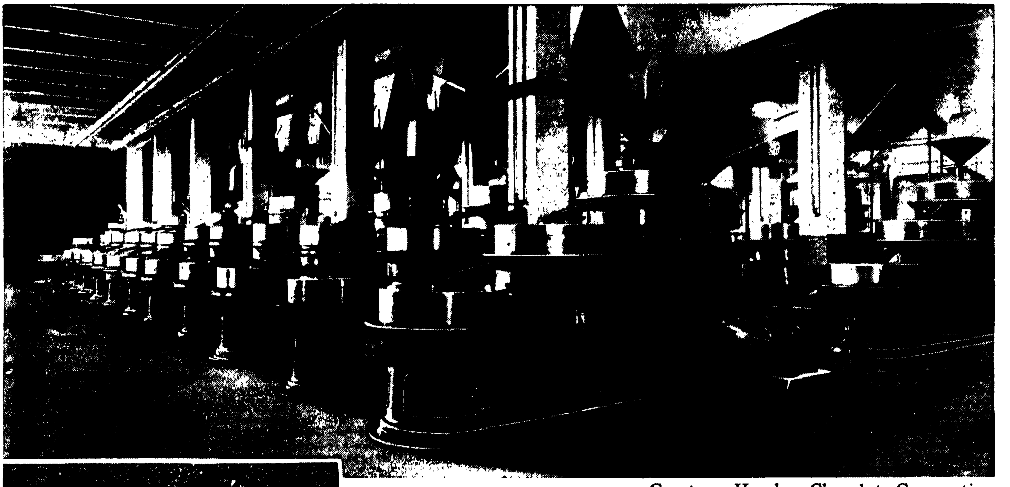
Courtesy, Brazilian Government Information Bureau

A cocoa (cacao) pod cut open, showing seeds and pulp. The pod is about as long as the pencil above it.

War, Daniel Peter of Vevey, Switzerland, discovered how to blend chocolate and milk and sugar, and made possible the milk-chocolate bars that we all like so much today.

The food value of this candy is due to the milk and sugar contained in it, and not to the pure cocoa. In moderate quantities, sweet chocolate is highly beneficial to children and to grownups in restoring the energy used up by physical exertion. Thus it has become a popular food with mountain climbers and with soldiers, and is included in many army rations in powdered or solid form.

Nowadays the world's supply of cocoa comes from tropical countries all around the world, but most of it is grown in the Gold Coast and Nigeria in Africa, and in Brazil, South America. The trees, which are carefully cultivated on great plantations, are wide-branching evergreens and grow as high as twenty or twenty-five feet. They begin to bear fruit when they are about six or seven years old. The leaves are long and oval in shape, and the flowers, which grow right out of the trunk and main branches, are rose, shading to yellow. The fruit consists of ribbed pods, very much like elongated cantaloupes, that often reach a length of one foot. When ripe, these pods contain from twenty to forty beans, embedded in a moist white pulp. The beans are flat and purplish brown, and look somewhat like shelled almonds, only a little larger. These beans were used as money by the Aztecs, who carried them in little bags, each valued according to the number of beans it contained.



Courtesy, Hershey Chocolate Corporation

The nibs are ground between three sets of millstones in these machines. The butter in the nibs is melted into liquid by the heat created in the grinding. We then have a chocolate liquor. From this point on, the making of chocolate and cocoa and milk-chocolate varies.

Courtesy, Walter Baker Chocolate

When the chocolate has been ground and refined, it is stored for a while in vats, at a definite temperature, so as to "age" or mellow it.

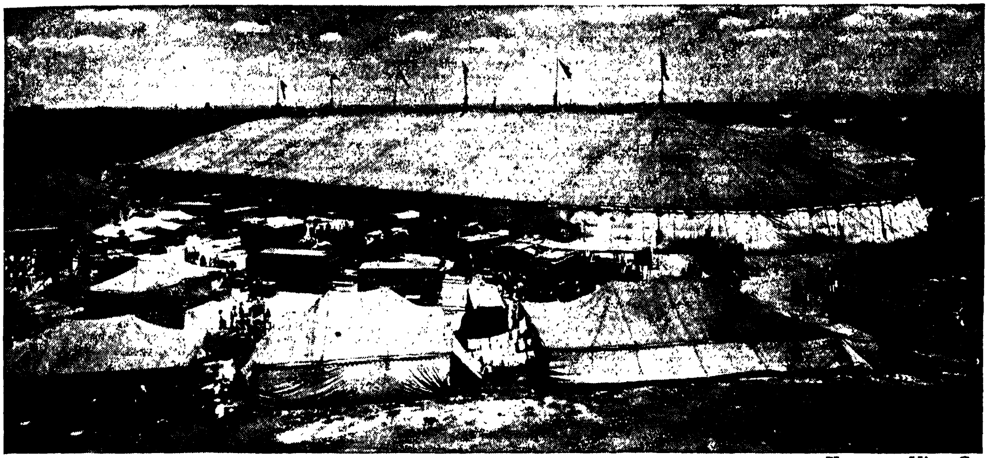
When the pods are ripe they are carefully cut from the trees, and the pulp and beans are scooped out and put in tanks or spread on banana leaves or coconut matting to ferment until the pulp has disappeared and certain changes have taken place in the beans. They are then dried in the hot sun, packed into bags and shipped to the markets of the world. During normal times the countries that consume the greatest amount of the raw beans are the United States, which takes about forty per cent, Germany, Great Britain, Holland, France and Spain. The largest manufacturing plants in the world are in the United States.

In these plants, with their shining machinery, the beans are cleaned and any twigs or little stones are removed, and then they are roasted for forty minutes in great revolving ovens. When they have been roasted just long enough they are taken out and rapidly cooled, so that their own heat will not cook them any further. By this time the thin shells of the beans have become brittle and are removed by machinery, which also breaks the beans into smaller pieces. These small pieces, which are called "nibs," are then ground until the friction of the grinders melts the cocoa butter, which is 54 per cent of the bean, changing the cocoa nibs into a rich, thick liquid, which is the basis of all chocolate products.

What happens next depends upon whether the cocoa is to be made into hard chocolate or powdered cocoa. To make hard, or "baking," chocolate, the basic liquid is put through several grinding processes, the final one lasting for four days and four nights. When it comes out, rich and smooth, it is poured into molds to harden into bars. This kind of chocolate is used in our kitchens for making chocolate desserts, and for making certain kinds of candies.

Powdered, or "breakfast," cocoa is made by squeezing about half of the cocoa butter out of the basic liquid, and drying, grinding and sifting the rest of the chocolate. Milk-chocolate is made by mixing milk and sugar, condensing them until they are like soft taffy, and blending the mixture with the basic chocolate liquid. Milk-chocolate has an especially delicious flavor.

The cocoa butter that is taken out when powdered cocoa is made is used for many purposes, among them the making of ointments, cosmetics, soaps and medicines.



Keystone View Co.
The circus has come to town! Here are the tents of the Ringling Brothers, Barnum and Bailey Combined Shows.

THE STORY OF THE CIRCUS

OUR modern circus is a large affair, the largest amusement enterprise in the world. This greatness represents a gradual development from the humblest of beginnings.

The name "circus" itself goes back to the days of ancient Rome. The Roman circus was a huge racecourse, where stirring chariot races were held before a vast number of spectators. It was also the scene of sham fights on horseback, athletic games and, at certain times, of wild-animal fights and combats between gladiators.

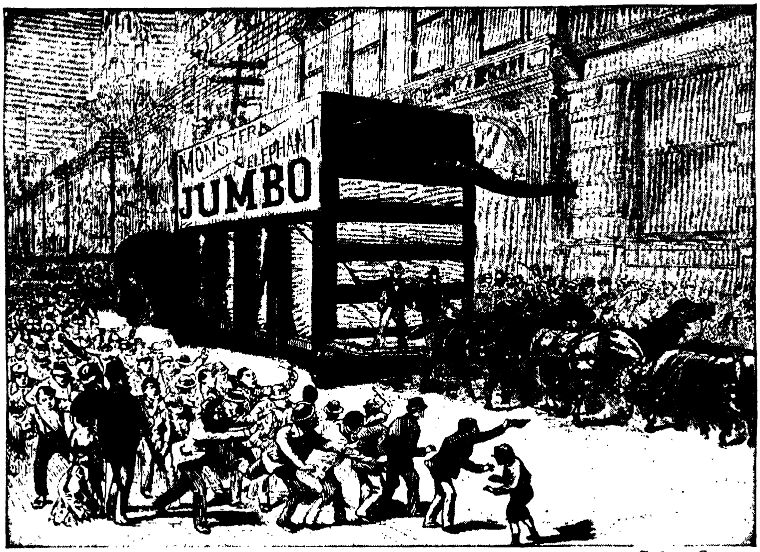
Certain features of this ancient circus are still to be found in the circus of modern times. There is the opening march of the performers; there are the chariot races; there is the appearance of wild beasts as a part of the performance. The modern circus, however, did not begin as an imitation of the ancient one. The features that remind us of the ancient circus were added at a later day.

The circus really began when Philip Astley, a former sergeant major in the British cavalry, decided to combine feats of horsemanship with a number of other features. Before his time, displays of skillful riding had not been uncommon, but these were simply riding exhibitions with little or no variety. Astley developed a varied and interesting performance. This show, which reached its full development about 1780, was staged in the Amphitheatre Riding House near London. Feats of horsemanship were the chief attraction; but there were also pageants, given on a stage in the center of the ring. There were rope dancers and tumblers. A fair lady exhibited her very long hair. Several clowns kept the audience in an uproar with their droll antics.

Astley was invited to go to Paris at the invitation of the French queen, Marie Antoinette. In Paris, Astley and his son gave performances which delighted the French people who saw them. The circus appeared before the French court at Versailles and Marie Antoinette gave the younger Astley a gold medal. Later, after the Astley circus returned to England, an Italian, Franconi, established another of the same type in Paris. Thereafter the circus spread rapidly all over Europe.

The first circus to come to America was that of the Englishman, Thomas Pool, who began his performances in Philadelphia in the year 1785. In 1792 John Bill Ricket set up a famous circus in Philadelphia. One of his performances was attended by President Washington. Other circuses followed. By 1820 as many as thirty were wandering through the eastern states and giving shows.

These early circuses would seem puny in-



Culver Service

A famous episode in the history of the circus. Jumbo, a "monster" elephant sold by the London Zoo to an American circus man, P. T. Barnum, arrives in New York and is transferred from the Battery to Madison Square Garden. This sketch by an artist who witnessed the scene shows the excitement caused by Jumbo's arrival.

deed if we judged them by modern standards. They generally consisted of a couple of wagons, four horses, a half dozen performers and a clown. They performed on any vacant lot that was available. No seats were provided, although a kindly farmer in the vicinity would sometimes lend a few chairs for the use of the ladies. The number of spectators was very small. Two hundred and fifty patrons was considered to be a large audience.

The circus grew rapidly from such modest beginnings. Soon a tent was set up to protect the show from the elements, and benches were provided for the spectators. The number of performers was increased and the equipment became much more elaborate. As early as 1828, for example, the circus of Buckley and Wicks traveled with 40 horses, 8 wagons and 35 performers. As many as 800 spectators could be accommodated in the tent, which had a diameter of 75 feet.

Other improvements and additions were constantly made throughout the nineteenth century by men like Cooke, Spaulding, Rogers, Van Amburgh and Forepaugh. No one, however, did more to make the circus the gigantic spectacle it is today than the famous American showman, Phineas T. Barnum.

In 1836 Barnum, then a young man of twenty-six, began his far-famed circus career when he joined the traveling show of Aaron Turner. This first venture was not a very profitable one, however. Barnum was forced to withdraw for a time from the circus field, and he decided to seek success elsewhere.

In 1841 he became the owner of the American Museum in New York. This museum was to contribute a great deal to the development of the circus side shows of a later day: the giants, the dwarfs, the bearded ladies, the snake charmers, the sword swallowers and all the rest.

For Barnum's new museum was not a museum as the word is used today. When Barnum acquired it, it was a storehouse of relics and curiosities, including a live anaconda snake, a tame alligator and many stuffed animals. Barnum so transformed the museum that for the next thirty years it was the amusement center of New York. He provided jugglers, educated dogs, trained fleas, fat boys, giants and dwarfs, including the famous dwarf General Tom Thumb. There were many other features besides.

While the museum was delighting its audiences, Barnum interested himself in a number of other enterprises. He exhibited the dwarf General Tom Thumb in England, France and Belgium before crowded audiences. He brought the famous Swedish singer, Jenny Lind, to this country, and the ninety-three concerts that she gave under Barnum's direction made her name famous throughout America.

Barnum also backed several ventures which were more closely connected with the circus. In 1849 he entered into partnership with S. S. Stratton, Tom Thumb's father, and organized the Great Asiatic Caravan, Museum and Menagerie. This enterprise, which included a menagerie and a number of freaks, among them General Tom Thumb, toured the country for four years with considerable success. Later Barnum formed a similar venture in partnership with Van Amburgh, the owner of a large menagerie. This new show, combining Van Amburgh's animals with the curiosities of Barnum's museum, toured the country in the summer of 1867, and in the following winter it appeared in Barnum's museum. The burning of the museum building put an end to the enterprise; and Barnum decided to retire from the show business.

He was too active a person, however, to remain in retirement very long. One day two veteran showmen, W. C. Coup and Dan Costello, proposed that he join them in forming a huge traveling show that was to combine a variety show, a menagerie and a museum, or collection of freaks. In other words it was to be a full-fledged traveling circus like those of the present day.

Barnum seized eagerly upon this opportunity. In April, 1871, the new company, known as P. T. Barnum's Circus, Menagerie and Museum, opened in Brooklyn, New York. This circus was the largest that the world had ever seen. There were feats of horsemanship, flying trapeze artists, wild animal acts. There were battalions of clowns. There was Esau, the bearded boy, whose mother was the bearded lady. There was a family of Fiji cannibals, whose fierceness disappeared only when they sold photographs of themselves to the audience. And the menagerie, besides a generous supply of lions, tigers, leopards, elephants and the rest, boasted of what was then a comparatively rare animal in this country, the giraffe.

The circus toured the country in the summer months in its own railway cars. In the winter a large part of it was exhibited in the Hippotheatron, an imposing building in New York. After the Hippotheatron was burned to the ground in 1878, winter exhibitions were given in a new and larger building, the famous Madison Square Garden. (This was not the present Garden, but a building which stood for forty years on

Ewing Galloway, N. Y.

This photograph takes us behind the scenes in the dressing-room tent of a large circus. You will notice that pails of water take the place of the faucets and the washbowls of ordinary make-up rooms. Shaving becomes a rather difficult operation. Circus folks, however, are accustomed to conditions like these and accept them with hearty good nature. The spirit of comradeship among performers more than makes up for the lack of conveniences.

Madison Square, before being torn down in 1926.)

In 1880 Barnum, having become the sole owner of the circus, combined it with another show, the guiding spirit of which was the well-known showman, James A. Bailey. The new combined show became known as Barnum and Bailey, the Greatest Show on Earth.

This huge show justified its proud title, for with Barnum and Bailey the circus reached its full development. Originally, the chief attraction of a circus had been the daring feats of horsemanship. Other attractions, though important, had served chiefly to fill up the intervals between the various equestrian acts. By this time there was such a wealth of new attractions that the daring horseback riders became quite secondary in importance. They have never quite recovered their former place. The one ring of the older circus no longer sufficed. Another ring was added and then another. The three-ring arena with a hippodrome track (oval track for horses) around it is still used today by large circuses.

Courtesy, Ringling Bros., Barnum and Bailey.
Uncle Sam (a circus performer on stilts) has a friendly chat with an admirer.

Chief among the attractions of Barnum and Bailey's Circus was the most famous of all elephants, Jumbo. It was billed as the largest elephant in the world, and although the claim was never proved, it was certainly very large. It had been the property of the London zoo and had been sold to Barnum for $10,000. Barnum caused rumors to be spread that Jumbo was heartbroken at leaving the children of London. Soon all England was protesting bitterly against Jumbo's departure and even Queen Victoria is said to have joined the protest. The result was a great deal of very valuable publicity. When, in spite of the wrath of the English public, Barnum finally brought Jumbo to the United States, the huge elephant had become very famous. It created a sensation wherever it was exhibited. Some time later it is said to have died a hero, saving a baby elephant from an oncoming railway train at the cost of its own life. Some unfeeling people say that this touching story is a legend.

Another elephant episode turned out rather badly for Barnum and Bailey. They had proudly announced that they were to exhibit a sacred white elephant, smuggled from Siam. At once a rival circus man, Adam Forepaugh, announced that he too was going to show a sacred white elephant to the public. It so happened that Barnum and Bailey's specimen was perfectly genuine. Yet the audience plainly showed its disappointment. They had expected to see a "white" elephant, and what they saw was a pinkish gray animal that differed but slightly from the ordinary elephant in color.

But Forepaugh's elephant was greeted with the greatest enthusiasm, for it was gleaming white. And well it might be, for its color came from several coats of white paint and enamel applied to an ordinary elephant.

Barnum died in 1891 and Bailey took over the management of the circus, which retained its old name. At this time the circus of the seven Ringling brothers, with headquarters in the Middle West, was a keen rival. At last the two circuses entered into an agreement. They divided all circus territory between them. New York was to be the headquarters for Barnum and Bailey, Chicago for the Ringlings.

Since that time circuses have gradually combined to form ever larger groups. The largest group of all was formed in 1929 when John Ringling, the last survivor of the Ringling brothers, acquired control of the American Circus Combination, which included such large circuses as those of Sells-Floto, Hagenbeck-Wallace, John Robinson, Sparks and Al G. Barnes.

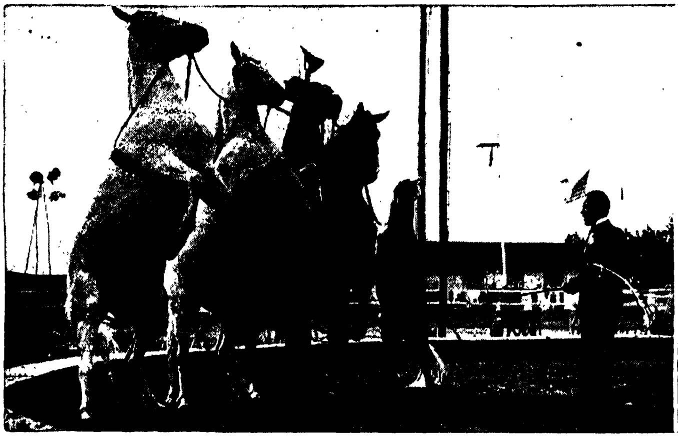
At the present time the circus has reached its full development, not only in the United States and Canada but in many other lands besides: in England, France, Germany, Italy, Russia. The great depression of the 1930's caused a setback; and labor trouble has

TWO FAVORITES AT THE CIRCUS

Courtesy, Ringling Bros., Barnum and Bailey; Chester Photo Service

This kindly clown is treating a hungry giraffe to a between-meals snack. Clowns, with their ridiculously ill-fitting clothes and their faces concealed behind a mask of grease paint and other make-up, are a constant delight at the circus. The giraffe, the tallest animal in the world, is a star of the circus menagerie.

SOME POPULAR CIRCUS ACTS



These two pictures show how training is carried on at the Florida winter quarters of a big circus.

(right), Pictures Inc.
Circus elephants doing their act. Elephants are among the most dependable animal performers.

A thrilling wild-animal act at the circus. It is very difficult to make lions and tigers, natural enemies, perform together like this.
Pictures, Ringling Bros., Barnum and Bailey

haunted the circus for years. In the late 1930's, however, the circus in the United States took on new life, with elaborate and beautiful scenes, new, exciting animal acts and other modern features. World War II caused another setback, chiefly because of labor problems and food shortages and transportation troubles. Two tragic fires occurred which almost "broke the heart" of the circus. We hope for better fortunes in circus history in the years ahead.

THE MODERN CIRCUS CARRIES ON ALL THE FINE TRADITIONS OF ITS PAST

For the circus is a tried old friend that remains true to its fine old traditions. There have been and there still are variations of the circus. The Wild West Show, made popular by the late Buffalo Bill Cody, flourishes. There are rodeos and carnivals. There are circus acts combined with vaudeville or even musical comedy. These may be considered as special forms of the circus. But somehow, none of them seems as genuine as the traditional Big Show, with its street parade, its clowns and trapeze artists, its daredevil horsemen, its tightrope walkers, its chariot races, its wild-animal acts, its menagerie and its seemingly endless supply of peanuts and pink lemonade. And the modern circus gives freely of all these features.

The circus has always been popular, too, because it has never stopped long enough in one place to make us tire of its presence. The larger shows, it is true, often begin their season in March or in April by establishing themselves in some large city, perhaps even in a permanent building. There they may be housed for several weeks or even more. But thereafter they take to their tents and roam throughout the country. They seldom stop anywhere on their route for more than a few days, and in most towns they stay for one day only. Zoos, aquariums and museums are always with us and for that reason we are apt to become indifferent to them. But the circus comes and departs again so suddenly that we have no time to become indifferent to it.

THE BIG MORNING STREET PARADE OF THE CIRCUS IS A FINE SPECTACLE

Even the morning street parade of the circus seems a fantastic spectacle. The huge elephants, the prancing white saddle horses, the procession of wild animals in bright red cages—these seem strangely out of place amid modern streets, with their tall buildings, their motor cars and their bustling crowds. We must have turned back the pages of time!

Courtesy, Ringling Bros., Barnum and Bailey

Trapeze artists at the circus. Acts like this require great skill and strength and perfect timing. The performers must put in years of practice.

But the wonders really begin within the big top of the circus itself. There is the grand march into the arena with which the performance begins. We see the huge elephants bedecked with trappings of purple and gold. Mounted on horseback, there are Russian Cossacks in huge white fur caps, turbaned sheiks with flowing robes, beautiful ladies in satins and velvets and glittering spangles. We see the grotesque clowns, with their mouths extending from ear to ear, their huge bellies and their ridiculously long shoes.

And what impossible things take place in the arena, once the show begins! The performers swing dizzily through space on flying trapezes, they are shot from the mouths of cannon, they dance on tightropes seventy-five feet in the air, they enter cages full of lions and tigers. Elephants dance, dogs walk, monkeys ride on bicycles. When we wander into the side shows we see a living skeleton of 45 pounds chatting amiably with a plump lass who may weigh all of 700. And over yonder a 3-foot dwarf is perched on the palm of an 8-foot giant.

Perhaps the greatest wonder of all is the appearance and disappearance of the circus when it is on the road. Yesterday there was an empty lot somewhere on the outskirts of the town, an ugly lot perhaps, overgrown with weeds and covered with rubbish. Today it is a city of canvas, housing a thousand humans and hundreds of animals within its tents. Tomorrow this city will have vanished. Wonderful, isn't it?

The astonishing efficiency that makes all this possible is not less wonderful.

Hardly has the long train reached the town where the circus is to appear, when the range wagons, containing the kitchen equipment, are on their way to the lot. When they arrive, the cooks immediately set about preparing breakfast for all hands.

In the meantime the lot superintendent is busily engaged setting up little red flags in every part of the lot. These indicate the location of each part of the city of tents which will soon arise. When the wagons containing the tent and seat equipment arrive at last, there is no confusion. The little red flags show each wagon where it is to go, and there it proceeds without the slightest hesitation or loss of time.

The lot is cleared of weeds and rubbish, and everything is in readiness for setting up the big tents. The workers stretch the tent canvas, erect the center poles, hoist the canvas and drive in stakes. Other crews are busily at work setting up the seats for the spectators. When the tents are up, when the seats are in place, when the rings of the arena have been liberally strewn with wood shavings, all is in readiness for the show to begin.

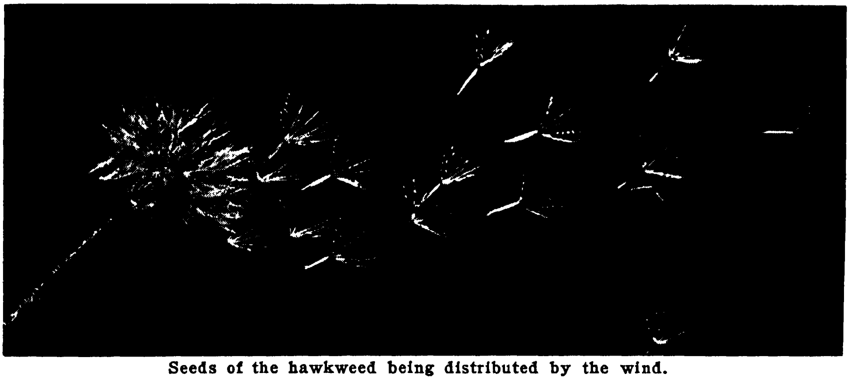
Preparations for departure begin long before the last performance is well under way. The cookhouse tents, the horse tents and the blacksmith shop have already been taken down and loaded on their wagons and are on their way to the freight yards.

Moving goes on constantly during this last performance. No sooner has an act been completed than its equipment is loaded on wagons, and performers and equipment alike are on their way. After a while only the big top, or main tent, is left standing. When the last spectator has left, the big-top gang goes to work. The canvas falls to the ground, the huge center poles topple, and both canvas and poles are loaded upon their wagons. Soon the last wagon-load of equipment has left the lot. The city of tents has become a mere empty lot again.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 1215.

Courtesy, Ringling Bros., Barnum and Bailey

A young circus bareback rider practicing her art. These riders perform in a track in the main arena. A ring-master stands in the center of the track cracking a whip, while the horses go round and round at a trot, never breaking their pace. In the meantime their daring riders perform all sorts of seemingly impossible feats.



Seeds of the hawkweed being distributed by the wind.

THE FLOWER'S WONDERFUL SEED-BOX

WE have seen that the fruit of a plant is its wonderful seed-box. Let us now look more carefully at the precious contents of the box, and see especially how the seeds are sown and distributed far and wide over the earth.

Inside the flower's seed-box, the ovary, there are ovules, and these ovules are *possible* seeds. The ripe ovule is the seed; but we do not get at the heart of the matter till we are clear that the seed contains a very young plant, the embryo. Besides this very young plant, which will develop into a seedling, there is a store of condensed food, as in a grain of wheat, and there are protective seed-coats, or husks. The store of food, which is a sort of legacy, may be outside the young plant, though within the seed-coats, or it may be in the young plant itself, as we see clearly in peas or beans.

The simplest way in which seeds are sown is by the cracking and bursting of the seed-boxes. Then the seeds tumble out, as we may see in the ripe pod of a pea. The liberated seeds may be washed away by water, or swept along the ground by the wind, or buried in an earthworm's hole. Seeds lying loose may be collected by ants and stored in an ant-hill. But an ant may lose the seed it is carrying, and this is another way in which seeds are scattered.

In some cases the seed-box bursts explosively, as we may both hear and see if we sit among the gorse on a warm autumn day. The seeds are jerked out to a little distance, for the drying of the wall releases certain springs in a jack-in-the-box fashion. In the balsam, or jewel weed, whose Latin name is *Impatiens noli-me-tangere* (touch-me-not), the jerking out of the seeds is very effective indeed.

In this case five valves suddenly roll up like watch-springs and sling the seeds out; the force is due, not to a sharp release of dried-up fibres, but to a layer of living cells very rich in water which expand suddenly when the trigger is pulled by touching the tip of the ripe fruit. The most famous explosive fruit is that of a tropical plant called *Hura crepitans.* It bursts with a report like a pistol-shot and scatters the seeds for several yards. Then there is the squirting Italian cucumber, where the fruit bursts and scatters the seeds along with its *liquid* contents.

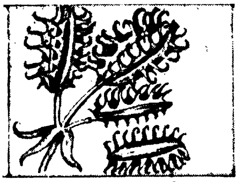
The great advantage of explosion over simple breakage is that the seeds are thrown out beyond the immediate neighborhood of the parent plant. Otherwise there would be unwholesome overcrowding among the seedlings.

Another way in which seeds are scattered is by the fruits becoming attached

HOW THE WIND HELPS TO CARRY ON THE

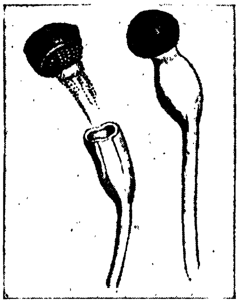

Medick seeds with hooks for catching in wool.

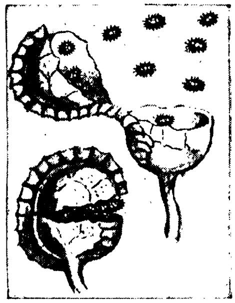

Hooked seeds of the avens.

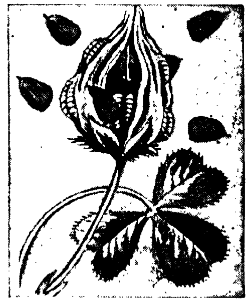

Hooked seeds of the orlaya.


Cyperus-like sedge with spiked seeds.


The explosive squirting cucumber seed.


Philobolus fungus spores scattered by explosion.

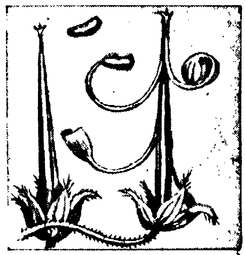

Male fern's spore case bursts, scattering spores.


Common wood-sorrel expels its seeds.

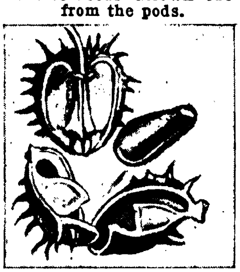

Spring bitter vetch seeds spring out.

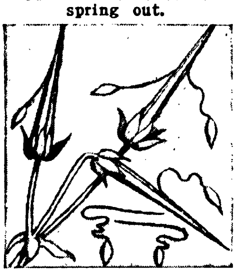

Violet seeds thrown out from the pods.

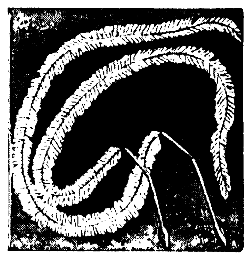

Cuckoo flower's seeds spring out.


Expulsion of crane's bill seed.

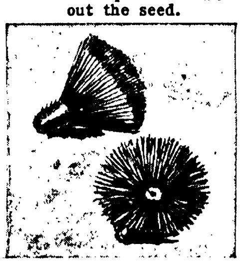

Germander's seed hurled away.


Castor-oil plant throws out the seed.

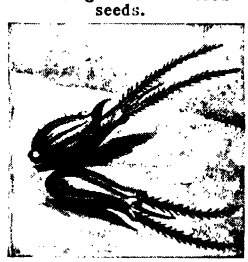

Stork's bill seeds parachute to earth.


Feather grass's feathered seeds.


Spiked goat-grass seeds work along the ground.


Starry scabious seeds that hop along the ground.


Starry clover's seed that creeps along.


Hard-grass seed that works its way along.

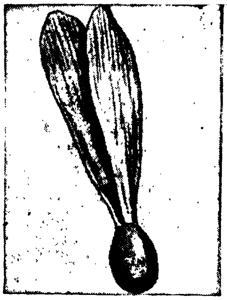
RACE OF FLOWERS THROUGHOUT THE WORLD

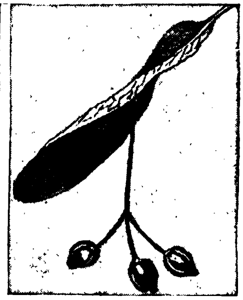

Trichia fungus with spores exposed to wind.


Griminia moss with spore capsules open and closed.


Moonwort with spore case closed and open.

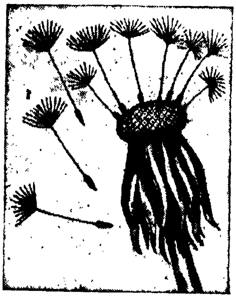

Split moss with spore capsule closed and open.


The winged seed of the ash.

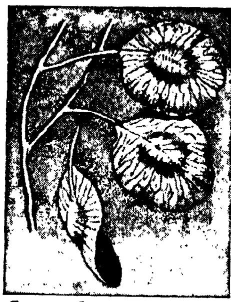

Linden tree's winged seeds.


Common hop seeds falling.


Cotton-grass seeds flying off.

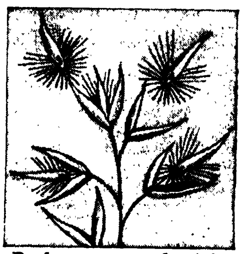

Dandelion seeds take flight.


Flight of Cat-tail seeds from ripe head.


Swamp dogwood's winged seeds.


Feathered seed of mountain avens.


Feathered seed of virgin's bower.


Bush grass seeds take flight.


Winged seeds of tree of heaven.


Seed keys of the maple, single and double.


Winged seeds of artedia fully ripe.


Two-winged seed of triopteris.


Winged seeds of opoponax with broad sails.


Horsetail spores with spirals, rolled and unrolled.

to passing animals, such as rabbits and sheep. They cling for a while by means of roughnesses, hooks or bristles, and then fall off or are rubbed off. This is true of agrimony, cockleburs, some grasses and stick-tight, or "beggar ticks." In nutlet fruits and others which do not liberate the seed till it sprouts in the ground, there is very little practical difference between the fruit and the seed which fills it. Therefore we may include among the different kinds of seed-scattering the attachment of the dry fruit to the fur or fleece of animals.

THE WAY IN WHICH THE THRUSH SPREADS THE MISTLETOE SEEDS

The seeds of water-plants may be carried on the feet of birds from one pool to another, and a clodlet formed on a bird's foot on a plowed field may contain many seeds which will be sown elsewhere. Thus Darwin got eighty-two seeds to sprout from a ball of earth that had formed on a partridge's foot, and that was after the ball had been kept dry for three years!

A peculiar kind of sowing is seen in the mistletoe. The white berry contains one seed imbedded in glue-like pulp which hardens on exposure to air. Now, the thrush likes the pulp, but it does not like the seed. Yet it is a little difficult to reject the seed when swallowing the fruit, and the seed often adheres to the bird's bill—whereupon the thrush cleans it off by wiping its bill on a branch! In this strange way the seed is sown; it remains glued to the branch till genial spring weather comes; then it sprouts and fixes itself more firmly. It is not till the second spring that it begins to grow vigorously. In the case of one of the tropical mistletoes the seeds are sometimes smeared by birds on to telegraph wires, where, of course, they die!

THE SEEDS WITH PARACHUTES FOR MAKING FLIGHTS IN THE AIR

It should also be noticed that when a thrush swallows the whole fruit, the undigested seed may be passed out none the worse for its journey down the food-canal, and this would be another kind of sowing. But it is not the usual one.

What is unusual in the case of the thrush and the mistletoe berry is common among other fruit-eating birds and among fruit-eating mammals. The fruit is swallowed, its soft parts are digested, the stones or seeds are unharmed, and they are passed out again, it may be miles from the place where they were swallowed.

On the other hand, there are many birds and mammals that are able to digest the seeds they swallow. This is of some practical importance for man. A creature digesting the seeds of weeds is helping the farmer by checking the spread of pests. A creature that swallows the seeds and passes them out again undigested and unharmed is plainly scattering abroad what is injurious.

One of the most important agencies in seed-scattering is the wind, and this applies particularly to small fruits or seeds which have parachutes, or floats, of some sort. The fruit of the maple is a nutlet borne at the end of a long blade-like parachute. When it is torn from the tree by a gust of wind, it sinks with a beautiful twisting motion which often carries it far beyond the tree's shadow. If we throw it up into the air again, we can watch its peculiar twisting flight as it sinks, and we can observe that it does not return to us.

THE SEED THAT FLIES THROUGH THE AIR LIKE A BUTTERFLY

There are many other fruits with parachutes, such as elm and ash, and in some cases the parachute belongs to the seed itself. Thus the seed of a bignonia has broad wings and is so finely balanced that it "floats lightly along through the air in an almost horizontal course, and with the motion of a butterfly."

Very useful, too, is the down of fine hairs seen on many small fruits and seeds. Thistle-down and dandelion-down are fine examples. The feathery plumes of the fruits of traveler's-joy, or old-man's-beard, often entangle in long lines which float through the air with a beautiful wavy motion. The fruits or seeds are borne like gossamer-spiders on the wings of the wind.

They are scattered far and wide. The down makes it more difficult for them to sink in the air and it gives the favoring breeze something to grip. In the case of a very light fruit, like that of the groundsel, it has been suggested that the sun's rays striking on the tuft of white hairs and warming the immediately surrounding atmosphere may produce a small eddy which lifts what is certainly "as light as gossamer" even when there is no breeze. They say that the groundsels had their original headquarters on the Andes, from where they have spread—thousands of different kinds—over the whole earth;

and part of the success of this journeying must surely be due to the parachutes.

What strikes one is the great variety of ways in which the sowing of seeds is brought about in nature. Coconuts are floated by the currents of the sea to distant islands—what a contrast between this and the groundsel's aerial journeys! The fruit-stalks of some wall-plants bend away from the light and poke the seed-box into a crevice of the wall—what a contrast between this and the way the seeds of the wild cherry are sown by birds! The fruit-stalk of the peanut bends to the earth and pushes the fruit into a hole—what a contrast between this and the balsam's impatient explosion! The rose-of-Jericho of the desert curls its dry branches into a ball which is torn up by the wind and rolled along the ground for great distances, scattering the seeds as it goes; and the same sort of thing occurs in the grass called spinifex and in some other cases—what a contrast between this and the liberation of seeds from neatly made little holes at the top of a poppy-head!

The meaning of the great variety is simply that plants have in different ways counteracted their great handicap—that they are fixed to one place. Those have been most successful which have been best able to scatter their seeds. Although many seeds come to nothing, wide scattering increases the chances of finding suitable and less crowded places where they may sprout and grow; where the seedling may become a plant which will have room to spread out its leaves and flowers, and nourishment to develop its fruits and seeds. So the chain of plant life lengthens.

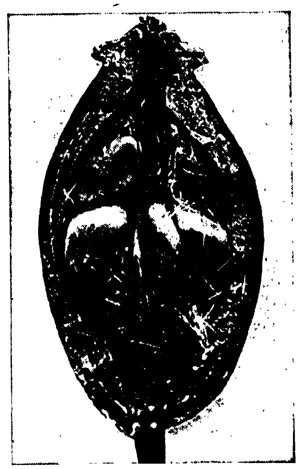
Seeds of the balsam expelled from their case.

The burst seed-cases and the flying seeds of the monkey's-dinner-bell.

Bursting seed-cases of the thorn-apple.

A section through an ivory-nut.

The long and spiky seed-cases of eschscholtzia.

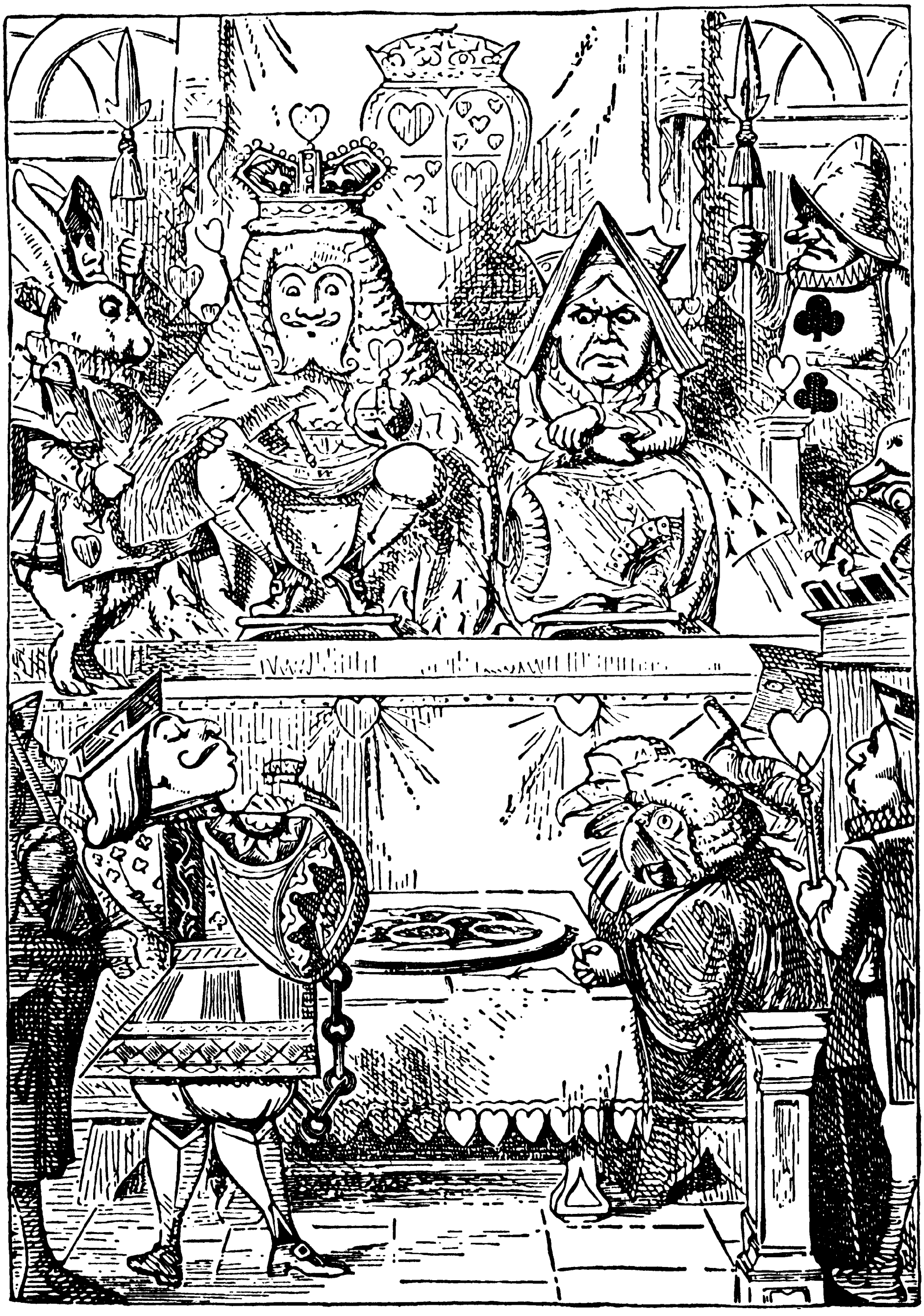


A much enlarged section of the thorn-apple.

THE WONDERFUL WAY IN WHICH NATURE PROTECTS THE SEEDS AND SENDS THEM OUT INTO THE WORLD

THE NEXT STORY OF PLANT LIFE IS ON PAGE 1275.

THE KING AND QUEEN ON THEIR THRONE



The King and Queen were seated on their throne; the Knave was standing before them, in chains. The judge was the King; and, as he wore his crown over the wig, he did not look at all comfortable, and it certainly was not becoming. In the very middle of the court was a table, with a large dish of tarts upon it. They looked so good that it made Alice quite hungry to look at them. "I wish they'd get the trial done," she thought, "and hand round the refreshments." But there seemed to be no chance of this.

Alice in Wonderland

By Lewis Carroll

Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do; once or twice she had peeped into the book her sister was reading, but it had no pictures or conversations in it, "and what is the use of a book," thought Alice, "without pictures or conversations?"

So she was considering in her own mind (as well as she could, for the hot day made her feel very sleepy and stupid) whether the pleasure of making a daisy-chain would be worth the trouble of getting up and picking the daisies, when suddenly a white rabbit with pink eyes ran close by her.

There was nothing so *very* remarkable in that; nor did Alice think it so very much out of the way to hear the Rabbit say to itself: "Oh dear! Oh dear! I shall be too late!" (when she thought it over afterwards, it occurred to her that she ought to have wondered at this, but at the time it all seemed quite natural); but when the Rabbit actually *took a watch out of its waistcoat pocket,* and looked at it, and then hurried on, Alice started to her feet, for it flashed across her mind that she had never before seen a rabbit with either a waistcoat pocket or a watch to take out of it, and, burning with curiosity, she ran across the field after it, and was just in time to see it pop down a large rabbit-hole under the hedge.

In another moment down went Alice after it, never once considering how in the world she was to get out again.

The rabbit-hole went straight on like a tunnel for some way, and then dipped suddenly down, so suddenly that Alice had not a moment to think about stopping herself before she found herself falling down what seemed to be a very deep well.

Either the well was very deep, or she fell very slowly, for she had plenty of time as she went down to look about her, and to wonder what was going to happen next. First, she tried to look down and make out what she was coming to, but it was too dark to see anything; then she looked at the sides of the well, and noticed that they were filled with cupboards and bookshelves. Here and there she saw maps and pictures hung upon pegs. She took down a jar from one of the shelves as she passed; it was labeled ORANGE MARMALADE, but, to her great disappointment, it was empty. She did not like to drop the jar for fear of killing somebody underneath, so managed to put it into one of the cupboards as she fell past it.

"Well," thought Alice to herself, "after such a fall as this, I shall think nothing of tumbling downstairs. How brave they'll all think me at home! Why, I wouldn't say anything about it, even if I fell off the top of the house." (Which was very likely true.)

Down, down, down. Would the fall *never* come to an end? "I wonder how many miles I've fallen by this time?" she said aloud. "I must be getting somewhere near the centre of the earth. Let me see: that would be four thousand miles down, I think—" (for, you see, Alice had learnt several things of this sort in her lessons in the schoolroom, and though this was not a *very* good opportunity for showing off her knowledge, and there was no one to listen to her, still it was good practice to say it over). "Yes, that's about the right distance—but then I wonder what latitude and longitude I've got to?" (Alice had not the slightest idea what latitude was, or longitude either, but she thought they were nice grand words to say.)

Presently she began again.

"I wonder if I shall fall right *through* the earth? How funny it'll seem to come out among the people that walk with their heads downwards! The Antipathies, I think" (she was rather glad there was no one listening this time, as it didn't sound at all the right word); "but I shall have to ask them what the name of the country is, you know. Please, ma'am, is this New Zealand or Australia?" And she tried to curtsey as she spoke, Fancy *curtseying* as you're falling through the air! Do you think you could manage it? "And what an ignorant little girl she'll think me for asking! No, it will never do to ask; perhaps I shall see it written up somewhere."

Down, down, down. There was nothing else to do, so Alice began talking again. "Dinah'll miss me very much to-night, I should think." (Dinah was the cat.) "I hope they'll remember her saucer of milk at tea-time. Dinah, my dear, I wish you were down here with me. There are no mice in the air, I'm afraid, but you might catch a bat, and that's very like a mouse, you know. But do cats eat bats, I wonder?" And here Alice began to get rather sleepy, and went on saying to herself in a dreamy sort of way: "Do cats eat bats? Do cats eat bats?" and sometimes, "Do bats eat cats?" for, you know, as she couldn't answer either question, it didn't much matter which way she put it. She felt that she was dozing off, and had just begun to dream that she was walking hand in hand with Dinah, and was saying to her very earnestly: "Now, Dinah, tell me the truth, did you ever eat a bat?" when suddenly, thump! thump! down she came upon a heap of sticks and dry leaves, and the fall was over.

Alice was not a bit hurt, and she jumped up on to her feet in a moment. She looked up, but it was all dark overhead; before her was another long passage, and the White Rabbit was still in sight, hurrying down to it. There was not a moment to be lost. Away went Alice like the wind, and was just in time to hear it say, as it turned a corner: "Oh, my ears and whiskers, how late it's getting!" She was close behind it when she turned the corner, but the Rabbit was no longer to be seen. She found herself in a long, low hall, which was lit up by a row of lamps hanging from the roof.

There were doors all round the hall, but they were all locked, and when Alice had been all the way down one side and up the other, trying every door, she walked sadly down the middle, wondering how she was ever to get out again.

Suddenly she came upon a little three-legged table all made of solid glass. There was nothing on it but a tiny golden key, and Alice's first idea was that this might belong to one of the doors of the hall; but, alas! either the locks were too large, or the key was too small, but, at any rate, it would not open any of them. However, on the second time round she came upon a low curtain she had not noticed before, and behind it was a little door about fifteen inches high. She tried the little golden key in the lock, and, to her great delight, it fitted.

Alice opened the door, and found that it led into a small passage, not much larger than a rat-hole. She knelt down and looked along the passage into the loveliest garden you ever saw. How she longed to get out of that dark hall, and wander about among those beds of bright flowers and those cool fountains, but she could not even get her head through the doorway; "and even if my head would go through," thought poor Alice, "it would be of very little use without my shoulders. Oh, how I wish I could shut up like a telescope! I think I could, if I only knew how to begin." For you see, so many out-of-the-way things had happened lately that Alice had begun to think that very few things indeed were really impossible.

There seemed to be no use in waiting by the little door, so she went back to the table, half hoping she might find another key on it, or, at any rate, a book of rules for shutting people up like telescopes. This time she found a little bottle on it ("which certainly was not here before," said Alice), and tied round the neck of the bottle was a paper label, with the words DRINK ME beautifully printed on it in large letters.

It was all very well to say "Drink me," but the wise little Alice was not going to do *that* in a hurry. "No, I'll look first," she said, "and see whether it's marked *'poison'* or not"; for she had read several nice little stories about children who had got burnt, and eaten up by wild beasts and other unpleasant things, all because they *would* not remember the simple rules their friends had taught them; such as, that a red-hot poker will burn you if you hold it too long; and that, if you cut your finger *very* deeply with a knife, it usually bleeds; and she had never forgotten that, if you drink much from a bottle marked "poison," it is almost certain to disagree with you sooner or later.

However, this bottle was *not* marked "poison," so Alice ventured to taste it and, finding it very nice (it had, in fact, a sort of mixed flavor of cherry-tart, custard, pineapple, roast turkey, toffy, and hot buttered toast), she very soon finished it off.

"What a curious feeling!" said Alice. "I must be shutting up like a telescope."

And so it was, indeed; she was now only ten inches high, and her face brightened up at the thought that she was now the right size for going through the little door into that lovely garden.

First, however, she waited for a few minutes to see if she was going to shrink any further; she felt a little nervous about this, "for it might end, you know," said Alice to herself, "in my going out altogether, like a candle. I wonder what I should be like then?" And she tried to fancy what the flame of a candle looks like after the candle is blown out, for she could not remember ever having seen such a thing.

After a while, finding that nothing more happened, she decided on going into the garden at once, but, alas for poor Alice, when she got to the door she found she had forgotten the little golden key, and when she went back to the table for it she found she could not possibly reach it. She could see it quite plainly through the glass, and she tried her best to climb up one of the legs of the table, but it was too slippery; and when she had tired herself out with trying, the poor little thing sat down and cried. . . .

Soon her eye fell on a little glass box that was lying under the table. She opened it, and found in it a very small cake, on which the words EAT ME were beautifully marked in currants.

"Well, I'll eat it," said Alice, "and if it makes me grow larger, I can reach the key; and if it makes me grow smaller, I can creep under the door; so either way I'll get into the garden, and I don't care which happens."

She ate a little bit, and said anxiously to herself: "Which way? Which way?" holding her hand on the top of her head to feel which way it was growing, and she was quite surprised to find that she remained the same size; to be sure, this is what generally happens when one eats cake, but Alice had got so much into the way of expecting nothing but out-of-the-way things to happen that it seemed quite dull and stupid for life to go on in the common way.

So she set to work, and very soon finished off the cake.

II

"Curiouser and curiouser!" cried Alice (she was so much surprised that for the moment she quite forgot how to speak good English. "Now I'm opening out like the largest telescope that ever was. Good-bye, feet!" (for when she looked down at her feet they seemed to be almost out of sight, they were getting so far off). "Oh, my poor little feet! I wonder who will put on your shoes and stockings for you now, dears? I'm sure *I* shan't be able. I shall be a great deal too far off to trouble myself about you; you must manage the best way you can. But I must be kind to them," thought Alice, "or perhaps they won't walk the way I want to go. Let me see; I'll give them a new pair of boots every Christmas." . . . .

Just at this moment her head struck against the roof of the hall; in fact, she was now rather more than nine feet high, and she at once took up the little golden key and hurried off to the garden door.

Poor Alice! It was as much as she could do, lying down on one side, to look through into the garden with one eye, but to get through was more hopeless than ever. She sat down and began to cry again.

"You ought to be ashamed of yourself," said Alice, "a great girl like you" (she might well say this), "to go on crying in this way! Stop this moment, I tell you!"

But she went on all the same, shedding gallons of tears, until there was a large pool all around her, about four inches deep and reaching half down the hall.

After a time she heard a little pattering of feet in the distance, and she hastily dried her eyes to see what was coming. It was the White Rabbit returning splendidly dressed, with a pair of white kid gloves in one hand and a large fan in the other. He came trotting along in a great hurry, muttering to himself as he came: "Oh, the Duchess! the Duchess! Oh! *Won't* she be savage if I've kept her waiting!"

Alice felt so desperate that she was ready to ask help of anyone; so, when the Rabbit came near her, she began, in a low, timid voice:

"If you please, sir—"

The Rabbit started violently, dropped the white kid gloves and the fan, and skurried away into the darkness as hard as he could go.

Alice took up the fan and gloves, and, as the hall was very hot, she kept fanning herself all the time she went on talking:

"Dear, dear! How queer everything is today! And yesterday things went on just as usual. I wonder if I've been changed in the night? Let me think: was I the same when I got up this morning? I almost think I can remember feeling a little different. But if I'm not the same, the next question is: Who in the world am I? Ah, *that's* the great puzzle!"

And she began thinking over all the children she knew that were of the same age as herself, to see if she could have been changed for any of them.

"I'm sure I'm not Ada," she said, "for her hair goes in such long ringlets, and mine doesn't go in ringlets at all; and I'm sure I can't be Mabel, for I know all sorts of things, and she, oh, she knows such a very little! Besides, *she's* she, and *I'm* I, and—oh dear, how puzzling it all is! I'll try if I know all the things I used to know. Let me see: four times five is twelve, and four times six is thirteen, and four times seven is—oh dear, I shall never get to twenty at that rate! However, the multiplication table doesn't signify; let's try geography. London is the capital of Paris, and Paris is the capital of Rome, and Rome —no, *that's* all wrong, I'm certain. I must have been changed for Mabel. I'll try and say 'How doth the little—' " And she crossed her hands on her lap as if she were saying lessons, and began to repeat it, but her voice sounded hoarse and strange, and the words did not come the same as they used to do:

"How doth the little crocodile
Improve his shining tail,
And pour the waters of the Nile
On every golden scale!

"How cheerfully he seems to grin,
How neatly spreads his claws,
And welcomes little fishes in
With gently smiling jaws!"

"I'm sure those are not the right words," said poor Alice, and her eyes filled with tears again as she went on, "I must be Mabel after all." . . . .

As she said this she looked down at her hands, and was surprised to see that she had put on one of the Rabbit's little white gloves while she was talking.

"How *can* I have done that?" she thought. "I must be growing small again."

She got up, and went to the table to measure herself by it, and found that, as nearly as she could guess, she was now about two feet high, and was going on shrinking rapidly. She soon found out that the cause of this was the fan she was holding, and she dropped it hastily, just in time to save herself from shrinking away altogether.

"That *was* a narrow escape," said Alice, a good deal frightened at the sudden change, but very glad to find herself still in existence; "and now for the garden." And she ran with all speed back to the little door; but, alas! the little door was shut again, and the little golden key was lying on the glass table as before, "and things are worse than ever," thought the poor child, "for I never was so small as this before, never! And I declare it's too bad, that it is!"

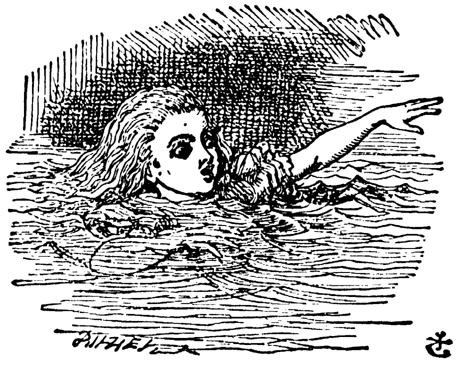
As she said these words her foot slipped, and in another moment, splash! she was up to her chin in salt water. Her first idea was that she had somehow fallen into the sea. . . . However, she soon made out that she was in the pool of tears which she had wept when she was nine feet high.

"I wish I hadn't cried so much," said Alice, as she swam about, trying to find her way out. "I shall be punished for it now, I suppose, by being drowned in my own tears. That *will* be a queer thing, to be sure. However, everything is queer today."

Just then she heard something splashing about in the pool a little way off, and she swam nearer to make out what it was. At first she thought it must be a walrus or hippopotamus, but then she remembered how small she was now, and she soon made out that it was only a mouse that had slipped in like herself.

"Would it be of any use, now," thought Alice, "to speak to this mouse? Everything is so out-of-the-way down here that I should think very likely it can talk; at any rate, there's no harm in trying." So she began: "O Mouse, do you know the way out of this pool? I am very tired of swimming about here, O Mouse." (Alice thought this must be the right way of speaking to a mouse; she had never done such a thing before, but she remembered having seen in her brother's Latin Grammar, "A Mouse—of a mouse—to a mouse—a mouse—O mouse.") The Mouse looked at her rather inquisitively, and seemed to her to wink with one of its little eyes, but it said nothing.

"Perhaps it doesn't understand English," thought Alice; "I dare say it's a French mouse come over with William the Conquerer." So she began again: "Où est ma chatte?" which was the first sentence in her French lesson book. The Mouse gave a sudden leap out of the water, and seemed to quiver all over with fright. "Oh, I beg your pardon!" cried Alice hastily, afraid that she had hurt the poor



animal's feelings. "I quite forgot you don't like cats."

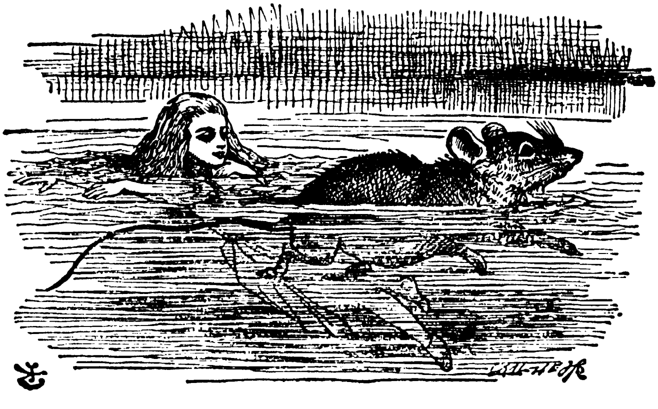
"Not like cats!" cried the Mouse, in a shrill, passionate voice. "Would *you* like cats if you were me?"

"Well, perhaps not," said Alice, in a soothing tone; "don't be angry about it. And yet I wish I could show you our cat Dinah; I think you'd take a fancy to cats if you could only see her. She is such a dear quiet thing," Alice went on, half to herself, as she swam lazily about in the pool, "and she sits purring so nicely by the fire, licking her paws and washing her face; and she is such a nice soft thing to nurse, and she's such a capital one for catching mice— Oh, I beg your pardon!" cried Alice again, for this time the Mouse was bristling all over, and she felt certain it must be really offended. "We won't talk about her any more if you'd rather not."

"We indeed!" cried the Mouse, who was trembling down to the end of its tail. "As if *I* would talk on such a subject! Our family always hated cats—nasty, low, vulgar things! Don't let me hear the name again!"

"I won't, indeed!" said Alice, in a great hurry to change the subject of conversation.

"Are you — are you fond —of—of dogs?" The Mouse did not answer, so Alice went on eagerly: "There is such a nice little dog near our house I should like to show you. A little bright-eyed terrier, you know, with oh, such long curly brown hair! And it'll fetch things when you throw them and it'll sit up and beg for its dinner, and all sorts of things. I can't remember half of them—and it belongs to a farmer, you know and he says it's so useful, it's worth a hundred pounds! He says it kills all the rats and— Oh dear!" cried Alice in a sorrowful tone. "I'm afraid I've offended it again." For the Mouse was swimming away from her as hard as it could go, and making quite a commotion in the pool as it went.



So she called softly after it:

"Mouse, dear! Do come back again, and we won't talk about cats or dogs either, if you don't like them!" When the Mouse heard this, it turned round and swam slowly back to her; its face was quite pale (with passion, Alice thought), and it said in a low, trembling voice: "Let us get to the shore, and then I'll tell you my history, and you'll understand why it is I hate cats and dogs."

It was high time to go, for the pool was getting quite crowded with the birds and animals that had fallen into it; there were a Duck and a Dodo, a Lory and an Eaglet, and several other curious creatures. Alice led the way, and the whole party swam to the shore.

III

They were indeed a queer-looking party that assembled on the bank—the birds with draggled feathers, the animals with their fur clinging to them, and all dripping wet, cross and uncomfortable.

The first question, of course, was how to get dry again; they had a consultation about this. . . . At last the Mouse tried to dry them out by reciting dry stories from history. But after some time Alice said she was as wet as ever. So they decided to hold a Caucus race. In this strange sort of race they all started off when they liked and stopped when they liked so that it was not easy to know when the race was over. However, when they had been running half an hour or so, and were quite dry again, the Dodo suddenly called out, "The race is over!" and they all crowded round it, panting, and asking, "But who has won?"

This question the Dodo could not answer without a great deal of thought, and it sat for a long time with one finger pressed upon its forehead while the rest waited in silence. At last the Dodo said, "*Everybody* has won, and all must have prizes."

"But who is to give the prizes?" quite a chorus of voices asked.

"Why, *she*, of course," said the Dodo, pointing to Alice with one finger; and the whole party at once crowded round her, calling out in a confused way, "Prizes, prizes!"

Alice had no idea what to do, and in despair she put her hand into her pocket, and pulled out a box of comfits (luckily the salt water had not got into it), and handed them round as prizes. There was exactly one a-piece, all round.

"But she must have a prize herself, you know," said the Mouse.

"Of course," the Dodo replied very gravely. "What else have you got in your pocket?" he went on, turning to Alice.

"Only a thimble," said Alice sadly.

"Hand it over here," said the Dodo.

Then they all crowded round her once more, while the Dodo solemnly presented the thimble, saying, "We beg your acceptance of this elegant thimble"; and, when it had finished this short speech, they all cheered.

Alice thought the whole thing very absurd, but they all looked so grave that she did not dare to laugh, and as she could not think of anything to say, she simply bowed, and took the thimble, looking as solemn as she could.

The next thing was to eat the comfits: this caused some noise and confusion, as the large birds complained that they could not taste theirs, and the small ones choked and had to be patted on the back. However, it was over at last, and they sat down again in a ring, and begged the Mouse to tell them something more.

"Mine is a long and sad tale," said the Mouse, sighing.

"It *is* a long tail, certainly" said Alice, looking down with wonder at the Mouse's tail; "but why do you call it sad?" And she kept on puzzling about it while the Mouse was speaking, so that her idea of the tale was something like this:

———"Fury said to
a mouse, That
he met
in the
house,
'Let us
both go
to law:
I will
prosecute
you.—

Come, I'll
take no
denial:
We must
have a
trial;
For
really
this
morning
I've
nothing
to do.'

Said the
mouse to
the cur,
'Such a
trial,
dear sir,
With no
jury or
judge,
would be
wasting
our breath.'

'I'll be
judge,
I'll be
jury,
said
cunning
old Fury;
'I'll try
the whole
cause,
and
condemn
you
to
death.' "

Alice soon offended the Mouse, which was very sensitive, and it went off in a huff. Then when she mentioned Dinah to the others, and

told them that was the name of her cat, the birds got uneasy, and one by one the whole party gradually went off and left her all alone. Just when she was beginning to cry, she heard a pattering of little feet, and half thought it might be the Mouse coming back to finish its story.

IV

It was the White Rabbit, trotting slowly back again, and looking anxiously about as he went, as if he had lost something; and she heard him muttering to himself: "The Duchess! The Duchess! Oh, my dear paws! Oh, my fur and whiskers! She'll get me executed, as sure as ferrets are ferrets! Where *can* I have dropped them I wonder?" Alice guessed in a moment that he was looking for the fan and the pair of white kid gloves, and she very good-naturedly began hunting about for them, but they were nowhere to be seen—everything seemed to have changed since her swim in the pool, and the great hall, with the glass table and the little door, had vanished completely.

Very soon the Rabbit noticed Alice, as she went hunting about, and called out to her in an angry tone: "Why, Mary Ann, what *are* you doing out here? Run home this moment, and fetch me a pair of gloves and a fan. Quick, now!" And Alice was so much frightened that she ran off at once in the direction he pointed to, without trying to explain the mistake that he had made.

"He took me for his housemaid," she said to herself as she ran. "How surprised he'll be when he finds out who I am! But I'd better take him his fan and gloves—that is, if I can find them." As she said this, she came upon a neat little house, on the door of which was a bright brass plate with the name W. RABBIT engraved upon it. She went in without knocking, and hurried upstairs, in great fear lest she should meet the real Mary Ann and be turned out of the house before she had been able to find the fan and gloves.

"How queer it seems," Alice said to herself, "to be going messages for a rabbit! I suppose Dinah'll be sending me on messages next."

By this time she had found her way into a tidy little room with a table in the window, and on it—as she had hoped—a fan and two or three pairs of tiny white kid gloves. She took up the fan and a pair of the gloves, and was just going to leave the room when her eye fell upon a little bottle that stood near the looking-glass. There was no label this time with the words DRINK ME, but, nevertheless, she uncorked it and put it to her lips.

"I know *something* interesting is sure to happen," she said to herself, "whenever I eat or drink anything; so I'll just see what this bottle does. I do hope it'll make me grow large again, for really I'm quite tired of being such a tiny little thing."

It did so, indeed, and much sooner than she had expected; before she had drunk half the bottle, she found her head pressing against the ceiling, and had to stoop to save her neck from being broken. . . . She went on growing and growing, and very soon had to kneel down on the floor; in another minute there was not even room for this, and she tried the effect of lying down with one elbow against the door, and the other arm curled round her head.

Still she went on growing, and, as a last resource, she put one arm out of the window, and one foot up the chimney, and said to herself:

"Now I can do no more, whatever happens. What *will* become of me?"

Luckily for Alice, the little magic bottle had now had its full effect, and she grew no larger; still, it was very uncomfortable, and, as there seemed to be no sort of chance of her ever getting out of the room again, no wonder she felt unhappy.

"It was much pleasanter at home," thought poor Alice, "when one wasn't always growing larger and smaller, and being ordered about by mice and rabbits. I almost wish I hadn't gone down this rabbit-hole; and yet — and yet — it's rather curious, you know, this sort of life. I do wonder what *can* have happened to me! When I used to read fairy tales, I fancied that kind of thing never happened, and now here I am in the middle of one." . . .

After a few minutes she heard a voice outside, and stopped to listen.

"Mary Ann! Mary Ann!" said the voice. "Fetch me my gloves this moment!" Then came a little pattering of feet on the stairs. Alice knew it was the Rabbit coming to look for her, and she trembled till she shook the house, quite forgetting that she was now about a thousand times as large as the Rabbit, and had no reason to be afraid of him.

Presently the Rabbit came up to the door, and tried to open it; but, as the door opened inwards, and Alice's elbow was pressed hard against it, that attempt proved a failure. Alice heard him say to himself: "Then I'll go round and get in at the window."

"That you won't," thought Alice, and, after waiting till she fancied she heard the Rabbit just under the window, she suddenly spread out her hand, and made a snatch in the air. She did not get hold of anything, but she heard a litle shriek and a fall, and a crash of broken glass, from which she concluded that it was just possible he had fallen into a cucumber-frame, or something of the sort.

Next came an angry voice, the Rabbit's:

"Pat! Pat! Where are you?" And then a voice she had never heard before: "Sure then, I'm here. Digging for apples, yer honor."

"Digging for apples, indeed!" said the Rabbit angrily. "Here! Come and help me out of *this!"* (Sounds of more broken glass.)

"Now tell me, Pat, what's that in the window?"

"Sure, it's an arm, yer honor." (He pronounced it "arrum.")

"An arm, you goose! Who ever saw one that size? Why, it fills the whole window!"

"Sure, it does, yer honor; but it's an arm for all that."

"Well, it's got no business there, at any rate; go and take it away."

There was a long silence after this, and Alice could only hear whispers now and then, such as: "Sure, I don't like it, yer honor, at all—at all." "Do as I tell you, you coward!"

And at last she spread out her hand again, and made another snatch in the air.

This time there were *two* little shrieks, and more sounds of broken glass.

"What a number of cucumber-frames there must

be!" thought Alice. "I wonder what they'll do next? As for pulling me out of the window, I only wish they *could.* I'm sure I don't want to stay in here any longer."

She waited for some time without hearing anything more. At last came a rumbling of little cart-wheels, and the sound of a good many voices all talking together; she made out the words: "Where's the other ladder? Why, I hadn't to bring but one; Bill's got the other. Bill, fetch it here, lad. Here, put 'em up at this corner. No, tie 'em together first, they don't reach half high enough yet. Oh, they'll do well enough; don't be particular! Here, Bill, catch hold of this rope! Will the roof bear? Mind that loose slate! Oh, it's coming down! Heads, below!" (a loud crash). "Now, who did that? It was Bill, I fancy. Who's to go down the chimney? Nay, *I* shan't. *You* do it? *That* I won't, then! Bill's got to go down. Here, Bill, the master says you've got to go down the chimney!"

"Oh! So Bill's got to come down the chimney, has he?" said Alice to herself. "Why, they seem to put everything upon Bill. I wouldn't be in Bill's place for a good deal; this fireplace is narrow, to be sure; but I *think* I can kick a little."

She drew her foot as far down the chimney as she could, and waited till she heard a little animal (she couldn't guess of what sort it was) scratching and scrambling about in the chimney close above her; then, saying to herself, "This is Bill," she gave one sharp kick, and waited to see what would happen next.

The first thing she heard was a general chorus of "There goes Bill!" then the Rabbit's voice alone: "Catch him, you by the hedge!" Then silence, and then another confusion of voices: "Hold up his head. Brandy now. Don't choke him. How was it, old fellow? What happened to you? Tell us all about it."

Last came a little squeaking voice. ("That's Bill," thought Alice.) "Well, I hardly know. No more, thank ye; I'm better now, but I'm a deal too flustered to tell you. All I know is, something comes at me like a Jack-in-the-box, and up I goes like a skyrocket."

"So you did, old fellow," said the voices of the others, speaking in chorus.

"We must burn the house down," said the Rabbit's voice.

And Alice called out as loud as she could: "If you do, I'll set Dinah at you."

There was dead silence instantly, and Alice thought to herself: "I wonder what they *will* do next? If they had any sense, they'd take the roof off." After a minute or two, they began moving about again, and Alice heard the Rabbit say: "A barrowful will do to begin with."

"A barrowful of *what?*" thought Alice. But she had not long to doubt, for the next moment a shower of little pebbles came rattling in at the window, and some of them hit her in the face. "I'll put a stop to this," she said to herself, and shouted out: "You'd better not do that again!" which produced another dead silence.

Alice noticed, with some surprise, that the pebbles were all turning into little cakes as they lay on the floor, and a bright idea came into her head.

"If I eat one of these cakes," she thought, "it's sure to make some change in my size; and, as it can't possibly make me larger, it must make me smaller, I suppose."

So she swallowed one of the cakes, and was delighted to find that she began shrinking directly. As soon as she was small enough to get through the door, she ran out of the house, and found quite a crowd of little animals and birds waiting outside. The poor little Lizard, Bill, was in the middle, being held up by two guinea-pigs, who were giving it something out of a bottle. They all made a rush at Alice the moment she appeared; but she ran off as hard as she could, and soon found herself safe in a thick wood.

V

Once in the wood, she was anxious to get back to her right size again, and then to get into that lovely garden. But how? Just then she saw an enormous puppy looking down at her from among the trees. She held up a stick for it to catch, and the next moment it was playing with great delight; but as Alice was so small and the puppy so large, she was in danger of getting hurt by it, so she escaped when it was out of breath. If she could only get something to eat or drink, she was sure something would happen to her. Peeping over a mushroom, she beheld a large blue caterpillar sitting on the top with its arms folded, quietly smoking a long hookah, and taking not the smallest notice of her or of anything else. At length, in a sleepy sort of way, it began talking to her, and she told it what she wanted so much — to grow to her right size again.

"I should like to be a *little* longer," she said. "Three inches is such a wretched height to be."

"It is a very good height indeed," said the Caterpillar angrily, rearing itself upright as it spoke (it was exactly three inches high).

"But I'm not used to it," pleaded poor Alice in a piteous tone. And she thought to herself: "I wish the creatures wouldn't be so easily offended."

"You'll get used to it in time," said the Caterpillar; and it put the hookah into its mouth and began smoking again.

This time Alice waited patiently until it chose to speak again. In a minute or two the Caterpillar took the hookah out of its mouth and yawned once or twice, and shook itself. Then it got down off the mushroom, and crawled away into the grass, merely remarking as it went: "One side will make you grow taller, and the other side will make you grow shorter."

"One side of *what?* The other side of *what?*" thought Alice to herself.

"Of the mushroom," said the Caterpillar, just as if she had asked it aloud; and in another moment it was out of sight.

Alice remained looking thoughtfully at the mushroom for a minute, trying to make out which were the two sides of it; and as it was perfectly round, she found this a very difficult question. However, at last she stretched her arms round it as far as they would go, and broke off a bit of the edge with each hand.

"And now which is which?" she said to herself, and nibbled a little of the right-hand bit to try the effect. The next moment she felt a violent blow underneath her chin; it had struck her foot!

She was a good deal frightened by this very sudden change, but she felt that there was no time to be lost, as she was shrinking rapidly; so she set to work at once to eat

get her head down to *them,* and was delighted to find that her neck would bend about easily in any direction, like a serpent. She had just succeeded in curving it down into a graceful zigzag, and was going to dive in among the leaves, which she found to be nothing but the tops of the trees under which she had been wandering, when a sharp hiss made her draw back in a hurry: a large pigeon had flown into her face, and was beating her violently with its wings.

"Serpent!" screamed the Pigeon.

Alice was at last able to convince the pigeon that, in spite of her long neck, she was not a serpent, and was not looking for pigeon's eggs to eat.

"Well, be off, then!" said the Pigeon in a sulky tone, as it settled down again into its nest. Alice crouched down among the trees as well as she could, for her neck kept getting entangled among the branches, and every now and then she had to stop and untwist it. After a while she remembered that she still held the pieces of mushroom

some of the other bit. Her chin was pressed so closely against her foot that there was hardly room to open her mouth; but she did it at last, and managed to swallow a morsel of the left-hand bit.

"Come, my head's free at last!" said Alice in a tone of delight, which changed into alarm in another moment, when she found that her shoulders were nowhere to be found: all she could see, when she looked down, was an immense length of neck, which seemed to rise like a stalk out of a sea of green leaves that lay far below her.

"What *can* all that green stuff be?" said Alice. "And where *have* my shoulders got to? And oh, my poor hands, how is it I can't see you?" She was moving them about as she spoke, but no result seemed to follow, except a little shaking among the distant green leaves.

As there seemed to be no chance of getting her hands up to her head, she tried to

in her hands, and she set to work very carefully, nibbling first at one and then at the other, and growing sometimes taller and sometimes shorter, until she had succeeded in bringing herself down to her usual height.

It was so long since she had been anything near the right size, that it felt quite strange

at first; but she got used to it in a few minutes. The next thing was, to get into that beautiful garden. Just then Alice came suddenly upon an open place, with a little house in it about four feet high. "Whoever lives there," thought Alice, "it'll never do to come upon them this size: why, I should frighten them out of their wits!" So she began nibbling at the right-hand bit again, and did not venture to go near the house till she had brought herself down to nine inches high.

VI

Outside the house she saw a Fish-footman bringing to a Frog-footman an invitation from the Queen to the Duchess, asking her to play croquet. The Duchess lived in the house, and a terrible noise was going on inside, and when the door was opened a plate came crashing out. But Alice got in at last, and found a strange state of things. The door led right into a large kitchen, which was full of smoke from one end to the other: the Duchess was sitting on a three-legged stool in the middle, nursing a baby; the cook was leaning over the fire, stirring a large caldron which seemed to be full of soup.

"There's certainly too much pepper in that soup!" Alice said to herself, as well as she could for sneezing.

There was certainly too much of it in the air. Even the Duchess sneezed occasionally; and as for the baby, it was sneezing and howling alternately without a moment's pause. The only two creatures in the kitchen that did not sneeze were the cook, and a large cat which was sitting on the hearth and grinning from ear to ear.

"Please, would you tell me," said Alice, a little timidly, for she was not quite sure whether it was good manners for her to speak first, "why your cat grins like that?"

"It's a Cheshire cat," said the Duchess, "and that's why. Pig!"

She said the last word with such sudden violence that Alice quite jumped; but she saw in another moment that it was addressed to the baby, and not to her, so she took courage, and went on again:

"I didn't know that Cheshire cats always grinned; in fact, I didn't know that cats *could* grin."

"You don't know much," said the Duchess; "and that's a fact."

At this point the cook took the caldron of soup off the fire, and set to work throwing everything within her reach at the Duchess and the baby.

"Oh, *please* mind what you are doing!" cried Alice, jumping up and down in an agony of terror. "Oh, there goes his *precious* nose!" as an unusually large saucepan flew close by.

"Here! you may nurse it a bit, if you like!" said the Duchess to Alice, flinging the baby at her as she spoke. Alice took the baby outdoors, and, behold, it turned into a little pig, jumped out of her arms and ran away into the wood.

"If it had grown up," she said, "it would have made a dreadfully ugly child; but it makes rather a handsome pig, I think."

She was a little startled now by seeing the Cheshire Cat — which she had first seen in the house of the Duchess—sitting on a bough of a tree a few yards off. The Cat only grinned when it saw Alice. It looked good-natured, she thought; still, it had *very* long claws and a great many teeth, so she felt that it ought to be treated with respect.

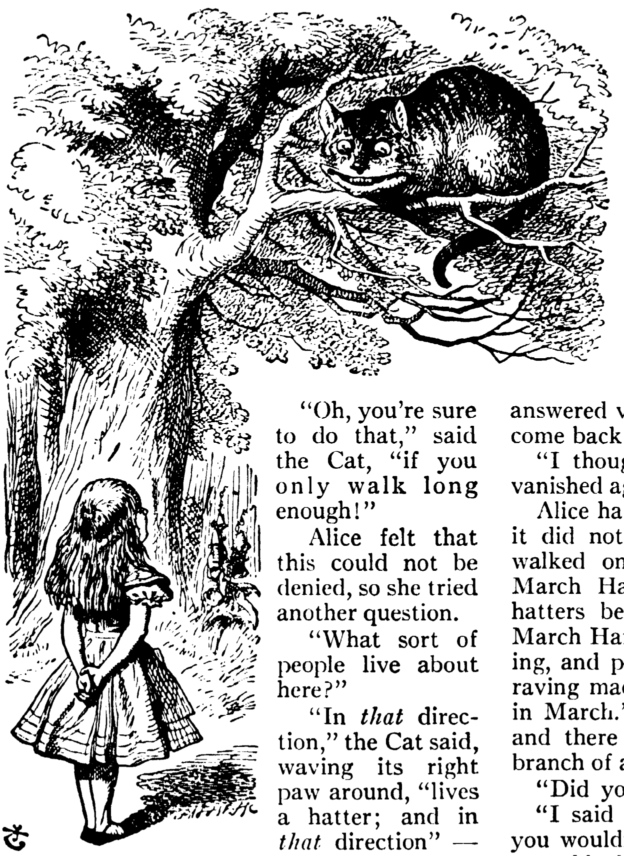
"Cheshire Puss," she began rather timidly, as she did not at all know whether it would like the name; however, it only grinned a little wider. "Come, it's pleased so far," thought Alice, and she went on: "Would you tell me please, which way I ought to walk from here?"

"That depends a good deal on where you want to get to," said the Cat.

"I don't much care where—" said Alice.

"Then it doesn't matter which way you walk," said the Cat.

"So long as I get *somewhere,*" Alice added as an explanation.



"Oh, you're sure to do that," said the Cat, "if you only walk long enough!"

Alice felt that this could not be denied, so she tried another question.

"What sort of people live about here?"

"In *that* direction," the Cat said, waving its right paw around, "lives a hatter; and in *that* direction" — waving the other paw — "lives a March Hare. Visit either you like; they're both mad."

"But I don't want to go among mad people," Alice remarked.

"Oh, you can't help that," said the Cat; "we're all mad here! I'm mad. You're mad."

"How do you know I'm mad?" said Alice.

"You must be," said the Cat, "or you wouldn't have come here."

Alice didn't think that proved it at all; however, she went on: "And how do you know that you're mad?"

"To begin with," said the Cat, "a dog's not mad. You grant that?"

"I suppose so," said Alice.

"Well, then," the Cat went on, "you see, a dog growls when it's angry, and wags its tail when it's pleased. Now, *I* growl when I'm pleased, and wag my tail when I'm angry. Therefore I'm mad."

"*I* call it purring, not growling," said Alice.

"Call it what you like," said the Cat. "Do you play croquet with the Queen to-day?"

"I should like it very much," said Alice, "but I haven't been invited yet."

"You'll see me there," said the Cat, and vanished. . . . Alice waited a little, and while she was still looking at the place where it had been, it suddenly appeared again.

"By-the-by, what became of the baby?" said the Cat. "I'd nearly forgotten to ask."

"It turned into a pig," Alice answered very quietly, just as if the Cat had come back in a natural way.

"I thought it would," said the Cat, and vanished again.

Alice half expected it to appear again, but it did not; so after a minute or two she walked on in the direction in which the March Hare was said to live. "I've seen hatters before," she said to herself; "the March Hare will be much the more interesting, and perhaps as this is May it won't be raving mad—at least, not so mad as it was in March." As she said this, she looked up, and there was the Cat again, sitting on a branch of a tree.

"Did you say pig, or fig?" said the Cat.

"I said pig," replied Alice; "and I wish you wouldn't keep appearing and vanishing so suddenly; you make one quite giddy."

"All right," said the Cat; and this time it vanished quite slowly, beginning with the end of the tail, and ending with the grin, which remained after the rest of it had gone.

"Well, I've often seen a cat without a grin," thought Alice; "but a grin without a cat! It's the most curious thing I ever saw in all my life."

She had not gone much farther before she came in sight of the house of the March Hare; she thought it must be the right house, because the chimneys were shaped like ears and the roof was thatched with fur. It was so large a house that she did not like to go nearer till she had nibbled some more of the left-hand bit of mushroom, and raised herself to about two feet high; even then she walked up towards it rather timidly, saying to herself: "Suppose it should be raving mad after all. I almost wish I'd gone to see the Hatter."

THE NEXT STORIES ARE ON PAGE 1178.

A picture by Bernardino Luini, showing Jesus among the doctors, National Gallery, London.

VENICE RISES AND ITALY WANES

IT would seem that when Leonardo da Vinci, Michelangelo and Raphael had made their supreme gifts to the world's store of beauty, great Italy had done her share of giving and doing; she might well have folded her hands and rested. But one of the most amazing features in the history of painting in that glorious country is the rise of the school of Venice, the lovely, haunting city set like a jewel on an arm of the sea.

The early art of Venice centres round two men, one an artist and the father of artists, Jacopo Bellini, and the other a dealer in antiques, Squarcione. In Padua, neighbor to Venice, Squarcione had his shop, and round him gathered a group of artists. Squarcione may indeed be called the founder of the Paduan school, from which Venice gained her first lessons in painting.

Squarcione, a strange and eager man with an overwhelming love for beautiful things, had traveled much about Italy, and had also spent some time in Greece. In his wanderings he made a collection of works of art, among them some fragments of Greek sculpture which awakened intense interest among the Paduan group of students. One of these, Mantegna, Squarcione presently adopted as his son, and through this young and powerful genius the Paduan school learned to love and follow Greek art. Through all the work of Mantegna we can see that he was seeking the classic ideal. His forms have the clear lines and the firmness of sculpture. His art is one of the loftiest, and perhaps the coldest, that Italy produced.

Donatello's bronzes made a strong impression upon Mantegna's art; and another influence was that of the Bellini family, into which he married. In 1459, at the age of twenty-eight, he went to Mantua to work under the patronage of the Gonzaga family, painting their portraits and decorating their palaces with scenes of court life. His greatest works are his admirable frescoes in Padua and Mantua. He left also a collection of pictures, drawings and engravings which are treasured in various galleries. In Mantegna's later work he allows his feeling for shape and line to override any sense of color he may have possessed, and produces a monochrome (one-color) effect.

Jacopo Bellini, of whose work little remains, is overshadowed by his sons, Giovanni and Gentile, who were the first great masters of Venice. But although through the Bellinis Paduan art became the inspiration of Venetian, another slight influence was at work in the paintings of artists on the island of Murano.

The best men of this little colony were the Vivarini family. Alvise Vivarini worked as a pupil in the studio of his father Bartolommeo, and the style of the two men was very like in spirit to the Sienese. There is a picture by the elder Vivarini in the National Gallery, London; but his greatest work, and that of his son, is at Venice. A pupil of Alvise was Lorenzo Lotto, whose paintings show something of the Sienese spirit, and a peculiar gentle sadness which perhaps we may say was the outcome of his own temperament.

THE MAN WHO GAVE VENICE THE IDEA OF PAINTING IN OILS

During the time the Bellinis were working an artist called Antonello da Messina is said to have brought to Venice from Flanders, where he had been working, the method of painting in oil, an innovation of the highest importance to Venice. Antonello was a painter who, in an epoch less crowded with great men, would have gained far more distinction. His best work is portraiture. The finest examples are the Condottiere, in the Louvre, and Portrait of a Man, now in a private house in Milan. Another of his portraits—supposed to be of himself—is in the National Gallery, London, together with a picture which is his earliest signed work—The Saviour—a painting of the Crucifixion, and another of St. Jerome in his Study.

The Venetian artists, adopting oil as a medium, did not use it as we understand it now. They still painted in tempera, where the pigment coloring-matter is mixed with white of egg, and when the picture was fully worked out, and almost finished, they added the final coat in oil. This method, however, made a vast difference to the progress of painting in Venice, where damp and misty airs played havoc with exposed fresco and pure tempera.

THE MEN WHO GAVE VENICE ITS FINE PICTURES OF PAGEANTS

The careers of Gentile and Giovanni Bellini together cover the great years of Venetian painting. In the work of these two men, with Crivelli, another pupil of Alvise Vivarini, we see the growth of the peculiar qualities which were to mark Venetian art for another century and a half. For the first time in the history of Italian painting color was considered as part of the making of a picture, and not added as an after-thought.

With the Bellini school began the pageant pictures so natural to a city where civic and religious processions of an amazing brilliance took place, when the doge and his followers showed themselves as a mass of bewilderingly beautiful color against the fair and lovely background of Venetian streets and waterways. This was the kind of picture the people of Venice hailed with great delight. They gloried in the pageantry of pictures like Gentile Bellini's Corpus Christi, or Preaching of St. Mark, or the St. Ursula pictures by Carpaccio, a pupil of Gentile.

The Bellinis and their friends were not concerned with the meaning of things—rather with their brightness and beauty. Some of their portraits are magnificent, such as that of the Doge Leonardo Loredano, by Giovanni, in the National Gallery, London. They painted religious subjects rather because they made great pictures than because they had a spiritual significance.

PICTURES THAT STIR THE HEART AFTER CENTURIES OF CHANGE

Only a few pictures by Gentile Bellini are left in the world, and the best of those are at Venice. His pageant pictures give an unusual effect of open air. An Oriental touch in some of his works is explained by his having gone to Constantinople in 1479, when the Sultan asked the Government of Venice to send their best painter.

It has been said that Giovanni Bellini was a whole school in himself. He went through many stages, absorbing and showing in his work the various changes through which Venetian art passed during his long lifetime and in different men's hands, from Mantegna to Titian. He painted chiefly religious subjects and allegories. His most notable weakness, perhaps, is that he could not express movement. The beauties of noble form, soft color and rich tone which we call truly Venetian are found first in his pictures. Giovanni's influence stirred all the neighborhood, rising in a crescendo of greatness to Titian, his immortal pupil. Many men owed their training and ideals to him, including Carpaccio and Cima da Conegliano. Carpaccio is remarkable as a great illustrator, a story-teller; and Cima as a painter of gentle, charming women represented as saints.

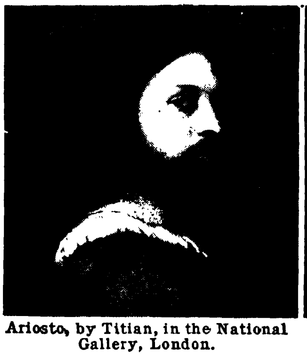
PICTURES FROM ITALY'S GREAT DAYS

Doge Giovanni Mocenigo, portrait by Gentile Bellini.

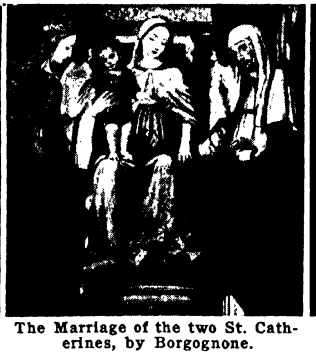
The Madonna of the Basket, by Correggio.

A portrait of himself, by Antonello da Messina.

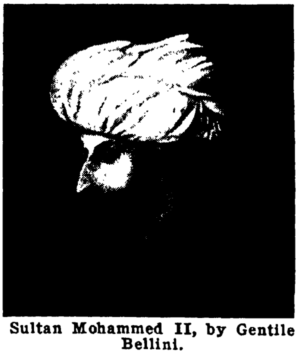
The Three Sisters, by Palma Vecchio.



Ariosto, by Titian, in the National Gallery, London.



The Marriage of the two St. Catherines, by Borgognone.



Sultan Mohammed II, by Gentile Bellini.

Many of the paintings in these pages are from photographs by Messrs. Alinari, Anderson, Hanfstaengl and Bruckmann.

Other artists, followers of Giovanni Bellini, were Giorgione (1477–1510), Palma Vecchio (1480–1528) and Sebastiano del Piombo (1485–1547). The first of these is far the greatest, and had a considerable effect not only on the other two but on many other artists of the day. In Giorgione's work all the light and color and richness of the Venetian school ran riot. Giorgione had discovered the witchery of nature's loveliness. He was one of the first to give landscape a place of equal importance with the figures. He has nothing to do with the asceticism underlying the work of many other Italian schools of painting, nothing to do with the fine seriousness of his master Giovanni Bellini. He is completely satisfied with the beauty of life in Venice, drenched in color, haloed by the sun, girdled by the sea. The paintings of Titian and Giorgione stand out because of this quality. Even after the passage of five hundred years, during which time their color and radiance have suffered, these pictures stir our hearts.

THE MARVELOUS ART AND INDUSTRY OF THE GREAT TITIAN

Giorgione died in the early thirties, and there are only about fifteen pictures of his in existence now. The Piping Shepherd in Hampton Court, England, is a rare and lovely piece of work, as are the Fête Champêtre, in the Louvre, the Virgin and Child and Saints, in the Church of Castelfranco.

The Bellinis and their followers are sometimes spoken of as the youth of art in Venice, Titian as its vigorous young manhood, Giorgione as an exuberance natural to both, Tintoretto as Venetian art in its glorious prime.

Titian, or Tiziano Vecelli, who began as a pupil of Giovanni Bellini, would have soared to greatness in whatever country and generation he had been born. He lived from 1477 to 1576.

He could watch and admire the work of other geniuses and could imitate it, but in doing so he would make the quality he sought altogether his own. All through his long lifetime he was working, experimenting, trying this style and that subject, and was always supremely great. If it were not for his industry we might think that his greatness grew like the lilies, without taking thought. When we look at his work, we realize that almost every picture was a separate adventure into which he flung the power and zest of his nature. He had nothing of the sorrowful gift of temperament, such as clouded Michelangelo's life with gray. He was a born pagan, and though he did much work of a religious character, he died a pagan, full of the happiness that the keen vision of beautiful things provokes.

THE MAN WHO COULD NOT HELP PAINTING LOVELY THINGS

By walking about for a few minutes in a gallery where the Italian schools are represented, we may be able to understand just what it is that makes the appeal of Titian—not the reason why artists worship the great Venetian, but the reason why he appeals to ourselves, those who are not artists.

We go first to the Sienese, and see what the first painters of Italy were about, see their bad drawing, their self-consciousness, the simple joy in painting which makes their wry-necked saints so interesting. Then we go to the Florentines, and see how carefully they were studying all the time—a little cold, utterly sure of their lines when once they had got them. If we are quite honest we may have to confess that we like many of these great men because we think we ought to, but when we get to the Venetian painters we are suddenly at home; we should like their pictures even if we were not taught that they were great; and Titian is the genius who in that way is at once our friend. He paints because he cannot help it, because the world is so full of beautiful things and he must set down what he sees.

Titian left a great pile of work for the joy of mankind, and it is now scattered in many different places. There are so many of his pictures in Madrid and Vienna that they in themselves give us a reason for wanting to visit those cities. Venice, of course, and Florence, are rich in treasures of Titian's work. Paris owns about a dozen, Dresden eight; in London there are nine or ten; and in collections in the United States the great Venetian is represented.

THE SPACIOUS AND INSPIRING PAINTINGS OF TINTORETTO

Tintoretto, called the Michelangelo of Venice, is not so near to everyday human taste as was Titian even in the gravity of his old age. Tintoretto sought huge and exacting problems in his work and seemed self-consciously to measure them with his own strength. His aim was to combine in his own work the design of Michelangelo and the color of Titian. Many of his pictures are large piled-up compositions in which space, figure-drawing, color, and light and shade make difficulties which only a genius could overcome. Two such pictures are The Massacre of the Innocents and The Presentation in the Temple—both in Venice.

THE TREMENDOUS WORK DONE BY THESE OLD ARTISTS

The color has faded in most of his larger pictures, and only in some of his portraits and small sketches do we get an idea of his palette. He turned away a little from the glowing warm color usual to Venetian painters, and worked in the silvery tones in which Titian himself, in his old age, was beginning to find pleasure.

As in the case of Titian, the number of paintings by Tintoretto in existence makes one wonder how these artists contrived to find time to eat and sleep. There are over a hundred of Tintoretto's paintings in Venice, twenty in Vienna, ten in Florence, and dozens scattered about in other towns of Europe. Others are in London and in the United States.

THE VERONA SCHOOL OF ARTISTS AND THEIR INFLUENCE

Tintoretto shared with an artist from Verona, Paolo Veronese, the last honors of sixteenth-century art in Venice. Verona was a dependency of Venice, and for three or four generations artists had been working there, creating a small school of their own and affecting very much the art life of neighboring towns. Paolo Veronese, the pupil of Brusascorci, was the outcome of this movement. He saw subjects more as pictures and less as figure-studies than did most of the painters of his day. He had a freshness and a serenity of his own, and though classed with the Venetians and imbued with their love of light and brilliant costume, he retained, throughout, his own personality. The feeling of his work is largely decorative. Italy was now under the Spanish domination, and in Paolo Veronese's work is reflected a little of the Spanish ceremonial and style of dress.

He painted, among many other works, a series of banquet scenes for the walls of refectories in monasteries. The most celebrated is the Marriage at Cana—an immense picture including 130 figures.

Here the great period of Venetian painting comes suddenly to an end. In the eighteenth century there was in Venice a strange and brief revival of Renaissance art, most beautifully born out of due time, in the work of Giovanni Battista Tiepolo, who really belongs to the sixteenth century. Venice was very little changed—still gay, pleasure-loving, rioting in color and sunlight; and this artist threw all her magic qualities into his pictures. A very fine specimen of his painting is the Adoration of the Magi, now at Munich. Two other artists who were working at about the same time were Guardi and Canaletto. They painted beautiful pictures of the city of the lagoons, full of light and space.

There were several minor schools in north Italy similar to those of Verona and Padua, and artists in these communities maintained a steady activity, even if they did not rise to great heights.

THE GOOD PAINTERS WHOSE PICTURES ARE PERHAPS TOO PRETTY

The Milanese school as a whole erred on the side of prettiness. Ambrogio Borgognone (about 1455–1523) is not so much open to this charge as many other artists of Milan. He painted some very fine religious subjects and a number of low-toned, beautiful landscapes with figures. Two of his pictures are in the National Gallery, London, but his best work is to be seen in his frescoes and altarpieces in Italy.

The Milanese school seemed to suffer from Leonardo da Vinci's visit to the town, as the great master's work found many imitators who could not aspire to his greatness and only parodied his style. Bernardino Luini was perhaps the weakest of these followers. His pictures are too finished, too charming. Some frescoes which Luini painted in the church of Saronno showed that he was capable of good painting, but for the most part his productions were merely "pretty."

The school of Brescia produced, among many artists of only passable merit, two painters—Moretto and Moroni. Their work can be best studied in Brescia, but various other cities of Europe and America possess excellent examples of their painting. Moroni painted only portraits, and was a pupil of Moretto, who painted frescoes and large group pictures as well as portraits, and who was the strongest representative of the school.

Correggio, who lived from 1494 to 1534,

exercised on Italian art of his own and the next century an influence almost as powerful as that of Michelangelo. He had the great Florentine's passion for form without his solemnity and grandeur, and he had a fatal facility—a kind of easy knack—for showing movement and foreshortening in figures which was only just balanced by his genius. This is shown in the wonderful painting of the Assumption, in the dome of Parma Cathedral, and in the Virgin and Child with St. George, in the Dresden Gallery. The artist's greatest fault was that he overcrowded his spaces.

THE STRIKING OF THE DEATH-KNELL OF ITALIAN ART

Correggio was, above all, a painter of beautiful women. His Madonnas are very lovely, a little too lovely, perhaps. He is happiest in his pictures of the women of Classical story. He is especially noted for his able handling of light and shade, which was never more skillfully treated than in his Holy Night, in the Royal Museum, Dresden. In this picture the light shining upon the group seems to radiate from the Infant in the manger.

In the late sixteenth century and the early seventeenth, art in Italy centred in Bologna. There a number of painters, headed by members of the family of Carracci, formed a school whose principle was that each artist should imitate the best qualities of the greatest Italian artists. In painting, after a student has mastered drawing he has still other problems to deal with: color treatment, space composition and perspective. A true artist solves these problems for himself, instead of trying to use another man's methods to save himself trouble. Although some of the work of the Carracci themselves was notable, and showed an instinct for greatness, their followers struck the death-knell of Italian art.

THE EMOTIONS AND THOUGHTS THAT GREAT ART REPRODUCES

In their work, instead of strength, we get prettiness; instead of portraits which show in a face the soul of a man or woman, we get a pleasing expression, a passing feeling—a smile, a frown, happiness on the surface, pain of the passing moment. Great art does not aim at easy effect; it is impersonal, and reaches beyond the accident of the hour. It reproduces those feelings and thoughts which are like the foundations of a person's character, and which in time can make a beautiful face repulsive and a plain face lovely.

If you see a portrait which reminds you of a photograph, as of a lady with a charming smile, and all the lines of age carefully touched out, be sure that portrait is poor art. Leonardo's famous Mona Lisa does not come under this ban, because in her subtle smile was expressed the woman's character, history and destiny. A face like Guido Reni's Ecce Homo, which appeals to a shallow emotion without appealing to reason and thought, is poor art.

The best men of the Carracci school of Bolognese art were Albano, Domenichino, Guido Reni and Guercino. In spite of their other weakness some of these artists were excellent decorators. Domenichino's Last Supper, and Guido Reni's Aurora, both in Rome, are sufficient proof of that.

HOW TO KNOW THE TRUE FROM THE FALSE IN ART

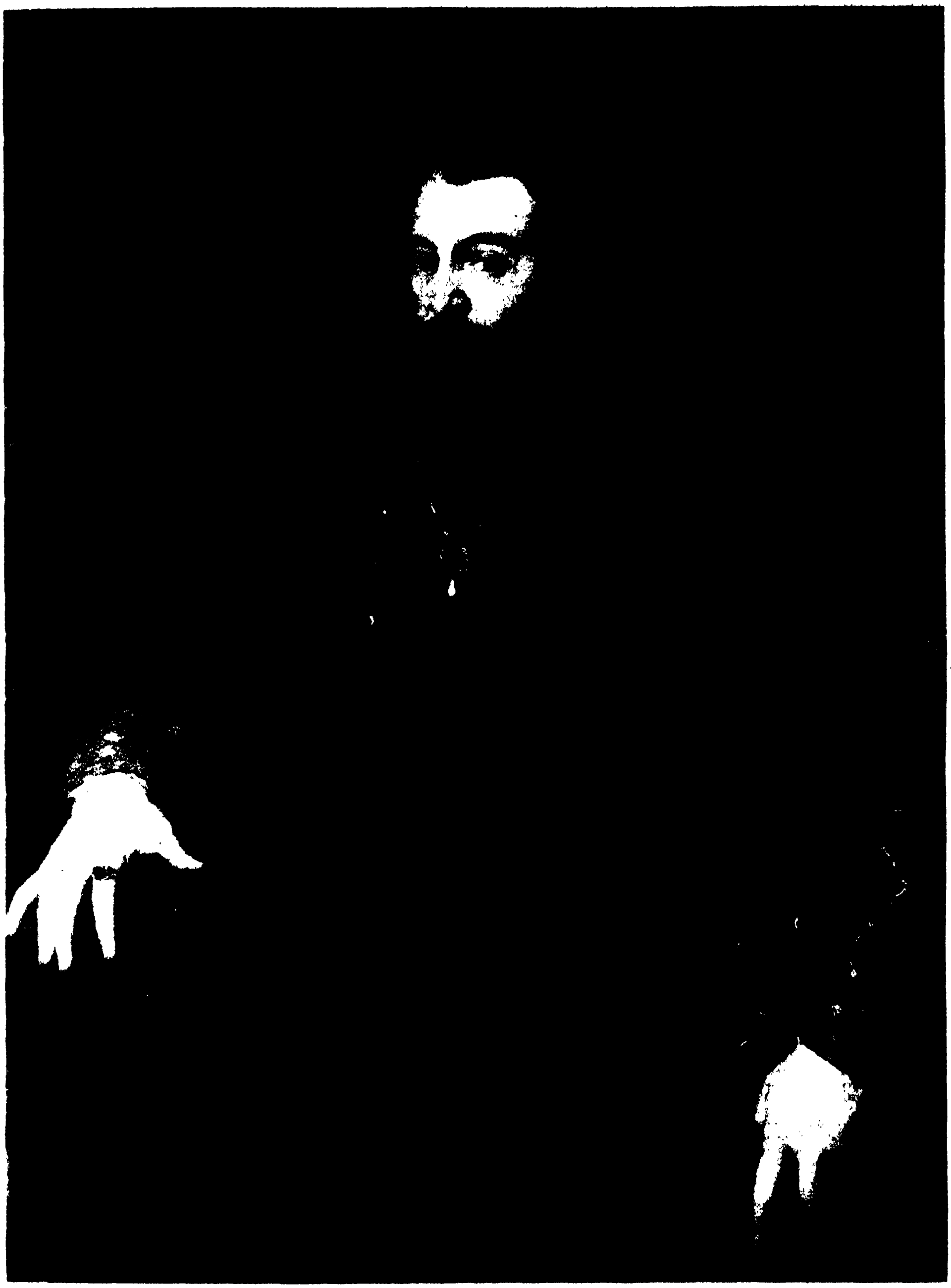
Presently an artist called Caravaggio came into prominence, and he turned his fellow-workers away from imitating and taught them a rather brutal realism. He went for most of his models to vulgar people and in his earlier pictures used genre subjects, such as card-players in an inn or gipsy fortune-tellers. Later he painted large religious groups, but the figures of the saints were sometimes coarse and unlovely. The really great one is a Burial of Christ, now in the Vatican.

An artist of Naples, Salvator Rosa, was a fine painter of landscape and war pictures, and he stands out as being stronger than the rest.

Unhappily, the artists of the decadent period in Italy produced an enormous number of pictures. They are seen in almost every gallery in Europe, and they have an easy triumph with people who have not had the advantage of learning to know the true from the false in art. This is not easy to know. The only way we can guard ourselves from false idols in the world of beauty is to have real acquaintance with the great. If we have once learned to love Michelangelo and Beethoven, we need not be afraid of liking the wrong kind of music and pictures; sooner or later the anchor will pull; Beethoven and Michelangelo, if we but trust them and listen to them, will set us right.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 1220.

PICTURES OF THE TIME OF TITIAN



Courtesy of the Metropolitan Museum of Art

THE PORTRAIT OF ALFONSO D'ESTE BY TITIAN, IN THE METROPOLITAN MUSEUM, NEW YORK

THE EMPRESS ISABELLA, BY TITIAN, IN THE PRADO, MADRID

A PORTRAIT, BY ANTONELLO DA MESSINA, IN ANTWERP MUSEUM

THE MADONNA AND CHILD, BY GIOVANNI BELLINI, VENICE

THE HOLY FAMILY WITH ST. PAUL AND ST. GEORGE, BY GIOVANNI BELLINI, THE ACADEMY, VENICE

AURORA, BY GUIDO RENI, IN THE VILLA ROSPIGLIOSI AT ROME

THE MARRIAGE AT CANA, BY PAOLO VERONESE, IN THE DRESDEN GALLERY

LA FORNARINA, BY PIOMBO, UFFIZI GALLERY, FLORENCE

LAURA DE' POLA, BY LORENZO LOTTO, AT THE BRERA, MILAN

FLORA, BY TITIAN IN THE UFFIZI GALLERY, FLORENCE

THE MADONNA AND ST. JEROME, BY CORREGGIO, IN THE PARMA GALLERY

THE HOLY FAMILY WITH ST. CATHERINE, BY TITIAN, NATIONAL GALLERY, LONDON

THE MEETING OF JACOB AND RACHEL, BY PALMA VECCHIO, AT DRESDEN

ST. GEORGE, BY MANTEGNA, THE ACADEMY, VENICE

MAGDALEN, A PAINTING BY PAOLO VERONESE

A NOBLEMAN, BY MORETTO, NATIONAL GALLERY, LONDON

THE MADONNA OF THE CUCCINA FAMILY, BY PAOLO VERONESE, IN THE DRESDEN GALLERY

THE TRANSFIGURATION, BY GIOVANNI BELLINI, IN THE NAPLES MUSEUM

THE MARRIAGE OF ST. CATHERINE, BY TINTORETTO, AT VENICE

Photo by Brown Brothers

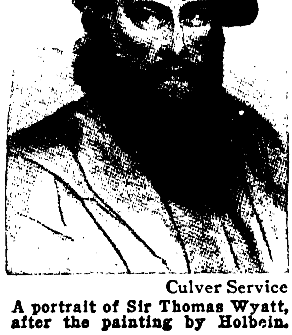
This painting by John Claxton shows Spenser reading the manuscript of his FAERIE QUEENE to Sir Walter Raleigh.

SHAKESPEARE'S FELLOWS

A CENTURY OF GROWTH IN ENGLISH LITERATURE

TWO courtiers of King Henry VIII are usually said to be the pioneers in a new kind of poetry and the beginners of the great movement which finally produced Spenser and Shakespeare and Milton. They are Henry Howard, Earl of Surrey, and Sir Thomas Wyatt, both men of great ability.

Sir Thomas Wyatt (1503-1542) was educated at Cambridge and went to court, where he filled many offices under the crown and was sent on diplomatic missions to various European countries. Probably while he was abroad, he became interested in the Renaissance type of poetry that was being written in Italy and France. This poetry used verse forms (like the sonnet) which were not common in English; and it celebrated love in a way the English poems did not. The model and inspiration for this "new poetry" was the Italian Petrarch, who lived at about the same time as Chaucer. That was about a century and a half before Wyatt's time. (As you can see, the Renaissance was late in reaching England.) Wyatt translated many of Petrarch's poems and adapted them to his own style. Besides sonnets, Wyatt wrote satires and some very attractive English ballads, or songs. His moods were varied, and his work shows a deft and vigorous mastery of English metre. Wyatt is manly, independent and very English.



Culver Service

A portrait of Sir Thomas Wyatt, after the painting by Holbein.

Henry Howard (Earl of Surrey) (1517-1547) was the eldest son of the Duke of Norfolk. He was descended from royalty. He was brought up as a companion to the King's son, Henry Fitzroy, Duke of Richmond, who later married Surrey's sister. Surrey wrote a poem about Windsor Castle (on an occasion when he was imprisoned there) recalling the happy days of his boyhood at the castle, with the sworn friendships, the handball games (in which a player sometimes missed the ball when he saw a fair lady watching him from the window above), the tournaments where they played at the jousting which knights of earlier days had done in earnest, the deer hunts in Windsor forest, the long stories told in the evenings and the secretly composed poems of love.

Surrey carried on the work Wyatt had begun in introducing foreign measures into English. He developed the kind of sonnet known as the Shakespearean, or English, sonnet; and he introduced into English poetry the kind of verse we call blank verse—unrimed lines in iambic pentameter, the metre that goes de dúm, de dúm, de dúm, de dúm, de dúm (Sweet Aúburn, lóveliest village óf the pláin). Surrey translated two books of Virgil's AENEID in this novel metre. Shakespeare's great dramatic verse and Milton's PARADISE LOST are in this metre. Surrey also translated and adapted sonnets of Petrarch's. Where Wyatt is rough and vigorous, Surrey is smooth and musical. Sweetness and harmony are to him more important than striking effects. The main line of English poetry owes much to Surrey.


Culver Service
The Earl of Surrey, aged twenty-nine.

Surrey's personality is apparent in some of his poems. One of them, for example, was written on the occasion when he, and the younger Thomas Wyatt, the poet's son, were arrested and put in jail for going about the streets of London at night and breaking windows with their stonebows. In his poem Surrey pretends that he broke the sober citizens' windows only to show them what sinful sluggards they were! One of his serious poems is in praise of Wyatt.

The poems of Wyatt and Surrey were first published extensively in a volume that appeared some years after they were both dead. Its title was SONGS AND SONNETS, written by the right honorable Lord Henry Howard, late Earl of Surrey, and others (1557). Apparently the book became a sort of model and companion for the Elizabethans. Shakespeare's Master Slender in THE MERRY WIVES OF WINDSOR, a simple fellow who needs help with his wooing, says, "I had rather than forty shillings I had my book of Songs and Sonnets here." To later ages the volume has always been known as TOTTEL'S MISCELLANY, so named after the printer. It is one of the great and influential books in the history of English poetry.

Thomas Sackville, Earl of Dorset (1536-1608), is the next poet of importance; he gave up literature for statesmanship when he was about twenty-five, but by then he had made two important contributions, one as part author of the first regular English tragedy written on classical models, GORBODUC; and the other, a contribution to an ambitious work called THE MIRROR FOR MAGISTRATES. This latter work was a collection of verse complaints supposedly uttered by great men and women of the past, telling how they had fallen from high position into misfortune and disaster. It had an important influence on the development of Elizabethan tragedy. Several poets collaborated (worked together) in writing the book. Sackville's contribution was the complaint of Henry, Duke of Buckingham, adviser to Richard III, and a remarkable INDUCTION to it, which describes a visit to hell. The vivid pictures and the sonorous music of the verse make the INDUCTION an important halfway mark between the poetry of Chaucer and Spenser's FAERIE QUEENE.

SPENSER USHERS IN THE GOLDEN AGE OF POETRY

Edmund Spenser (1552-1599), "the prince of poets in his time," to quote his monument, was educated at the Merchant Taylors' School and at Cambridge. The great era of Elizabethan poetry was ushered in with the publication of his SHEPHERDS' CALENDAR in 1579. It was dedicated to Sir Philip Sidney, the friend and patron of poets, himself a poet, critic and novelist. The book did not bear the poet's name, but only the modest pen-name *Immerito* (by one without merit). THE SHEPHERD'S CALENDAR is a series of twelve pastoral eclogues. Eclogues are poems in which shepherds debate, sing, complain of love or the hard life of poets, or celebrate the beauties of some lady.

For variety of metre and skill in versification, imagination and accomplishment, England had seen nothing like this before. Here at last was proof that the English language was capable of the finest art. Dialogs on religion, satires, love songs, mourning songs and a song in praise of the Queen furnished the subject matter. The remarkable thing about the book was the suppleness and grace of the verse, its genuine music, its masterful unity of form and idea.

The language Spenser used was deliberately old-fashioned and quaint. He chose this style to fit the speakers of his lines, who were supposed to be shepherds. Actually, many of the so-called shepherds were really Spenser's friends in disguise. Even the mighty Chaucer comes to life again in THE SHEPHERD'S CALENDAR. As Tityrus, "god of shepherds," he teaches Colin (Spenser) how to make fine poetry. Spenser returned to his pastoral style ten years later and wrote COLIN CLOUT'S COME HOME AGAIN, describing his trip to the English court under the sponsorship of his friend Sir Walter Raleigh (the Shepherd of the Ocean). In the years between these two works Spenser had been busy on the great poem that was to be his masterpiece, THE FAERIE QUEENE. Three books of it were published in 1590, and three more in 1596. He completed only these six books and two cantos of the seventh book; the poem was designed to have twelve. Spenser explained his plan in a letter to Raleigh prefixed to the poem. The purpose of it, he said, was to fashion a gentleman or noble person in virtuous and gentle discipline. There were to be twelve books, and a specific virtue was illustrated in the hero of each one, a knight who undertook a mission from Gloriana, Queen of Fairyland. All the twelve virtues were to be summed up in the person of Prince Arthur, and Arthur would appear at critical moments in the action of the various books. In addition to this moral allegory, there was a political and religious allegory, so that Sir Artegal, the hero of Book Five, represents the moral virtue of Justice but is also a picture of Lord Grey of Wilton, under whom Spenser served as secretary in Ireland.

Culver Service

This picture from the 1598 edition of Spenser's FAERIE QUEENE shows the Red Cross Knight just as he is conquering the dragon.

This elaborate scheme was in the literary fashion of the time. But it is not necessary to follow all the allegory in order to enjoy the poem or see its greatness. The plot is a series of knightly adventures, like the stories which make up Malory's MORTE d'ARTHUR; these stories are well and vividly told, with considerable suspense.

For the verse form of THE FAERIE QUEENE Spenser invented his own stanza, which has been called the Spenserian stanza ever since. It is a nine-line stanza, with a rime scheme *ababbcbcc*, and ending with a line six feet long instead of the usual five (hexameter, or Alexandrine, instead of pentameter). Such stanzas will carry a long narrative poem without becoming monotonous. Moreover, it is possible to make each stanza a little picture, complete in itself, and Spenser's powers of description were equal to those of any poet who ever wrote English. The Spenserian stanza is very musical. It is shorter than the sonnet (nine lines instead of fourteen) and does not break up into parts as the sonnet tends to do. It is held together by the rimes; and the last line, with its greater length, gives a satisfying finality to the verse. Other poets from his day to ours have looked up to Spenser as master of the poet's art. He is often called "the poet's poet"; yet you do not have to be a poet to enjoy him.

THE SONNETS AND SHORT POEMS OF SPENSER

Spenser's minor works are almost as important as his masterpiece. He, like most of the other Elizabethans, wrote a cycle (group) of love sonnets. He called his AMORETTI (little love poems); and they rank with the sonnets by Shakespeare and Sidney as the finest accomplishment of an age that produced many fine poems in that form. Spenser's are often serious; some of them are not strictly love poems. He explains in the eightieth sonnet that he is writing this series while gathering breath after the tremendous effort of the six books of THE FAERIE QUEENE, to which he plans to return refreshed and with his spirits raised.

His EPITHALAMION is a song written to celebrate his own marriage. It describes the events of the wedding day from morning to night; it is written in an elaborate stanza form of which the last line is always some variant of "That all the woods shall answer and their echo ring." He wrote FOUR HYMNS, Platonic poems celebrating the love and beauty of woman, of nature and of Christ. A volume called COMPLAINTS included a satire on the court—MOTHER HUBBARD'S TALE—and TEARS OF THE MUSES, a complaint about the lack of appreciation of poetry in his time.

Spenser suffered from the rebellion in Ireland, lost his home at Kilcolman Castle and finally came to England where he died in 1599. He was already recognized as one of England's greatest poets, and at his funeral, which was paid for by the Earl of Essex, his fellow-poets passed by the bier and dropped into the grave elegies on him they had written and the pens with which they had written them.

Spenser owed much to the patronage and interest of two prominent courtiers at Queen Elizabeth's court, both of them famous as men of affairs and men of letters as well. They were Sir Philip Sidney (1554-1586) and Sir Walter Raleigh (1552-1619). Sidney was the nephew of the Earl of Leicester, Queen Elizabeth's favorite. He seemed to the people of his day to embody all the virtues of the old days of knighthood. He was a critic who defended the art of poetry in a witty, learned and judicious essay, one of the few fine pieces of Elizabethan criticism. He was a poet who wrote, in ASTROPHEL AND STELLA, a sonnet cycle which ranks with those of Spenser and Shakespeare. He composed the ARCADIA, a prose romance. This is an elaborate pastoral story, with many intertwined plots, but it is not mere entertainment. It is a serious political and moral work as well. It went through fourteen editions in the century after its publication, and Shakespeare found in the ARCADIA the material for the subplot of his KING LEAR.

SIR WALTER RALEIGH, POET AND ADVENTURER

Sir Walter Raleigh is best known now as the colonizer, explorer and founder of Virginia, the introducer of tobacco into England and the man who spread his cloak over a mud puddle for the Queen to walk on. (This last story is a mere legend; there is no real evidence of its truth.) But Raleigh was not a mere swashbuckling adventurer; he was a gifted poet, a serious historian and a bold thinker. Much of his poetry is now lost, but we have Spenser's word for it that Raleigh was "himself as skillful in that art as any." Most of his CYNTHIA, a pastoral poem to Queen Elizabeth, is lost, but we have a few lyrics which show the personal and passionate nature of the man. He especially reflects the bitter attitude of one who has spent his life at a sovereign's court, expecting reward for his services, being disappointed, seeing the hypocrisy and fawning which are the tools of the courtier's trade. His "What is our life? a play of passion," "Farewell, false love, the oracle of lies" and THE PASSIONATE MAN'S PILGRIMAGE are alone enough to make him a reputation as a poet, even if he had been known for nothing else.

Raleigh's HISTORY OF THE WORLD was

SCENE FROM SPENSER'S POEM OF CHIVALRY

An incident from Spenser's Faerie Queene wherein the Princess Britomart, disguised as a knight, rescues the Lady Amoret. Afterward Britomart becomes the wife of Sir Artegall, a brave Cornish knight.

written in the Tower of London during his long imprisonment there. He was executed on a trumped-up charge of treason in 1619.

There were many other poets of Shakespeare's age who left something of value; it was a period in which the art of writing verse was widely practiced, by politicians, preachers, merchants, doctors, lawyers and students. Henry Constable (1562-1613), Samuel Daniel (1562-1619) and Michael Drayton (1563-1631) are all noteworthy for their sonnet cycles, and the last two did ambitious longer works. Daniel wrote a verse dialog in praise of learning, called MUSOPHILUS; a poem on the model of the complaints in THE MIRROR FOR MAGISTRATES called THE COMPLAINT OF ROSAMUND, and a verse history of the civil wars between the houses of York and Lancaster. In addition he composed classical tragedies and a work of criticism called A DEFENSE OF RHYME. He was a conservative, restrained, polished writer, serious and reflective, and earnest in his love of learning. He has been highly praised by later poets, notably Wordsworth and Housman.

Culver Service

Ben Jonson.

Drayton, like Shakespeare, a Warwickshire man, tried his hand at almost all the forms of poetry popular among the Elizabethans. His sonnet cycle, IDEA, his series of poetical epistles called ENGLAND'S HEROICAL EPISTLES, a fairy poem called NYMPHIDIA, and his mammoth poem on the English countryside, POLY-OLBION, represent his achievement. Perhaps his finest thing is the sonnet in IDEA beginning "Since there's no help, come, let us kiss and part," which Rossetti called "almost the best in the language."

THOMAS CAMPION WROTE MUSIC AS WELL AS POETRY

Thomas Campion (1567-1619), composer as well as poet, wrote some of the finest lyric poems ever written in English. His verse is free and melodious, varied and graceful. "When thou must home to shades of underground" and "There is a garden in her face" find their place in almost every collection of English poetry. Other songs by Campion, like the merry "Jack and Joan they think no ill" or the serious "To music bent is my retired mind," are equally fine.

After the death of Queen Elizabeth (1603) we find a new chapter beginning in English poetry. The two who had most to do with the changes were Ben Jonson (1573-1637), who is discussed in this article under the dramatists, and John Donne (1573-1631). There were still, to be sure, some poets who followed Spenser, but the poets of this new age were mainly working in other directions.

John Donne, whose earliest poems were written in the 1590's, is the first great poet of the period to break from the tradition of Petrarch. Donne's vigor and energy throw off the decoration and sweetness of Elizabethan poetry. To find any previous writer at all like him we must go back to Wyatt. Donne wrote satires, love poems of extraordinary vitality and spirit, funeral elegies and, finally, religious sonnets. His style seems rough compared with the smooth rhythms of the Elizabethans; Ben Jonson declared that Donne, for not keeping of accent, deserved hanging. But his method and ideals as a poet were different from those of Jonson; the two can no more be compared than Browning can be compared with Tennyson. Donne makes us feel that an actual voice is speaking to us as we read; he often begins a poem with an angry outburst or a command. The poems show a man who is thinking and feeling with passionate intensity. Donne brings into his poetry figures and images from the new science (this was the age of Galileo and Harvey), exploration and discovery, philosophy and history. Sometimes his conceits, or figures, seem elaborate and far-fetched, as when he compares two lovers to the two arms of a draftsman's compass. This peculiarity was much imitated, and the poets who practiced it were called by Dr. Johnson the "metaphysical" poets, a name which has stuck. After a rather wild youth, Donne settled down, but a secret marriage against the wishes of the bride's father cost him his position and for years he was dependent upon friends. Finally, after repeated persuasions, he entered the Church, and there his great gifts found their outlet. He became one of the greatest preachers of his time and was made dean of St. Paul's Cathedral in London. His sermons are masterpieces of seventeenth century prose.

Under Ben Jonson's leadership, much of the lyric poetry of this day turned away from Elizabethan ornateness. Poetry became restrained, musical and simply worded. The most notable among Jonson's followers, a group called "the tribe of Ben," was Robert Herrick (1591-1674), a clergyman in the Church of England whose genial love of the good things of this life make him a most attractive symbol of "merry England." He was a jolly character, living in a country parish in Devonshire and longing for the gaiety of London. His poems celebrate the blessings of his house, his friends, his wine, his maid Prue and the harvest. His best-known poem is "Gather ye rosebuds while ye may," which reflects his attitude toward life. This was the most popular poem published in the seventeenth century.

From a rare print showing a marble bust of Robert Herrick.

Elizabethan drama had three sources: the folk dance and folk play, the drama which started in connection with the liturgy of the Church and, finally, the classical drama of Rome. The classical influence came last. We find it flowering in the generation just before Shakespeare became a playwright. A group of young university-trained men came to London and found that they could make a living by writing plays for the popular players, who were by this time organized into something like professional companies. The players usually went under the protection of some great nobleman and were technically his servants; this was a device to protect them from the law against rogues, vagabonds and "masterless men." If you were an actor, the sensible thing to do was to wear the livery of some powerful lord, or you might be picked up as a tramp. In addition, letters from the lord who was your patron would make it easier to get permission from the town officials to put on your play when you were touring the country. (Fairly often the plague raged so fiercely in London that no public assemblies were permitted and plays could be given only in the country towns.)

Both pictures, Culver Service

The Fortune Theatre, in Golden Lane, was one of the famous London theaters. Opened in 1600, it was burned down in 1621.

The young university men who began writing for the players were thus lowering themselves socially, for the popular stage was hardly respectable. The productions were at first given in the courtyards of inns; a collection was taken from the audience who stood on the ground around three sides of the platform where the players acted. Those who could afford it might rent a room in the inn and watch the play from a window. This origin of the playing-place was important, for it had an influence upon the shape and structure of theater buildings when they came to be built in 1576 and later.

In the first place, the audience surrounded the stage on three sides and stood very close to where the players were; this meant that the actors could make remarks to the audience (such remarks were called "asides") in a natural way. The plays were given in the afternoon, by natural daylight, and there was no roof over the pit or yard; accordingly, there was none of the illusion which our modern stage produces by means of lighting. There was no curtain on the front of the stage; there might be a curtain at the back, and behind this a smaller area which could be used, when the curtains were opened, as a cave or a study or something of the sort. Finally, it was possible to use windows or a balcony on the second floor for some scenes, so the stage had two levels. These three areas became the outer, inner and upper stage when the regular public Elizabethan theater was developed.

It is necessary to remember these things about the stage in order to understand some parts of the plays of

Shakespeare and his fellows. For instance, if a character died in a scene on the outer stage, there had to be a funeral procession to carry the body off. Today the curtain goes down at the end of the act and the "dead" actor simply rises and walks off the stage. The Elizabethan stage had no such curtain. There was little scenery (in our sense) on the Elizabethan stage, so the locality of a scene, when it matters, is always indicated in the lines spoken by the actors. Thus, in As You Like It, Rosalind and Celia, last seen at the court, enter, and Rosalind says, "Well, this is the forest of Arden." In our day, radio plays must also describe their scenes; though we have sound-effects that help.

With such a theater the young poets had to work, if they wrote for the popular players. But there were also other actors, for instance, the boys of the great choir schools, who played indoors and to a more aristocratic audience. In the latter part of Shakespeare's life his company had both a public or outdoor, theater (The Globe) and an indoor, or private, theater (The Blackfriars). With this combination they could play both winter and summer. Often plays which had proved popular in The Globe were produced later, indoors, for the Queen and her courtiers. Elizabethan drama at its best pleased all classes of society.

LYLY'S POLISHED STYLE ADDS A NEW WORD TO THE LANGUAGE

One of the young university wits specialized in courtly comedies to be played by the boys of St. Paul's School. His name was John Lyly (1554-1606). After making a great success with a prose work called Euphues, with its highly polished, even affected, style (called "euphuism" after his book), he turned to the stage and wrote a series of charming court comedies in the 1580's. His plays do not have much of a story, but they have witty and graceful dialog. In many of them the characters represent actual people in the court circle; so the plays had something of the interest of a charade. Lyly provided more refined and cultivated entertainment than had yet been seen in the English theater.

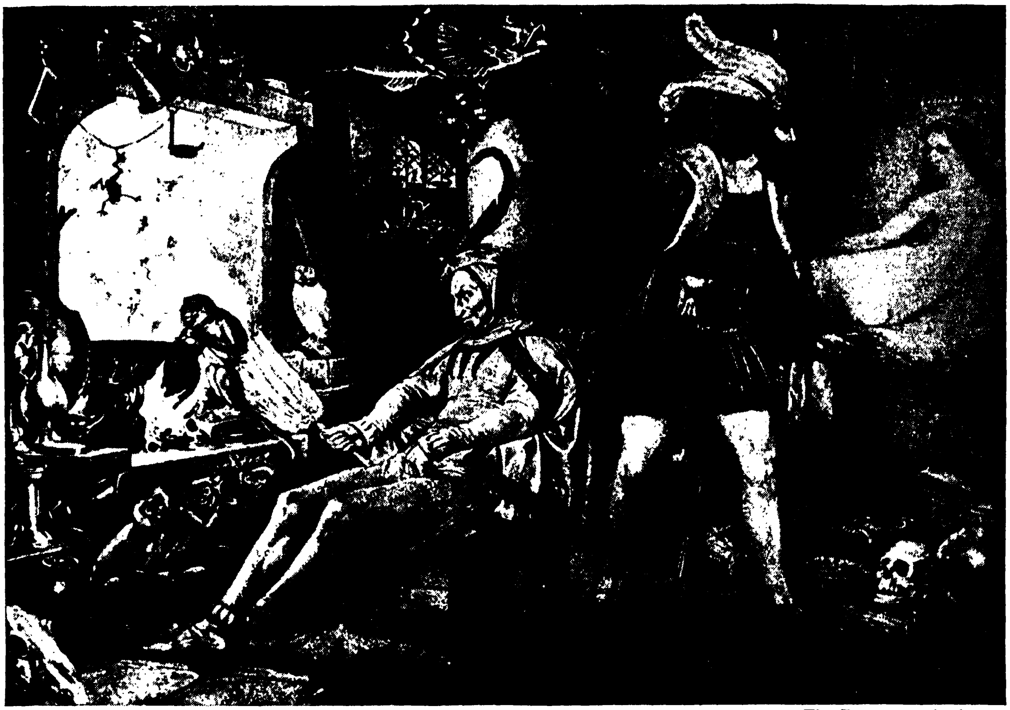
George Peele (1558-1598), like Lyly an Oxford man, turned a genuine lyric gift to the service of the stage. He wrote a pageant called The Arraignment of Paris for presentation before Queen Elizabeth by the children of the Chapel Royal. In it he flatters the Queen by having the golden apple, which Paris of Troy awarded to Venus as the most beautiful of the goddesses, awarded to Queen Elizabeth instead! Peele also wrote, for the professional adult companies, plays on historical subjects and one on David. His masterpiece, The Old Wives' Tale, is a comedy in which magic and realism, folklore and romance are all combined. Peele seems to have led a wild life and to have died in poverty.

ROBERT GREENE, WHOSE LIFE WAS SHORT AND STORMY

Another young man from Oxford University who lived a squalid, dissipated life and died early was Robert Greene (1558-1592). He was a most prolific and rapid writer; in the course of his short life he managed to turn out pastoral romances (one of which Shakespeare used as the source for The Winter's Tale), a series of pamphlets exposing the methods of London underworld cheats and criminals and some prodigal-son stories based upon the adventures of his own life. He wrote also a series of sad repentance pieces at the end, telling of his own sins and warning others to avoid them. In addition he wrote plays. Like Peele, he used history and the Old Testament for plot material; but his masterpiece is a comedy, Friar Bacon and Friar Bungay. It combines magic, low comedy and a delightful romantic story of a prince, a country girl and her lover.

Besides Greene's contribution to the drama, he has left us the first reference on record to Shakespeare as a playwright. In a passage in a book called Greene's Groatsworth of Wit (1592) he pleads with his university-trained friends to give up writing for the players and not to trust them, for they will finally, he says, abandon you in your poverty. "Yes, trust them not," he writes, "for there is an upstart crow, beautified with our feathers that . . . supposes he is as well able to bombast out a blank verse as the best of you; and being an absolute *Johannes fac-totum* (Jack-of-all-trades), is in his own conceit the only Shake-scene in a country." Greene is indignant that an upstart like Shakespeare, a mere actor, should set himself up as a poet as good as men with a university education.

By far the greatest of these university wits was a Canterbury citizen's son, Christopher Marlowe (1564-1593). He was educated at the King's School, Canterbury, and Corpus Christi College, Cambridge. Toward the end of his career at the university he was employed in some business of the Queen's; just what it was we do not know,



The Bettmann Archive
The scene from DOCTOR FAUSTUS, in which Mephistopheles shows Faustus the most beautiful woman who ever lived.

but the university was going to refuse him the degree of Master of Arts when it received a letter from the Queen's Privy Council, saying that Marlowe's absences from his college had been spent in rendering good service to the Queen "in matters touching the benefit of the country." The university was ordered to confer the degree at the next commencement, which it proceeded to do; and Marlowe left Cambridge in 1587, a Master of Arts.

MARLOWE, WHO IS SECOND ONLY TO SHAKESPEARE

Marlowe lived only about five years after leaving the university, but during that time he made a contribution to English drama and English poetry which can be surpassed only by a man who was born in the same year as himself, William Shakespeare. (If Shakespeare had died in 1593, when Marlowe did, he would today be almost unknown; none of his great work had been done then.) Marlowe's first play, TAMBURLAINE, appeared in 1587, the same year he left the university. The play, a heroic spectacle of a Scythian shepherd who rose to be the conqueror of kings and emperors, set an entirely new standard for serious drama. Its magnificent blank verse sweeps out into the theater and makes the poetry of earlier plays seem like awkward and stilted doggerel by comparison. Tamburlaine, the conqueror, "threatens the world with high astounding terms," as Marlowe's prologue says. The rôle gave a talented actor, Edward Alleyn, the first great "star" part in English drama. The action is highly theatrical; Tamburlaine mounts his chariot by using Bajazeth, the conquered Turkish emperor, as a footstool, and he harnesses captive kings to his chariot instead of horses, thundering at them as he cracks his whip.

"Holla, ye pampered jades of Asia,
That cannot go but twenty miles a day!"

The play was a sensational success, and a sequel was quickly written and produced. Marlowe centered his whole play on the chief character. This encouraged other dramatists to deepen and develop the characters in their plays—to make the men and women of the stories more lifelike.

His next play, DR. FAUSTUS, is equally lively as a show. Faustus, like Tamburlaine,

Courtesy, Parke, Davis & Company

Many of the great Elizabethans gathered at the Mermaid Tavern. Here we see Ben Jonson (left) and three friends.

has the ambition, the "aspiring mind," of the man of the Renaissance, but his search for power is intellectual, not military; and he sells his soul to the devil for this power. When Faustus uses his power to call up Helen of Troy from the shades, and greets her, we have these magic lines:

> Was this the face that launched a thousand ships,
> And burnt the topless towers of Ilium? . . .
> Here will I dwell, for Heaven be in these lips,
> And all is dross that is not Helena.
> I will be Paris, and for love of thee,
> Instead of Troy, shall Wittenberg be sacked;
> And I will combat with weak Menelaus,
> And wear thy colours on my plumëd crest;
> Yea, I will wound Achilles in the heel,
> And then return to Helen for a kiss.
> Oh, thou art fairer than the evening air
> Clad in the beauty of a thousand stars . . .

The play ends with the terrifying climax of Faustus' last hour of life. The panic of approaching damnation, marvelously conveyed by the poetry, is heightened by the striking of the clock at the half-hour and again at the end.

Marlowe followed FAUSTUS with THE JEW OF MALTA, whose hero aspires to power through money—"infinite riches in a little room." But in this play the hero is so villainous that the effect is fantastic, not tragic. Finally, Marlowe wrote a play on a subject taken from English history, EDWARD II. This time he portrayed a weak king, whose downfall came about as a result of his character. Marlowe thus showed that the new emphasis on character and the new wonderful poetry were not dependent upon a play about a superman, like TAMBURLAINE; they could be used also to show a changing character, even one with fatal weaknesses. EDWARD II is the most mature play Marlowe wrote. Shakespeare imitated it closely in his own RICHARD II; and Shakespeare's RICHARD II is a preliminary sketch for HAMLET.

The university wits often lived wild and dissipated lives in London. The legal records of the time show us some traces of Christopher Marlowe. In 1589 he was in jail on a charge of homicide. In 1592 he was bound to keep the peace after threatening a couple of constables with death. In 1593 two acquaintances, one a former roommate, accused him of atheism and other subversive opinions, so the Privy Council investigated him. While he was staying near London to report daily to the Privy Council he was killed, in self-defense, by a companion in an argument over who should pay the bill at their inn.

Marlowe's ex-roommate, who denounced him to the Council, was Thomas Kyd (1558-1594). He was not, apparently, a university man; but he was familiar with the classics, and his one important play, THE SPANISH TRAGEDY, was as popular and influential as TAMBURLAINE. It utilizes many of the devices of the Latin dramatist Seneca—a ghost, revenge as the motive for tragedy, sensational and bloody murders and verse of a pompous sort. Kyd knew how to combine classical and popular elements, and his play held the stage for a long time. There is some good evidence to show that Kyd was the author of an old play of HAMLET, now lost, which Shakespeare used as the basis of his HAMLET.

During Shakespeare's active career as a playwright in London, there were two main professional companies who were rivals for public patronage. Shakespeare was the leading playwright of one of these, the Lord Chamberlain's Men (the King's Men after 1603). The other company, the Lord Admiral's Men (Queen's Men after 1603), worked under the partial control of a manager-landlord named Philip Henslowe (died 1616). Henslowe's diary, or account book, still exists, and we can see from it how the writers supplied plays for the commercial players. Henslowe often had to bail his writers out of jail or advance them money on the first part of a play so that they could eat while they were finishing it; the payment for plays was small, and a man of the theater who depended upon his pen alone had a hard time of it.

The Red Bull Theatre, showing inner and outer stages and audience.

The most important of Shakespeare's contemporaries in the theater was a man who shared neither Shakespeare's general style nor ideals, nor his popular success. He was Ben Jonson (1573-1637). Jonson was a vigorous and colorful personality; and he had a profound influence upon the development of later drama. He was born in London, and his stepfather, a bricklayer, brought him up in the same trade. But Jonson managed to get an education at the Westminster School under William Camden, one of the most learned men of the age. He profited so well from his studies that it would be hard to match Jonson's classical learning in any writer of the age, university-trained or not. He ran away to fight in the Low Countries and returned to London, where in 1597 he appears in Henslowe's diary as a player.

BEN JONSON, WHO GAVE DIGNITY TO THE DRAMATIST'S ART

Jonson wrote some brilliant comedies, realistic and satiric, based upon the theory of "humors," or predominant eccentric traits, which make men ridiculous in various ways. Jonson's plays are skillfully plotted, and they give a vivid and lively picture of the life of the times. His EVERY MAN IN HIS HUMOUR, the first of his great plays, was given by Shakespeare's company in 1598 and Shakespeare acted in it. VOLPONE in 1606, THE ALCHEMIST in 1610 and BARTHOLOMEW FAIR in 1614 are his other masterpieces in comedy. Jonson wrote classical tragedies, CATILINE and SEJANUS and others, but they were too heavy to be popular. In the latter part of his life he was the author of masques, or entertainments for celebrations at court.

Jonson took his art very seriously and in 1616, the year of Shakespeare's death, brought out a large folio volume of his plays, which he called "The Works of Benjamin Jonson." This act cost him some ridicule; but from that time writers began to think more about plays as works worthy to be published.

Jonson's life is full of interest. In single-handed combat with an enemy in the Low Countries he killed his man. He slew one of Henslowe's actors in a duel. He took a walking trip to Scotland, and an amusing record of his talk while there has been preserved. He was given a Master of Arts degree by Oxford; and he refused a knighthood from the King, but accepted a pension which made him, in effect, a kind of poet laureate. He gathered younger poets around him in regular meetings at the Devil Tavern, and his influence for good, sound verse, for classical ideals of clarity and finish, did much to raise the level of lyric verse in the seventeenth century. He was the greatest critic of his age, and his wise and generous lines on Shakespeare do justice to both author and subject.

Besides Shakespeare and Marlowe and Jonson, the age produced a swarm of minor dramatists, many of whom would not be considered minor if they had worked in any period but their own great one. George Chapman (1560-1634) is perhaps best known as the translator of Homer, but he was also a dramatist whose plays show the variety of types enjoyed by the Elizabethan playgoer—farce, comedy of humors, a mixed kind later called tragicomedy, and tragedy. Chapman used French history for plot material in some of his serious plays and succeeded in making something approaching the modern problem play. BUSSY D'AMBOISE (1604) is generally considered his masterpiece.

Some of the playwrights achieved success with plays aimed directly at the taste of the middle class, the merchants and business men who were becoming the most powerful group in English society. Thomas Dekker (1572-1632) captured in THE SHOEMAKERS' HOLIDAY the spirit which takes pride and delight in the spectacle of an ordinary shoemaker rising to be Lord Mayor. He surrounded his hero with an atmosphere of good fun among the craftsmen and apprentices of London, and gave us a strain of appealing sentiment in a pair of lovers separated by a


The Maids Tragedie.
AS IT HATH BEENE
diuers times Acted at the Black-Friers by the Kings Maiesties Seruants.
Newly perused, augmented, and inlarged, This second Impression.

LONDON,
Printed for Francis Constable, and are to be sold at the White LION in Pauls Church-yard. 1622.

Culver Service

Title-page of Beaumont and Fletcher's MAID'S TRAGEDIE, 1622.

war. Dekker's prose pamphlets as well as his plays have an interest for modern readers; he gives a lively picture of the details of Elizabethan life. His Gull's Hornbook (fool's primer) draws an amusing picture of how the objectionable young fellow of the time behaved at the playhouse and elsewhere about town. Thomas Heywood (1570-1641) was educated at Cambridge, but he was always loyal to his middle-class origin and he provided for the public romantic adventure plays like The Four Prentices of London, history plays, classical plays and his masterpiece, a domestic tragedy, A Woman Killed with Kindness.

Thomas Middleton (1580-1627) wrote plays of London life, less satirical than Jonson's. A Trick to Catch the Old One and A Chaste Maid in Cheapside are the best known of his comedies. John Marston, who turned from the study of law to writing satire in verse, became a dramatist and finally ended up as a country parson. He shows something of the bitter and cynical spirit which affected sensitive men in the early seventeenth century. The Malcontent (the melancholy and discontented man) is his best-known play.

Many of the plays of the time were written by two or more authors in collaboration. Almost every dramatist did some work in collaboration with others. The most famous team of collaborators consists of Francis Beaumont (1584-1616) and John Fletcher (1579-1625). They were both "gentlemen," or members of a social class higher than that of the ordinary tradesmen. One of their plays, The Knight of the Burning Pestle, is an amusing satire on the popular lower-class plays like Heywood's Four Prentices. Beaumont and Fletcher wrote for the aristocrats and courtiers, as Heywood and Dekker wrote for the citizens.

A type of play which combined both the sensationalism of tragedy and the happy ending of comedy was developed by them, and the type became so popular that Shakespeare tried his hand at it in Coriolanus and The Winter's Tale. It was called tragicomedy. Philaster, or Love Lies A-Bleeding is usually considered the best example of this type. The Maid's Tragedy (which *is* a tragedy) shows that the aristocratic taste of the time could be content with less human and universal motives than we find in the tragedies of Shakespeare. Fletcher succeeded Shakespeare as the chief playwright for the King's Company, and he was in turn followed by Philip Massinger (1583-1640) who died only two years before the closing of the theaters by the Puritans. Massinger's best-known play is a comedy, A New Way to Pay Old Debts, whose villain is a moneylender and capitalist of the new sort, drawn from a character in real life. He also wrote tragicomedies and tragedies.

Culver Service

Francis Beaumont (left) and John Fletcher (right) wrote so many plays together that they are remembered as a writing team.

Any tragedy after Shakespeare must seem weak and inferior; but two plays by John Webster (1580-1625) are worth mention. These are The Duchess of Malfi and The White Devil, both full of violence and melodrama, but with great touches of characterization and brilliant flashes of poetry. John Ford (1586-after 1639) is remembered for his tragedy The Broken Heart and James Shirley (1596-1666) for both tragedies and comedies, including The Cardinal and The Lady of Pleasure. Shirley succeeded Massinger as the chief dramatist for the King's Company. Once he wrote a play on a plot furnished by the King himself. The King said he liked that play better than any he had seen for seven years.

After the first few years of the seventeenth century, English society split more and more definitely into two groups, the opposing parties of the coming revolution: the Cavaliers, or king's party, and the Puritans. The drama of the period (1610-1642) is drawn closer and closer to the tastes of the court. The court was affected and even silly in its tastes, so the plays lost that human and universal character which they had in the heyday of Shakespeare. So the decline in drama was not simply a matter of the lack of playwrights of genius.

By Hallett D. Smith.

THE NEXT STORY OF LITERATURE IS ON PAGE 1235.

GNAWERS and BURROWERS —or RODENTS

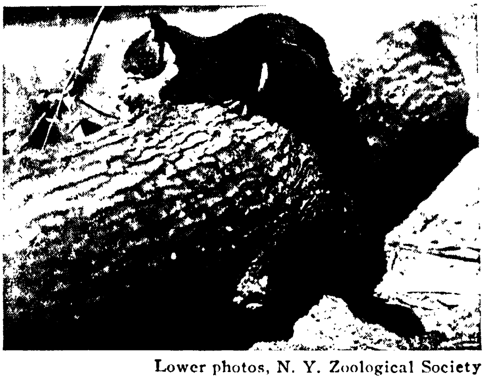

U. S. Forest Service photo
This handsome gray squirrel lives in California.

IN previous articles we have told you about the great order Carnivora, or flesh-eating animals. We come now to the rodents, known as the order Rodentia. All animals in this order have a pair of front teeth or incisors that are like chisels, in both upper and lower jaws. These chisels keep growing throughout the animal's life. With these front teeth rodents can gnaw through astonishingly tough materials—leather and nut shells, for instance. The beavers can gnaw through the trunk of a good-sized tree. There are no eye teeth, or canines, which the flesh-eaters have, but instead there is a gap. The rabbits and their close relatives differ from all other rodents in having another smaller pair of incisors behind the large upper chisel-like teeth; and the rabbits chew from side to side, while other rodents slide their lower jaw back and forth when grinding their food. Many of these animals live in holes, or burrows; and so we can describe the rodents as gnawers and burrowers.

Rodents are the largest order of mammals. There are more than twenty families and perhaps twenty thousand species. Some of the rodents are well known, such as the different squirrels, beaver, mice and rats, porcupines, guinea pigs and rabbits; but many more are seldom seen, even in zoos. The rodents are a very old order and they have always been just as different from other mammals as they are to-day, judging from the very earliest traces of them which have been found.

Rodents are usually small in size, but they have big families and usually they have a number of litters each year. Rodents grow up quickly, often in a year or less; this gives them more generations than larger mammals. There are far more rodents for each square mile of the earth's surface than any other kind of mammal, and the combined weight of these little animals living on earth is greater


The spry little white-nosed fox squirrel.


Lower photos, N. Y. Zoological Society
The Malabar squirrel has a long, sleek tail.

than that of the bigger mammals.

The rodents feed chiefly on plants and plant matter, although most of them eat meat occasionally and a few live largely on fish. Many kinds of rodents eat the same foods we do and damage our crops or destroy food stored in warehouses. Sometimes the damage they cause may be serious, although most of the harm is done by only a few kinds. Each house rat does about three dollars' worth of damage every year in our country and these pests are numbered in millions. House mice are even more abundant and probably do as much total harm. Some other rodents are injurious, but they are kept down by the flesh-eaters as a rule.

American Museum of Natural History, N. Y.
This flying squirrel can glide from one tree to another.

To balance partly the damage and destruction done by these, other rodents are useful to us. Beavers, muskrats, chinchillas, squirrels and rabbits have fur that we value highly for warmth and beauty. Most of the fur-bearing mammals of other orders, such as foxes, lynx and the weasel family, depend on their rodent prey for food. Indeed, we may think of rodents as factories for turning grass and vegetables into meat for the flesh-eaters.

We eat some rodents, too; rabbits and squirrels are commonly hunted for food. The early American Indians ate woodchucks, muskrats, beavers and several other rodents. In Africa there are many places where meat is very scarce. In such regions any animal is welcome food and rats are caught to satisfy the meat hunger. Soon after Columbus discovered America, guinea pigs were brought back to southern Europe where they were raised for food, just as they had been raised by the Indians in some parts of South America.

Some damage is done to trees by squirrels and mice, but these animals also hide away nuts and seeds, a few of which may start new trees. Another service of the rodents is in making soil useful for crops; the work of burrowing rodents, continued for thousands of years, has built up much of the good farm land.

The squirrels are found all over the world, except on the small islands of the oceans and in the Australian region. They live in trees, in holes in the ground or among the rocks; most of them look much like our friends of the park. Some are no bigger than mice, but others are almost as big as a domestic cat, about three feet long, including the very long tail. They are usually active during the daytime, unlike most rodents which hide by day; but the flying squirrels are night-loving. In cold climates many of them sleep through the winter. Like other rodents, many of the squirrels store up food for future need.

In the eastern part of our continent, from Canada to Florida, the common gray squirrel thrives in our city parks; it lives in the hardwood forest as far west as Minnesota. Black individuals are found in many places, but they are the same species. The gray squirrel was taken to England, where it became so much at home that it drove the native red squirrel out of many places. The Pacific gray squirrel and the one found in Arizona are two different species; they live in the mixed pine and oak forests, sometimes in spruce and firs. The handsome tuft-eared squirrels of New Mexico and Arizona are gray with reddish backs and white undersides. On the north edge of the Grand Canyon, the Kaibab squirrel is found, its underside and legs black; its back is gray.

U. S. Forest Service photo
A Kaibab squirrel at attention.

The Eastern fox squirrel is a large and handsome fellow, blackish or reddish in color, depending on the locality. It is more common nowadays in the South and Middle West. The American red squirrels, or chickarees, of several species live in northern spruce and fir forests and in similar country in the mountains. Other squirrels, of many sizes and colors, are found in Central and South America. There are so many we can not mention them all.

The European red squirrel looks much like our chickaree, but its ear-tufts are large, especially in winter. It is found from the British Isles to Japan and from Italy to Lapland. The color varies from reddish to gray. In the colder regions the fur grows long and soft. These squirrels are hunted and trapped for their fur in Russia, the countries of Scandinavia and Germany.

New York Zoological Society
The Eastern chipmunk at its meal.

Tree squirrels are common in Africa and Asia. In India and the Malay regions there are smaller tree squirrels, striped or olive-colored. As you go down the Chindwin River in Burma, you see a strange thing — one species changes color. It is olive brown near the river's source, but as you travel you notice paler and paler individuals until you find some that are nearly white.

Species that make their homes under the ground we call ground squirrels. Their tails are usually less bushy than those of the tree squirrels, and they have smaller ears; but they are often able to climb quite well. Our common chipmunks, both the two-striped Eastern species and the four-striped Western kinds, are little ground squirrels. Chipmunks are found in eastern Asia, too, and skins of these are sometimes used to make fur coats. Like many ground squirrels, chipmunks sleep most of the winter, but they also lay in a store of nuts and seeds in case they should wake up hungry. They are apt to have particularly good appetites at such a time.

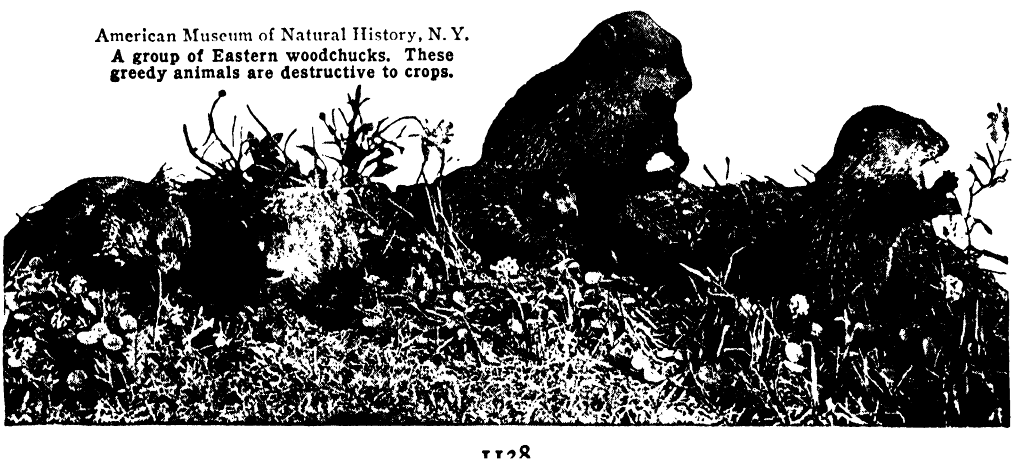
The striped gopher, or spermophile, of the Middle West is one of the ground squirrels; other species also are common in the West, from Mexico to Alaska. They feed chiefly on seeds, but some of the striped gophers are fond of roots and tubers.

The suslik of eastern Europe and Asia is closely related to our spermophiles and so is the well-known prairie dog of the Western plains. These fat squirrels are usually called prairie dogs because they sit up and yap at intruders; their voices are like the bark of a Pekingese dog. They used to live in great colonies, or "dog towns." Sometimes many millions of animals lived in "towns" covering hundreds of square miles.

Each prairie dog in a "town" has a burrow which goes almost straight down for about fifteen feet, then it turns horizontally to the nest chamber. In the flat country each hole has a rim around it, almost a foot high to prevent flooding from the occasional heavy rains. When an enemy approaches, the prairie dogs all yap and dive down their holes. After a long while they stick out their heads cautiously. If the intruder has gone, they come out again. On page 599 we tell you how the clever coyotes work in pairs to outwit the prairie dogs, and catch them for food.

If the prairie dogs were not so hard to catch they might be raised for food, because they are well flavored and always fat. They live on grass and eat a great deal. Thirty prairie dogs eat about as much as a sheep will consume. Since the plains country has

American Museum of Natural History, N. Y.
A group of Eastern woodchucks. These greedy animals are destructive to crops.



been turned into farms and used for grazing, these rodents have been considered enemies of the rancher and farmer and almost exterminated. Only a few small prairie-dog towns remain, chiefly in the mountains, and a person may travel in the West for weeks without seeing one prairie dog.

Giants of the ground squirrel group are the marmots. The common woodchuck of the eastern United States and Canada is one of the marmots. Others are the yellow-bellied and hoary marmots of the Rocky Mountains, the European marmot of the Alps, Pyrenees and Carpathians, and the bobac marmot of Russia, Siberia and Mongolia. This last species is used for fur, but it is best known as one of the chief offenders causing the terrible plague which swept Europe and Asia many times in the past. The germ that causes the dread disease is carried by fleas. The plague is carried from the marmots to rats by fleas and from rats to people. The disease can be caught directly from infected animals, when they are skinned, for instance.

African ground squirrels are closely related to the tree squirrels of that great continent, but their habits are much like those of the susliks and spermophiles. The African ground squirrels have coarse hair, like dry spruce needles, instead of fur.

U. S. Forest Service photo
The beaver is a famed architect and builder.

The flying squirrels are handsome and interesting rodents. They do not really fly, but glide by means of a thin skin stretched between their front and hind limbs. These squirrels climb high in a tree, jump and spread their gliding planes; some may go as much as 250 feet before they land on another tree. We have flying squirrels in the eastern United States, all across Canada and down the western mountain ranges. Many species live in Asia; there, in the Indo-Malay region, is found the giant flying squirrel, more than a yard long from nose to tail tip. Other species of flying squirrels in this region are no larger than mice. The flying squirrels are usually smoky gray, with a while underside. In southern Asia red, black and spotted species are known.

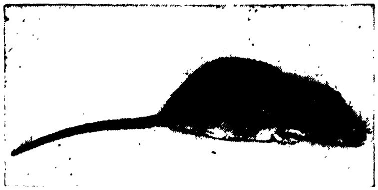
Beavers are among the best known of the rodents. Once they were common in Europe, but only a few remain there now. More are found in the less settled parts of North America and Asia. Beaver fur was important and valuable when North America was being

American Museum of Natural History, N. Y.
Beavers laying up winter supplies. They drag the felled logs to their burrows; there they gnaw away at the bark.

U. S. Dept. of Interior
The muskrat has fine fur.

N. Y. Zool. Soc.
The thirteen-lined gopher.

N. Y. Zool. Soc.
The quaint Egyptian jerboa.



U. S. Dept. of Interior
The common brown house rat.

settled and it was one of the chief causes of exploration. To get beaver, fur trappers and traders went out into the wilds, built trading posts and forts and opened up the country for settlement. At one time, beaver skins were used as money. But the trappers almost destroyed the beaver. Around 1880 only a few beavers were left and they were in the most inaccessible places. Now, with protection, this rodent is coming back to our wooded streams and ponds.

Beavers are thickset and heavy, weighing up to sixty-five pounds. Their legs are short and strong. The hind feet are webbed, and this helps them in swimming. The tail is flat and naked, covered with scales. The tail is used as a rudder when swimming; it also serves to make loud splashes, as warnings of danger to the beaver colony, and to prop up the beaver when he is gnawing down trees.

U. S. Dept. of Interior
The house mouse has few friends.

Deep water is necessary for a beaver. His winter food supply of bark must be kept under water; and when the only entrance to a home is deep under water, enemies do not come visiting. In cold climates the pond must be so deep that it will not freeze solid—the beavers must come out to get their food. If the beaver home, or lodge, is in a lake no dam is needed, and when beavers live in a river they often live in burrows in the banks. Beavers living in small streams must build dams. These they make of sticks, mud and stones; dams may be six or eight feet high and as long as a city block.

The lodges are also made of sticks and mud; generally they are round, ten feet or more across and with thick walls. Inside each lodge is a roomy chamber, where the beaver makes a nest of shredded bark. Sometimes, when all the trees the beavers like have been cut down around the pond, they dig long canals to other stands of trees and float their food down to the home pond.

The dams act like giant sieves to hold back the water and settle the fine particles of soil in the streams, especially after rains. Much of the rich meadowland in our mountains was made this way. The water seeps out into the earth all around the dam, making it rich. This continent owes a debt to the beavers.

Amer. Mus. of Nat. Hist., N. Y.
The sewellel or mountain beaver.

Amer. Mus. of Nat. Hist., N. Y.
These lemmings live in Sweden.

N. Y. Zool. Soc.
The prairie dog likes company.

Two families of rodents are probably distantly related to the squirrels, but we can not be sure. The sewellel, or, as it is more often called, the "mountain beaver" of the Pacific states is a chunky animal about the size of a woodchuck, but without a tail that you can see. It is the only survivor of an ancient fossil group, some of which had horns. Mountain beavers are dark brown in color and they live in extensive underground burrows, usually in moist woods. They come out at night and few people have ever seen these animals.


The Brazilian tree porcupine.


Photos, N. Y. Zool. Soc.
The hairy tree porcupine.

Another family of strange rodents are the African scaly-tailed flying squirrels. They look much like real flying squirrels, but their skulls and teeth are very different. Their tails have large, pointed scales on the underside, near the base, and are probably used in climbing. Some species are no larger than mice, but others are two feet in length. Their gliding "planes" are supported by rods of cartilage, one from each elbow instead of from the wrist, as in the true flying squirrels. A single rare species has no flying membrane, but in other ways proves to be a close relative.

Pocket rats, kangaroo rats and pocket gophers are American rodents that are thought to be very distantly related to the squirrels and beavers. They look more like big-headed rats or mice. The pocket gophers live under the ground and feed on roots, while the kangaroo rats and pocket mice live on seeds. Many of them look something like small kangaroos and, like those animals, they hop on their hind legs when running. All have fur-lined cheek pouches, or pockets, opening on either side of their mouths and extending back to the shoulder.

Rats and mice are the most numerous of the rodents, or indeed of all the mammal families. We commonly use the name "rat" for any rodent that looks like the house rats and is more than a foot in total length, while the smaller rat-like rodents are called mice. Sometimes these names are used when there is no real relationship to true rats or mice.

Dormice live in Europe, Asia and Africa, but not in the Americas. We all remember the dormouse in ALICE IN WONDERLAND that was always going to sleep. Its name means "sleeping mouse," and it is called sleeper in most European languages. In the autumn the handsome, bushy-tailed rodents curl up in snug holes and sleep throughout the winter. They come out in warm weather at night and usually live in trees, feeding on seeds and fruit, not despising insects. One or two are almost as big as rats, but most of this family are only a little larger than the house mouse.

House rats and mice, which are found all over the world, voles and lemmings of the northern lands, the truly wild rats and mice, hamsters and a multitude of others, live under many conditions. Some are desert-dwellers, others live in the dense forests and jungles; others have taken to the water and live in ponds or streams, sometimes catching and living on fish; some (the gerbils of Africa and Asia) jump like kangaroos, while others have gone underground and live like the pocket gophers, on the roots of plants. There is hardly a way of liv-


U. S. Forest Service photo
A fine specimen of the yellow-haired porcupine.

ing which the rat family has not tried. Some are strict grass-eaters or seed-eaters.

The house pests we all know will eat almost anything that human beings like. They are the most enterprising of modern mammals; some of this family got as far as Australia and the Solomons by riding drifting trees from island to island in the course of millions of generations. Others were in the little boats sailed by the brown and black

The olive aguti.

races of mankind that spread from the Asiatic islands as far as Hawaii and New Zealand; while in the last hundred years traders have carried and introduced our house rats almost everywhere in the world.

The capybara.

The hamsters are an ancient type, found in Europe and Asia. They are more closely related to the wild American rats and mice than either of those are related to the house rats. Hamsters live in long underground burrows and lay up large stores of grain; this makes farmers try to destroy them wherever they occur. Field mice, or voles, have short ears and tails; they, too, do damage to crops when they become abundant. Their large relatives, the lemmings, are common in northern countries, such as Norway and Alaska. In some years the lemmings increase to unbelievable millions. Then they move out and march across the country, eating everything green as they go. Their eyes are not good; they can see only a few feet ahead. Yet they march on, over, under or around every obstacle. Nothing stops them until they reach the sea and plunge in. All that reach the sea drown; and along the way sea birds, birds of prey and many other animals kill numbers of the marching rodents. Still more fall victim to disease. Only a few remain behind on the old home territory, and from these few a new plague of lemmings will come. Since under good conditions a single pair of lemmings might have almost a million descendants in a year, the hordes soon build up again; and the march of death again takes place.

The muskrat is common in the swamps, ponds and shallow lakes of the United States and Canada, except in Florida and parts of California. Some were imported into Europe, where they have been a pest. They have several litters of young in a year, usually five or six in a litter, but sometimes as many as nine. Because muskrats are so numerous their fur is the most valuable of the fur crops. When the long hairs are removed, the fur is dyed and sold as Hudson seal, but whole furs are also popular. Coats of muskrat fur are warm and lighter than most furs.

The bamboo rats, looking like big gophers, and the mole-rats of Asia are distant cousins of the mouse family. They live underground, and they rarely come out of their burrows.

Photos, N. Y. Zoological Society

The coypu rat is a plump little rodent.

The jerboas and jumping mice are like small kangaroos, as were the kangaroo rats and gerbils mentioned earlier. They have large hind feet, strong legs and a long tail. They go bounding along on the hind legs, taking long jumps. Jumping mice are found in most parts of the northern United States and Canada, and in the mountain meadows of the West. They sleep through the winter.

The jerboas are even more kangaroo-like; they live in the drier parts of northern Africa, and in Asia. Both of these types of rodents are only distantly related to the true rats and mice.

The springhaas is probably a distant cousin of the jerboas, but it is as large as a fox. The springhaas is yellowish in color. It lives in Africa, east and south of the Congo forest.

The true porcupines of southern Europe, Africa and Asia have spines which are solidly attached to the skin. They dig holes, but do not climb trees. The big crested porcupine and his relatives are covered with enormous quills, some of them two feet in length. When attacked the porcupine spreads out the quills like spears, and runs backward at the enemy. Some smaller kinds look rather like rats and have only short spines. A distant relative, the African cane rat, has bristles instead of quills. It lives in swampy places.

Cuban tree rat.

Photos, N. Y. Zool. Soc.
The viscacha of South America.

The American porcupines belong to a different family, although they, too, are armed with quills. They live in the trees, feeding on twigs and leaves. Some South American porcupines have long prehensile tails (tails which can catch hold of things, as monkey tails do). The New World porcupines have quills that are loosely attached and have barbed tips. If the quills are left in a wound they fester and irritate the victim, and it takes a pair of pliers to pull them out. In the North American species the quills on the tail are long, and when the porcupine is defending itself the tail is lashed from side to side, a dangerous weapon which can inflict painful wounds.

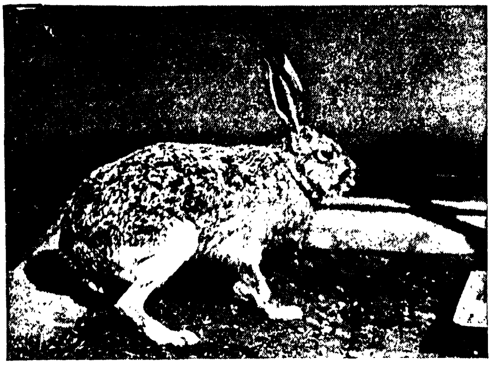
Most of the South American rodents are distant relatives of the porcupines, even when they have soft fur like the chinchillas, fur more valuable than sable or ermine. The viscacha is a big, coarse-haired relative of the chinchilla that lives like a woodchuck on the plains and mountain sides of South America. The cavy, or guinea pig, is another distant relative, and its cousin, the mara, or Patagonian cavy, looks like a hare, is about the same size and lives like one. The capybara or carpincho, the largest rodent now living, is as large as a half-grown pig and weighs about a hundred pounds; it is a water-loving cavy, found in South America and Panama. Agutis look somewhat like short-eared rabbits, but they, too, are cousins of the guinea pig.

Another well-known South American rodent is the coypu, or nutria. Nutria is really the Spanish name for otter, a name wrongly given to the coypu because of its sleek fur and its life in the water. The coypu looks like a giant muskrat; it is the size of a young beaver and in habits it resembles both these rodents. The rat-like hutias of Cuba and some other islands of the Caribbean, and the gopher-like rodent of the Andes are relatives of the coypu.

Next we come to the rabbits and their cousins. The pikas, or mouse-hares, look as if they belonged between rodents and the rabbit family, but they are, in fact, much closer to the rabbits under the skin. They, with the rabbits, have a second pair of upper gnawing teeth, unlike the rodents proper. Pikas live in the mountains of western North America, from Alaska to New Mexico and California; others are found in the mountains and hills of eastern Asia. Our pikas make their homes in rocky places and are rarely seen, so closely does the gray of their coat match the color of the rocks. The little piles of dried grass and weeds, like small haycocks, may be seen under rocks where the pikas have gathered their winter food, or their peculiar squeaking whistle, or bleat, may be heard, but the animals themselves are seldom in man's view.

The spotted cavy.

The names rabbit and hare are often misused. Our North American jack rabbits and



This lively jack rabbit lives in North America.

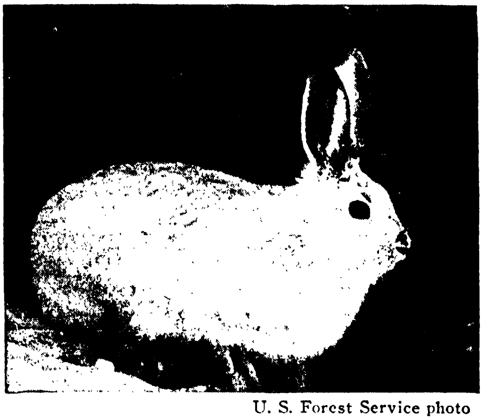
Upper photos, N. Y. Zoological Society

The cottontail rabbit is a familiar species.

snowshoe rabbits are really hares, while the tame Belgian "hare" is a breed of the European rabbit, like other domestic rabbits. The newborn young of true rabbits are naked and blind. They are kept in a nest, usually in an underground burrow. Young hares are furry at birth and soon can take care of themselves; they never go underground. Our cottontail is more like a rabbit than a hare in its habits; and while it does little digging, it uses the burrows of other mammals frequently.

Rabbits do much damage in England, where they were introduced long ago by the Romans. When some were taken to Australia about a hundred years ago no one guessed how much harm they could do. They multiplied to millions in a little while, in spite of all efforts at control. Even wire fencing hardly protects the farms. Nowadays the meat and fur of the Australian rabbits partly pay for the work that must be done to keep their numbers down.

We can not say much about the breeds of domestic rabbits, they are so numerous and so varied. Some are grown chiefly for their fur, other breeds are raised for their flesh. The chinchilla rabbits have fur much like the true chinchilla in color and texture, while the Belgian "hares" and New Zealand whites are good meat producers. The Angora rabbit has long woolly fur, which is clipped, plucked and used in the manufacture of cloth. Almost every color of rabbit has been bred—white, red, gray, black, bluish, brown, yellow and pied.



U. S. Forest Service photo

The snowshoe rabbit turns white in winter.

The many wild members of the rabbit family all look much alike, except in color. Some, like the snowshoe rabbits or varying hares of the northern lands, turn white in winter. Others, like the southern marsh rabbits, sometimes take to the water and swim, things we don't expect from rabbits. The jack rabbits of our western plains are long-legged and long-eared, built for speed in running. The antelope jack rabbit is even more extreme; its legs and ears are the longest, and when it runs it twitches the skin, first of one side, then the other, flashing the white underlying hair in a strange display.

Some rabbits of southern Asia have harsh, coarse fur and very short ears. One species, found on Sumatra, is perhaps the most peculiar of the whole wild rabbit tribe; it is brownish in color, becoming reddish brown on the rump, a black stripe runs down the back and there are other black stripes on the sides and around the legs. The ears of this rabbit are hardly longer than those of a cat.

By John Eric Hill, Assistant Curator, Recent Mammals, American Museum of Natural History.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 1259.

POEMS OF FLOWERS AND TREES

Illustrated by Rudolf Freund

Come into the Garden, Maud

By ALFRED, LORD TENNYSON (1809-1892)

COME into the garden, Maud,
For the black bat, night, has flown,
Come into the garden, Maud,
I am here at the gate alone;
And the woodbine spices are wafted abroad,
And the musk of the rose is blown.

All night have the roses heard
The flute, violin, bassoon;
All night has the casement jessamine stirred
To the dancers dancing in tune;
Till a silence fell with the waking bird,
And a hush with the setting moon.

I said to the lily, "There is but one
With whom she has heart to be gay,
When will the dancers leave her alone?
She is weary of dance and play."
Now half to the setting moon are gone,
And half to the rising day;
Low on the sand and loud on the stone
The last wheel echoes away.

I said to the rose, "The brief night goes
In babble and revel and wine.
O young lord-lover, what sighs are those,
For one that will never be thine?
But mine, but mine," so I sware to the rose,
"For ever and ever, mine."

And the soul of the rose went into my blood,
As the music clashed in the hall:
And long by the garden lake I stood,
For I heard your rivulet fall
From the lake to the meadow and on to the wood,
Our wood, that is dearer than all;

From the meadow your walks have left so sweet
That whenever a March-wind sighs
He sets the jewel-print of your feet
In violets blue as your eyes,
To the woody hollows in which we meet
And the valleys of Paradise.

Queen rose of the rosebud garden of girls,
Come hither, the dances are done,
In gloss of satin and glimmer of pearls,
Queen lily and rose in one;
Shine out, little head, sunning over with curls,
To the flowers, and be their sun.

There has fallen a splendid tear
From the passion-flower at the gate.
She is coming, my dove, my dear;
She is coming, my life, my fate;
The red rose cries, "She is near, she is near";
And the white rose weeps, "She is late";
The larkspur listens, "I hear, I hear";
And the lily whispers, "I wait."

She is coming, my own, my sweet;
Were it ever so airy a tread,
My heart would hear her and beat,
Were it earth in an earthy bed;
My dust would hear her and beat,
Had I lain for a century dead;
Would start and tremble under her feet,
And blossom in purple and red.

The Rhodora

By RALPH WALDO EMERSON (1803-1882)

IN MAY, when sea-winds pierced our solitudes,
I found the fresh Rhodora in the woods,
Spreading its leafless blooms in a damp nook,
To please the desert and the sluggish brook.
The purple petals, fallen in the pool,
Made the black water with their beauty gay;
Here might the red-bird come his plumes to cool,
And court the flower that cheapens his array.
Rhodora! If the sages ask thee why
This charm is wasted on the earth and sky,
Tell them, dear, that if eyes were made for seeing,
Then Beauty is its own excuse for being:
Why wert thou there, O rival of the rose!
I never thought to ask, I never knew:
But, in my simple ignorance, suppose
The self-same Power that brought me there brought you.

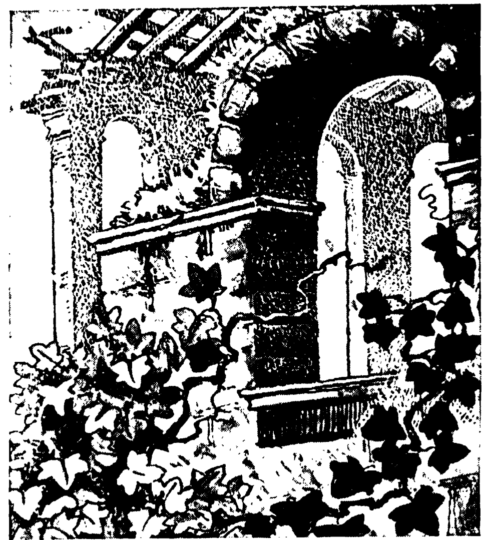
The Ivy Green

By Charles Dickens (1812-1870)

Oh, a dainty plant is the Ivy green,
That creepeth o'er ruins old!
Of right choice food are his meals I ween,
In his cell so lone and cold.
The wall must be crumbled, the stone decayed,
To pleasure his dainty whim;
And the mouldering dust that years have made
Is a merry meal for him.
Creeping where no life is seen,
A rare old plant is the Ivy green.

Fast he stealeth on, though he wears no wings,
And a staunch old heart has he.
How closely he twineth, how tight he clings
To his friend the huge Oak Tree!
And slily he traileth along the ground,
And his leaves he gently waves,
As he joyously hugs and crawleth round
The rich mould of dead men's graves.
Creeping where grim death has been,
A rare old plant is the Ivy green.

Whole ages have fled and their works decayed,
And nations have scattered been;



But the stout old Ivy shall never fade,
From its hale and hearty green.
The brave old plant, in its lonely days,
Shall fatten upon the past:
For the stateliest building man can raise
Is the Ivy's food at last.
Creeping on, where time has been,
A rare old plant is the Ivy green.

A Daisy at Christmas

By James Montgomery (1771-1854)

There is a flower, a little flower
With silver crest and golden eye,
That welcomes every changing hour,
And weathers every sky.

The prouder beauties of the field
In gay but quick succession shine;
Race after race their honors yield,
They flourish and decline.

But this small flower, to Nature dear,
While moons and stars their courses run,
Wreathes the whole circle of the year,
Companion of the Sun.

It smiles upon the lap of May,
To sultry August spreads its charms,
Lights pale October on his way,
And twines December's arms.

The purple heath and golden broom,
On moory mountains catch the gale;
O'er lawns the lily sheds perfume,
The violet in the vale.

But this bold floweret climbs the hill,
  Hides in the forest, haunts the glen,
Plays on the margin of the rill,
  Peeps round the fox's den.

Within the garden's cultured round
  It shares the sweet carnation's bed;
And blooms on consecrated ground
  In honor of the dead.

The lambkin crops its crimson gem;
  The wild bee murmurs on its breast;
The blue-fly bends its pensile stem
  Light o'er the skylark's nest.

'Tis Flora's page,—in every place,
  In every season, fresh and fair;
It opens with perennial grace,
  And blossoms everywhere.

On waste and woodland, rock and plain,
  Its humble buds unheeded rise;
The Rose has but a summer reign;
  The Daisy never dies!

Hepaticas

By Archibald Lampman (1861-1899)

The trees in their innermost marrow
  Are touched by the sun;
The robin is here and the sparrow:
  Spring is begun!

The sleep and the silence are over:
  These petals that rise
Are the eyelids of earth that uncover
  Her numberless eyes.

Daffodils

By William Wordsworth (1770-1850)

I wandered lonely as a cloud
  That floats on high o'er vales and hills,
When all at once I saw a crowd,
A host, of golden daffodils;
Beside the lake, beneath the trees,
Fluttering and dancing in the breeze.

Continuous as the stars that shine
And twinkle in the milky way,
They stretched in never-ending line
Along the margin of a bay:
Ten thousand saw I at a glance,
Tossing their heads in sprightly dance.

The waves beside them danced; but they
Out-did the sparkling waves in glee:
A poet could not but be gay,
In such a jocund company:
I gazed—and gazed—but little thought
What wealth the show to me had brought:

For oft, when on my couch I lie
In vacant or in pensive mood,
They flash upon that inward eye
Which is the bliss of solitude;
And then my heart with pleasure fills,
And dances with the daffodils.

Trees*

By JOYCE KILMER (1886-1918)

I THINK that I shall never see
A poem lovely as a tree,
A tree whose hungry mouth is prest
Against the earth's sweet flowing breast;
A tree that looks at God all day,
And lifts her leafy arms to pray;
A tree that may in summer wear
A nest of robins in her hair;
Upon whose bosom snow has lain;
Who intimately lives with rain.
Poems are made by fools like me,
But only God can make a tree.

*From Trees and Other Poems, by Joyce Kilmer, copyright 1914. George H. Doran, publishers.

A Forest Hymn

By WILLIAM CULLEN BRYANT (1794-1878)

THE groves were God's first temples. Ere man learned
To hew the shaft, and lay the architrave,
And spread the roof above them—ere he framed
The lofty vault, to gather and roll back
The sound of anthems; in the darkling wood,
Amid the cool and silence, he knelt down,
And offered to the Mightiest solemn thanks
And supplication. For his simple heart
Might not resist the sacred influence
Which, from the stilly twilight of the place,
And from the gray old trunks that high in heaven
Mingled their mossy boughs, and from the sound
Of the invisible breath that swayed at once
All their green tops, stole over him, and bowed
His spirit with the thought of boundless power
And inaccessible majesty. Ah, why
Should we, in the world's riper years, neglect
God's ancient sanctuaries, and adore
Only among the crowd, and under roofs
That our frail hands have raised? Let me, at least,
Here in the shadow of this aged wood,
Offer one hymn—thrice happy, if it find
Acceptance in His ear.

My Garden

By THOMAS EDWARD BROWNE (1830-1897)

A GARDEN is a lovesome thing, God wot!
Rose plot,
Fringed pool,
Ferned grot—
The veriest school
Of peace; and yet the fool
Contends that God is not—
Not God! in gardens! when the eve is cool?
Nay, but I have a sign:
'Tis very sure God walks in mine.

The Wild Honeysuckle

By PHILIP FRENEAU (1752-1832)

FAIR flower, that dost so comely grow,
Hid in this silent, dull retreat,
Untouched thy honeyed blossoms blow,
Unseen thy little branches greet:
No roving foot shall crush thee here,
No busy hand provoke a tear.

By Nature's self in white arrayed,
She bade thee shun the vulgar eye,
And planted here the guardian shade,
And sent soft waters murmuring by;
Thus quietly thy summer goes,
Thy days declining to repose.

Smit with those charms, that must decay,
I grieve to see your future doom;
They died—nor were those flowers more gay,
The flowers that did in Eden bloom;
Unpitying frosts and Autumn's power
Shall leave no vestige of this flower.

From morning suns and evening dews
At first thy little being came;
If nothing once, you nothing lose,
For when you die you are the same;
The space between is but an hour,
The frail duration of a flower.

My Heart Shall Be Thy Garden*

By ALICE MEYNELL (1850-1922)

MY HEART shall be thy garden. Come, my own,
Into thy garden; thine be happy hours
Among my fairest thoughts, my tallest flowers,
From root to crowning petal, thine alone.
Thine is the place from where the seeds are sown
Up to the sky inclosed, with all its showers.
But ah, the birds, the birds! Who shall build bowers
To keep these thine? O friend, the birds have flown.

For as these come and go, and quit our pine
To follow the sweet season, or, new-comers,
Sing one song only from our alder-trees,
My heart has thoughts, which, though thine eyes hold mine,
Flit to the silent world and other summers,
With wings that dip beyond the silver seas.

*From Poems of Alice Meynell: Charles Scribner's Sons.


The Last Rose of Summer

By THOMAS MOORE (1779-1852)

'TIS the last rose of summer,
   Left blooming alone;
All her lovely companions
   Are faded and gone;
No flower of her kindred,
   No rose-bud is nigh,
To reflect back her blushes,
   Or give sigh for sigh.

I'll not leave thee, thou lone one!
   To pine on the stem;
Since the lovely are sleeping,
   Go, sleep thou with them.
Thus kindly I scatter
   Thy leaves o'er the bed
Where thy mates of the garden
   Lie scentless and dead.

So soon may *I* follow,
   When friendships decay,
And from Love's shining circle
   The gems drop away.
When true hearts lie withered,
   And fond ones are flown,
O who would inhabit
   This bleak world alone?

To the Fringed Gentian

By WILLIAM CULLEN BRYANT (1794-1878)

THOU blossom bright with autumn dew,
And colored with the heaven's own blue,
That openest when the quiet light
Succeeds the keen and frosty night,

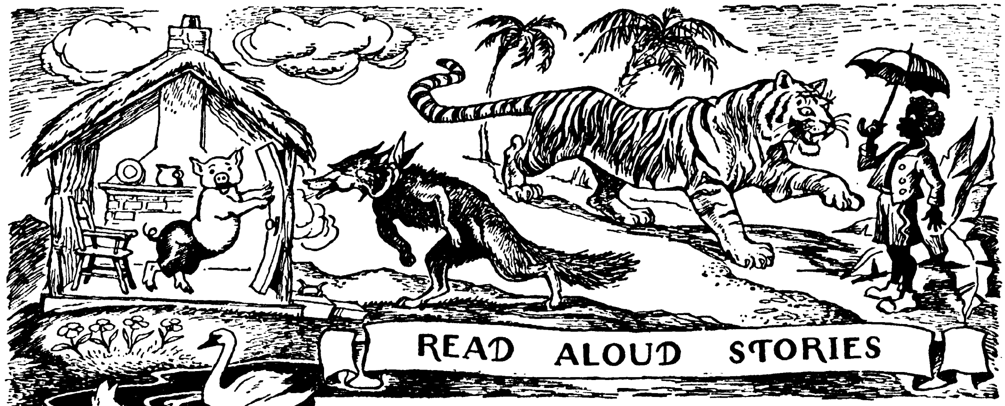
Thou comest not when violets lean
O'er wandering brooks and springs unseen,
Or columbines, in purple dressed,
Nod o'er the ground-bird's hidden nest.

Thou waitest late and com'st alone,
When woods are bare and birds are flown,
And frost and shortening days portend
The agèd year is near his end.

Then doth thy sweet and quiet eye
Look through its fringes to the sky,
Blue—blue—as if that sky let fall
A flower from its cerulean wall.

I would that thus, when I shall see
The hour of death draw near to me,
Hope, blossoming within my heart,
May look to heaven as I depart.

THE NEXT POEMS ARE ON PAGE 1269.



Rum-pel-stilt-skin

This Version is by Ellen McLoughlin

ONCE upon a time in a deep forest there lived a funny little fellow with a funny name—Rum-pel-stilt-skin.

He had a great big head and a long beard and skinny legs and big feet.

But his hands! His hands could do wonderful things, as you shall hear.

Rum-pel-stilt-skin lived in a tiny house in the forest, far away from the king's palace.

Now the king was a very greedy man. All he ever thought about was gold, gold, gold, money, money, money.

So one evening the king led his wife, the queen, into a room where there was nothing but a spinning-wheel and a heap of straw, and he said to her "Spin this straw into gold before morning, or else . . .!" Then he went out and locked the door.

The poor queen began to cry. But she hadn't cried very long before a funny little man hobbled into the room on his thin legs and his big feet.

"Who are you and how did you get in?" asked the queen.

"Never mind," answered the funny little man. "What are you crying for?"

"Because the king says I must spin this straw into gold, and I do not know how."

"What will you give me to do it?" asked the funny little man.

"My necklace," promised the queen.

The little man sat down at the wheel. Whrr! Whrr! Whrr! Pretty soon the gold was all spun.

The queen gave the little man her necklace and off he went.

Next morning the king was greatly astonished and pleased to see the gold.

But a few days later he locked the queen up with a bigger heap of straw. Once more she sat down and cried. But the funny little man hobbled in and said, "What will you give me to help you this time?"

"The ring on my finger," said the queen.

The little man sat down at the wheel and Whrr! Whrr! the straw was soon spun into gold.

"I'll take your ring, please," said the little man.

"Here it is," said the queen, "and before you go I should like to know your name."

The little man only laughed, and away he went.

Next morning the king was very happy to have so much new gold and he praised the queen and told her she was the cleverest woman in the world.

But soon he led her again to a bigger pile of straw than before. The whole room was full of straw.

"Spin this into gold before morning," he commanded," and I'll never ask you to do any more work!" Then he went out and locked the door.

The queen started to cry, but just then the funny little man appeared and said, "Ah! This is a big task! What will you give me to do it for you?"

"I have nothing left to give," said the poor queen.

"Then promise me," said the little man, "the first child you have."

Without thinking, the queen promised, and the little man sat down at the wheel. Whrr! Whrr! Whrr! Whrr! Whrr!

"There!" he said. "There's your room full of gold!" and away he went.

The king was delighted!

The next year the king and queen had a little baby boy. His parents loved him very much, but when the baby was a few months old, the funny little man came to the queen's chamber to take the child away.

The queen begged and pleaded, but no, the little man would not go away without the child. At last he said, "I shall give you a chance. If, in three days, you can guess my name, you may keep your child."

The queen stayed awake all night, thinking of names. In the morning she sent messengers through the kingdom to learn all the names there were.

On the first day the little man came again.

"Is your name John?"

"No."

"Is it Benjamin?"

"No."

"Is it George or Matthew or James or Fred or Peter or Frank or Ralph or Lawrence or Patrick?"

"No."

She thought of one hundred and fifty-five other names, and it was not any of them, so then the little man went home.

In the morning he stood before the queen again.

"Is your name Stephen?"

"No."

"Is it Eric or Rudolf or Allan or William or Warren or Edward or Moses or Paul or Anthony or Charles or Henry or Joseph or Leo?"

No, it was none of them. The queen thought of a thousand and twenty-one more names, but it was none of them.

"Do you give up?" asked the little man.

"No, come back tomorrow," said the queen, and away he went.

Early the next morning the messengers began to arrive with their lists of names. But there were no new names. Then the very last messenger arrived and he had a story to tell.

"Last evening in the forest," he said, "I saw a little house, and in front of the house was a fire and around the fire danced a funny little man with a big head and a long beard and skinny legs and big feet.

"He danced and he sang:

'Little does my lady dream
Rum-pel-stilt-skin is my name.' "

The queen clapped her hands for joy, and just at that minute the funny little man appeared.

"Is your name Tom?" said the queen.

"No!"

"Is it Ferdinand?"

"No!"

"Is it Rum-pel-stilt-skin?"

"Ow!" cried the little man, stamping his foot in a rage.

Then he went back to his house in the forest, and the queen kissed her baby and sang to him; "Rum-pel-stilt-skin was his name! Rum-pel-stilt-skin was his name!" And nobody ever saw the funny little man again.

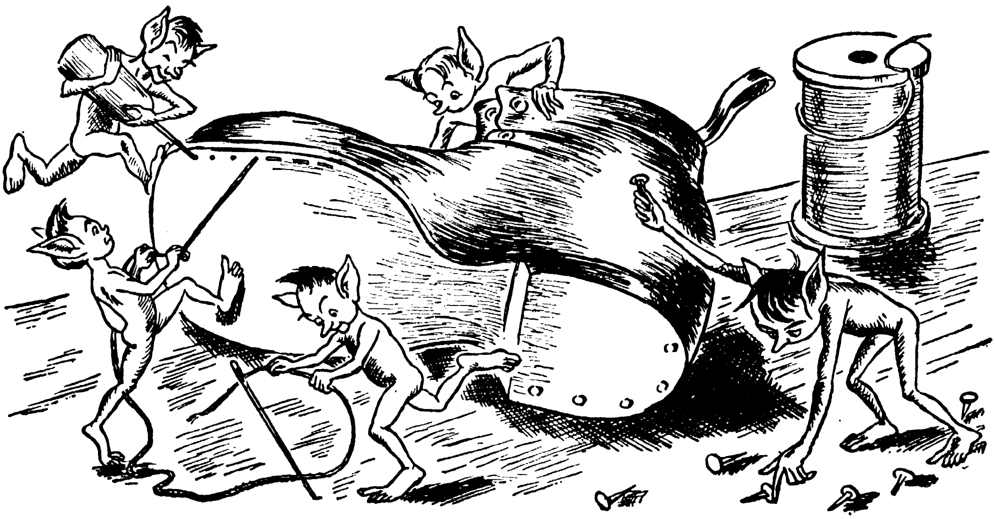
The Elves and the Shoemaker

A German Folk-Tale

This Version is by Margaret Lima Norgaard

There was once a poor shoemaker who had just leather enough to make one pair of shoes. He cut these out in the evening and went to bed, intending to make them up the next morning. But what was his surprise when he awoke to find the shoes already made, standing side by side on his work-table!

The good man did not know what to think. He looked the shoes over carefully, turning them around and around, and the more he looked the more he wondered. There was not a poor stitch in the whole job; they were the most perfect and the prettiest shoes he had ever seen. He would have liked to keep them, just to look at them, but he was very poor, so he sold them that same day for a good price, and bought enough leather with the



money to make two pairs more.

It was evening before he had the two pairs cut out, and he went to bed early that he might get up at daybreak to begin work. But when he got up in the morning, there stood the two pairs of shoes already made up, as pretty as you please! He sold these too, and bought leather enough for four pairs more. And again the strange thing happened; he found the shoes all made up by morning. So it went for some time; as many shoes as he cut out were always finished before he awoke, and the work was so perfectly done that buyers paid more than he asked.

One evening, not long before Christmas, when the shoemaker had cut out the usual quantity of leather, he said to his wife:

"What say you to stopping up this night to see who it is that helps us so kindly?"

The wife liked the thought, so they left a light burning and hid themselves in a corner of the room where some clothes were hanging. As soon as it was midnight, in came two little elves who climbed up on the table and sat there cross-legged, stitching and sewing and hammering away at the shoes so swiftly that the shoemaker, half the time, could not see the flying fingers but only the finished shoes piling up on the table. When all the shoes stood ready, the little elves scampered out the door and were gone.

The next morning the wife said: "The little elfmen have made us rich and we must do something for them in our turn. They wear no clothes at all and they must be cold I shall make them shirts and coats and trousers and stockings and caps, and do you make them sturdy shoes."

The shoemaker was willing, but he said: "I have heard that elves will not work for pay. If we give them gifts, they may never come back."

"So be it," said the wife, "but let us clothe them none the less. If they do no more work for us, we shall still be well off."

So the good man and his good wife set to work and made up suits all of green, as the elves like them, and on the caps the wife sewed little silver bells. One evening, when all was ready, they laid their presents on the table and hid themselves to watch what should happen.

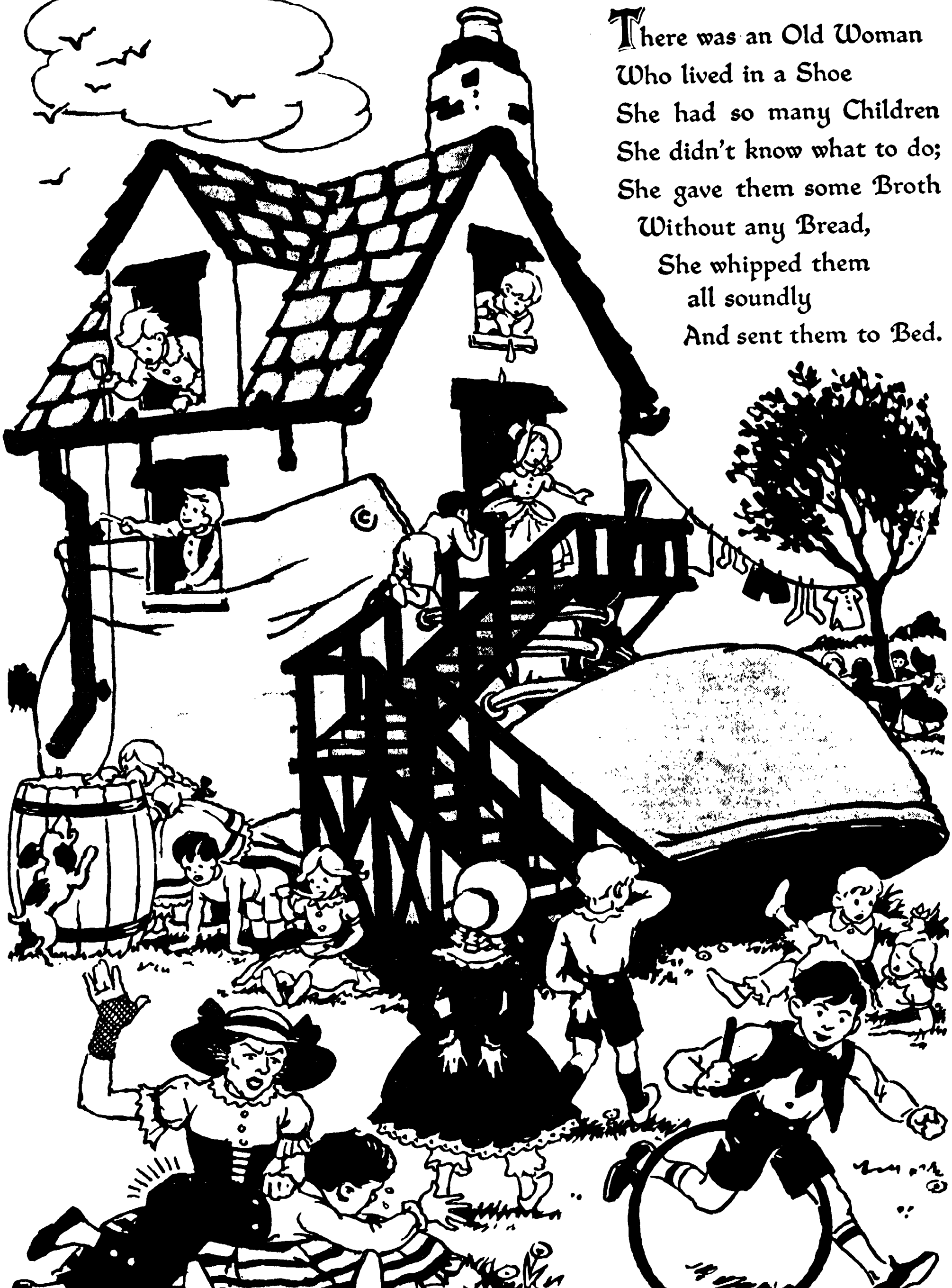
At midnight, in skipped the elves ready for work. When they saw no leather, but the suits and shoes instead, they stood still in great surprise, but soon they began to laugh and clap their hands with joy. They put on the shirts and coats and trousers and caps and stockings and shoes, and smoothed and patted them, shaking their heads all the while to set the bells on their caps a-jingle. Then they began to sing:

"Now we've clothes for all to see,
  Shoemakers we'll no longer be.
We'll skip and play and dance away,
  And leave good fortune here to stay."

They hopped and jumped over the stools and chairs, and at last, as merry as could be, they danced out of the door. After that, they did not come again, but the shoemaker and his wife lived happily ever after.

THE NEXT READ ALOUD STORIES ARE ON PAGE 1528.

There was an Old Woman
Who lived in a Shoe
She had so many Children
She didn't know what to do;
She gave them some Broth
Without any Bread,
She whipped them
all soundly
And sent them to Bed.



HICKORY, DICKORY, DOCK

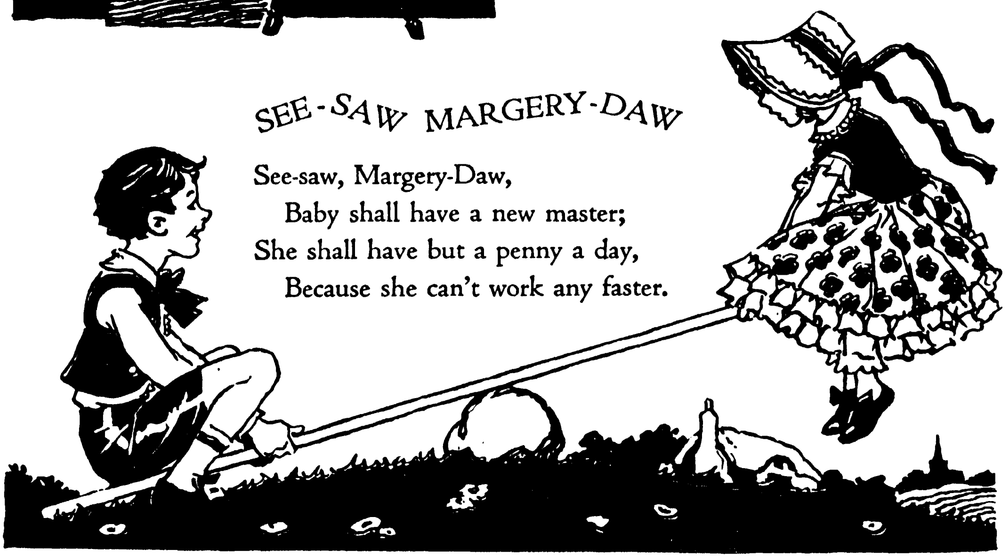
Hickory, Dickory, Dock,
The mouse ran up the clock,
The clock struck
ONE,
The mouse
ran
down,
HICKORY,
DICKORY,
DOCK.

LITTLE TOMMY TUCKER

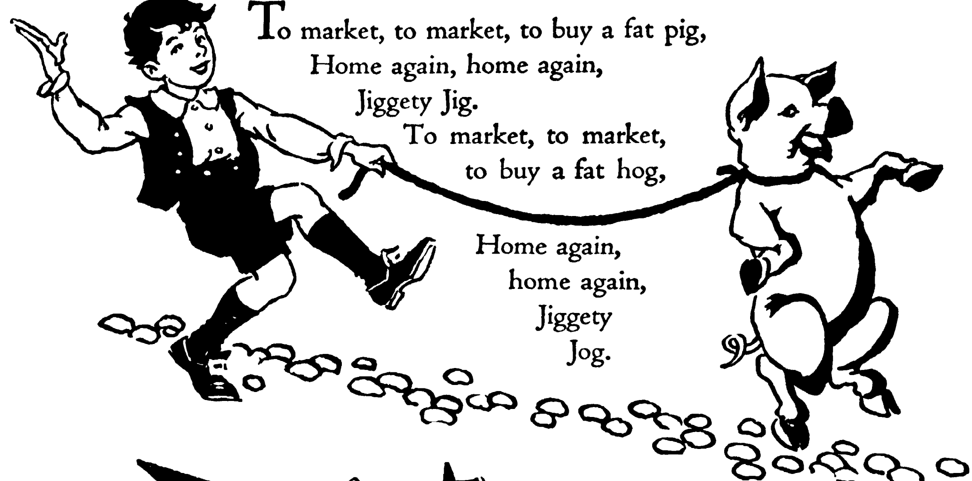
Little Tommy Tucker
Sings for his supper;
What shall he eat?
White bread and butter.
How shall he cut it
Without a knife?
How can he marry
Without a wife?

SEE-SAW MARGERY-DAW

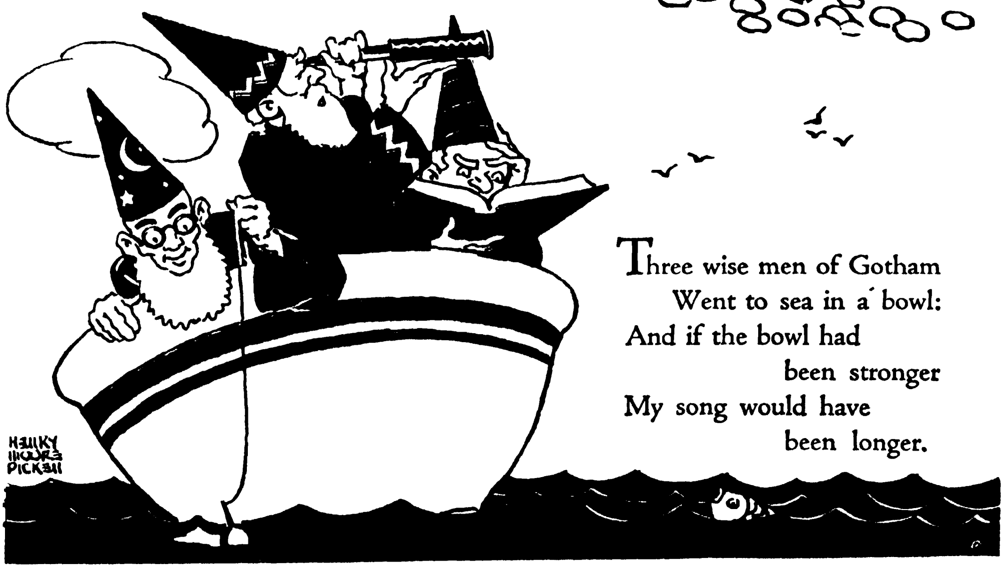
See-saw, Margery-Daw,
Baby shall have a new master;
She shall have but a penny a day,
Because she can't work any faster.



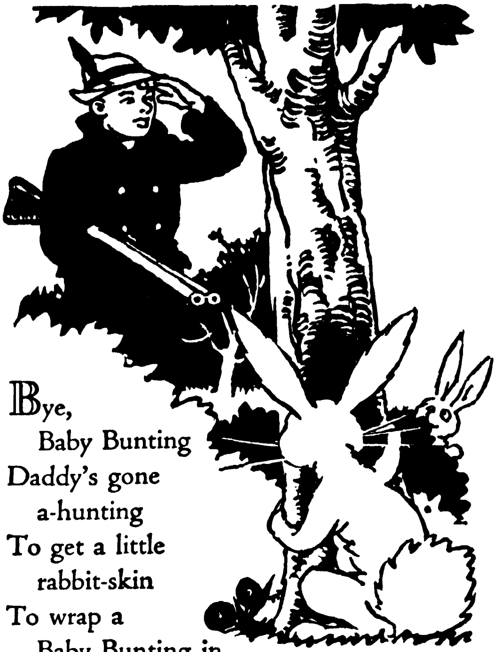
"Where are you going to, my pretty maid?"
"I am going a-milking, sir," she said.
"May I go with you, my pretty maid?"
"You're kindly welcome, sir," she said.
"What is your father, my pretty maid?"
"My father's a farmer, sir," she said.
"Say, will you marry me, my pretty maid?"
"Yes, if you please, kind sir," she said.
"Will you be constant, my pretty maid?"
"That I can't promise you, sir,"
she said.
"Then I won't marry you, my pretty maid!"
"Nobody asked you, sir," she said.



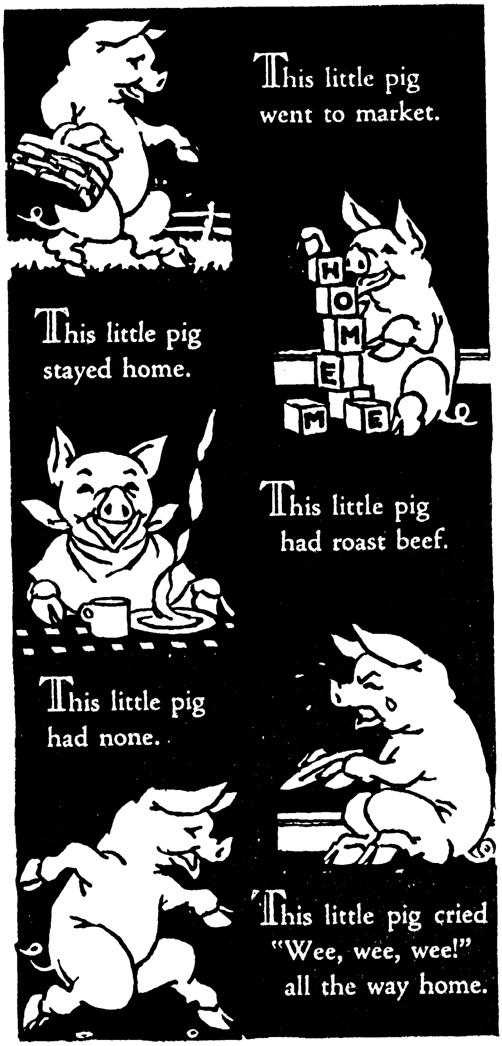
To market, to market, to buy a fat pig,
Home again, home again,
Jiggety Jig.
To market, to market,
to buy a fat hog,
Home again,
home again,
Jiggety
Jog.



Three wise men of Gotham
Went to sea in a bowl:
And if the bowl had
been stronger
My song would have
been longer.



Bye,
Baby Bunting
Daddy's gone
a-hunting
To get a little
rabbit-skin
To wrap a
Baby Bunting in.



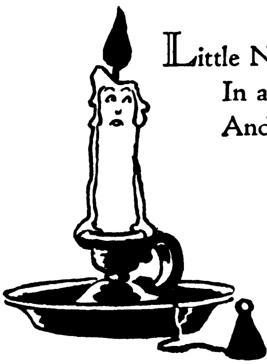
This little pig
went to market.

This little pig
stayed home.

This little pig
had roast beef.

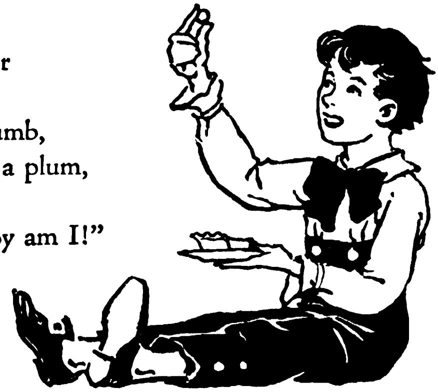
This little pig
had none.

This little pig cried
"Wee, wee, wee!"
all the way home.



Little Nanny Etticoat,
In a white petticoat,
And a red nose;
The longer
she stands
The shorter
she grows.

Little Jack Horner sat in a corner
Eating a Christmas pie;
He put in his thumb,
And he took out a plum,
And said
"What a good boy am I!"



Underwood and Underwood

A group of children rehearsing a radio play which they have written.

HOW TO WRITE A RADIO PLAY

ONE of the newest professions is that of writing plays for the radio. Hundreds of these plays are produced each week: original dramas, comedies, and adaptations of stage plays, short stories and novels. Would you like to know how to write one and present it?

It will not be necessary for you to sell your play to a broadcasting system in order to produce it before an audience. You may purchase from a radio supply store a little microphone that can easily be attached to your home radio. Directions for connecting it are included in the box in which it is packed. It would be best, however, to have a grown-up help you, so that you may be sure it will work well. When the microphone is set up, take it into the next room and close the door. Though you and your fellow-actors will be quite invisible to the audience gathered before your radio, your voices will come over the loudspeaker as if they were being sent out from a real broadcasting station.

But before you can perform, you must write your play. The first rule is: make your plot simple and avoid complex minor plots. It is much more difficult for a radio audience to follow the action of a play than for a stage audience, which can use both sight and hearing; the radio audience has to rely on hearing alone. Consequently, if the plot is too complicated, a moment's inattention on the part of the radio audience may cause it to lose track of the whole thing.

It is best not to have too many characters in a radio play. If you do, the radio audience is likely to become confused. Very effective radio skits have been built up around only two characters; it is seldom advisable to have more than five. When a character is brought into the play for the first time, he should be immediately introduced. Generally speaking, an unknown voice should not break into a radio conversation unless it is first identified: "Here comes Johnny," or "Let's ask Mary" or, after a ring on the doorbell, "Why, Cynthia, come right in!"

There are various ways of bringing out the individual traits of your characters. One of the most important, naturally, is to stress the different voices. Unless these contrast sharply, they will all sound alike to your audience. Make one voice drawling, another rapid-fire; one harsh, another soft, etc.

The different characters that you present in your play may be described by one or more of the other persons in the play, or by the dialogue or by the action. If a man flies into a temper when a servant makes a slight error, or keeps interrupting the conversation of other people or is offensively boastful, your audience will realize at once the sort of person he is.

The personal traits of your characters must be brought out as early as possible. This will help to keep each character distinct in the mind of the audience. If your audience does not know within a minute or two whether your character is supposed to be young or old, slow or quick in his movements, calm, or fidgety, your play is not very effectively written.

YOUR DIALOGUE MUST TAKE THE PLACE OF ACTION

Dialogue must be unusually clear and precise in a radio play. On the stage, gestures and facial expressions can often take the place of words. In radio, words and sounds do all the work. The dialogue should be natural. Read each sentence aloud after you have written it. Ask yourself whether the character who is speaking would talk like that in real life. Have the dialogue correspond to your character's age and station in life; don't have your children talk like adults or your policemen like school teachers. Watch your "s" sounds very closely, because they have a tendency to become a hiss on the air. Do not let too many "s" sounds come together. When a sentence like "She simply sat on Susie's sofa" comes out of the loudspeaker, the effect is that of an angry snake resenting your presence.

THE ANNOUNCER PROVIDES THE ILLUSION OF SCENERY

One of the most difficult things for the radio play to accomplish is to create a stage setting in the minds of the audience. When the curtain goes up on a stage, the audience sees at once what is on the stage and who is on the stage. In a radio play the setting has to be made clear to the ears of the audience. It must be built up first of all by the announcer, who is really quite an important person. Like the Prologue of an Elizabethan play, he must make up for the deficiency in scenery. He must inform the audience, clearly and vividly, where the scene is laid, and what characters are on the stage when the scene opens. Here again, simplicity is the watchword. If he says that the scene is the huge dining hall of a medieval castle, with a large table in the centre and tapestry on the walls, the audience will be able to visualize this background throughout the play. If, however, the announcer describes at great length the carvings on the table, the figures in tapestry, the lighting arrangements and so on, the audience will find it difficult to keep all these details in mind.

Very often the first few lines of the dialogue will help make the setting vivid. A dialogue like this:

"SHE: My goodness, but I'm hungry.
HE: Well, let's look at the menu . . ."

will help to fix in our minds the announcer's preliminary statement that the scene takes place in a restaurant.

In the older type of radio drama, when there were several scenes, the announcer would take advantage of the interval between scenes (the "break," as it is called) to describe what the next scene was to be and to tell the audience just how much time had elapsed. Nowadays, it is considered much more effective to have the dialogue tell all this. Suppose five days have elapsed since characters A and B parted in the lobby of the Waldorf Astoria Hotel, at the end of Scene 1. Scene 2 might begin like this:

"A: Well, here we are again in the good old Waldorf Astoria.
B: You'd never think we saw each other last only five days ago."

Most of the action of your play must be told in dialogue. Such sentences as "How dare you smile at me!" "Must you always smoke after breakfast?" "Why are you looking out of the window?" tell the audience the action referred to in the stage directions. Writers for the radio also utilize the fact that the nearer the speaker stands to the microphone, the louder his voice will sound, whereas it will become fainter as he goes away. This enables the audience to visualize, to a certain extent, the movements of the actors. When the actor is to stand close to the microphone, the stage direction will read: "UP MIKE" (up to the microphone); when he is supposed to stand further away, the directions read "AWAY MIKE" (away from the microphone). When a person goes away from the microphone, we say that he "fades out"; when he comes closer to it, he "fades in."

To indicate stage business, sound effects of many kinds are very useful. A clap of thunder, the sound of a siren, a scream—all these will help to make the action vivid. Entire books have been written about the production of sound effects for the radio.

Some of these effects require special apparatus. In certain cases phonograph records are made of applause, shouting of crowds, animal sounds and the like, and these sounds are faded into the microphone from the control room as occasion requires.

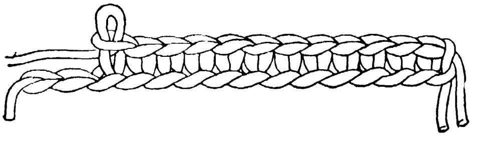
Many sound effects will be beyond your resources. There are a number of sounds, however, that you will be able to produce over the air. To indicate the closing of a door, simply close a door; to indicate the sound of a whistle, blow a whistle. There are times, however, when it is necessary to "fake" a sound. If a fire is called for in the script, you cannot simply start a fire near the microphone. Again, sounds sometimes suffer a distortion over the air. For example, a well-known children's program once began with the ringing of a school bell. To insure a realistic effect, a real school bell was used for the purpose. Over the air, however, it sounded like the bell of a locomotive, and not a few listeners thought that it announced a stirring railroad drama. Often, therefore, it is advisable to manufacture your sound effect. For example, you may produce the sound of crackling flame by crumpling a bit of cellophane in front of the microphone. Wind may be imitated by rubbing two taut pieces of canvas together. To indicate a storm, rattle a sheet of tin or drop some dried peas into a kettle. For a violent hurricane, run an electric massage vibrator over the skin of a drum. You will find it fascinating to experiment with sound effects over your microphone; you may even be able to produce some that will be startlingly new.

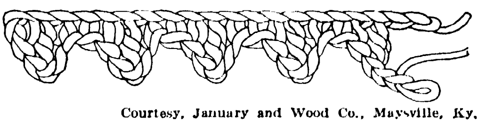
When you have become adept in producing your sound effects, remember that these will be helpful in arousing the interest of your audience and in creating the necessary atmosphere for the play. It is often advisable to begin your play with some startling sound, particularly if you are writing a melodrama.

Music is often important. It serves to bridge the rather awkward gap between the announcer's opening words and the beginning of the play itself. It serves much the same purpose as the stage curtain. When the music stops, we know that the curtain has gone up; when the music plays again, the curtain has gone down. It is particularly useful to make the break between two scenes and the final drop of the curtain. In giving your own play, you should provide musical effects if it is at all possible. A small string orchestra, or a violin and piano, or a piano alone would serve the purpose very well. Be sure that your music is in harmony with the atmosphere of your play. Do not begin a play based on a fairy story with a popular dance tune, or play Russian music for a scene that is laid in Scotland.

Many of the articles in The Book of Knowledge contain dramatic stories that could form the basis of a radio play. The Book of Golden Deeds is particularly rich in such stories.

CROCHETED EDGINGS OF YARN





Courtesy, January and Wood Co., Maysville, Ky.

Edgings of this type are extremely smart when used as a finishing braid for pillows, drapes, slip covers, hand made rugs, and many other household items.

Tailored Edge—Chain stitch a strand to go generously around what ever you are going to decorate. Allow for shrinkage for there will be a slight reduction in length when the next row of crocheting is put on.

For a tailored edge, use two colors. Using a Number 0 steel crochet hook, crochet a strand of the first color, the required length. Next, with the second color single stitch into every chain stitch. See left above.

Lace Edge—Crochet a chain as long as the desired length of braid. Into every stitch of this braid, first crochet 1 single stitch in third from hook, then 1 double crochet in next stitch. Crochet 3, slip stitch into top of double crochet. This forms a picot. Slip 1 stitch (sometimes called a half-stitch). Next single crochet 1, double crochet 1, chain 3, slip stitch into top of double crochet, and 1 slip stitch. You now have 2 scallops. Continue in this way to end of chained strand.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 1283.

MOTION

WHY THINGS MOVE, HOW THEY MOVE AND WHY THEY STOP

THE word physics comes from the Greek word for nature. When we study physics, therefore, we are studying the great laws of nature; and by this study men have learned to help themselves in many ways. A pilot knows, for instance, that if he has a good tail wind his plane can make better speed. An airplane designer streamlines his planes; the engineer of planes for high altitudes includes mechanisms to increase the air pressure; gunnery experts must know a great deal about gravitation; inventors in radio and other electronics devices must be well acquainted with the tiny atom and its particles. In fact, the knowledge of physics touches our life at almost every point; and the more we learn about its great fundamental laws, the better equipped we will be to play our chosen part in the world. This is true even of the artist and of the musician, and of the business man and business woman as well.

You have already learned about the three states of matter, solids, liquids and gases, and about the ninety-two different elements, or kinds of matter, that are found in our universe. You know about one of the greatest of all physical forces, gravitation—that force by which every bit of matter in the universe tends to attract and be attracted by every other bit of matter in the universe. You know that the attraction increases as the mass increases and as the distance decreases. Gravitation holds the earth's atmosphere to it; the atmosphere is heavier closer to the earth and thinner on a mountain top, and thins out almost to nothingness in the altitudes far above the earth.

A SOLID, A LIQUID AND A GAS ARE FORMS OF MATTER IN VARIOUS STATES OF MOTION

Yet gravitation does not hold things stock-still. The air is moving, clouds move, we move, trains and ships move. Even airplanes rise up from the earth, seeming to defy gravitation. Almost everywhere there is motion. The three forms of matter are matter in three states of motion. Heat and cold are determined by motion of molecules. Even inside the atom there is motion. Things in motion are not defying gravitation, they are obeying its laws.

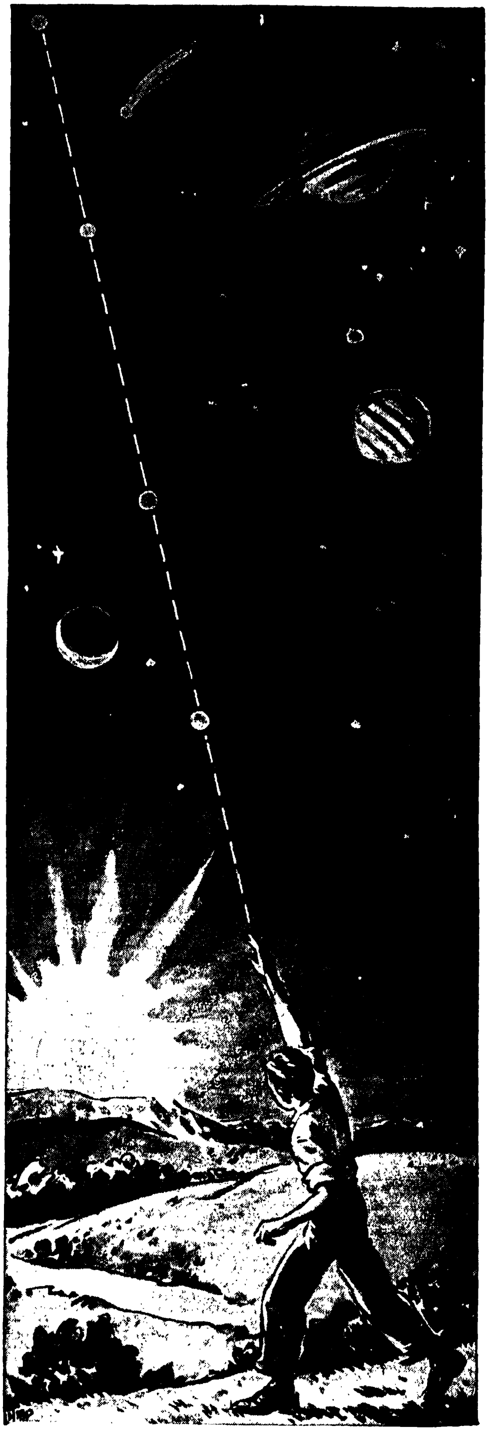
NEWTON, WHO EXPLAINED THE PRINCIPLE OF GRAVITATION, SET FORTH LAWS OF MOTION

Sir Isaac Newton, who discovered the principle of gravitation, set forth three laws of motion which help us to understand gravitation. These three laws are explained below.

I—The Law of Inertia, or the law of doing nothing. This law has two parts:

1. *When a thing is moving it does nothing of itself to change its motion.* It will go on moving forever, in exactly the same direction and at the same speed, unless some other force stops it or turns it or makes it go slower or faster. A bullet shot out of a gun would never drop to earth were it not for the fact that the earth's gravitation pulls it down. When you sit in a swing, and somebody gives you a good push and the swing goes upward, you would go up and around the branch on which the swing is tied, and continue forever circling round the branch, if friction did not slow you down and if the earth's gravitation did not pull you down.

We see a ball thrown up into the air, or thrown over the surface of the earth, and we



If you could throw a ball far enough into the sky, the earth would not attract it any more, and it would never come down.

know the motion ceases. This is our experience with practically all motions, and so we might get the idea that when a thing moves it gets tired after a time and stops. This is not so. The smallest touch applied to the biggest thing, sufficient to move it at all, will keep it moving at that speed and in that direction forever. When a ball thrown up is stopped, the earth by its pull stops it, and the resistance of the air also helps in the stopping. When a ball rolling along the ground stops, it does so because the resistance of the air and the friction of the ground stop it.

THE PERPETUAL MOTION MACHINE IS A DREAM THAT IS NOT VERY LIKELY TO COME TRUE

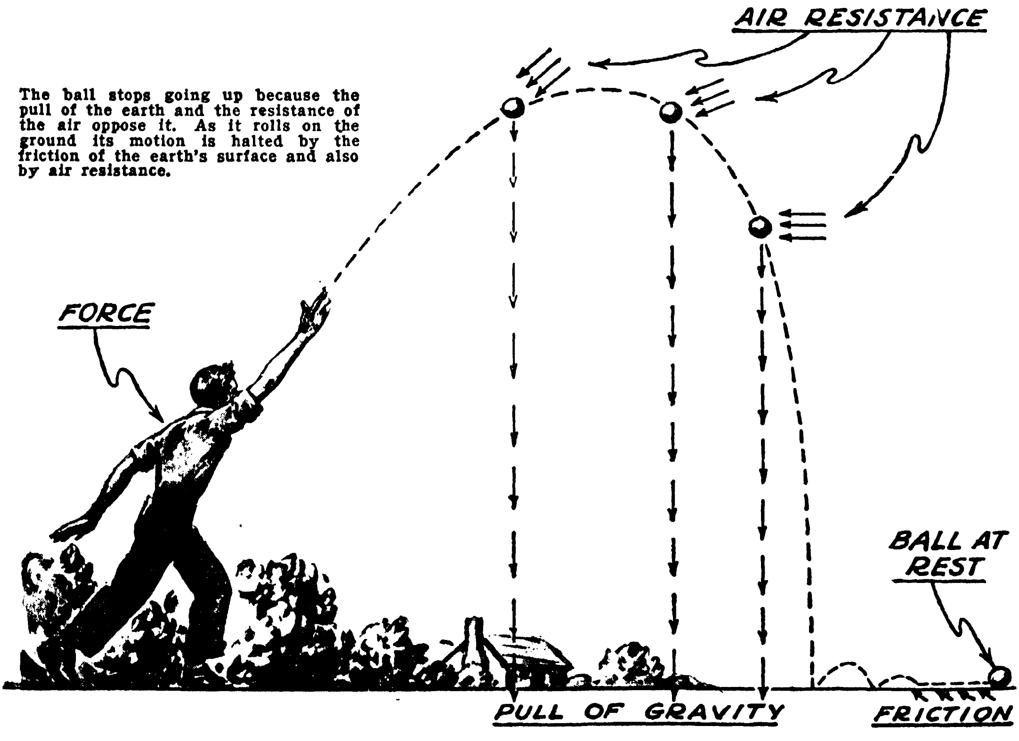
Pondering this half of Newton's Law of Inertia, men have tried to make machines that would go on forever—perpetual motion machines—that could be started and then left to run by themselves. Think of the energy this would save the world, if such machines were possible! Power would always be at hand for electric lights without the need for coal or running water. Clocks would have to be wound only once. Ships and trains and airplanes and automobiles would run along without fuel after their engines were once started.

Unhappily, such an easy-going world is not likely to be made. It remains true that a moving thing does nothing of itself to change its motion. However, machines wear out, friction slows down parts, gravitation enters the picture. In short, a perpetual-motion machine appears to most people to be impossible. Now for the second part of the Law of Inertia.

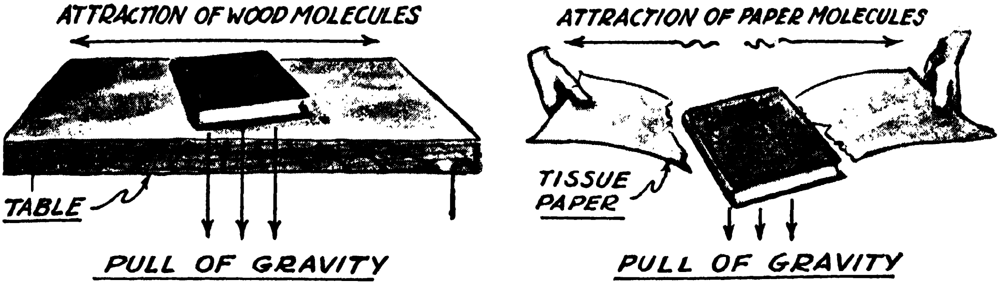
2. *When a thing is at rest, it remains at rest, doing nothing, until something moves it.* That is easy enough to understand. A stone on the ground remains there unless someone picks it up or kicks it aside, or unless the earth caves in under it or something rolls against it. Millions of stones were bumped along by the last great glacier to its farthest point. The glacier melted. The stones remained and are there to this day. They have no power in themselves to move.

The tendency, therefore, is for a thing at rest to remain at rest, and for a thing in motion to go on moving.

This is a proof of another law in physics:



The ball stops going up because the pull of the earth and the resistance of the air oppose it. As it rolls on the ground its motion is halted by the friction of the earth's surface and also by air resistance.



A book on a wooden table is pulled downward by the force of gravity; the table pushes back with an equal and opposite force. The result is equilibrium. Tissue paper, however, fails to push up enough, and the book falls.

the law of the Conservation of Matter and Energy. This law states that matter and energy can not be made out of nothing; and that matter and energy can not be destroyed. If things at rest could start moving of themselves, then motion would be created from nothing. If moving things could be stopped without something stopping them, motion would be completely destroyed. We explain fully the Conservation of Energy in the article beginning on page 1358. The law is mentioned here to show that it and Newton's First Law of Motion support each other.

Newton's Second Law of Motion is quite simple and you see its effects every day.

II—*The force required to set a body in motion or to stop a body already in motion is greater, the greater the mass. Also, the force required is greater, the quicker the motion.* A baby can exert enough force to move a toy building block across a floor. He could not move a sofa—the force required to move such a mass is too great. Likewise, less force is required to stop a hoop rolling down a hill than to stop a loaded toboggan. The toboggan has far more mass. Also, push a revolving door gently and it will go round slowly; push it hard and it will go round fast.

Furthermore, the thing moves in the direction of the straight line in which the force acts. This is true even if there are twenty different forces acting in different directions on a body, and it is true whether the body was at rest or already moving when the forces in question started to act. Strike a marble that is at rest with an agate. The marble that was struck will roll along in the same direction as the agate.

Rolling down a hill we have a light hoop and a heavy rock. The hoop has very little mass in comparison with the rock. Therefore, it takes less force to stop the hoop. The tree will stop the hoop, but not the rock.

Now suppose a marble is not at rest, but rolling toward you. Send an agate out to strike it. The stone (marble or agate) which has the greater momentum will force the other stone to change its course; the two stones will roll along in the same direction.

Using this law, it is possible for us to find out exactly in what direction and at what rate a body will move. (To know at what rate a body will move we must know the force acting on the body and the mass or weight of the body.) We discover also the profound truth that rest is a state of balance of forces; some forces are pulling, but other forces are pushing. These exactly oppose each other, and so the result is rest.

Gravitation pulls a book down as it lies on a wooden table. The table pushes upwards with the same force—it supports the book. A tissue-paper table, on the other hand, would not push upward with a great enough force—the molecules of paper do not attract each other as much as do those of wood. Hence, the book will fall. A thing is at rest, therefore, when all forces acting on it are balanced. Such a state is called *equilibrium.*

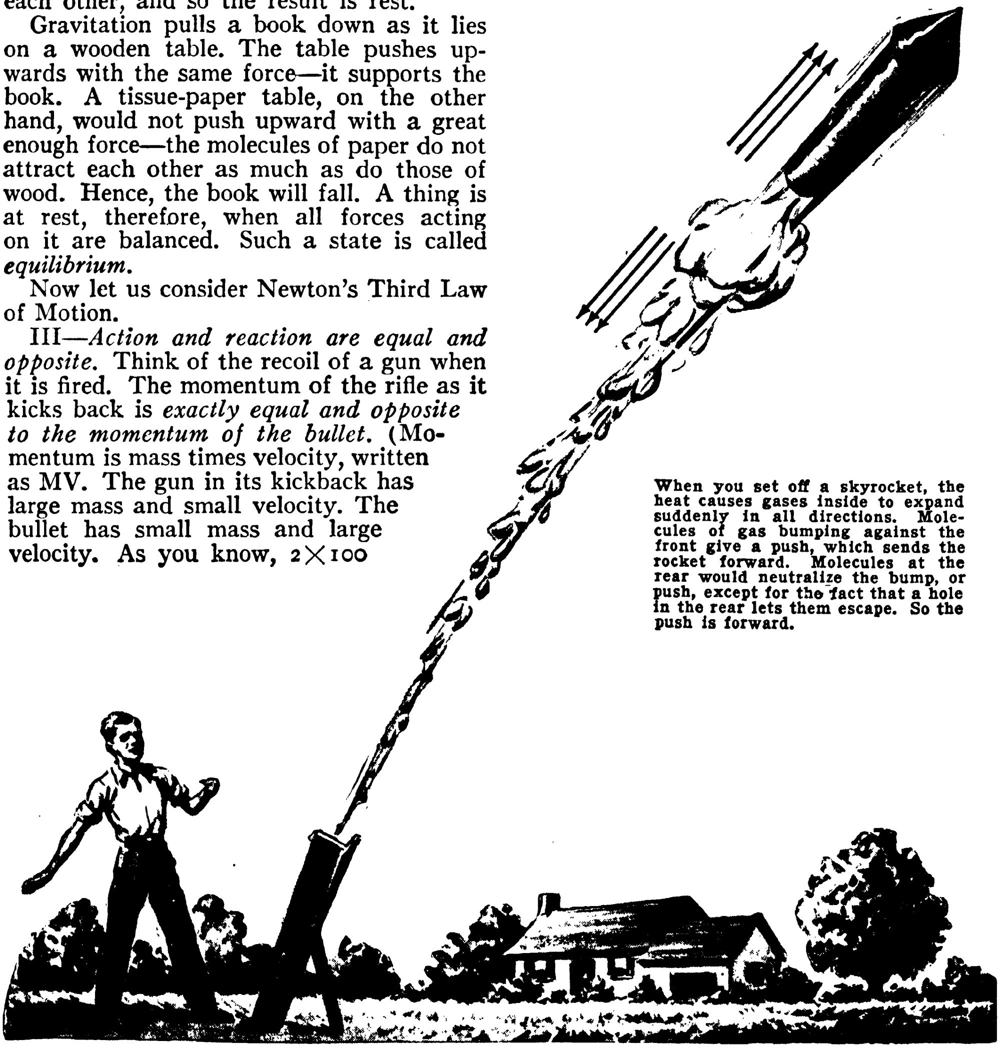
Now let us consider Newton's Third Law of Motion.

III—*Action and reaction are equal and opposite.* Think of the recoil of a gun when it is fired. The momentum of the rifle as it kicks back is *exactly equal and opposite to the momentum of the bullet.* (Momentum is mass times velocity, written as MV. The gun in its kickback has large mass and small velocity. The bullet has small mass and large velocity. As you know, 2×100 is the same as 100×2; $3\times750=750\times3$, etc.)

An example of the Third Law of Motion is found in the skyrocket. When you light it, gases are produced; they expand rapidly, pushing in all directions. The push to the front equals the push to the rear, and they should cancel each other. However, there is an exit in the rear and the gases escape this way. The resulting motion is toward the front.

All these laws are of supreme importance, and though we may not be able to understand all their details, we should certainly know something about them.

THE NEXT STORY OF SCIENCE IS ON PAGE 1355.



When you set off a skyrocket, the heat causes gases inside to expand suddenly in all directions. Molecules of gas bumping against the front give a push, which sends the rocket forward. Molecules at the rear would neutralize the bump, or push, except for the fact that a hole in the rear lets them escape. So the push is forward.

VOLUME IV

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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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.

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From the T. F. Healy Collection

Patrick Henry delivering his famous oration: "If this be treason, make the most of it!"

THE REVOLUTION

WE have learned how England and her colonies forced France to give up her North American colonies. Only a few years later the original English colonies rose up against the mother country and, with the help of France, became an independent nation. This war, which lasted for more than seven years, is called the American Revolution. The people of Canada, who at that time were almost all French, remained loyal to England, although the rebelling colonies tried to persuade them to join the war for independence.

The trouble which finally led to this war really began when the different colonies were first planted. All of the European nations that had colonies in the New World considered that they existed only to benefit the mother country. At first they were merely places from which to get raw materials. Later, as the settlements grew, they also became valuable as consumers of goods manufactured in the mother country. France, England, Holland and Spain all had laws designed to benefit the home country at the expense of the colonies. The original charters of some of the English colonies contained rules governing colonial trade, and from time to time other laws were added. Among these were several Navigation Acts, which regulated the shipping to and from the colonies.

According to these acts no English colony could send rice, indigo, tobacco and certain other articles to any country except England, and these products must be carried in English or colonial ships. Moreover, the colonists were not permitted to buy goods from any country except England. Thus, if a Virginia planter wanted to buy some of the silk woven in France, and if a French merchant wanted to buy some Virginia tobacco, they could not deal with each other directly. The Virginian would have to send his tobacco to England, to be bought by an English merchant, who could sell it at a much higher price to the Frenchman. The English merchant could then buy the silk from France and sell it at a much higher price to his customer over in Virginia.

You can see from this that the English merchant got two profits, one from the French merchants and one from the Virginian, and the price of carrying the silk and the tobacco between England and the colony was paid to an English or colonial shipowner. This made it rather expensive for people in the colonies to buy goods made in foreign countries; in fact it almost forced them to buy English-made goods. This was a good thing for the English manufacturers and merchants, but it was not so satisfactory for the colonists. They had to pay high prices for everything they got from England because the English merchants did not have to compete against foreign merchants for the colonial trade but could charge whatever they wished.

These were not the only laws which worked against the people of the colonies. Because England wanted to build up her manufacturing trade, the colonies were forbidden to develop manufactures of their own. Instead of making articles out of iron from their own mines, or weaving cloth from the wool from their own sheep, the colonists were required to send these raw materials over to England and buy the manufactured articles from there. (This did not include home spinning and weaving.) At that time neither England nor any other European country needed food from its colonies. When the English colonists began to raise more grain than they needed, they were not allowed to send any to England unless a tax on every bushel was paid. This was what we to-day call a protective tariff, and it was intended to protect the English farmers.

AT FIRST THE TRADE RESTRICTIONS WERE NOT WELL ENFORCED

At first these laws did not make so much difference to the colonists because they were not enforced. The colonists traded wherever they pleased, and smuggling went on quite openly. There were several reasons why the English government neglected to enforce these laws. At first the colonial trade amounted to very little and was not worth the cost of enforcing the laws. Then, too, during much of the seventeenth century, England was busy with political troubles at home, including a civil war. As we know, the eighteenth century brought a series of wars in Europe and America which were ended only in 1763, when the French were driven out of North America.

It was toward the end of the French and Indian War that the English government began to show a new spirit. George III came to the English throne and he was determined to be king in fact as well as in name. His grandfather and great-grandfather had both been born in Germany and never really felt at home in England. Because they could not speak English well they had depended greatly upon their ministers and had taken little active part in the government of the country. George III was determined to change this state of affairs. He considered himself an Englishman, and he believed that the king of England, and not the Parliament, should be the main power in the government. The character of George III had an important effect upon colonial affairs, because he took an active part in forming the policies that helped to bring on the Revolution.

WHEN THE WARS WERE OVER MANY PROBLEMS AROSE

As the French and Indian War came to an end, and both the English government and the colonies began to have time to stop and look around them, each found much to complain about in the other. All through the war the British had felt that the colonists were doing less than they should have done. Each colony was jealous of the other colonies. There was no central government and each colony did as much or as little as it pleased toward the common defense.

On the other hand, the colonists had fought by the side of regular troops and had done as well, or better, in many battles. They began to have more confidence in themselves and to think of themselves as a part of the British Empire, not as being merely under the British Empire. They were loyal to the Crown and to King George, but they began to believe, and to say, that the legislature of each colony should make that colony's laws, and not the British Parliament, which was thousands of miles away.

After the French and Indian War the British Government decided to keep an army in the colonies to help protect the more outlying sections from hostile Indians. It was also decided that the British Government should appoint and pay the judges, for it was felt that the judges appointed or elected by the colonists themselves too often decided against the British and in favor of colonials in law cases. The Royal government also thought it would be a good idea to have the colonies pay some of the cost of the French and Indian War, since it had been partly fought for their protection. All of this seemed quite fair to the British, but most of the colonists were of a quite different opinion.

Several new laws about taxes were made, but that known as the Stamp Act was the most far-reaching and the most disliked by the colonists. This act was passed by the British Parliament in 1765. Under it all legal papers, such as wills, contracts and deeds, licenses to sell certain goods, mortgages, college diplomas, almanacs and newspapers had to carry a government stamp on each sheet of paper. These stamps cost different amounts, ranging from about one cent to fifty dollars. Such taxes were paid in England without much objection from the taxpayers, and very few people over there seem to have had any idea that the colonists would object to paying them.

In the eyes of the government this tax law did not seem harsh or unreasonable. But England had left the colonies alone too long. They had grown to believe, as we have said, that Parliament had no right to lay any tax on them, since they had no voice in Parliament. There was great excitement in every colony, and the cry, "No taxation without representation," was heard up and down the land. In several colonies secret societies called "Sons of Liberty" were formed to resist the payment of the tax.

Another matter which aroused the anger of the colonists was an order that the lands between the Alleghenies and the Mississippi, which had been won from the French, should not be opened to settlement. The Royal government intended that these lands should be reserved for the Indians for the time being, and the few people who had already settled in them were warned to leave. The colonists were not interested in the welfare of the Indians. They had fought for these lands and had won them, and they were not willing to give them up.

This quaint picture of the Boston Massacre was made from a very rare old print engraved by Paul Revere, who carried the news of the British march on Lexington and Concord to the farmers along the road. We must confess that Revere, who was a goldsmith in Boston, was more successful as a messenger than as an artist. He became a prominent citizen of Boston, grew rich and had great influence in politics. Some of the houses shown in the picture are still standing in Boston to-day.

The anger and determination of the people of the colonies were shown in many ways. In some towns mobs collected and rioting took place. The men in charge of the stamps were beaten and ordered to resign. If they refused to do so, their houses were burned and they were threatened with hanging. Some of them were seized and covered with hot tar and feathers, a very cruel form of torture. Many boxes of stamps were burned. More moderate people simply refused to pay the tax. These men sent delegates from among the leading citizens to a meeting in New York where a written protest was drawn up against "taxation without representation." This meeting was called the Stamp Act Congress. It included delegates from all of the colonies and it was held in October, 1765.

THE ENGLISH WERE AMAZED AT THE AMERICANS' ANGER

The people of England were astonished when they heard of the anger of the Americans. They themselves paid stamp taxes much heavier than were charged the colonists. But perhaps the people in England had forgotten that most of these angry colonists were of English stock. The English themselves had fought a civil war and cut off the head of King Charles I because of troubles which grew out of taxation without the consent of Parliament. Some Englishmen claimed that every member of Parliament represented everybody in all of the British colonies. The colonists, however, declared that a man could not represent a country in which he did not live, and of whose problems he had no personal knowledge.

THE STAMP ACT WAS REPEALED AND OTHER TAXES WERE LEVIED

Parliament repealed the Stamp Act in 1766, and there was much rejoicing in the colonies. However, Parliament still held that it had the right to pass any laws it pleased for America. The next year an act was passed placing taxes on all tea, glass, lead, paints and a few other articles brought into the colonies. The money from these taxes was to be used to pay the salaries of governors, judges and other officers of the Crown. Before this the colonists had had some power over these governing officers, for they could—and sometimes did—refuse to pay their salaries. This act would make all colonial officials servants of the king instead of the people.

It is hardly surprising that the people of the colonies refused to accept this new tax law. Indeed, it is difficult to see why the king and his advisors should have thought, even for a minute, that people who had so violently objected to the stamp tax would meekly accept a law that not only provided new taxation, but cut down their self-governing powers. It was not long before the Royal government was made to realize its mistake.

PROTESTS AND RIOTS GREETED THE NEW TAXES

First the colonists agreed among themselves to stop buying the taxed articles, and the legislatures began to talk about resisting by force. The governors of some colonies ordered the members of the legislatures to go home. (The governors, you must remember, were appointed by the king.) In Boston there were riots, and in 1768 the king sent soldiers there. The soldiers and the people were constantly quarreling. In March, 1770, a few soldiers fired upon a mob which was throwing stones and snowballs at them, and killed four and wounded seven. This was called the "Boston Massacre." We show you a picture of it, from an engraving made at the time by Paul Revere.

The merchants of London were all this time losing much money because the colonists refused to buy their goods, and they and many other Englishmen wanted Parliament to stop trying to tax the Americans. George III, however, was an almost insanely stubborn man, and he would not give in. He firmly believed that any policy that he favored must be right, and that anyone who opposed it was disloyal to the king and an enemy of the country. He made Lord North, who was the prime minister, do as he wished, though North himself was not entirely sure that the king's measures were wise. Many other people supported the king's views. Some of them did so because it suited their interests, and some because of an exaggerated loyalty to the king. One of these last was the great Doctor Samuel Johnson, the author, about whom you can read on page 1867 of our book. Doctor Johnson said that the Americans "ought to be thankful for anything we allow them short of hanging."

THE FIGHT AT ALAMANCE CREEK AND THE BOSTON TEA PARTY

Parliament, only a few weeks after the "Boston Massacre," took the tax off all articles except tea, but a tax of six cents a pound was left on that popular drink. The English government was now not interested in the money, but only in keeping the right

Photo, N. L. Stebbins

The statue of the Minute Man, by Daniel Chester French, stands near the Concord bridge where the farmers fired "the shot heard round the world."

to tax the colonies. The people of the colonies at first did not refuse to pay the tax; they simply smuggled. In North Carolina, some of the people who thought that they were unjustly taxed called themselves Regulators and drove out some judges. They were defeated at Alamance Creek in 1771 by troops under the royal governor, William Tryon, and about two hundred were killed or wounded. Many of those who remained alive crossed the mountains into the land which became Tennessee and Kentucky.

When the Americans still refused to buy tea from England, and instead bought tea smuggled in from Holland, the Royal government tried another method. It had been the custom for the British East India Company to ship the tea to England and sell it to tea merchants there. These merchants resold it to the colonies. Thus the people of the colonies had to pay a price for tea which included, not only the profits of the East India Company and the English tea merchants, but also a tax of a shilling a pound (about twenty-five cents) which the government collected on tea leaving English ports. Now Parliament made a special ruling. The East India Company was permitted to ship tea directly to the colonies instead of sending it to England first. This saved the colonists the English middleman's profit and the shilling export tax, so that even with the tax of six cents a pound the colonists would get their tea more cheaply than the people of England could. However, the colonists still would not pay the tax, for they were determined in their belief that the English government had no right to tax them at all.

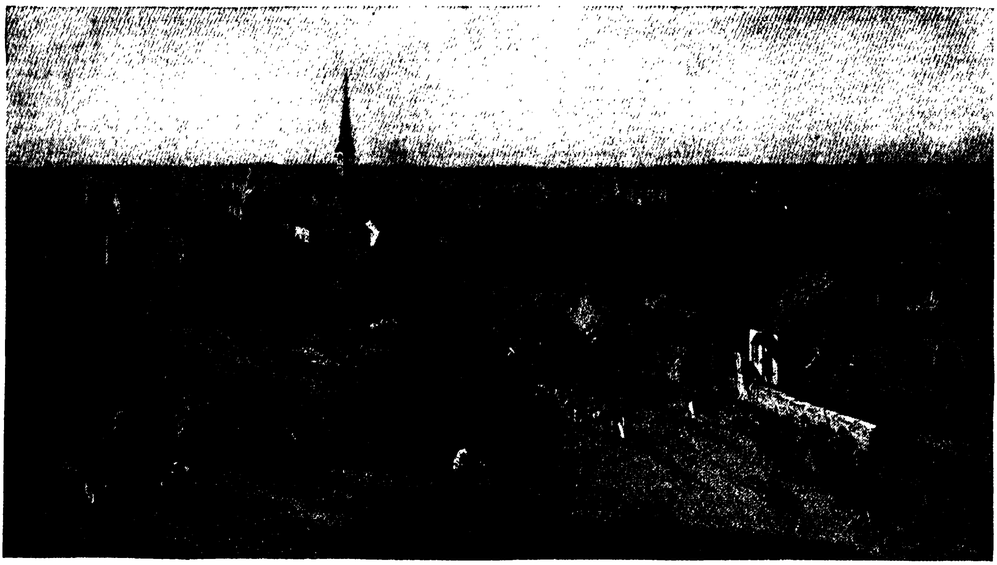
Ships loaded with tea were sent in 1773 to Charleston, Philadelphia, Boston and New York. At Philadelphia and New York the ships were forced to turn around and go back to England with their tea. In Charleston the tea was stored in damp cellars where it soon spoiled. In Boston a party of men disguised as Indians boarded the ships one night and emptied the tea into the bay. This was called the "Boston Tea Party."

The Government decided that this was too much to bear from the unruly colonies, and that they must be punished. Even those members of Parliament who had been friendly to the colonists thought that they had gone too far. Several very strict laws were passed, and the port of Boston was closed to ships. An army officer, General Thomas Gage, was put in charge, with the hope that Massachusetts would be starved into giving up, and that the other colonies would be so frightened that they would submit at once.

THE MEETING OF THE FIRST CONTINENTAL CONGRESS

The result was not what the English expected. The other colonies sent food to Boston by land, and Massachusetts refused to pay any taxes to General Gage's government. The colonies, except Georgia, elected delegates who met in Philadelphia on September 5, 1774. This is called the First Continental Congress. This body sent a letter to England telling of their wrongs. Then it published a Declaration of Rights in which all the rights of British citizens were claimed. Finally, the Congress agreed to advise the people not to buy any British goods until the colonies were treated better.

In the meantime the different colonies at once began to organize troops and to collect weapons, powder and bullets. General Gage heard that a quantity of military supplies was stored in the little village of Concord, near Boston. On the night of April 18, 1775, troops were sent from Boston to capture these stores and to seize two leading patriots, John Hancock and Samuel Adams, who were then at Lexington. The plan was dis-



From an old print

This picture shows the British red-coats retreating from Concord after the fight with the Minute Men. As they retreated the angry farmers kept on shooting at them from behind trees and fences, and many of the soldiers were killed. This victory over British regulars greatly encouraged the people of the colonies.

covered by some Bostonians, and several men, including Paul Revere, rode furiously through the night, ahead of the British troops, and warned the people. The poet Longfellow tells of Paul Revere's ride, in verses that are exciting to read, though Longfellow changes the story a little.

Many of the colonists of the region had joined the militia, a volunteer band. They promised to be ready for service at a minute's notice, and so came to be called Minute Men. When the red-coated British troops reached Lexington they found a little band of Minute Men drawn up on the village green. The British commander, Major Pitcairn, ordered them to go away, but they did not move until they were fired upon. Seven were killed and nine wounded. The rest scattered, for there were not enough of them to fight the redcoats.

The British marched on, seven miles to Concord, only to find that most of the store of arms had been taken away and that other bands of stubborn farmers were on the ground. The news of Lexington had spread like wildfire through the countryside, and the farmers with their muskets came swarming from every direction like angry bees. Sharp fighting took place and the British were forced to retreat. The hardest part of the fighting was at Concord Bridge. A century later Ralph Waldo Emerson wrote a famous poem about this fight at Concord Bridge. You may find this poem on page 3008.

From behind walls, trees and fences the battling farmers fired upon the retreating soldiers. A running fight followed during which the British lost nearly 300 men and the Americans lost 100. If reinforcements had not come out from Boston to meet the weary troops the whole force would probably have been captured or killed. This battle is usually considered the beginning of the Revolution.

The news of the victory quickly spread to the farthest frontier settlements. Riders on swift horses told the story; boats carried it by sea to the harbors along the coast. From all New England men hurried to Boston. Benedict Arnold and Israel Putnam led volunteers from Connecticut, and John Stark came down from New Hampshire. Putnam is said to have left his oxen hitched to the plow. Soon 16,000 men were besieging Boston. On May 10 the forts at Ticonderoga and Crown Point were taken by the Green Mountain Boys under Ethan Allen and Seth Warner, and a large supply of powder and many cannon were taken. Some of these guns were later taken to Boston to be used against the British there.

When the news reached North Carolina, late in May, the people of Mecklenburg

County assembled at Charlotte and declared themselves independent of Great Britain. The royal governor, before he fled to the protection of a British war vessel at Wilmington, called these resolutions the "most horrid and treasonable publications yet issued in America."

On June 17 the Battle of Bunker Hill, as it is called, took place outside Boston. Three times the British troops marched up the long slope of Breed's Hill (near Bunker Hill) to attack the earthworks that the Americans had made at the top. Twice the British were driven back, with a terrible loss of life, but the third attack succeeded, for the Americans had used up all their powder.

Meanwhile the Second Continental Congress, made up of delegates from the different colonies, had met in Philadelphia on May 10, 1775, and voted to raise an army. The Virginian, George Washington, was chosen to lead. On July 3, 1775, standing under a great elm tree at Cambridge, Massachusetts, he took command of raw, untrained citizen-soldiers and began the long task of changing them into a real fighting force. At this time there were about 16,000 of these troops around Boston, mostly from New England.

The Congress decided to try to capture Montreal and Quebec. An expedition under General Richard Montgomery took Montreal on November 12, 1775. The next day a force under General Benedict Arnold appeared before Quebec. On the last day of the year Arnold, and Montgomery, who had joined him, attacked the city. The attack failed. Montgomery was killed, Arnold was wounded and almost half of the army was captured. The rest, with amazing pluck, withdrew to a position outside the city and kept up the siege of Quebec until May 6, 1776, when they were driven off by a fleet from England. In the meantime, however, Washington's siege of Boston was having greater success, and on March 17, the British troops in Boston, and a number of citizens who had remained loyal to the Crown, sailed with the fleet to Halifax, Nova Scotia. The scene of fighting moved away from Boston. Washington took his army to New York and the second act of the drama was ready to begin.

We have mentioned the Loyalists or Tories, as they were called, in Boston. There were many of these in the other older settled parts of the colonies. Some of them fled early in the war, but others stayed until the end. They thought that the rebels could not

This picture, from the painting by Emanuel Leutze, shows the wife of General Schuyler setting fire to her grain fields so that the British soldiers should not be able to make use of the crop for food.

possibly win and that the king's troops would soon restore order. The Tories were often very badly treated by the patriots, but when their side seemed to be winning they, in turn, were very harsh. Most of them gave whatever aid and information they could to the British. Strangely enough, the most truly loyal of all were sometimes people who had the greatest reason to hate the German royal family of England.

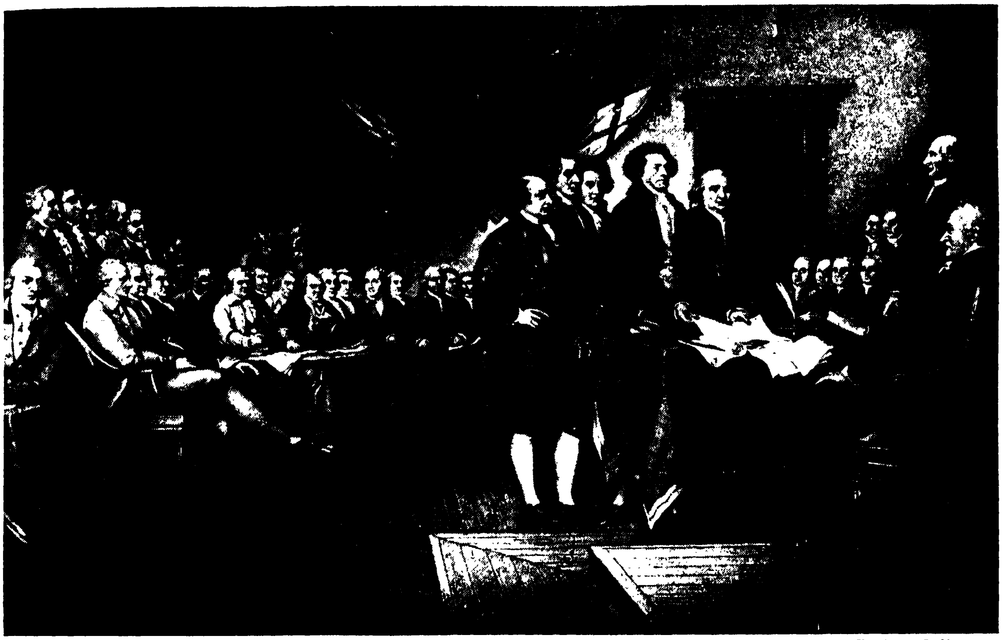
In the Cape Fear River settlements in North Carolina there was a large group of Scottish Highland families which had escaped or been driven out of Scotland not many years before. They had taken part in the attempt, in 1745, to restore Prince Charles Stuart, the Young Pretender, to the throne of England and Scotland, for they did not believe that the Hanoverian kings had any real right to the throne. Among them was Flora Macdonald, who, as a young girl, had helped the Young Pretender to escape after the uprising had failed. These Cape Fear Highlanders did not join the rebels in North Carolina. Instead, 1,600 of them marched toward Wilmington early in 1776 to join the British fleet against the patriots. At a place called Moore's Creek, on February 27, they were met by a force of 1,000 Whigs, or Patriots, and were utterly defeated. Among those who were taken prisoner was Allan Macdonald, the husband of Flora. The news of this battle so discouraged the commander of the British fleet that he did not try to take Wilmington, but sailed on to Charleston, South Carolina. A rude fort of palmetto logs had been built at Charleston, and its defenders drove the fleet away, after damaging many ships.

In spite of all the fighting, for a long time the colonies as a whole did not wish to be separated from England. They claimed that they were not fighting against England, but against the bad advisers of the King. They sent petitions to the King, but he refused to read them or to have any dealings with such disobedient subjects. He also hired about 20,000 troops from the rulers of some small German states, among them Hesse-Cassel, and sent them over to help put down the rebellion. These German troops were called Hessians by the colonists, who hated them and resented having foreign hired troops sent over to punish them.

By the spring of 1776, however, the feeling had grown that the colonies must be-

From an old print

On March 17, 1776, the British commander at Boston, Sir William Howe, put all his troops and guns on board the ships of the British fleet and sailed away to Halifax in Nova Scotia. Here we see General Howe and his staff overseeing the embarkation of the army. Never again did Boston have a hostile army to contend with.



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John Trumbull painted this picture for the Capitol at Washington. John Hancock, president of the Congress, receives the Declaration of Independence from the committee appointed to draft it. The committeemen are (left to right) John Adams, Roger Sherman, Robert Livingston, Thomas Jefferson and Benjamin Franklin.

come completely independent. Soon after Moore's Creek, North Carolina had voted for independence, and other colonies followed. The royal governors were driven out and elected ones put in their places. On June 7, 1776, Richard Henry Lee of Virginia moved in the Congress "that these United Colonies are, and of a right ought to be, free and independent states." The question was discussed for several weeks, for many good men had not yet given up hope that England and the colonies might somehow agree. Page 7579 tells you about the committee appointed to draw up a declaration of the colonists' reasons for separating from England. Finally, on July 4, 1776, the Declaration of Independence, written by Thomas Jefferson, was agreed upon by the Congress. It was not signed until sometime later, after it had been engraved on parchment. By that time many of the men had returned to their homes in the various colonies, and it was months before all of them got to sign it.

The war was now begun in earnest. The first plan of the British was to gain control of the Hudson River, thus cutting the colonies in two. Then one army was to move down from Canada, while another land force under General Sir William Howe and the fleet under his brother, Admiral Lord Howe, were to capture New York City, then held by Washington. The army from Canada was driven back by Benedict Arnold, but the other was more successful.

The Howe brothers had many more men than Washington had, and they almost captured the American forces, which were stationed on Long Island. The American army was defeated in the battle, but on the dark and foggy night of August 29, 1776, Washington managed to get his forces across the East River to Manhattan, safely out of the British trap. He then marched to the northern part of Manhattan Island and camped about where the College of the City of New York now stands. Howe followed, but was defeated in a battle on Harlem Heights, near where Columbia University is now. In order to avoid being surrounded, Washington was forced to retreat from Manhattan Island. At White Plains, on October 29, Howe gained some advantage, and on November 16 he captured Fort Washington on the Hudson River and took 3,000 prisoners.

Washington feared that Howe intended to march on to Philadelphia, and so he crossed

FOREIGN FRIENDS AND FOES

Lafayette and Rochambeau were brave Frenchmen who fought for us. Baron Steuben, a brave German officer, and Kosciuszko, a gallant Pole, also helped the American cause. General Burgoyne surrendered at Saratoga in 1777, while General Howe and Sir Henry Clinton found conquering America was hard work, and Lord Cornwallis surrendered his entire army. Tarleton was a cruel British cavalry leader.

Washington Crossing the Delaware, painted by Emanuel Leutze, is one of the best-loved of American historical pictures. It is now in the Metropolitan Museum in New York. It shows Washington and his men making the difficult crossing of the ice-filled river on Christmas night, to surprise the Hessian troops and capture Trenton.

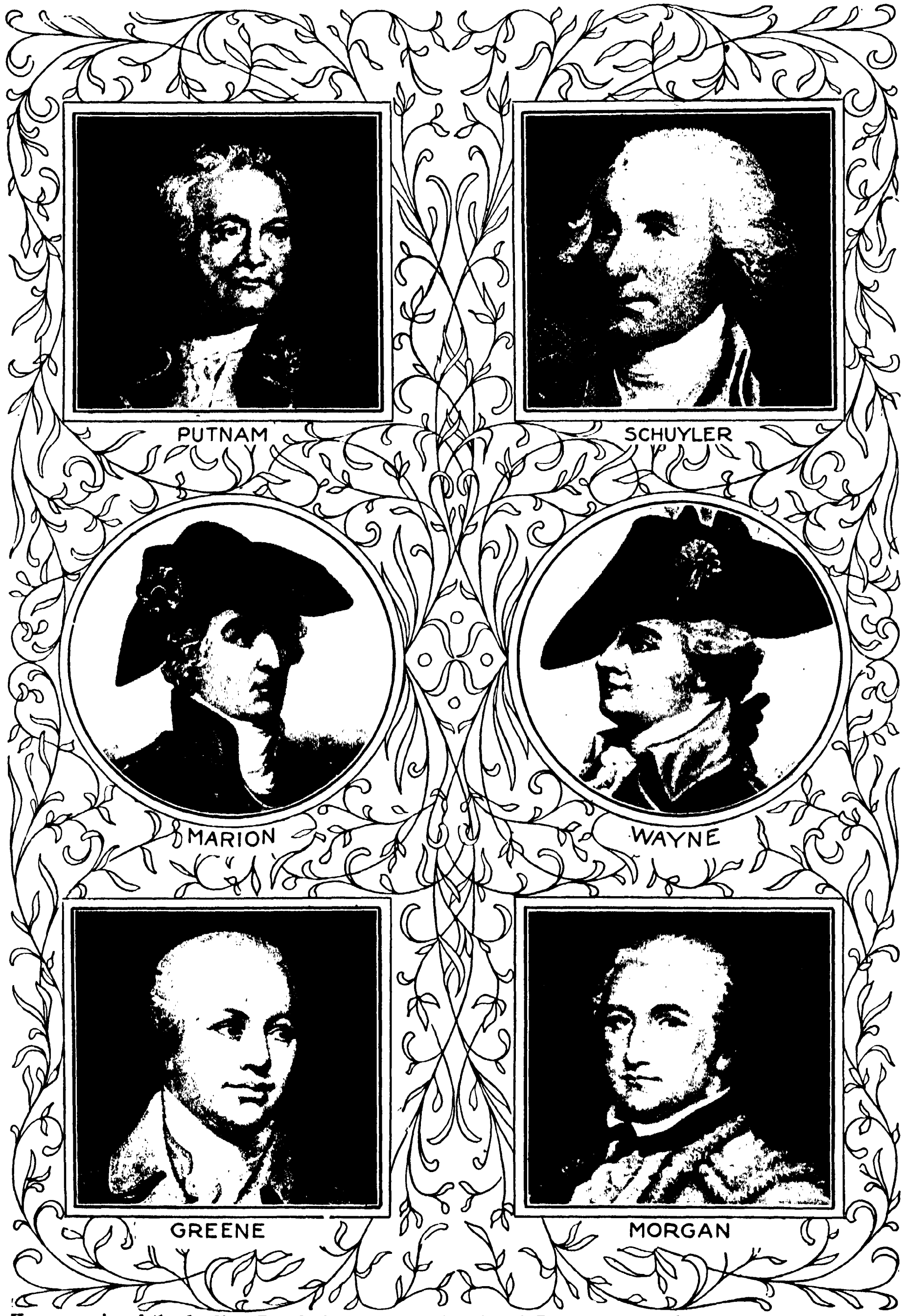
over the Hudson River to New Jersey. Nearly half of his army was still on the New York side, under General Charles Lee, who was ordered to cross into New Jersey also. Lee, who was a former English army officer, was jealous of Washington and contemptuous of his military ability. He really thought he would make a better commander-in-chief than Washington, and he did not bother to obey orders promptly. The result was that when he did cross into New Jersey, he was captured through his own carelessness. In the meantime Washington did not have enough troops with him and had to retreat across New Jersey to Pennsylvania. Although Lee had been captured by the British, his troops were able to join Washington.

Up to this time the Continental Army, as Washington's army was called, had undergone some rather discouraging experiences. Now they were to have a bright interval. The Hessian troops were quartered in Trenton, New Jersey, on the Delaware River. Thinking that the Americans were miles away and quite helpless anyway, the Hessians celebrated Christmas with all the gaiety that they were accustomed to back in Germany. Naturally they were quite sleepy that night, and while they slept Washington, with 2,500 men, crossed the Delaware River, then filled with floating ice, and captured more than a thousand of the startled Germans.

The British had begun to think that the war was over. It is said that some of the officers had sent their luggage on board ship at New York, thinking soon to return to England. But when the news of this sudden stroke came, they hurried back to New Jersey, only to have a part of their forces surprised and defeated at Princeton, about a week after the defeat at Trenton. Washington could not risk a battle with the whole British army, however, so he withdrew into the hills around Morristown, where the British were afraid to attack him.

The result of the first year of the war was, on the whole, favorable to the Americans. Though they had suffered many defeats, they had won a few important victories which showed the British and the world that the colonies could fight and that they intended to do so. The very fact that the war had lasted more than a year and the British were no nearer winning than when it started, was in itself a triumph for the colonies. Many people back in England wanted to give up the war and let the colonies go, but King George and his party refused to think of such a thing. France decided to encourage the Americans in order to increase the troubles of her old enemy, England, and began to lend money to the Americans.

AMERICAN REVOLUTIONARY GENERALS



Here are six of the leading Revolutionary generals. Israel Putnam was a brave Connecticut farmer, who fought all through the war. Philip Schuyler was about to capture Burgoyne when Gates was unjustly put in his place. Wayne was sometimes called "Mad Anthony," because of his bravery in battle, while Francis Marion was called the "Swamp Fox," as the British could not catch him. Daniel Morgan was a good officer and, next to Washington, Nathanael Greene was the best American general.

GENERALS OF THE CONTINENTAL ARMY

William Alexander (also called Lord Stirling) was born in New York in 1726 and died in 1783. He was promoted from brigadier to major general for his part in the Battle of Trenton.

Benedict Arnold (1741-1801). Born in Connecticut. A brilliant general, and at first a patriot, in 1780 he turned traitor. His plot to sell West Point to the British was discovered and he fled and joined the British army.

Thomas Conway (1733-1800). Born in Ireland and educated in France. He served in the Continental Army from December, 1777, to June, 1778, then returned to France.

Johann De Kalb (1721-1780). He was born in Germany and served in the French army. He died of wounds received at the Battle of Camden, where he fought heroically.

Horatio Gates (1729-1806). He was born in England. He held important commands both in the North and in the South in the Revolution.

Nathanael Greene (1742-1786). Born in Rhode Island, he was one of Washington's ablest generals. He succeeded Gates in the southern campaign which wore out the British.

Nicholas Herkimer (1728-1777). Born in the Mohawk Valley and a veteran of the French and Indian Wars. He had great influence in the valley. He died after winning at Oriskany.

Henry Knox (1750-1806). Born in Boston, he took part in the siege of that city. Later he was put in charge of the artillery for the army. He was the first U. S. Secretary of War.

Thaddeus Kosciusko (1746-1817). Born in Poland, he fought bravely and brilliantly in the American Revolution. Later he fought for the freedom of Poland, becoming a national hero.

The Marquis de Lafayette (1757-1834). At the age of nineteen he came to America to fight for liberty. He served on Washington's staff and fought Cornwallis in Virginia.

Charles Lee (1731-1782). Born in England, he had served in the British and Polish armies. Unreliable and untrustworthy, he was dismissed from the army in 1780.

Benjamin Lincoln (1733-1810). Born in Massachusetts. He played an important part at Saratoga and in the South. He was Secretary of War in the Confederation Congress, 1781-1783.

Alexander McDougall (1731-1786). Born in Scotland, he was a leader of the Sons of Liberty before the Revolution. He fought in many battles and succeeded Arnold at West Point.

Francis Marion (1732-1795). A South Carolinian, his skillful tactics against a stronger foe earned him the name of "Swamp Fox." He fought entirely in the South.

Hugh Mercer (1725-1777). A Scot who had been with the Young Pretender at Culloden, he died of his wounds after the Battle of Princeton.

Thomas Mifflin (1744-1800). A Philadelphian, he was a member of the First Continental Congress and first governor of Pennsylvania.

Richard Montgomery (1736-1775). Born in Ireland, he fought in the French and Indian Wars. He was killed at the siege of Quebec.

Daniel Morgan (1736-1802). Born in New Jersey, he moved to Virginia where he fought in the frontier wars. In the Revolution he fought at Quebec, Saratoga and Cowpens.

Andrew Pickens (1739-1817), a South Carolinian born in Pennsylvania. He was noted for his skill in harassing the British and their Cherokee Indian allies.

Casimir Pulaski (1748-1779), a young Polish exile who fought brilliantly at Brandywine and elsewhere, but was killed leading a cavalry charge at the siege of Charleston.

Israel Putnam (1718-1790). A Connecticut farmer and veteran of the colonial wars. He fought with bravery and skill till a stroke of paralysis ended his fighting days.

Arthur St. Clair (1734-1818). A Scot who had served under Wolfe at Quebec. He organized the New Jersey militia, and in 1789 became governor of the Northwest Territory.

Philip Schuyler (1733-1804) was born in Albany, of a famous Dutch patroon family. He was partly responsible for the victory at Saratoga.

John Stark (1728-1822). Born in New Hampshire, he raised a regiment which he led at Bunker Hill, and it was he who won the Battle of Bennington.

Baron Frederick von Steuben (1730-1794). A German who had served under Frederick the Great, he began to train and organize the army at Valley Forge and greatly improved it.

John Sullivan (1740-1795) of New Hampshire, a member of the First Continental Congress and an able general. In 1779 he crushed the Indian resistance in western New York.

Thomas Sumter (1734-1832), a Virginian who was an active military leader in the South. After the war he entered the Senate, then became Minister to Brazil.

John Thomas (1725-1776). Born in Massachusetts, he commanded at Roxbury and Dorchester Heights. Sent to Quebec after Montgomery's death, he died of smallpox soon after his arrival.

William Thompson (1725-1781), born in Ireland. He fought in the French and Indian Wars and took part in the expedition to Quebec in the Revolution.

Artemas Ward (1727-1800), born in Massachusetts. He commanded at Boston until Washington arrived, then he resigned from the army, but took an active part in politics.

Anthony Wayne (1745-1796). A Pennsylvanian. He was famous for his victory at Stony Point and for his defeat of the northwestern Indians at Fallen Timber in 1792.

Some Frenchmen who really sympathized with America's struggle for freedom came over to join in the fighting. One of these was the nineteen-year-old Marquis de Lafayette, whom Washington afterward grew to love as if he were his own son. With Lafayette came the brave French general, De Kalb, who was killed at the Battle of Camden in 1780. Other foreigners who came over to help the colonies included Baron von Steuben, a Prussian army officer who did much to train the American troops; and two Polish noblemen, Kosciusko and Pulaski. Kosciusko took part in the capture of Burgoyne's army, of which we shall tell further on, and Pulaski was killed in an attempt to capture Savannah from the British.

HOW THE BRITISH TRIED AGAIN TO CAPTURE THE HUDSON RIVER

The British again decided to capture the Hudson River. In 1777 the plan was for an army under General John Burgoyne to march down from Canada along Lake Champlain toward Albany. Another army, under St. Leger, was to start from Lake Ontario, move east through the Mohawk Valley, stir up the Tories and the Six Nations, and finally join Burgoyne. The third army, under Sir William Howe, was to go up the Hudson from New York to Albany. General Philip Schuyler, the American commander, had a very small force at first, and could not fight Burgoyne; but as he retreated, he cut down trees, destroyed bridges and made the roads so bad that Burgoyne took twenty days to go twenty miles.

HOW THE BRITISH PLAN FAILED AND THEY WERE DEFEATED

Some of the Indians joined the British, but few Tories came, and the cruelty of the Indians made more men join Schuyler. Burgoyne sent a party of Hessians to capture some military supplies the Americans had collected at Bennington, Vermont, but General John Stark defeated the British force and took 600 prisoners.

St. Leger started from Oswego to capture Fort Stanwix (it was called Fort Schuyler at the time). With him were British redcoats and a band of Indians under the great Mohawk chief, Joseph Brant. Tories from the Mohawk Valley also joined him. At Oriskany, ten miles from Fort Stanwix, a battle took place between Americans under General Nicholas Herkimer and part of St. Leger's force, chiefly Indians and Tories. This was one of the closest and bloodiest battles of the war. Both sides claimed the victory, but at the end the Americans were in possession of the field. St. Leger turned around and went back to Canada, so Burgoyne had no aid from him. Brave General Herkimer died of the wounds he received at the Battle of Oriskany.

Just when Schuyler's army had grown large enough to attack Burgoyne, General Gates' friends in Congress managed to have him put in Schuyler's place. On September 19 and on October 7, 1777, two bloody battles were fought near Saratoga and were won by the Americans, largely through the efforts of Benedict Arnold, Schuyler and Daniel Morgan. Burgoyne surrendered his whole army on October 17 as Howe had sent him no help.

HOW THE BATTLE OF SARATOGA TURNED THE TIDE

General Howe had made the mistake of trying to take Philadelphia before going to the aid of Burgoyne. Washington opposed him at Brandywine Creek, September 11, and three weeks later at Germantown, outside Philadelphia. Although Washington was defeated he was able to delay the British for some time. Then it was too late to send help to Burgoyne. Although Howe had gained Philadelphia, he had practically lost the war for the British. The Battle of Saratoga is considered one of the decisive battles of history, because it so impressed the French that they finally decided to recognize the independence of the American colonies, made a treaty with them and sent a fleet to help against the British fleet. It also discouraged the British Government so that it offered to give up every single point in the dispute that had caused the war, and agreed not to levy any taxes on the colonies if they would stop fighting for independence. But it was too late. The Americans cared only for independence, now that they had been fighting for three years.

THE COLD, HARSH WINTER AT VALLEY FORGE

All of this did not happen immediately after the Battle of Saratoga. The treaty of alliance with France was not signed until February, 1778, and after that it took some time for the new alliance to begin really working. In the meantime, while the British army was enjoying its stay in Philadelphia, Washington's army was starving and freezing in the little village of Valley Forge. The worst thing about this suffering was that it was unnecessary. There was food enough and clothing enough in the country. The

Congress, however, had not been given enough power by the states to enable it to manage well. It could not raise money by taxation so it had to print paper money which had no real value. The farmers and merchants had no confidence in this money and preferred to sell their food and other supplies to the British in Philadelphia, who could pay with gold and silver.

During all this time the colonies had had no real navy, though a few small vessels had been sent out as privateers to attack and capture British merchant ships. (A privateer is a ship owned by a citizen who is given permission by the government to attack ships belonging to the enemy.) Later, by the help of France, a few war vessels were gotten together and did great damage to the British. John Barry and John Paul Jones were the most famous of the first American naval heroes. You will find more about these two men if you look for their names in the Index volume.

In 1778-79, the most important events were the capture of Stony Point on the Hudson by the American General Anthony Wayne and the conquest of the Illinois country by Colonel George Rogers Clark with a few Kentucky frontiersmen. The Clark expedition is one of the most thrilling exploits in American history. Caskaskia, Cahokia and Vincennes were captured and all the territory between the Ohio and upper Mississippi rivers was brought under the American flag. At Vincennes, Clark took an important prisoner, General Hamilton, the British commander at Detroit. Hamilton was hated by the frontiersmen, who called him the "Ha'r-buyer" because he paid the Indians for the scalps that they took in raids on the settlements.

The British turned their efforts to the South and overran Georgia and South Carolina, but small bands of patriots under Francis Marion, Thomas Sumter, Andrew Pickens and others hid in the swamps and

From an old print

Washington's army spent the winter of 1777-78 at Valley Forge, where they suffered greatly from cold, hunger and lack of warm clothing. Here we see Washington studying a map, while some of his cold and ragged soldiers are warming themselves over a little fire built on the frozen, snow-covered ground.

carried on a guerrilla warfare against the Tories and British troops. Marion was often called the "Swamp Fox" because he was so silent and swift, and Sumter was called the "Game Cock" because he fought to the death.

Perhaps you have heard the story of the British officer who visited Marion under a flag of truce. A flag of truce is a white flag used when one side in a war wishes to send someone to talk with the enemy without being fired upon or taken prisoner. The officer was met at a certain place by some of Marion's men, who blindfolded him and led him through the swamps. Finally the bandage was removed from his eyes and he found himself in a little clearing in the forest. His business was soon finished, and General Marion asked him to stay to dinner. The officer saw no cook and no sign of anything cooking, though a fire was burning on the ground, but he accepted. Then Marion told his servant to serve dinner. The man raked aside the ashes of the fire and drew forth some sweet potatoes which had been roasting there. These he served on pieces of bark. There was no other food. The officer went back and reported to his superiors that men like Marion and his troops could not be conquered.

General Gates was given command of an army which the Americans sent to try to re-capture South Carolina and Georgia from the British. One night in August, 1780, Gates started out to make a surprise attack on the British general, Cornwallis. When he reached Camden, South Carolina, he met Cornwallis, who had planned a surprise attack on Gates. In the battle that followed the American army was cut to pieces.

Just about this time the treason of Benedict Arnold, about which you may read on page 3996, shocked the country, but a victory occurred soon after which was more encouraging. Colonel Patrick Ferguson, one of Cornwallis's officers, with about 1,100 British and Tories, was defeated and killed at King's Mountain, North Carolina, by a band of 900 backwoodsmen led by John Sevier, Isaac Shelby and others. The British were all killed or captured, while the Americans lost only twenty-eight men.

From an old print

The Battle of Cowpens, in South Carolina, was a brilliant victory for the Americans under General Morgan. This picture shows the fight that took place between the British Colonel Tarleton and the American Colonel William Washington (not a relative of General Washington). Tarleton was wounded in the hand.

John Trumbull's celebrated painting of the surrender of Cornwallis at Yorktown is in the Capitol at Washington. Actually Cornwallis was not present on this occasion, and General O'Hara acted in his place.

A new army was raised and put under General Nathanael Greene. Meanwhile Tarleton, the British cavalry leader, was defeated at the Battle of Cowpens, in South Carolina, by General Daniel Morgan, who then joined forces with Greene and fought a battle with Cornwallis at Guilford Court House. The Americans were beaten, but Cornwallis lost so many men that he decided to march to the coast and then join other British commanders in Virginia. Greene went back to South Carolina and soon drove the British there into Charleston.

In Virginia, Cornwallis tried to capture Lafayette, but failed. At one time he almost captured Thomas Jefferson, who was then the governor of Virginia. Finally Cornwallis sent a message to Sir Henry Clinton, who had taken Howe's place as commander of the British forces, asking for reinforcements. Early in August Cornwallis reached Yorktown, on the York River in Virginia, and waited for an answer from Clinton. Clinton, however, refused to send troops away from New York.

Washington was then on the Hudson River near West Point. The year before, 6,000 French troops under Count Rochambeau had been sent over, and Washington had just learned that a strong French fleet under the Count de Grasse was on the way. So a plan of campaign was made, the results of which we shall tell you. On August 19, 1781, Washington's army started marching to Yorktown, and reached Philadelphia before General Clinton found out what was happening. By that time the French fleet had made it impossible for Clinton to get help to Cornwallis by sea, and soon the American and French armies, about 16,000 in all, were at Yorktown. The siege was begun, and on October 19, 1781, Cornwallis surrendered.

On the day of surrender, the American and French armies were drawn up in two long lines, facing each other. The 8,000 men of the British forces were led between these two lines by Major General O'Hara, their bands playing a popular tune called The World Turned Upside Down. The Americans and French had imposed the same rather harsh terms of surrender that the British had imposed at the capture of Charleston, and Major General Benjamin Lincoln, who had been the American commander at Charleston, was appointed to receive the sword from O'Hara in token of surrender. The war was over, though peace terms were not signed until the next year.

THE NEXT STORY OF THE UNITED STATES IS ON PAGE 1299.

A CALENDAR OF THE REVOLUTION

1774 The First Continental Congress met in Philadelphia on September 5, and adjourned on October 26. All of the colonies except Georgia were represented.

1775 On March 23, Patrick Henry made his "Liberty or Death" speech at the Virginia Convention in St. John's Church, Richmond.

— April 19, the Battle of Lexington and Concord was won by the Minute Men.

— May 10, Ethan Allen and the Green Mountain Boys took Fort Ticonderoga.

— May 20, the Second Continental Congress met in Philadelphia with delegates from all the thirteen colonies.

— May 20, the Mecklenburg Declaration of Independence was signed in North Carolina.

— June 17, the Battle of Bunker Hill took place outside Boston.

— July 3, George Washington took command of the American army at Cambridge, Massachusetts.

— Sept. 14, Fort Johnson, South Carolina, was captured by Francis Marion.

— November 12, General Montgomery captured Montreal from the British.

— Dec. 31, Arnold and Montgomery were defeated at Quebec. This was the last attempt to capture Canada during the war.

1776 Feb. 27, Scottish Tories were defeated at Moore's Creek, North Carolina.

— March 17, the British evacuated Boston.

— June 28, the British attacked Fort Moultrie in Charleston Harbor and were driven off.

— July 4, the Declaration of Independence was adopted by the Congress.

— August 27, the Battle of Long Island was won by the British and Hessians.

— Sept. 16, Washington's troops won the Battle of Harlem Heights.

— Sept. 22, Nathan Hale was executed as a spy by the British in New York City.

— Oct. 11, in a naval battle on Lake Champlain Arnold's fleet stopped the British invasion from Canada.

— Oct. 28, the Americans were beaten at White Plains.

— Nov. 16, the British captured Fort Washington and took 3,000 prisoners.

— Dec. 20, the Congress moved from Philadelphia to Baltimore.

— Dec. 26, Washington crossed the Delaware and captured the Hessians at Trenton.

1777 Jan. 3, Washington's victory at Princeton.

— March 4, the Congress returned to Philadelphia.

— June 14, the Congress adopted the Stars and Stripes as the American flag.

— July 6, Burgoyne captured Ticonderoga.

— Aug. 6, the Battle of Oriskany was won by the Americans.

— Aug. 16, American victory at Bennington.

— Sept. 11, the Americans were defeated at Brandywine Creek, in Delaware.

— Sept. 26, Howe entered Philadelphia.

Sept. 27, the Congress moved to Lancaster, Pennsylvania, and three days later to York.

— Oct. 4, the Americans were defeated at Germantown, near Philadelphia.

— Oct. 17, Burgoyne's army surrendered at Saratoga.

— Nov. 17, the Congress adopted the Articles of Confederation, uniting the thirteen states.

— Dec. 17, Washington's troops went into winter quarters at Valley Forge.

1778 Feb. 5, a treaty of alliance with France was signed.

— June 28, the Battle of Monmouth, New Jersey. The British were forced to retreat.

— July 2, the Congress returned to Philadelphia.

— July 3, Indians and Tories massacred the people of Wyoming Valley, Pennsylvania.

— July 4, George Rogers Clark captured Fort Kaskaskia, Illinois.

— Aug. 29, the British were driven back at the Battle of Quaker Hill, Rhode Island.

— Nov. 11, Indians and Tories massacred the people of Cherry Valley, New York.

— Dec. 29, the British captured Savannah, Georgia.

1779 Feb. 23, Clark captured Vincennes, Indiana.

— July 16, the storming of Stony Point by Anthony Wayne's troops.

— Aug. 12, General Sullivan started an expedition against the Indians in New York State.

— Sept. 23, Naval victory of John Paul Jones in the Bonhomme Richard over the British frigate Serapis.

1780 Feb. 11, the British under Clinton captured Charleston.

— Aug. 16, the Americans were defeated by the British at Camden, South Carolina.

— Sept. 23, the capture of Major André brought to light the treason of Benedict Arnold. See page 3996.

— Oct. 7, the Americans won the Battle of King's Mountain, North Carolina.

1781 Jan. 17, American victory at Cowpens, South Carolina.

— March 15, the Battle of Guilford Court House, North Carolina.

— Sept. 5, the French fleet beat the British fleet in a battle in Chesapeake Bay.

— Sept. 8, the Battle of Eutaw Springs, South Carolina, was won by the Americans.

— Oct. 19, Cornwallis surrendered at Yorktown.

1782 Nov. 13, a preliminary peace treaty was signed at Paris.

1783 Sept. 3, the final treaty recognizing American independence was signed at Paris.

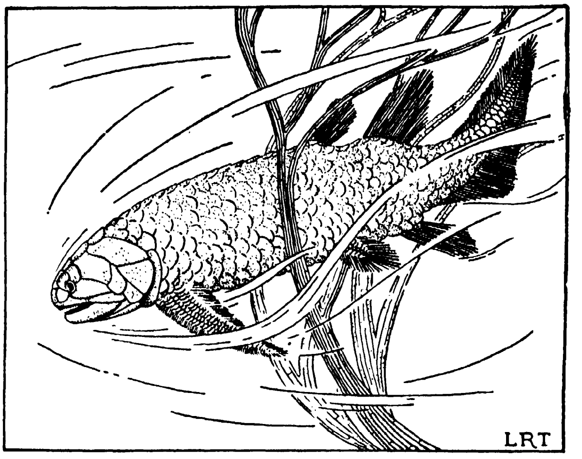
— Nov. 3, the Continental Army was formally disbanded.

— Nov. 26, the Congress began sessions at Annapolis, Maryland.

— Dec. 4, Washington bade farewell to his officers in New York City.

— Dec. 20, Washington resigned his commission to Congress at Annapolis.

THE WORLD IN THE DEVONIAN PERIOD



A Devonian ganoid, an ancient relative of the sturgeon. This fish was covered with thick, glossy scales.

WE now come to that very long period of the earth's history when the fishes were the highest and dominant form of life.

This geological period was known as the Devonian, because it was in Devonshire, England, that its chief rock, the Old Red Sandstone, was found in exceptional abundance and was first seen to represent a great era in the developing of life. It is also found, however, over vast tracts of North America, Africa, Northern Europe and elsewhere.

In studying the Silurian period we saw how the first fishes made their appearance in the rivers of the early world and later found their way into the sea. During the many years when the Silurian period was gradually changing into the Devonian these primitive fishes underwent numerous changes. Judging from fossils found in the rocks, more than a hundred different species of fishes abounded in the Devonian waters.

The fact that the bodies of the fishes were not encased in a hard shell, but grew about a central backbone, enabled them to develop flexibility and rapidity of movement. It also allowed them to grow to great sizes in some cases. For instance, Dinichthys, the "terrible fish," was twenty feet in length and had a jaw spread of four feet. Some of his teeth were two feet long. Another monster of those days was Coccosteus, who varied in length from one to twenty feet. The abilities to move freely and quickly and to grow large were the chief reasons why the Devonian fishes eventually became rulers of the rivers and the seas of that period.

A great many of the early fishes had bodies protected by bony plates, like coats of mail, which grew with the fish and suited the mode of life of each type. Pterichthys was a fish so heavily armored that its fossil remains were once thought to be those of a turtle or crab. Although this fish was no more than six inches long, its armor must have been an excellent defence against the scorpion-like eurypterids which lived in the same waters.

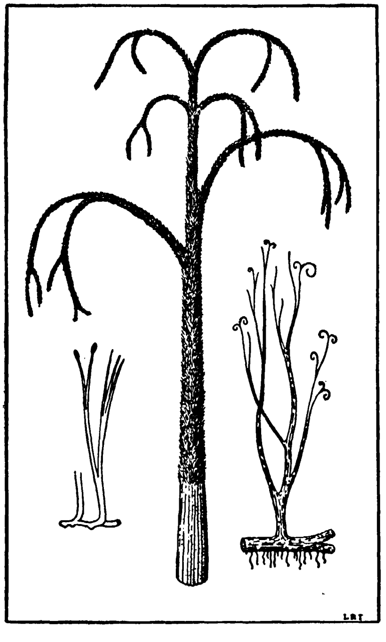
It was during the Devonian period that the first sharks appeared. Some of these were the first fishes to develop paired fins at the sides of their bodies. Few of the sharks were more than a foot long, although some reached a length of two and a half feet. All of them lacked the protecting armor of Pterichthys, being completely covered with scales.

The Devonian period is a most important one, not only because of the abundance of the fishes, but also because it marks the time when backboned creatures, or vertebrates, learned to breathe air and live on the land. The growth and development of all the great land animals that followed depended upon this change from sea to land. Let us see how it came about.

In addition to gills, Devonian fishes, like modern fishes, were equipped with air bladders which they could fill with air to aid them in floating. Gradually, in the course of many, many years, these air bladders developed into lungs, enabling the fish to breathe air directly. Some of these early lung-fishes are named Dipterus and Scaumenacia, and were almost identical with some forms living to-day in Australia, South America and Africa.

Now that animal life had taken to the land, it was necessary to develop a means of moving about in the new environment, so the fishes developed legs. This was accomplished by enlarging certain fins and losing others. Naturally, the first legs were not very satisfactory, but as time went on they began to show improvement. The Devonian rocks of Pennsylvania contain the first known footprint. This footprint is that of a very primitive amphibian, the lowest form of air-breathing, backboned animal. In the age which followed the Devonian period, the amphibians developed to a very great extent.

In general the climate of the Devonian period was warm and moist, although parts of the world were quite dry. In many sections swamps were abundant and furnished a perfect home for the rapidly increasing forests of land plants. Like the land animals, these plants developed from organisms that lived in the sea. Beginning as mosses, the land plants in time became the trees which filled the swampy Devonian forests. The first trees of which we have definite knowledge were found in Devonian rocks in New York. Some of their trunks were discovered still standing upright. These trees were from thirty to forty feet high and more than three feet in diameter. Ferns also flourished during the Devonian period, some having fronds three feet long and of a feather-like appearance. As far as is known, there were no flowers to decorate these dreary swamp-forests, and birds and insects were still creatures of the future. How silent and uninviting the landscape of that far-off day must have been!



Some plants that grew in Devonian forests. On the left and right are very primitive land plants; in the centre a lycopod tree.

In the United States, Devonian rocks underlie New York from the Erie Canal southward to the Pennsylvania boundary and reach farther south in narrow bands, and westward from Lake Erie to Chicago, with a small patch in northeastern Iowa. Patches occur in Colorado, in Arizona deep down in the grand canyon, and in Nevada. Sometimes these rocks are black shales, as under the Mississippi Valley; sometimes great coral reefs are found, as in the limestone causing the falls of the Ohio above Louisville, Kentucky; sometimes the rocks are sandstones, as in Pennsylvania. The great stores of gas and oil of Pennsylvania were held in the Devonian sandstones there. Among all these different rocks, however, is found little or no red sandstone, which often makes it difficult for us to understand why the English geologist Hugh Miller called the series the Old Red Sandstone.

In eastern Canada there are Devonian rocks around Montreal, in Gaspé peninsula and in New Brunswick and Nova Scotia. Along the course of the Mackenzie River and in the Canadian Rockies are areas where considerable thickness of these strata is found.

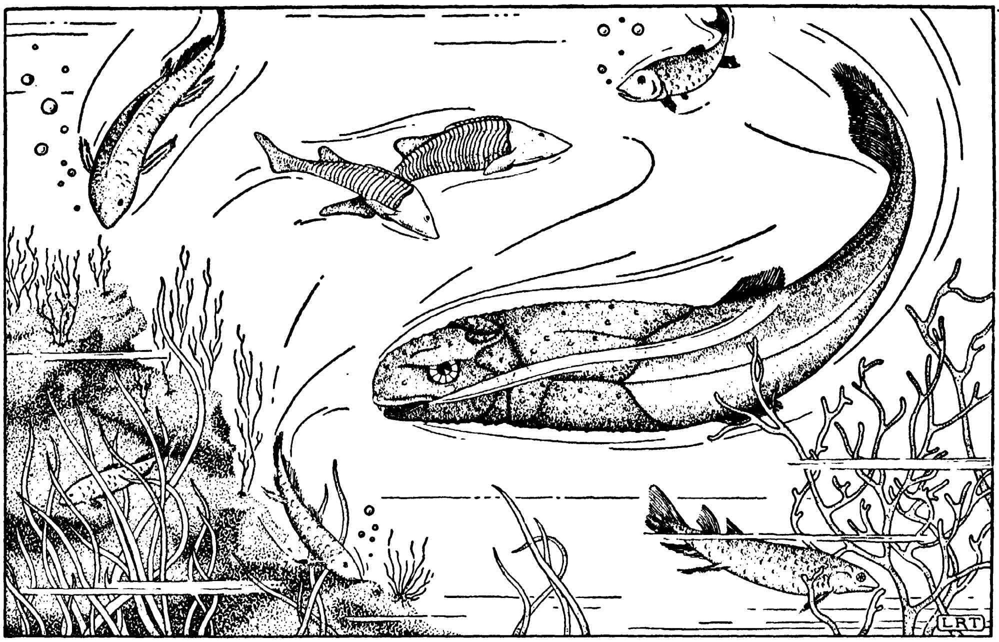
Volcanoes were many during the latter part of the period. Mount Royal, behind Montreal, is one of these, and there are many others.

The great Devonian sea covered the whole of Europe south of Belgium and and Denmark, while most of Northern Europe, and even possibly the North Atlantic, was land. But this land contained some great fresh-water lakes, probably three, comparable with the great Canadian lakes. It is believed that one of them extended from the north of Scotland to Norway across what is now the North Sea, that another extended across central Scotland and northern Ireland, the third covered south Wales and Herefordshire.

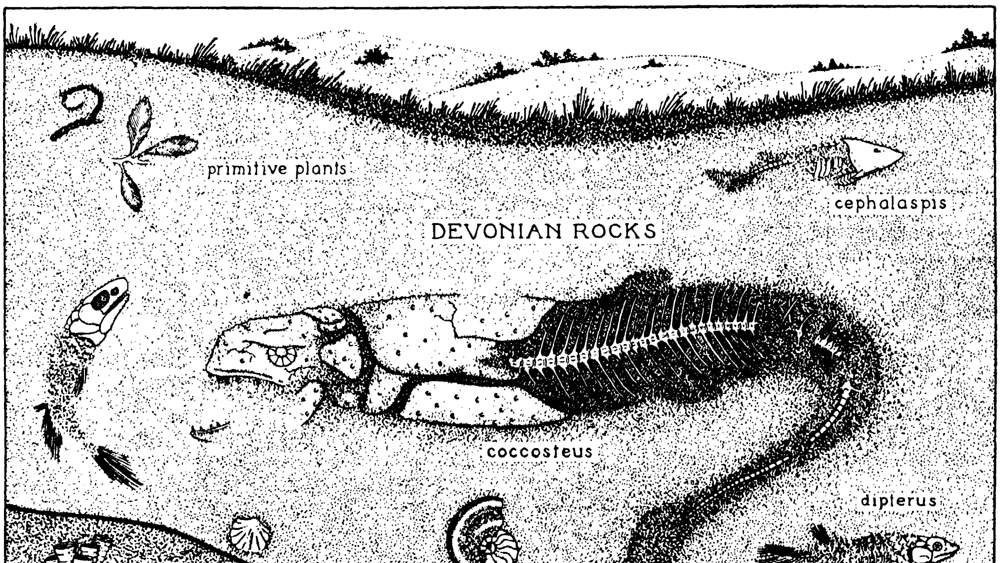
Devonian rocks are important to us because they furnish us with valuable commercial products. As we have seen, some gas and oil is contained in Devonian rocks of Pennsylvania. Another product is sand for the manufacture of glass. This comes from the white sandstone of Pennsylvania, Michigan and Ohio, which is unusually pure. Tin is sometimes found in Devonian rocks. It was not formed during the Devonian period, but at a later date was injected into the rocks by action of a volcanic nature.

THE NEXT STORY OF THE EARTH IS ON PAGE 1295.

IMAGINARY VIEW OF THE DEVONIAN PERIOD



This is a view of some of the sea and river life of the Devonian period. The large fish is a heavily-armored coccosteus. About him swim ganoids, primitive lung-fish and cephalaspis, the earliest known fish, which originated in the preceding Silurian period and continued to develop in the Devonian.



This picture shows a section through the rocks of the Devonian period containing fossil remains. The fossils are chiefly fishes, mingled with the remains of some of the early land plants that began to flourish in the warm swamplands that formed a large part of the Devonian landscape.

Alice in Wonderland

By Lewis Carroll

VII

There was a table set out under a tree in front of the house, and the March Hare and the Hatter were having tea at it; a Dormouse was sitting between them fast asleep, and the other two were using it as a cushion, resting their elbows on it, and talking over its head.

"Very uncomfortable for the Dormouse," thought Alice; "only, as it's asleep, I suppose it doesn't mind."

The table was a large one, but the three were all crowded together at one corner of it.

"No room! No room!" they cried out when they saw Alice coming.

"There's *plenty* of room!" said Alice indignantly. And she sat down in a large armchair at one end of the table.

"Have some wine," the March Hare said, in an encouraging tone.

Alice looked all round the table, but there was nothing on it but tea.

"I don't see any wine," she remarked.

"There isn't any," said the March Hare.

"Then it wasn't very civil of you to offer it," said Alice angrily.

"It wasn't very civil of you to sit down without being invited," said the March Hare.

"I didn't know it was *your* table," said Alice; "it's laid for a great many more than three."

"Your hair wants cutting," said the Hatter. He had been looking at Alice for some time with great curiosity, and this was his first speech.

"You should learn not to make personal remarks," Alice said, with some severity, "it's very rude."

The Hatter opened his eyes very wide on hearing this, but all he *said* was:

"Why is a raven like a writing-desk?"

"Come, we shall have some fun now," thought Alice. "I'm glad they've begun asking riddles. I believe I can guess that," she added aloud.

"Do you mean that you think you can find out the answer to it?" said the March Hare.

"Exactly so," said Alice.

"Then you should say what you mean," the March Hare went on.

"I do," Alice hastily replied; "at least—at least, I mean what I say. That's the same thing, you know."

"Not the same thing a bit," said the Hatter. "Why, you might just as well say that 'I see what I eat' is the same thing as 'I eat what I see.' "

"You might just as well say," added the March Hare, "that 'I like what I get' is the same thing as 'I get what I like.' "

"You might just as well say," added the Dormouse, who seemed to be talking in his sleep, "that 'I breathe when I sleep' is the same thing as 'I sleep when I breathe.' "

"It *is* the same thing with you," said the Hatter; and here the conversation dropped, and the party sat silent for minute, while Alice thought over all she could remember about ravens and writing-desks, which wasn't much.

The Hatter was the first to break the silence.

"What day of the month is it?" he said, turning to Alice, He had taken his watch out of his pocket and was looking at it uneasily, shaking it every now and then, and holding it to his ear.

Alice considered a little, and said:

"The fourth."

"Two days wrong," sighed the Hatter. "I told you butter wouldn't suit the works," he added, looking angrily at the March Hare.

"It was the *best* butter," the March Hare meekly replied.

"Yes, but some crumbs must have got in as well," the Hatter grumbled. "You shouldn't have put it in with the bread-knife."

The March Hare took the watch and looked at it gloomily; then he dipped it into his cup of tea, and looked at it again, but he could think of nothing better to say than his first remark: "It was the *best* butter, you know."

Alice had been looking over his shoulder with some curiosity.

"What a funny watch!" she remarked. "It tells the day of the month, and doesn't tell what o'clock it is."

"Why should it?" muttered the Hatter. "Does your watch tell you what year it is?"

"Of course not," Alice replied very readily; "but that's because it stays the same year for such a long time together."

"Which is just the case with *mine,*" said the Hatter.

Alice felt dreadfully puzzled. The Hatter's remark seemed to her to have no sort of meaning in it, and yet it was certainly English.

"I don't quite understand you," she said, as politely as she could.

"The Dormouse is asleep again," said the Hatter; and he poured a little hot tea on to its nose.

The Dormouse shook its head impatiently, and said, without opening its eyes:

"Of course, of course. Just what I was going to remark myself."

"Have you guessed the riddle yet?" the Hatter said.

"No, I give it up," Alice replied. "What's the answer?"

"I haven't the slightest idea," said the Hatter.

"Nor I," said the March Hare.

Alice sighed wearily.

"I think you might do something better with the time," she said, "than wasting it in asking riddles that have no answers."

"If you knew Time as well as I do," said the Hatter, "you wouldn't talk about wasting *it*. It's *him*."

"I don't know what you mean," said Alice.

"Of course you don't," the Hatter said, tossing his head contemptuously. "I dare say you never even spoke to Time."

"Perhaps not," Alice cautiously replied; "but I know I have to beat time when I learn music."

"Ah, that accounts for it!" said the Hatter. "He won't stand beating. Now, if you only kept on good terms with him, he'd do almost anything you liked with the clock. For instance, suppose it were nine o'clock in the morning, just time to begin lessons: you'd only have to whisper a hint to Time, and round goes the clock in a twinkling. Half-past one, time for dinner!"

("I only wish it was," the March Hare said to himself in a whisper.)

"That would be grand, certainly," said Alice thoughtfully; "but, then—I shouldn't be hungry for it, you know."

"Not at first, perhaps," said the Hatter; "but you could keep it to half-past one as long as you liked."

"Is that the way *you* manage?" Alice asked.

The Hatter shook his head mournfully. "Not I!" he replied. "We quarreled last March—just before *he* went mad, you know" (pointing with his teaspoon at the March Hare). "It was at the great concert given by the Queen of Hearts, and I had to sing:

'Twinkle, twinkle, little bat!
How I wonder what you're at!'

You know the song, perhaps?"

"I've heard something like it," said Alice.

"It goes on, you know," the Hatter continued, "in this way:

'Up above the world you fly,
Like a tea-tray in the sky.
Twinkle, twinkle—'"

Here the Dormouse shook itself, and began singing in its sleep: *"Twinkle, twinkle, twinkle, twinkle—"* and went on so long that they had to pinch it to make it stop.

"Well, I'd hardly finished the first verse," said the Hatter, "when the Queen bawled out, 'He's murdering the time! Off with his head!'"

"How dreadfully savage!" exclaimed Alice.

"And ever since that," the Hatter went on in a mournful tone, "he won't do a thing I ask. It's always six o'clock now."

A bright idea came into Alice's head. "Is that the reason so many tea-things are put out here?" she asked.

"Yes, that's it," said the Hatter with a sigh; "it's always tea-time, and we've no time to wash the things between whiles."

"Then you keep moving round, I suppose?" said Alice.

"Exactly so," said the Hatter; "as the things get used up."

"But what happens when you come to the beginning again?" Alice ventured to ask.

"Suppose we change the subject," the March Hare interrupted, yawning. "I'm getting tired of this. I vote the young lady tells us a story."

"I'm afraid I don't know one," said Alice, rather alarmed at the proposal.

"Then the Dormouse shall!" they both cried. "Wake up, Dormouse!" And they pinched it on both sides at once.

The Dormouse slowly opened its eyes. "I wasn't asleep," it said, in a hoarse feeble voice. "I heard every word you fellows were saying.".

"Tell us a story," said the March Hare.

"Yes, please do!" pleaded Alice.

"And be quick about it," added the Hatter, "or you'll be asleep again before it's done."

"Once upon a time there were three little sisters," the Dormouse began in a great hurry; "and their names were Elsie, Lacie, and Tillie; and they lived at the bottom of a well—"

"What did they live on?" said Alice, who always took a great interest in questions of eating and drinking.

"They lived on treacle," said the Dormouse, after thinking a minute or two.

"They couldn't have done that, you know," Alice gently remarked; "they'd have been ill."

"So they were," said the Dormouse; *"very* ill."

Alice tried a little to fancy to herself what such an extraordinary way of living would be like, but it puzzled her too much, so she went on: "But why did they live at the bottom of a well?"

"Take some more tea," the March Hare said to Alice very earnestly.

"I've had nothing yet," Alice replied in an offended tone, "so I can't take more."

"You mean you can't take *less,*" said the Hatter. "It's very easy to take *more* than nothing.

"Nobody asked *your* opinion," said Alice.

"Who's making personal remarks now?" the Hatter asked triumphantly.

Alice did not quite know what to say to this, so she helped herself to some tea and bread and butter, and then turned to the Dormouse and repeated her question: "Why did they live at the bottom of a well?"

The Dormouse again took a minute or two to think about it, and then said: "It was a treacle-well."

"There's no such thing," Alice was beginning very angrily, but the Hatter and the March Hare went "Sh! sh!" and the Dormouse sulkily remarked: "If you can't be civil, you'd better finish the story for yourself."

"No, please go on," Alice said very humbly; "I won't interrupt you again. I dare say there may be *one.*"

"One, indeed!" said the Dormouse indignantly. However, it consented to go on. "And so these three little sisters—they were learning to draw, you know—"

"What did they draw?" said Alice, quite forgetting her promise.

"Treacle," said the Dormouse, without

considering at all this time.

"I want a clean cup," interrupted the Hatter. "Let's all move one place on." He moved on as he spoke and the Dormouse followed him; the March Hare moved into the Dormouse's place, and Alice rather unwillingly took the place of the March Hare.

The Hatter was the only one who got any advantage from the change, and Alice was a good deal worse off than before, as the March Hare had just upset the milk-jug into his plate. Alice did not wish to offend the Dormouse again, so she began very cautiously: "But I don't understand. Where did they draw the treacle from?"

"You can draw water out of a water-well," said the Hatter; "so I should think you could draw treacle out of a treacle-well—eh, stupid?"

"But they were *in* the well," Alice said to the Dormouse, not choosing to notice this last remark.

"Of course they were," said the Dormouse—"well in."

This answer so confused poor Alice that she let the Dormouse go on for some time without interrupting it.

"They were learning to draw," the Dormouse went on, yawning and rubbing its eyes, for it was getting very sleepy; "and they drew all manner of things—everything that begins with an M—"

"Why with an M?" said Alice.

"Why not?" said the March Hare.

Alice was silent.

The Dormouse had closed its eyes by this time, and was going off into a doze; but, on being pinched by the Hatter, it woke up again with a little shriek, and went on: "—that begins with an M, such as mouse-traps, and the moon, and memory, and muchness — you know you say things are 'much of a muchness'—did you ever see such a thing as a drawing of a muchness?"

"Really, now you ask me," said Alice, confused, "I don't think—"

"Then you shouldn't talk," said the Hatter.

This piece of rudeness was more than Alice could bear; she got up in disgust, and walked off. The Dormouse fell asleep instantly, and neither of the others took the least notice of her going, though she looked back once or twice, half hoping that they would call after her.

The last time she saw them, they were trying to put the Dormouse into the teapot.

"At any rate, I'll never go *there* again," said Alice, as she picked her way through the wood. "It's the stupidest tea-party I ever was at in all my life."

VIII

Alice got into the beautiful garden at last, but she had to nibble a bit of the mushroom again to bring herself down to twelve inches after she had got the golden key, so as to get through the little door. It was a lovely garden, and in it was the Queen's croquet-ground. The Queen of Hearts was very fond of ordering heads to be cut off. "Off with his head!" was her favorite phrase whenever anybody displeased her. She asked Alice to play croquet with her, but they had no rules; they had live flamingoes for mallets, and the soldiers had to stand on their hands and feet to form the hoops. It was extremely awkward, especially as the balls were hedgehogs, who sometimes rolled away without being hit. The Queen had a great quarrel with the Duchess, and wanted to take her head off. Alice found the state of affairs in the lovely garden not all so beautiful as she had expected. But after the game of croquet, the Queen said to Alice:

"Have you seen the Mock Turtle yet?"

"No," said Alice. "I don't even know what a mock turtle is."

"It's the thing mock turtle soup is made from," said the Queen.

"I never saw one or heard of one," said Alice.

"Come on, then," said the Queen, "and he shall tell you his history."

As they walked off together, Alice heard the King say in a low voice to the company generally: "You are all pardoned."

"Come, *that's* a good thing!" she said to herself, for she had felt quite unhappy at the number of executions the Queen had ordered.

They very soon came upon a Gryphon, lying fast asleep in the sun.

"Up, lazy thing!" said the Queen; "and take this young lady to see the Mock Turtle, and to hear his history. I must go back and see after some executions I have ordered." And she walked off, leaving Alice alone with the Gryphon.

Alice did not quite like the look of the creature, but, on the whole, she thought it would be quite as safe to stay with it as to go after that savage Queen; so she waited.

The Gryphon sat up and rubbed its eyes; then it watched the Queen till she was out of sight, then it chuckled. "What fun!" said the Gryphon, half to itself, half to Alice.

"What *is* the fun?" said Alice.

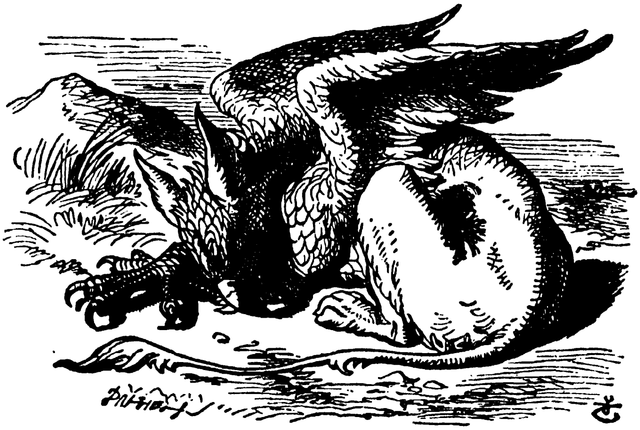
"Why, *she*," said the Gryphon. "It's all her fancy, that; they never executes nobody, you know. Come on!"

"Everybody says 'Come on' here," thought Alice, as she went slowly after it. "I never was so ordered about before in all my life, never!"

They had not gone far before they saw the Mock Turtle in the distance, sitting sad and lonely on a little ledge of rock, and as they came nearer, Alice could hear him sighing as if his heart would break. She pitied him deeply.

"What is his sorrow?" she asked the Gryphon, and the Gryphon answered, very nearly in the same words as before:

"It's all his fancy, that. He hasn't got no sorrow, you know. Come on!"



So they went up to the Mock Turtle, who looked at them with large eyes full of tears, but said nothing.

"This here young lady," said the Gryphon, "she wants for to know your history, she do."

"I'll tell it her," said the Mock Turtle in a deep, hollow tone. "Sit down, both of you, and don't speak a word till I've finished."

So they sat down, and nobody spoke for some minutes. Alice thought to herself: "I don't see how he can *ever* finish if he doesn't begin." But she waited patiently.

"Once," said the Mock Turtle at last, with a deep sigh, "I was a real turtle."

These words were followed by a very long silence, broken only by an occasional exclamation of "Hjckrrh!" from the Gryphon, and the constant, heavy sobbing of the Mock Turtle. Alice was very nearly getting up and saying: "Thank you, sir, for your interesting story," but she could not help thinking there *must* be more to come, so she sat still and said nothing.

"When we were little," the Mock Turtle went on at last, more calmly, though still sobbing a little now and then, "we went to school in the sea. The master was an old turtle—we used to call him Tortoise—"

"Why did you call him Tortoise if he wasn't one?" Alice asked.

"We called him Tortoise because he taught us," said the Mock Turtle angrily. "Really, you are very dull!"

"You ought to be ashamed of yourself for asking such a simple question," added the Gryphon; and then they both sat silent and looked at poor Alice, who felt ready to sink into the earth. At last the Gryphon said to the Mock Turtle:

"Drive on, old fellow! Don't be all day about it!" And he went on in these words:

"Yes, we went to school in the sea, though you mayn't believe it—"

"I never said I didn't!" interrupted Alice.

"You did!" said the Mock Turtle.

"Hold your tongue!" added the Gryphon, before Alice could speak again. The Mock Turtle went on:

"We had the best of educations—in fact, we went to school every day—"

"*I've* been to a day-school, too," said Alice. "You needn't be so proud as all that."

"With extras?" asked the Mock Turtle a little anxiously.

"Yes," said Alice; "we learned French and music."

"And washing?" said the Mock Turtle.

"Certainly not!" said Alice indignantly.

"Ah, then yours wasn't a really good school!" said the Mock Turtle, in a tone of great relief. "Now, at *ours* they had at the end of the bill, 'French, music, *and washing*—extra.'"

"You couldn't have wanted it much, living at the bottom of the sea."

"I couldn't afford to learn it," said the Mock Turtle, with a sigh. "I only took the regular course."

"What was that?" inquired Alice.

"Reeling and Writhing, of course, to begin with," the Mock Turtle replied; "and then the different branches of Arithmetic—Ambition, Distraction, Uglification, and Derision."

"I never heard of 'Uglification,'" Alice ventured to say. "What is it?"

The Gryphon lifted up both its paws in surprise, and stared at Alice.

"Never heard of uglifying!" it exclaimed. "You know what to beauty is, I suppose?"

"Yes," said Alice doubtfully; "it means—to—make—anything—prettier."

"Well, then," the Gryphon went on, "if you don't know what to uglify is, you *are* a simpleton."

Alice did not feel encouraged to ask any more questions about it, so she turned to the Mock Turtle, and said: "What else had you to learn?"

"Well, there was Mystery," the Mock Turtle replied, counting off the subjects on his flappers — "Mystery, ancient and modern, with Seaography; then Drawling—the Drawling-master was an old conger-eel, that used to come once a week; *he* taught us Drawling, Stretching, and Fainting in Coils."

"What was *that* like?" said Alice.

"Well, I can't show it you myself," the Mock Turtle said; "I'm too stiff. And the Gryphon never learned it."

"Hadn't time," said the Gryphon. "I went to the Classical master, though. He was an old crab, *he* was."

"I never went to him," the Mock Turtle said, with a sigh. "He taught Laughing and Grief, they used to say."

"So he did, so he did," said the Gryphon, sighing in its turn. And both creatures hid their faces in their paws.

"And how many hours a day did you do lessons?" said Alice, in a hurry to change the subject.

"Ten hours the first day," said the Mock Turtle; "nine the next, and so on."

"What a curious plan!" exclaimed Alice.

"That's the reason they're called lessons," the Gryphon remarked: "because they lessen from day to day."

This was quite a new idea to Alice, and she thought it over a little before she made her next remark.

"Then the eleventh day must have been a holiday?"

"Of course it was," said the Mock Turtle.

"And how did you manage on the twelfth?" Alice went on eagerly.

"That's enough about lessons," the Gryphon interrupted, in a very decided tone. "Tell her something about the games now."

IX

The Mock Turtle sighed deeply, and drew the back of one flapper across his eyes. He looked at Alice, and tried to speak; but for a minute or two sobs choked his voice.

"Same as if he had a bone in his throat," said the Gryphon, and it set to work shaking him and punching him in the back.

At last the Mock Turtle recovered his voice, and, with tears running down his cheeks, he went on again:

"You may not have lived much under the sea"—"I haven't," said Alice—"and perhaps you were never even introduced to a lobster" (Alice began to say, "I once tasted—" but checked herself, and said, "No, never") "so you can have no idea what a delightful thing a Lobster Quadrille is!"

"No, indeed," said Alice. "What sort of a dance is it?"

"Why," said the Gryphon, "you first form into a line along the seashore—"

"Two lines!" cried the Mock Turtle. "Seals, turtles, salmon, and so on. Then when you've cleared all the jelly-fish out of the way—"

"*That* generally takes some time," interrupted the Gryphon.

"You advance twice—"

"Each with a lobster as a partner!" cried the Gryphon.

"Of course," the Mock Turtle said. "Advance twice, set to partners—"

"Change lobsters, and retire in same order," continued the Gryphon.

"Then you know," the Mock Turtle went on, "you throw the —"

"The lobsters!" shouted the Gryphon, with a bound into the air.

"As far out to sea as you can—"

"Swim after them!" screamed the Gryphon.

"Turn a somersault in the sea!" cried the Mock Turtle, capering wildly about.

"Change lobsters again!" yelled the Gryphon, at the top of its voice.

"Back to land again, and—that's all the first figure," said the Mock Turtle, suddenly dropping his voice. And the two creatures, who had been jumping about like mad things all this time, sat down again very sadly and quietly, and looked at Alice.

"It must be a very pretty dance," said Alice timidly.

"Would you like to see a little of it?" said the Mock Turtle.

"Very much indeed," said Alice.

"Come, let's try the first figure," said the Mock Turtle to the Gryphon. "We can do without lobsters, you know. Which shall sing?"

"Oh, *you* sing!" said the Gryphon. "I've forgotten the words."

So they began solemnly dancing round and round Alice, every now and then treading on her toes when they passed too close, and waving their fore-paws to mark the time; while the Mock Turtle sang this, very slowly and sadly:

"Will you walk a little faster?" said a whiting to a snail,
"There's a porpoise close behind us, and he's treading on my tail.
See how eagerly the lobsters and the turtles all advance!
They are waiting on the shingle—will you come and join the dance?
Will you, won't you, will you, won't you, will you join the dance?
Will you, won't you, will you, won't you, won't you join the dance?

"You can really have no notion how delightful it will be
When they take us up and throw us, with the lobsters, out to sea!"
But the snail replied "Too far, too far!" and gave a look askance—
Said he thanked the whiting kindly, but he would not join the dance.
Would not, could not, would not, could not, would not join the dance.
Would not, could not, would not, could not, could not join the dance.

"What matters it how far we go?" his scaly friend replied,
"There is another shore, you know, upon the other side.
The further off from England the nearer is to France—
Then turn not pale, beloved snail, but come and join the dance.
Will you, won't you, will you, won't you, will you join the dance?
Will you, won't you, will you, won't you, won't you join the dance?"

"Thank you; it's a very interesting dance to watch," said Alice, feeling very glad that it was over at last. "And I do like that curious song about the whiting."

"Oh, as to the whiting," said the Mock Turtle, "they—You've seen them, of course?"

"Yes," said Alice; "I've often seen them at dinn—"

She checked herself hastily.

"I don't know where Dinn may be," said the Mock Turtle, "but if you've seen them so often, of course you know what they're like."

"I believe so," Alice replied thoughtfully. "They have their tails in their mouths, and they're all over crumbs."

"You're wrong about the crumbs," said the Mock Turtle. "Crumbs would all wash off in the sea. But they *have* their tails in their mouths; and the reason is—" Here the Mock Turtle yawned and shut his eyes. "Tell her about the reason, and all that," he said to the Gryphon.

"The reason is," said the Gryphon, "that they *would* go with the lobsters to the dance. So they got thrown out to sea. So they had to fall a long way. So they got their tails fast in their mouths. So they couldn't get them out again. That's all."

"Thank you," said Alice, "it's very interesting. I never knew so much about a whiting before."

"I can tell you more than that, if you like," said the Gryphon. "Do you know why it's called a whiting?"

"I never thought about it," said Alice. "Why?"

"It does the boots and shoes," the Gryphon replied very solemnly.

Alice was thoroughly puzzled. "Does the boots and shoes!" she repeated in a wondering tone.

"Why, what are *your* shoes done with?" said the Gryphon. "I mean, what makes them so shiny?"

Alice looked down at them, and considered a little before she gave her answer. "They're done with blacking I believe."

"Boots and shoes under the sea," the Gryphon went on in a deep voice, "are done with whiting. Now you know."

"And what are they made of?" Alice asked, in a tone of great curiosity.

"Soles and eels, of course," the Gryphon replied rather impatiently. "Any shrimp would have told you that."

"If I'd been the whiting," said Alice, whose thoughts were still running on the song, "I'd have said to the porpoise: 'Keep back, please;

we don't want *you* with us.' "

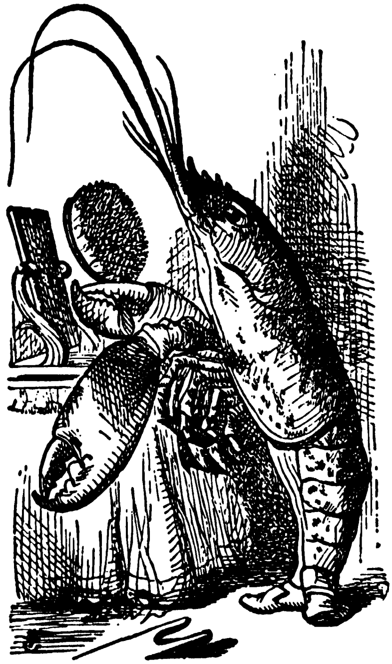
"They were obliged to have him with them," the Mock Turtle said. "No wise fish would go anywhere without a porpoise."

"Wouldn't it, really?" said Alice, in a tone of great surprise.

"Of course not!" said the Mock Turtle. "Why, if a fish came to *me*, and told me he was going on a journey, I should say: 'With what porpoise?' "

"Don't you mean 'purpose'?" said Alice.

"I mean what I say," the Mock Turtle replied in an offended tone. And the Gryphon added: "Come, let's hear some of *your* adventures."



"I could tell you my adventures, beginning from this morning," said Alice a little timidly; "but it's no use going back to yesterday, because I was a different person then."

"Explain all that," said the Mock Turtle.

"No, no; the adventures first!" said the Gryphon impatiently. "Explanations take such a dreadful time."

So Alice began telling them her adventures from the time when she first saw the White Rabbit. . . . . . After a while a cry of "The trial's beginning!" was heard in the distance.

"Come on!" cried the Gryphon. And, taking Alice by the hand, it hurried off. . . . "What trial is it?" Alice panted, as she ran, but the Gryphon only answered: "Come on!" and ran the faster.

X

The King and Queen of Hearts were seated on their throne when they arrived, with a great crowd assembled about them—all sorts of little birds and beasts, as well as the whole pack of cards. The Knave was standing before them, in chains, with a soldier on each side to guard him; and near the King was the White Rabbit, with a trumpet in one hand, and a scroll of parchment in the other. In the very middle of the court was a table, with a large dish of tarts upon it. They looked so good that it made Alice quite hungry to look at them. "I wish they'd get the trial done," she thought, "and hand round the refreshments." But there seemed to be no chance of this, so she began looking at everything about her to pass away the time. . . .

The twelve jurors were all writing very busily on slates. "What are they doing?" Alice whispered to the Gryphon. "They can't have anything to put down yet, before the trial's begun."

"They're putting down their names," the Gryphon whispered in reply, "for fear they should forget them before the end of the trial."

"Stupid things!" Alice began in a loud, indignant voice, but she stopped herself hastily, for the White Rabbit cried out: "Silence in the court!" and the King put on his spectacles and looked anxiously round, to make out who was talking.

Alice could see, as well as if she were looking over their shoulders, that all the jurors were writing down "stupid things!" on their slates, and she could even make out that one of them didn't know how to spell "stupid," and that he had to ask his neighbor to tell him. "A nice muddle their slates'll be in before the trial's over!" thought Alice.

One of the jurors had a pencil that squeaked. This, of course, Alice could *not* stand, and she went round the court and got behind him, and very soon found an opportunity of taking it away. She did it so quickly that the poor little juror (it was Bill, the Lizard) could not make out at all what had become of it; so, after hunting all about for it, he was obliged to write with one finger for the rest of the day. And this was of very little use, as it left no mark on the slate.

"Herald, read the accusation!" said the King.

On this the White Rabbit blew three blasts on the trumpet, and then unrolled the parchment scroll, and read as follows:

"The Queen of Hearts, she made some tarts,
  All on a summer's day;
The Knave of Hearts, he stole those tarts,
  And took them quite away."

"Consider your verdict," the King said to the jury.

"Not yet, not yet!" the Rabbit hastily interrupted. "There's a great deal to come before that!"

"Call the first witness," said the King; and the White Rabbit blew three blasts on the trumpet, and called out: "First witness!"

The first witness was the Hatter. He came in with a teacup in one hand and a piece of bread and butter in the other. "I beg pardon, your Majesty," he began, "for bringing these in; but I hadn't quite finished my tea when I was sent for."

"You ought to have finished," said the King. "When did you begin?"

The Hatter looked at the March Hare, who had followed him into the court, arm in arm with the Dormouse. "Fourteenth of March, I *think* it was," he said.

"Fifteenth," said the March Hare.

"Sixteenth," added the Dormouse.

"Write that down," the King said to the jury; and the jury eagerly wrote down all three dates on their slates, and then added them up and reduced the answer to shillings and pence.

"Take off your hat," the King said to the Hatter.

"It isn't mine," said the Hatter.

"Stolen!" the King exclaimed, turning to the jury, who instantly made a memorandum of the fact.

"I keep them to sell," the Hatter added as an explanation; "I've none of my own. I'm a hatter."

Here the Queen put on her spectacles, and began staring hard at the Hatter, who turned pale and fidgeted.

"Give your evidence," said the King; "and don't be nervous, or I'll have you executed on the spot."

This did not seem to encourage the witness at all; he kept shifting from one foot to the other, looking uneasily at the Queen, and in his confusion he bit a large piece out of his teacup instead of the bread and butter.

Just at this moment Alice felt a very curious sensation, which puzzled her a good deal until she made out what it was. She was beginning to grow larger again, and she thought at first she would get up and leave the court; but on second thoughts she decided to remain where she was as long as there was room for her.

"I wish you wouldn't squeeze so," said the Dormouse, who was sitting next to her. "I can hardly breathe."

"I can't help it," said Alice, very meekly; "I'm growing."

"You've no right to grow *here,"* said the Dormouse.

"Don't talk nonsense," said Alice more boldly; "you know you're growing too."

"Yes, but *I* grow at a reasonable pace," said the Dormouse, "not in that ridiculous fashion." And he got up very sulkily and crossed over to the other side of the court.

All this time the Queen had never left off staring at the Hatter, who trembled so that he shook both his shoes off.

"Give your evidence," the King repeated angrily, "or I'll have you executed, whether you're nervous or not."

"I'm a poor man, your Majesty," the Hatter began in a trembling voice, "and I hadn't but just begun my tea—not above a week or so—and what with the bread and butter getting so thin—and the twinkling of the tea—"

"The twinkling of *what?"* said the King.

"It *began* with the tea," the Hatter replied.

"Of course, twinkling begins with a T!" said the King sharply. "Do you take me for a dunce? Go on!"

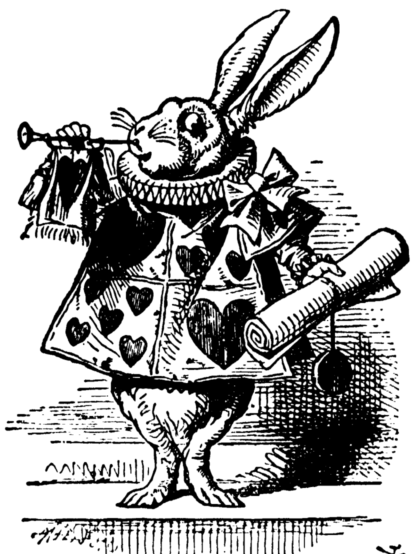
"I'm a poor man," the Hatter went on, "and most things twinkled after that — only the March Hare said—"

"I didn't!" the March Hare interrupted in a great hurry.

"You did!" said the Hatter.

"I deny it!" said the March Hare.

"He denies it," said the King; "leave out that part."



"Well, at any rate, the Dormouse said—" the Hatter went on, looking anxiously around to see if he would deny it too; but the Dormouse denied nothing, being fast asleep.

"After that," continued the Hatter, "I cut some more bread and butter—"

"But what did the Dormouse say?" one of the jury asked.

"That I can't remember," said the Hatter.

"You *must* remember," remarked the King, "or I'll have you executed."

The miserable Hatter dropped his teacup and bread and butter, and went down on one knee. "I'm a poor man, your Majesty," he began.

"You're a *very* poor *speaker,*" said the King.

Here one of the guinea-pigs cheered, and was immediately suppressed by the officers of the court. (As that is rather a hard word, I will just explain to you how it was done. They had a large canvas bag, which tied up at the mouth with strings: into this they slipped the guinea-pig, head first, and then sat upon it.)

"If that's all you know about it, you may stand down," continued the King.

"I can't go no lower," said the Hatter; I'm on the floor, as it is."

"Then you may *sit* down," the King replied.

Here the other guinea-pig cheered, and was suppressed.

"Come, that finishes the guinea-pigs!" thought Alice. "Now we shall get on better."

"I'd rather finish my tea," said the Hatter, with an anxious look at the Queen.

"You may go," said the King; and the Hatter hurriedly left the court, without even waiting to put his shoes on.

"—and just take his head off outside," the Queen added to one of the officers; but the Hatter was out of sight before the officer could get to the door.

"Call the next witness!" said the King. . . .

Alice watched the White Rabbit as he fumbled over the list, feeling very curious to see what the next witness would be like, "for they haven't got much evidence *yet,*" she said to herself. Imagine her surprise when the White Rabbit read out, at the top of his shrill little voice, the name "Alice!"

XI

"Here!" cried Alice, quite forgetting in the flurry of the moment how large she had grown in the last few minutes, and she jumped up in such a hurry that she tipped over the jury-box with the edge of her skirt, upsetting all the jurymen on to the heads of the crowd below and there they lay sprawling about, reminding her very much of a globe of goldfish she had accidentally upset the week before.

"Oh, I *beg* your pardon!" she exclaimed in a tone of great dismay, and began picking them up again as quickly as she could, for the accident of the goldfish kept running in her head, and she had a vague sort of idea

that they must be collected at once and put back into the jury-box, or they would die.

"The trial cannot proceed," said the King, in a very grave voice, "until all the jurymen are back in their proper places—*all*," he repeated with great emphasis, looking hard at Alice as he said so.

Alice looked at the jury-box, and saw that, in her haste, she had put the Lizard in head downwards, and the poor little thing was waving its tail about in a melancholy way, being quite unable to move. She soon got it out again, and put it right; "not that it signifies much," she said to herself; "I should think it would be *quite* as much use in the trial one way up as the other."

As soon as the jury had a little recovered from the shock of being upset, and their slates and pencils had been found and handed back to them, they set to work very diligently to write out a history of the accident, all except the Lizard, who seemed too much overcome to do anything but sit with its mouth open, gazing up into the roof of the court.

"What do you know about this business?" the King said to Alice.

"Nothing," said Alice.

"Nothing *whatever?*" persisted the King.

"Nothing whatever," said Alice.

"That's very important," the King said, turning to the jury. They were just beginning to write this down on their slates, when the White Rabbit interrupted. "*Un*important, your Majesty means, of course," he said, in a very respectful tone, but frowning and making faces at him as he spoke.

"*Un*important, of course, I meant," the King hastily said, and went on to himself in an undertone, "important — unimportant — unimportant — important —" as if he were trying which word sounded best.

Some of the jury wrote it down "important," and some "unimportant." . . . At this moment the King, who had been for some time busily writing in his notebook, called out "Silence!" and read out from his book: "Rule Forty-two. *All persons more than a mile high to leave the court.*"

Everybody looked at Alice.

"*I'm* not a mile high," said Alice.

"You are," said the King. "Nearly two miles high," added the Queen.

"Well, I shan't go, at any rate," said Alice. "Besides, that's not a regular rule; you invented it just now."

"It's the oldest rule in the book," said the King.

"Then it ought to be Number One," said Alice.

The King turned pale, and shut his notebook hastily. "Consider your verdict," he said to the jury, in a low, trembling voice. . . .

"No, no!" said the Queen. "Sentence first—verdict afterwards."

"Stuff and nonsense!" said Alice loudly. "The idea of having the sentence first!"

"Hold your tongue!" said the Queen, turning purple.

"I won't!" said Alice.

"Off with her head!" the Queen shouted at the top of her voice. Nobody moved.

"Who cares for you?" said Alice (she had grown to her full size by this time). "You're nothing but a pack of cards!"

At this the whole pack rose up into the air, and came flying down upon her; she gave a little scream, half of fright and half of anger, and tried to beat them off, and found herself lying on the bank, with her head in the lap of her sister, who was gently brushing away some dead leaves that had fluttered down from the trees on her face.

"Wake up, Alice dear!" said her sister. "Why, what a long sleep you've had!"

"Oh, I've had such a curious dream!" said Alice; and she told her sister, as well as she could remember them, all these strange adventures of hers that we have just been reading about; and when she had finished, her sister kissed her, and said: "It *was* a curious dream, dear, certainly. But now run in to your tea; it's getting late."

So Alice got up and ran off, thinking while she ran, as well she might, what a wonderful dream it had been.

But her sister sat still just as she left her, leaning her head on her hand, watching the setting sun, and thinking of little Alice and all her wonderful adventures, till she too began dreaming after a fashion, and this was her dream: First, she dreamed of little Alice herself: once again the tiny hands were clasped upon her knee, and the bright, eager eyes were looking up into hers—and still as she listened, the whole place around her became alive with the strange creatures of her little sister's dream.

So she sat on, with closed eyes, and half believed herself in Wonderland, though she knew she had but to open them again and all would change to dull reality—the grass would be only rustling in the wind, and the pool rippling to the waving of the reeds—the rattling teacups would change to tinkling sheep-bells—and the sneeze of the baby and the Queen's shrill cries to the voice of the shepherd boy, and all the other queer noises would change (she knew) to the clamor of the busy farmyard.

Lastly, she pictured to herself how this little sister of hers would, in the aftertime, be herself a grown woman; and how she would keep, through all her riper years, the simple and loving heart of her childhood; and how she would gather about her other little children, and make *their* eyes bright and eager with many a strange tale, perhaps even with the dream of Wonderland of long ago; and how she would feel with all their simple sorrows, and find a pleasure in all their simple joys, remembering her own child-life, and the happy summer days.

THE NEXT STORIES ARE ON PAGE 1332.

Culver Service

The shepherd Faustulus discovers Romulus and Remus. In the foreground we see the river god Father Tiber.

THE STORY OF ANCIENT ROME

I. THE ROMAN REPUBLIC

FIFTEEN miles from the mouth of Italy's river Tiber lies the great city of Rome. Men call it the Eternal City, for it has played an important part in the drama of human history for more than two thousand years. It reached its greatest glory in ancient times, when it became the centre of one of the world's mightiest empires. In this article and the one on page 1243 we shall tell you about the rise and fall of this wonderful state.

We know very little about the beginnings of Rome. According to the story told by most Roman historians, the Romans were descended from Æneas (ee-nee′-as), a hero of ancient Troy. Æneas escaped from Troy after it had been captured by the Greeks, and he made his way, with a number of followers, to the land of the Latins, south of the Tiber River. He married the daughter of Latinus, the king of the country, and he followed Latinus upon the throne.

Many generations afterward one of the daughters of the royal house had twin sons, called Romulus (raw′-muh-lus) and Remus (ree′-mus); their father was Mars, god of war. A tyrant king, who had usurped the throne, caused the two babes to be cast out upon the banks of the Tiber. A she-wolf found the infants, carried them to her cave and nursed them tenderly.

Some time later a shepherd came upon the boys in the cave. He took them home with him and brought them up to manhood. When they grew up, they drove out the usurper king and then decided to found a new city. Romulus wanted it to be on the Palatine Hill, near the Tiber; Remus preferred a neighboring hill. The two brothers quarreled and Remus was slain. Romulus grieved over the death of his brother, but he completed the construction of the city, which was called Rome after his own name. The Romans set the date of the foundation of Rome at a time that would correspond to 753 B.C.

The account that we have just given of the founding of Rome is based on legend, though there may be a grain of truth in it. As for the history of Rome for the next three hundred years or so, it is hard to say where the old legends end and the sober facts of history begin.

To continue with the account given by Roman historians, Romulus set up a kingdom that endured for about two hundred and fifty years—from 753 to 509 B.C. Seven kings in all reigned during this time. The first four were of the Latin race; the last three were descended from the Etruscans, who dwelt to the north of the Tiber. In the reign of the seven kings the city was greatly enlarged; it was built up around the Palatine Hill and six other hills in the vicinity. A number of neighboring cities were defeated in battle and were brought under the power of the Romans.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King Pyrrhus of Epirus.

The most important man in Rome during this time was the king, who was the war leader, judge and priest of his people. He was assisted by a council of elders called the senate. (The Latin word *senex*, from which senate comes, means old man.) The inhabitants of the city were divided into two classes—the patricians (pa-trish′-ans), or noble class, and the plebeians (plee-bee′-yans), or common people.

The patricians were descended from the original settlers of the city; the plebeians, from the inhabitants of conquered towns and from those who had come to Rome in order to trade or to seek protection. The political power was in the hands of the patricians, who alone could serve in the senate, the council of elders. At first the plebeians were forbidden to carry weapons and could not vote. They had won both privileges, however, before the kingdom came to an end.

The last of the kings was Lucius Tarquinius, or Tarquin, as he is generally called in English. This Tarquin was a tyrant, who made the people labor on public works for very little pay and who put to death all those who opposed his will. At last, in the year 509 B.C., Tarquin was driven into exile by a group of conspirators led by Brutus (broo′-tus), a noble of Rome.

The Romans now determined to do away with kings forever. They set up a republic with two leaders, called consuls; each was to serve as a check upon any ambitious plans that the other might have. The consuls were elected each year by an assembly made up of all the citizens; no consul was allowed to succeed himself in office. The senate became more important than under the kings. It was now made up of former magistrates, who were appointed to the senate for life. The senate was consulted on all important measures, and its advice was almost always followed.

When the state was in great peril, the government was turned over to a single man, called a dictator. He was given great power; he could make quick decisions in times when delay might prove fatal. He generally exercised his power for six months; then he became a plain Roman citizen again.

In the course of time other offices were created. Among the most important of the new officers were the censors, who had charge of the voting lists. They could take away political rights from those who behaved badly; therefore they came to be the guardians of public morals. The censors had many other duties, including management of the state money.

The plebeians of Rome were not at all satisfied with the new republic, for they had very little power in it. They could not become senators, or hold any important offices in the government. They voted, it is true; but elections were carried on in such a way that the vote of a plebeian counted for much less than that of a patrician. The plebeians had other grievances. Poor people who were in debt were treated harshly; sometimes they were made slaves.

At last the plebeians decided to take matters into their own hands. In the year 494 B.C. they withdrew to the Sacred Mount, near Rome, and threatened to found a new city unless conditions were improved. The patricians yielded. It was agreed that the plebeians were to elect two officers, called tribunes, who would defend the interests of the people against the ruling classes. These tribunes, whose number was increased later from two to ten, were given the right to veto the decisions of the consuls and the senate. In this way they could prevent the passage of measures that were unfair to the people.

Encouraged, the plebeians continued to fight for their rights. It was a long struggle, but a successful one; the patricians had to yield to one demand after the other. By the year 287 B.C. the plebeians had won complete equality before the law with the patricians.

While this struggle for political liberty was going on, the Romans were engaged in almost ceaseless fighting against foreign enemies. The exiled tyrant Tarquin tried desperately to win back his lost throne. He won the help of the Etruscans and, later, of certain Latin cities. But all his efforts were in vain. After the battle of Lake Regillus, in 496 B.C., he troubled the Romans no more. They were able to continue the career of conquest that had been begun under their former kings.

The Etruscans, who had been the allies of Tarquin, were a threat to Rome for many years to come. They had a more advanced civilization than the Romans; they had a powerful fleet; they were just as aggressive as the Romans. It was not until 396 B.C. that Rome definitely broke the power of these dangerous enemies by capturing the strong Etruscan fortress of Veii, less than ten miles from Rome itself.

Soon afterward the Romans met with a great disaster. Toward the beginning of the fourth century B.C. the Gauls, a race of barbarians dwelling in what is now France, had invaded Italy and had overrun the northern part of the peninsula. In 390 they crushed a Roman army at the Allia River and advanced upon Rome. They captured all of the city except the citadel, or fortress, upon the Capitoline Hill. They killed and burned and destroyed like the barbarians that they were. At last they agreed to leave Rome in exchange for a large quantity of gold.

The Gauls had completely destroyed the records that they found in the temples of the captured city. It is for this reason that we have so little reliable information about things that happened at Rome before the year 390 B.C. We generally have trustworthy accounts to go by, for events that took place after that date.

The Romans rebuilt their city and soon

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Sabine women stepping between their Roman husbands and their Sabine kinsmen, begging them not to fight.

regained their former power. They began to extend their conquests; city after city fell under their control. Their most bitter opponents in the fourth century B.C. were the Samnites, who held them at bay for almost fifty years (343-295 B.C.). At last the Samnites suffered such a terrible defeat at Sentinum, in 295 B.C., that they were forced to yield.

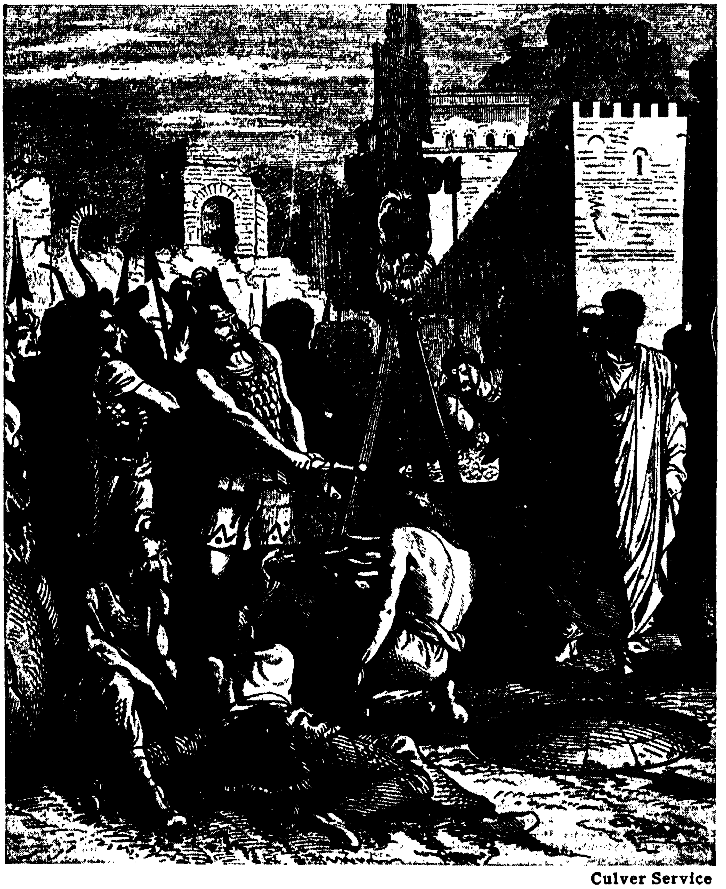
The Romans then turned their attention to the southern part of the Italian peninsula. Most of the cities in this region had originally been Greek colonies. Threatened by the might of the Roman Republic, they appealed for help to Pyrrhus (pir′-us), the warlike king of Epirus, in Greece.

Pyrrhus crossed over to Italy with a large army and succeeded in inflicting two severe defeats upon the Romans (280 and 279 B.C.). His own losses were so severe, however, that he was unable to follow up his successes. He is reported to have said: "Another such victory and I must return to Epirus alone." We still give the name of Pyrrhic victory to one in which the victors suffer almost as much as the vanquished.

Undiscouraged by defeat, the Romans kept up the fight against Pyrrhus. At last they defeated him decisively in the battle of Beneventum in 275. Pyrrhus had to return to his own land with the remnants of his once powerful army. The Greek cities of the south soon submitted to Rome.

Thereafter Rome ruled over practically the whole of the Italian peninsula. How had this city on the banks of the Tiber won mastery over so great a territory? The chief reason, perhaps, was that the Roman soldier was a remarkable fighting man. He was very patriotic. The armies of Rome were recruited from the entire body of the citizenry; they fought not for money but for love of country. Then, too, the Roman soldier was well trained and highly disciplined. He could get along with little food and baggage in a campaign. He fought stubbornly. Even when he was defeated, he inflicted terrible losses on the foe, as Pyrrhus had found to his cost.

Another reason for Rome's success was that she won the support of the peoples she had conquered. She ruled her subjects very wisely on the whole. Some of the conquered cities became partners in the Roman state; the members of the upper classes were granted Roman citizenship. Other cities were accepted as allies. They were allowed to govern themselves, to use the Roman law courts and to trade in Rome and her colonies. Furthermore, in order to strengthen her hold on the peninsula, Rome



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Episode of the Gallic invasion of 390 B.C. The Gauls have agreed to leave Rome in exchange for a large quantity of gold, which is being weighed out.

set up colonies of Roman citizens in every nook and corner of Italy.

She was now one of the leading powers in the western part of the Mediterranean Sea; the great city-state of Carthage was her only serious rival in this area. Carthage had been founded by the Phœnicians about 800 B.C., near what is to-day the city of Tunis. By the third century B.C. the Carthaginians had built up an empire that extended over much of northern Africa. They had a flourishing commerce and perhaps the greatest navy in all the Mediterranean.

Both Rome and Carthage were ambitious states, always seeking new lands to conquer. They kept up friendly relations with one another as long as their paths did not meet. But when the Carthaginians began to establish colonies in Sicily, which is separated from the Italian mainland by only a narrow strait, the Romans became very much alarmed. They could not endure the thought of so powerful a rival at their back door; besides, they wanted Sicily for themselves.

Culver Service

A Roman conqueror is being raised on his shield.

And so Rome and Carthage were soon locked in mortal combat. They fought three wars in all, extending over a period of more than a hundred years. These wars, which were to decide the mastery of the ancient world, are known to history as the Punic Wars (from the Latin word *Pœni,* meaning Carthaginians).

The First Punic War lasted for more than twenty years (264-41 B.C.). The Romans soon realized that they could not carry the war to their enemies unless they could meet the great Carthaginian fleet on equal terms. They had few ships, but this did not discourage them. They set to work to build up a big fleet, using as their model a Carthaginian galley that had been stranded on an Italian beach.

When their new ships were ready for combat, the Romans set out to meet the foe. In the great sea battle of Mylae in 260 B.C. they scored a brilliant victory, destroying many Carthaginian ships and scattering the rest. Thereafter the war continued for years with varying fortunes. It was not until the Romans won another important sea victory off the Ægatian Islands in 241 that the Carthaginians sued for peace. They gave up Sicily to the Romans and they promised not to wage war on Rome or her allies.

The peace of 241 served only to give Rome and Carthage a breathing space. Both continued to extend their possessions. In 239 B.C. Rome made Carthage give up Sardinia, a large island off the western Italian coast. Carthage made up for the loss of Sardinia by establishing herself in Spain. Under the leadership of the great general Hamilcar Barca, the Carthaginians conquered most of Spain up to the river Ebro.

In 219 B.C. the Carthaginian general Hannibal, the son of Hamilcar, laid siege to the Spanish town of Saguntum, which was an ally of Rome. The Romans sent ambassadors to Carthage to protest. While they were still protesting, Saguntum fell. The Romans were very angry and demanded that Hannibal should be given up to them. The Carthaginians refused; Rome declared war on her rival and the Second Punic War (218-01 B.C.) was on.

Hannibal, one of the greatest generals who ever lived, decided to carry the war to Roman soil. Collecting a powerful army in Spain, he marched northward, made his way through southern Gaul and at last reached the foot of the Alps. He crossed this great mountain barrier in nine days after suffering great hardships.

When he came down into the plains of northern Italy at last, he fought a pitched battle with the Romans at the Trebbia River (218) and inflicted a severe defeat upon them. Then he went into winter quarters. In the campaign of the following year he

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Roman soldiers storming the Byrsa, the citadel of Carthage, in 146 B.C. The capture of the Byrsa brought to an end a three-year siege.

won an even greater victory at Lake Trasimenus, about eighty miles north of Rome. Passing by Rome, he made his way to the southern province of Apulia, spreading death and destruction wherever he went.

The Romans now intrusted their safety to a dictator, Fabius Maximus (fay′-bi-us max′-i-mus). Fabius fought cautiously against the mighty Hannibal. He kept close at Hannibal's heels, cut off his supplies, killed stragglers and in general made life miserable for the Carthaginians; but he would never let himself be drawn into battle. As a result of these tactics he gave the Romans time to recover from their defeats. He is known to history as Fabius the delayer.

In 216 the Roman armies were turned over to other men. One of these new leaders, the consul Terentius Varro, rashly accepted battle with Hannibal at Cannæ, in Apulia, and the Romans suffered another disastrous defeat. Many cities of southern Italy now went over to the Carthaginians.

Yet, though Hannibal had won three great victories, he could not crush the spirit of the Romans. They raised new armies and continued the fight with dogged courage. Hannibal fought on for years in Italy, and he was a constant threat to the Romans. But he was never able to overcome their resistance. At last he was recalled from the peninsula in 203 in order to defend Carthage against a Roman army that had crossed over into northern Africa.

Publius Cornelius Scipio (sip′-ee-oh), the leader of this Roman army, was a foe worthy of the great Hannibal; he had won many victories over the Carthaginians in Spain. In the battle of Zama in 202 B.C. he utterly defeated Hannibal's forces. The Carthaginians decided to give up what now seemed to be a hopeless struggle, and in 201 B.C. the Second Punic War came to an end. Carthage gave up her fleet. She ceded Spain to the Romans and paid them a great sum of money.

The Romans never forgot how close they had been to disaster in the Second Punic War. When Carthage showed signs of recovering from the terrible losses she had suffered, many Romans declared that they would never be safe as long as their rival existed. The most bitter foe of Carthage was the famous Cato the Censor (see page 1362). After every speech he made in the senate, no matter what the subject was, he would end by saying: "Moreover, it is my opinion that Carthage must be destroyed!"

At last the Romans found a pretext to go to war with Carthage again. In this Third Punic War (149-46 B.C.) Carthage could not match the resources of Rome. Soon the Carthaginians were penned up within their own city walls. After three years the city was captured and destroyed.

Republican Rome was now at the height

of her power. In 190 B.C. the Romans had conquered Antiochus (an-ty'-oh-cus) III, king of Syria, and had annexed his possessions. Macedonia had fallen to Rome in 168 B.C. and Greece in 146. Thirteen years later the Romans inherited the dominions of Attalus (at'-a-lus), king of Pergamum (per'-ga-mum), in Asia Minor. The province of Asia was formed out of these territories.

At the beginning of her career of conquest Rome had sought to make friends and allies of the peoples she conquered. By the second century B.C. she had given up this wise policy. Conquered provinces were treated harshly. They were left to the mercies of the Roman governors, who were often greedy and brutal men. The collection of taxes was intrusted to men called tax farmers, who robbed the provinces right and left.

Great changes took place in Rome itself. The wealthier citizens began to adopt the luxuries and refinements of some of the countries that Rome had conquered. They were particularly delighted with the civilization of Greece. Greek philosophers, poets, sculptors and musicians were eagerly sought after. The Romans became more civilized than before. Unfortunately they also lost some of their finer qualities—their simplicity, their patriotism, their spirit of self-sacrifice, their honesty.

Slaves now played an important part in the everyday life of the country. They were to be found in great numbers upon the estates of the wealthy; they plowed the fields and tended the livestock. The small farmers, who had been the backbone of the Roman state, could not stand the competition of slave labor. Many of them had to sell their farms to their rich rivals.

There was now a great gulf between the ruling classes on the one hand and the great mass of propertyless citizens on the other. The poor found two noble champions in the last half of the second century B.C. These were the famous brothers, Tiberius and Gaius Gracchus (grak'-us), who served in turn as tribunes of the people.

They belonged to the nobility, but they tried to better the lot of the poor by providing them with land and with cheap provisions. They met the fierce opposition of the ruling classes. Tiberius was slain in 133; Gaius met a violent death in 121 B.C., as we tell you on page 1362. Other champions of the poor arose in time. Few of them were

Culver Service

Roman cavalry surrounding one of Hannibal's war elephants. These animals played an important part in the Carthaginian invasion of Italy, in the Second Punic War. They corresponded somewhat to the tanks of modern times.

as unselfish as Tiberius and Gaius Gracchus. Most of them used the support of the people in order to advance their own interests.

Toward the end of the second century B.C. the struggle between the rich and the poor was interrupted for a time. Italy was now threatened by an invasion of two northern peoples, the Teutones (too-toh′-neez) and the Cimbri (kim′-bree). They defeated several Roman armies; but at last they were overcome by the military genius of the consul Gaius Marius (may′-ri-us). He crushed the Teutones at Aix (aiks) in 102 and the Cimbri at Vercelli (ver-chel′-lee) in 101.

THE FIRST CENTURY B.C., WHEN MANY GREAT CHANGES TOOK PLACE AT ROME

The first century B.C. was perhaps the most fateful period in the history of ancient Rome. It was a time of revolution and change; of bitter fighting at home and abroad. It marked the end of the Roman Republic and the establishment of a government in which one man was the master.

In the year 90 B.C. a number of Italian allies of Rome demanded the rights of Roman citizenship. When this demand was refused, they threw off their alliance with Rome and soon war broke out. This struggle is known as the Social War (from the Latin *socii,* meaning allies). Though the allied cities were defeated, the Romans decided to give them what they had sought—full citizenship in the Roman state.

The Social War came to an end in 88 B.C. In that year there was a violent quarrel between two Roman generals—Marius, the conqueror of the Teutones and Cimbri, and Lucius Cornelius Sulla, who had become consul in 88. Marius was the head of the popular, or people's, party; Sulla had the support of the senate and the ruling classes. Soon open civil war broke out.

At first Sulla drove Marius and his followers from Rome. Then he left for Asia Minor to fight against a dangerous foe of the Romans — Mithridates (mith-ri-day′-teez), king of the Asiatic country of Pontus. Marius took advantage of Sulla's absence to seize control of Rome. There followed a terrible massacre of Sulla's supporters.

Marius died in 86 B.C., but his friends remained in power for several years. In 83, however, Sulla landed in Italy with a large army and defeated the friends of Marius in one battle after another. In 82 Rome fell to Sulla, and there was another frightful massacre—this time the leaders of the people were the victims.

In 81 Sulla had himself made dictator for an indefinite period. He abolished the office of the tribunes and he placed the supreme power of the state in the hands of the senate and the aristocratic party. Two years later, to the great surprise of all, Sulla gave up his dictatorship and retired to his country estate, where he died the following year.

Another noted general, Gnæus Pompeius, or Pompey (pom′-pee), as English-speaking people call him, now became prominent. In 70 B.C. he served as consul together with Crassus, the wealthiest man in all Rome. Pompey won great fame in the years that followed. He crushed the pirates of the Mediterranean Sea; he conquered Mithridates; he subdued the Jewish nation, capturing Jerusalem after a three-month siege.

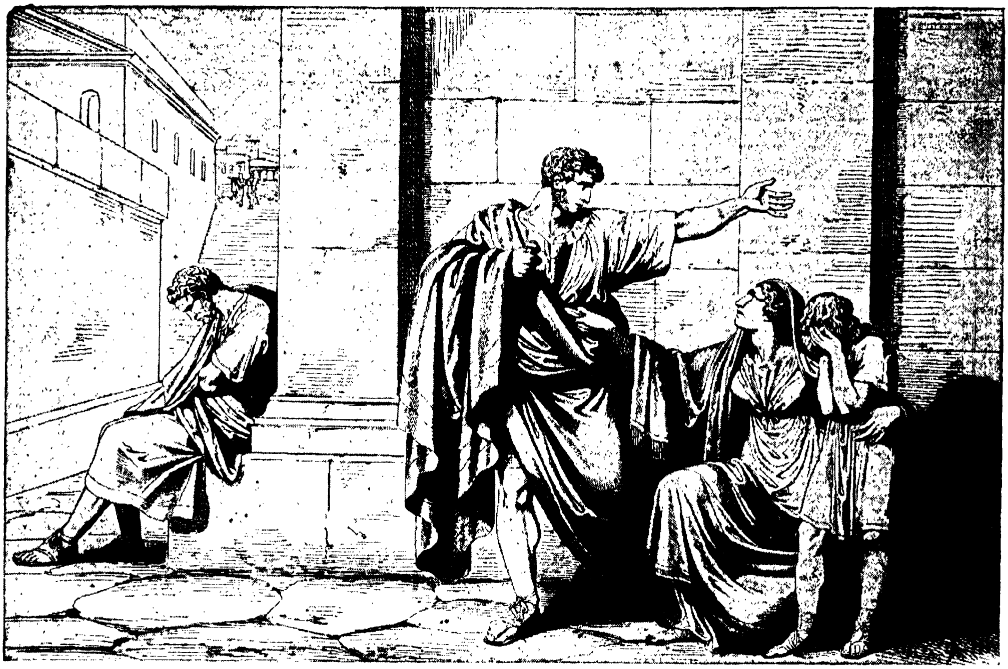
At first Pompey, a noble himself, had enjoyed the support of the senate and the aristocracy. But then he quarreled with the senate and he decided to come to an agreement with Gaius Julius Cæsar (see′-zer), the leader of the popular party. In the year 60 B.C. Pompey, Cæsar and the wealthy Crassus formed a political partnership, which was known as a triumvirate (try-um′-vi-rate; from a Latin word meaning government by three men). The partners now held all Rome in their grip.

CÆSAR WINS MANY GREAT VICTORIES OVER THE WARLIKE TRIBES OF GAUL

In 60 B.C. Cæsar became consul. In the following year, he was made governor of several provinces, including Gaul, the region now called France. Many of the Gauls, the barbarians who dwelt here, had never accepted the rule of Rome. In a series of brilliant campaigns Cæsar overcame them and by 51 B.C. the entire province had yielded to the might of Roman arms.

Pompey had become very jealous of Cæsar's successes and the friendship between the two men gradually cooled. Finally Pompey was reconciled with the senate. For their part the senators were glad to have his support against Cæsar, who was still the leader of the popular party.

When Cæsar's term of office as governor of Gaul came to an end in 49 B.C., the senate ordered him to give up the command of his armies. If Cæsar had done so, he would have been helpless against the attacks of his enemies. Therefore he refused to obey. Instead, he led his veteran troops across the Rubicon River, which separated Gaul from Italy, and advanced against Pompey and his friends. To this day we say that a person



Culver Service

Gaius Gracchus, tribune of the people, taking leave of his wife and son on the day of his death (121 B.C.).

"crosses the Rubicon" when he takes an important action from which there is no turning back.

Cæsar was soon master of all Italy. Pompey fled to Greece and there he collected a large army. Cæsar crushed his foes in Spain; then he sailed to Greece to do battle with his rival. Pompey's army was completely destroyed in the battle of Pharsalia in 48. The defeated general made his way to Egypt, where he was slain at the orders of that country's rulers. Cæsar carried on the fight against the supporters of Pompey in Africa and Spain. By 45 B.C. he was the undisputed master of Rome. (The story of Cæsar's life and of his conquests on three continents is told on page 1859. He was one of the world's greatest soldiers.)

Cæsar was a generous conqueror; he freely pardoned all those who had fought against him. The senate, which had bitterly opposed him, now heaped honors upon him. He was made dictator and censor for life; his portrait was struck on coins; the month of Quintilius was renamed Julius (our modern July) in his honor.

Cæsar did not take the title of king; but he ruled like a kindly monarch, interested in the welfare of his people. He passed several laws to give relief to debtors; he prohibited farming by slaves unless free men were allowed to work on the same farm. He developed a plan to settle in the provinces the unemployed people of Italy. All these projects were very wise. So were others that he had no chance to carry out.

Unfortunately Cæsar had risen too high to escape hatred. Some people, like Gaius Cassius (cash′-us), disliked him because he was so much greater than they. Others, like Marcus Brutus, regretted the old Republic, under which Romans had been free. Cassius, Brutus and a number of other dissatisfied citizens entered into a conspiracy against Cæsar. On March 15, 44 B.C., they fell upon the dictator at a meeting of the senate and stabbed him to death.

The assassins proclaimed that the old Roman Republic was to be restored. They were hailed by the senate. They also won the support of the famous orator, Marcus Tullius Cicero (siss′-e-roh), who thought that the good old days of political freedom were about to be restored. (See our life of Cicero, on page 1862.)

A curious situation now developed. The assassins of Cæsar became so unpopular at Rome that they had to leave the city. Octavian (oc-tay′-vi-an), Cæsar's adopted son and heir, appeared on the scene and came to an agreement with the senate. And soon fighting broke out, not between Cæsar's friends and his enemies, but between two friends of Cæsar. These friends were Octavian and Mark Antony (an′-toh-nee), who had been Cæsar's right-hand men.

In 43 B.C. the two rivals decided to become friends, for the time being at least. Together with a certain Lepidus (lep′-i-dus) they formed a second triumvirate. Then they joined battle with the forces of Brutus and Cassius and utterly routed them in the battle of Philippi, in Greece, in 42 B.C. Brutus and Cassius took their own lives after the defeat.

The members of the triumvirate now divided the Roman world between them. Octavian received Italy and the West; Antony took over the East. Lepidus was assigned Africa; but several years later he had to turn it over to Octavian. In the years that followed Octavian governed wisely. Antony, however, gave himself up to the pleasures of the Egyptian court, for Cleopatra, the fair queen of Egypt, had won his heart.

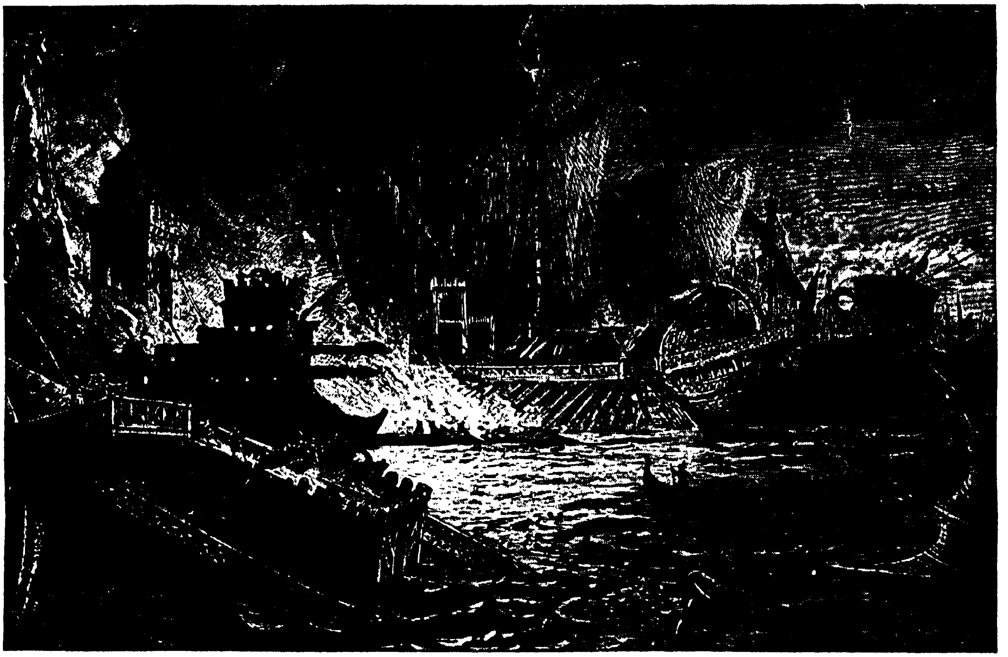
Octavian and Antony had never liked each other very much and they liked each other still less as time went on. At last war broke out between them. In a great naval battle off Actium, Greece, in 31 B.C., Octavian triumphed over the combined fleets of Antony and Cleopatra. In the following year he pressed the attack. Despairing of success, Antony and Cleopatra took their own lives. Egypt and the eastern provinces now accepted the rule of Octavian, who returned to Rome as a conqueror.

Toward the end of 28 B.C. Octavian announced that he was going to "hand over the Republic to the senate and the people of Rome." But the old Roman Republic was not revived. In 27 a government was set up in which, though certain republican institutions were kept, Octavian was given supreme power over the Roman state.

The Roman Republic had really ceased to exist some time before. Up to this time, however, even in the days when Cæsar ruled like a king, there was at least a faint hope that the Republic might be revived. But by 27 B.C. the Romans, weary of civil war and anarchy, were glad to give up their political freedom in exchange for peace.

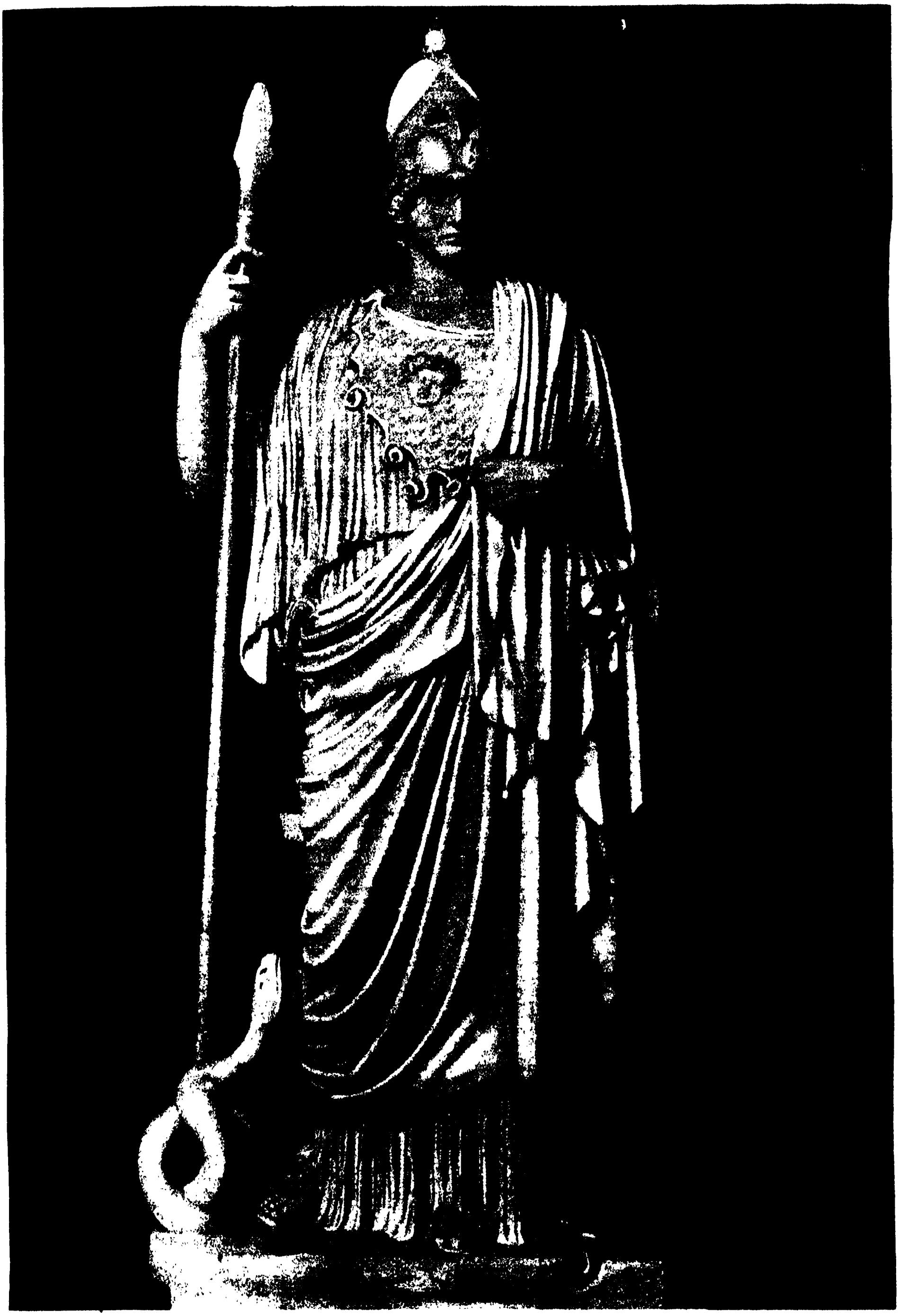
The Republic was gone forever. In its place was the Roman Empire, ruled by a single man. As an empire, Rome was to continue her career for centuries to come.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 1243.



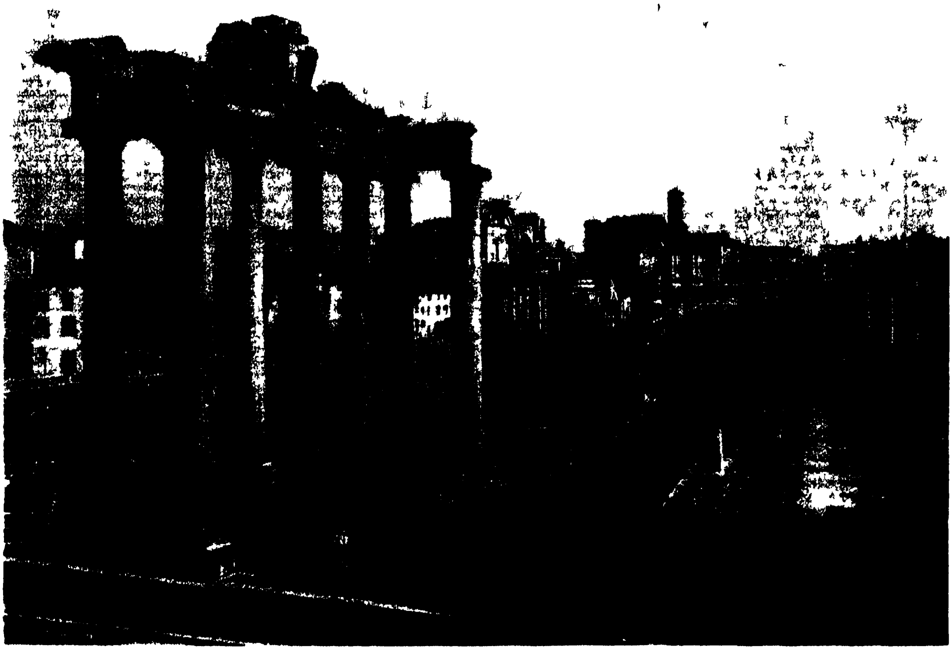
From an old print

The sea fight off Actium, Greece, 31 B.C. Here Octavian crushed the combined fleets of Antony and Cleopatra.



THE STATELY FIGURE OF MINERVA, IN THE VATICAN MUSEUM

THE SPACIOUS RUINS OF THE FORUM IN THE HEART OF ROME



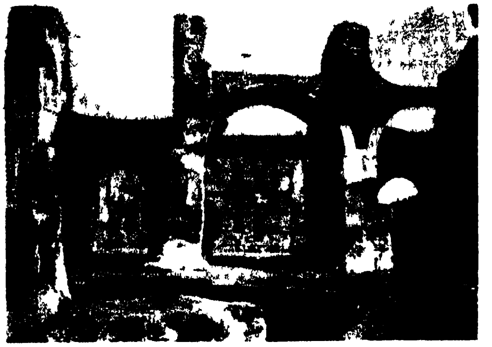
THE FORUM, LOOKING TOWARDS THE RUINS OF THE COLOSSEUM

THE SPLENDID ARCH OF CONSTANTINE STANDING BY THE COLOSSEUM

TRAJAN'S TRIUMPHAL ARCH AT BENEVENTO, ON THE APPIAN WAY

THE ARCH OF TITUS, SET UP AFTER THE CONQUEST OF JERUSALEM

A RUINED TEMPLE IN THE FORUM

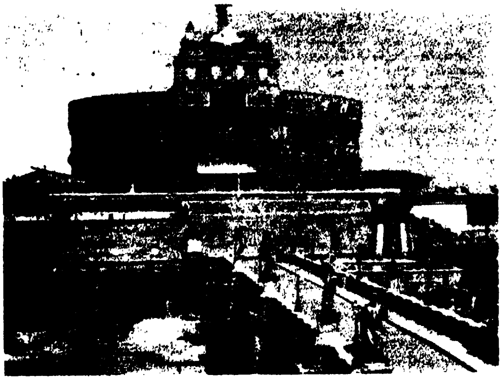


A FRAGMENT OF THE BATHS OF CARACALLA

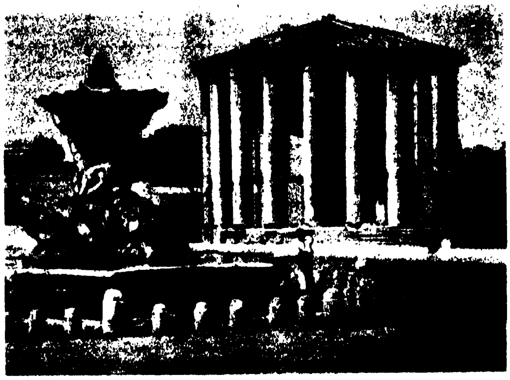
THE APPIAN WAY OVER WHICH PAUL WALKED TO ROME

THE RUINS ON THE PALATINE HILL AS SEEN FROM THE STREET

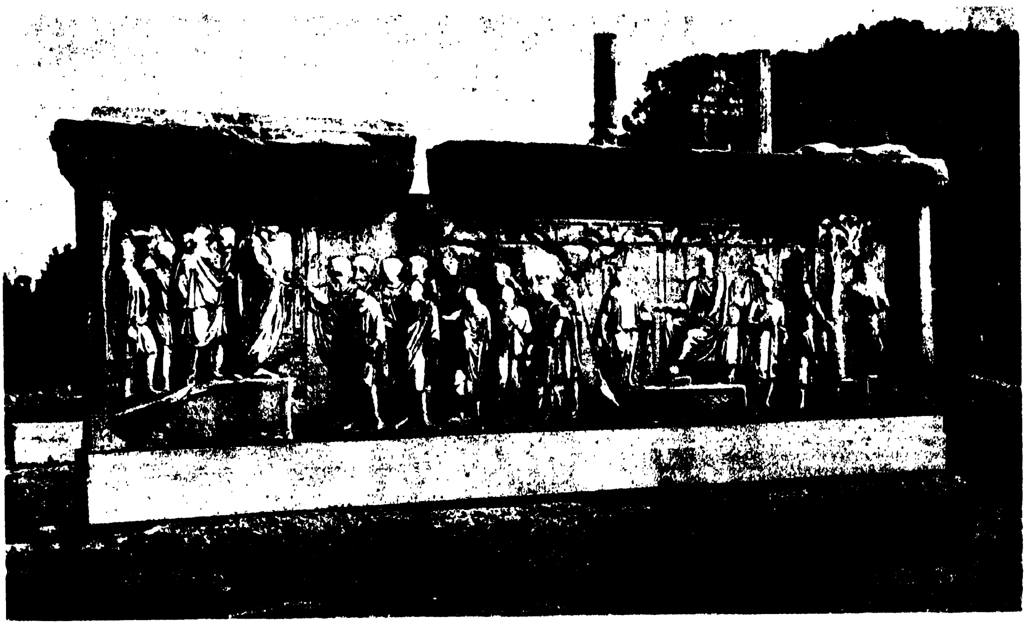
THE RUINS OF AN EARLY CHURCH OF THE TIME OF CONSTANTINE



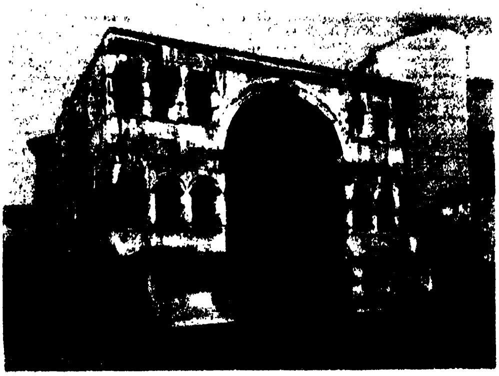
THE OLD CASTLE OF ST. ANGELO ON THE BANKS OF THE TIBER



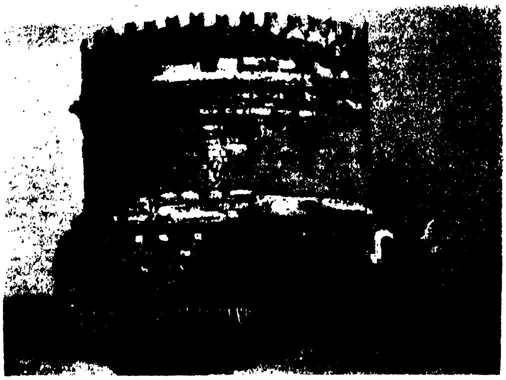
THE LOVELY CIRCULAR TEMPLE OF VESTA AS IT STANDS TODAY



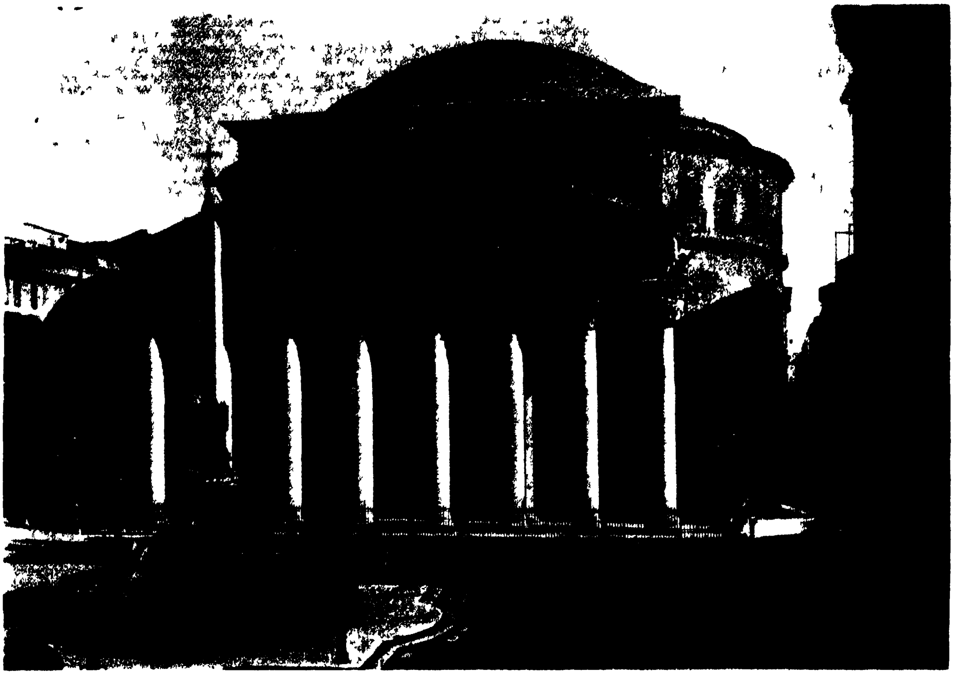
A FRAGMENT FROM A MONUMENT TO TRAJAN IN THE FORUM



THE ARCH OF JANUS, BUILT IN HONOR OF CONSTANTINE

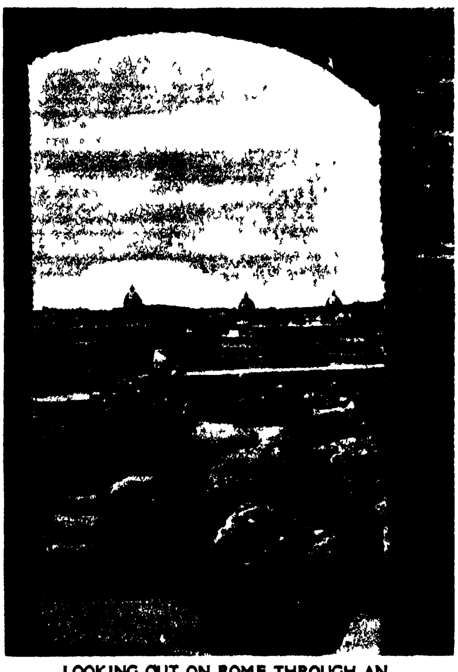


THE TOMB OF CÆCILIA METELLA ON THE APPIAN WAY



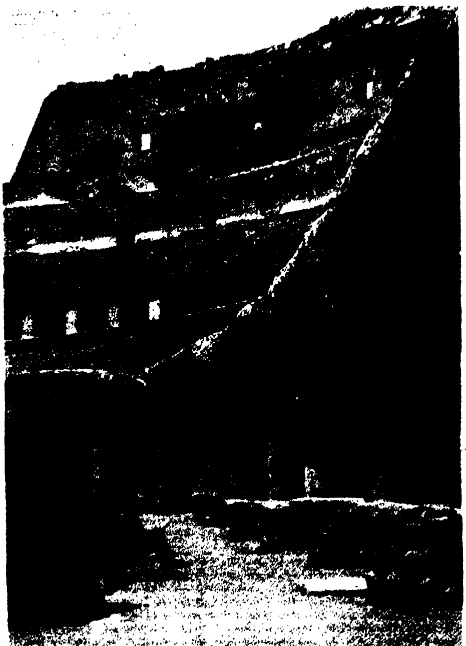
THE PANTHEON THE OLDEST COMPLETE BUILDING IN THE WORLD

TRAJAN'S COLUMN CARVED WITH TWENTY-FIVE HUNDRED FIGURES

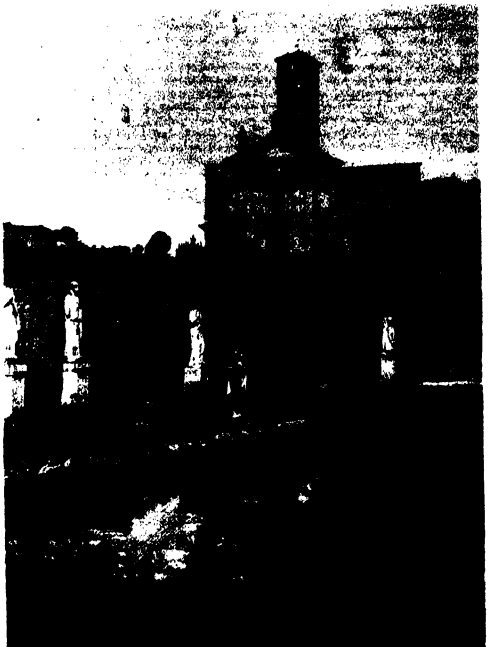


LOOKING OUT ON ROME THROUGH AN ARCH OF CÆSAR'S PALACE

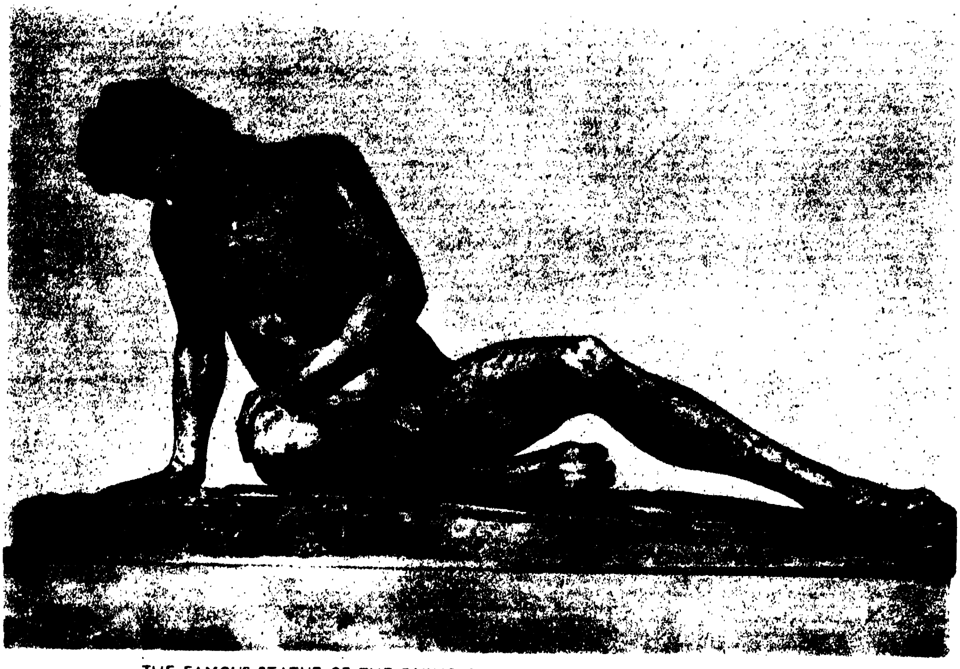
THE MOST SPECTACULAR RUIN IN ROME—THE COLOSSEUM



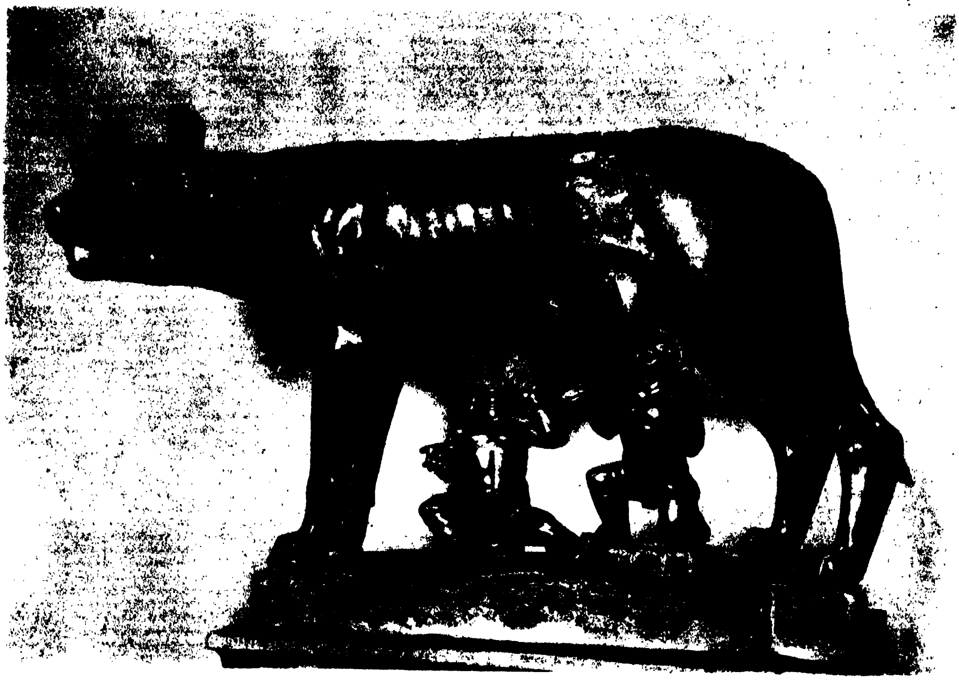
THE MASSIVE ARCHES OF THE RUINED COLOSSEUM



ALL THAT IS LEFT TODAY OF THE TEMPLE OF THE VESTAL VIRGINS



THE FAMOUS STATUE OF THE DYING GAUL, IN THE MUSEUM ON THE CAPITOL



THE STATUE OF THE WOLF WITH ROMULUS AND REMUS, IN THE MUSEUM ON THE CAPITOL

The photographs in these pages are by Messrs. Alinari, Anderson, Brogi, and McLeish.

THE HEART AND THE CIRCULATION OF THE BLOOD

ANCIENT peoples knew the great importance of the heart, although they did not understand its true importance or its true function. They thought that the heart was the seat of the feelings, or the emotions; and from that belief have come such expressions as "warmhearted," meaning friendly, or "brokenhearted," meaning crushed by sorrow. These beliefs have slowly been replaced by the modern knowledge of what the heart really does in the body.

It has been known for about 300 years that the heart actually is a very wonderful pump made of muscle. This pump keeps the blood moving about the body through a very remarkable system of tubes, or pipes, called blood vessels. The heart begins to beat some months before a baby is born and it continues to beat about 70 or 80 times each minute as long as that person lives. If the heart should stop for as long as a single minute during all that time, the person probably could not live, and he would certainly lose consciousness. This shows the very great need for keeping the blood moving all the time, which is the special job of the heart.

This picture shows us the position of the heart in the body. The heart lies within the chest cavity; its base is tilted toward the left side.

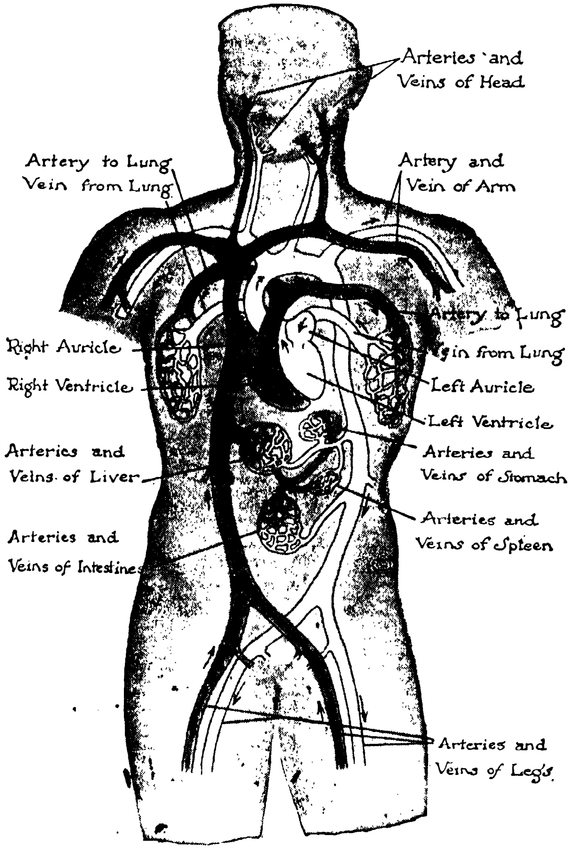
The heart lies in the upper half of the body within the portion called the chest. The chest is a box-like portion of the body, made firm and rigid by the ribs. Within are the heart in the center, with the two lungs wrapped around it. The lungs lie very close to the heart and to the large blood vessels which enter and leave it. Most people believe that the heart is on the left side of the chest, but this is not entirely true.

The heart is made up of muscle, and like all the muscles of the body it is able to contract, or tighten up. While it is relaxed, it fills with blood; and then, when it has filled with blood, it contracts, squeezing the blood out into large vessels called arteries. This movement is what you feel as the beat of your heart. It can be felt best about two or three inches toward the left side of the chest. The part which makes this movement of the chest is called the left ventricle, a very strong and powerful part of the heart, while the remainder of the heart (the part we can not feel) lies very close to the middle of the body.

If you put the fingers of one hand on the inside of your other wrist below the base of the thumb, you will feel a beat there, too. This is called the pulse and the beating of the heart makes the pulse. With every beat the heart sends a wave of blood through the arteries, the blood vessels which carry blood away from the heart. And the fingers at your wrist are over an artery. The pulse at the wrist is usually called *the* pulse; but every time the heart beats it sends a wave of blood through all the arteries. There are several other places where you can feel it. Perhaps you have noticed it at the temples on either side of the forehead or at either side of the base of the neck. This same pulsation is going on all over the body in all the arteries.

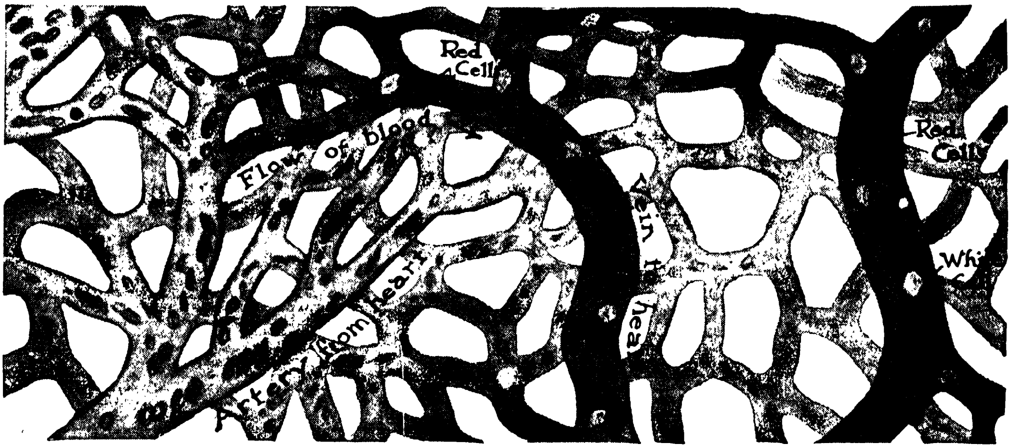
We have said that the heart always pumps the blood out into arteries. The reason is that there are valves in certain spots in the heart which allow the blood to go forward into the arteries, but never backward into the veins. Without these valves the heart would not be a reliable pump at all, because it could not push the blood in the same direction all the time. In certain heart diseases some of these valves may become scarred or damaged so that they allow some of the blood to leak backward and the heart does not pump blood well. If this condition becomes very bad, the person is said to have a failing heart or heart failure. You can hear how these valves sound when they are working properly by putting your ear very close to another person's chest at the place where you felt the heart beat. You will hear the regular lubb-dup, lubb-dup of the heart which is really the closing of the valves.

After the blood leaves the heart it moves away through the thick-walled arteries. They have walls of muscle and, like the heart, are able to contract and thus push the blood on. Their only function is to carry the blood out to the distant portions of the body. There very interesting changes occur. At their ends the arteries divide into small branches, and these in turn divide into a network of tiny tubes called capillaries. The capillaries have thin walls consisting of a single layer of very thin cells. Though small, they are very numerous and are spread through every part of the body. Through their thin walls, as through very fine cloth, food materials, oxygen and other substances pass from the blood to the tissues, in one direction, and carbon dioxide and waste products pass from the tissues into the stream of blood, in the other direction. Most of the blood itself stays in the capillaries but some of the liquid part of the blood actually seeps out into the tissues and in that way carries the food and oxygen to the tissue cells. This liquid part of the blood is called lymph and it is later gathered up out of the tissues and poured back into the blood through a vessel known as the lymphatic duct.



How the blood circulates. With the exception of the veins and arteries of the lungs, all the arteries are indicated in light color, and all the veins in dark color. The arteries lead away from the heart; the veins lead to the heart.

The greater portion of the blood which remains in the capillaries passes on into other blood vessels called the veins which are the channels leading back to the heart. Veins are branched at their ends and are connected with the capillaries, as the arteries are. There is no pulsation in the veins, and the blood flows back evenly. The flow back is aided by valves in the veins, much like those in the heart, which allow the blood to flow only toward the heart. Veins are often larger than arteries but their walls are much thinner and have very little muscle tissue in them. Many veins lie on the surface of the body just under the skin and can, therefore, be seen. You will notice them as blue streaks, or lines, on the arms and legs; and even though they contain blood, they are



Here we see a network of blood vessels. The arteries branch off into arterioles (little arteries), and these end in capillaries, distributed throughout the tissues. Some of the blood stays in the capillaries; some of it seeps out into the tissues. An exchange takes place. The blood gives up its oxygen and nourishing elements and receives the body's waste matter. It then enters the venules (little veins), which lead to the veins.

quite blue. If the veins appear to be blue, it is because the dark blood they contain has very little oxygen indeed. Therefore it does not have the bright red color that oxygen gives to blood—as in the case of the blood in the arteries.

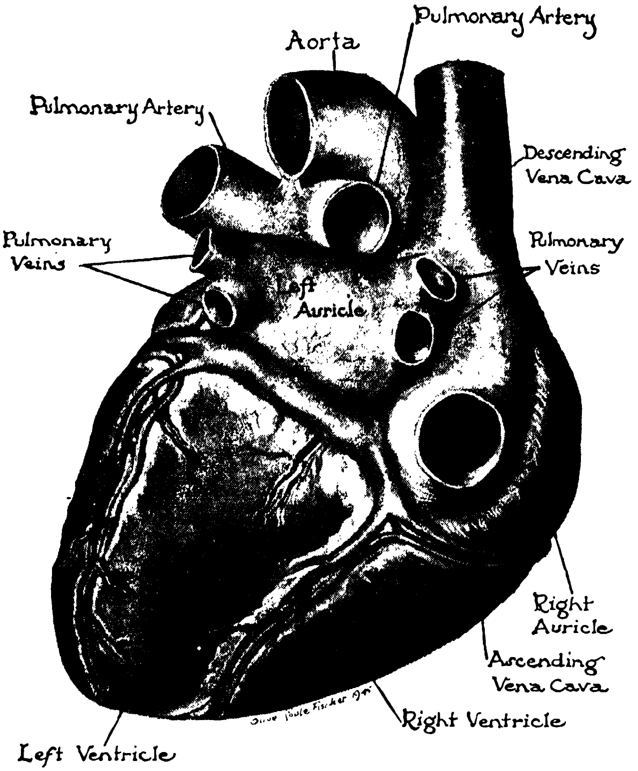
We have now seen that the blood goes in a continuous stream through the heart, arteries, capillaries and veins and thence back to the heart. In a fully grown person, there is about five to seven quarts of blood which is being continuously pumped around this circuit fast enough so that it may go around twice every minute. Some of the blood will go around very fast because it goes only to the lungs and right back to the heart, whereas another drop of blood may have to go to a foot and back. During exercise, the heart speeds up its action and pumps more blood at a faster rate than it does at rest. A complete circulation of the blood is quicker in small animals than in large ones and it may be quicker in a small boy than in a large man. Generally, the heart in a grown man who is lying quietly in bed will pump out about four to six quarts of blood each minute with, of course, the same amount of blood returning to it each minute through the veins.

Now, while the blood circulates in a continuous stream, it is necessary to explain that it really circulates in many circles. Some of these circles are very important in maintaining proper function of the body and one of them in particular is of great significance. It is the circulation through the lung. The circle through the lung is small and meets the great circle through the body in the heart.

The heart, then, is really two pumps. It has a right side and a left; the right side receives the impure blood from the body and sends it to the lungs; the left side gets the pure blood from the lungs and sends it to the body.

The two sides of the heart are made on the same principle, and each consists of two chambers. The upper one, which is the smaller, is called an auricle. It receives the blood and drives it into the lower chamber, called a ventricle, which is much larger and is stronger because of a thicker muscle wall. The right ventricle drives the blood only a short distance through the lungs, and therefore requires a moderately thick muscle wall. But the left ventricle must pump the pure blood to distant parts of the body at a higher blood pressure and so its muscle wall is very thick and powerful. It is the tip of the left ventricle which you feel when you put your fingers on the left side of your chest.

Several other circles of the blood circulation are of interest to us at this time. One of these is through the intestine where the arteries break up into a capillary bed which surrounds all the loops of the small intestine and other portions of the digestive tract. Thus, after the food has been digested, it passes through the walls of the digestive tube and is picked up by the blood flowing through the capillaries in the area. Blood seen coming away from capillary beds around the intestine is often milky or creamy in appear-



The heart (back view). Entering the heart through the vena cava, the blood goes to the right auricle, then to the right ventricle, to the pulmonary arteries, to the lungs, to the pulmonary veins, to the left auricle, to the left ventricle and to the aorta.

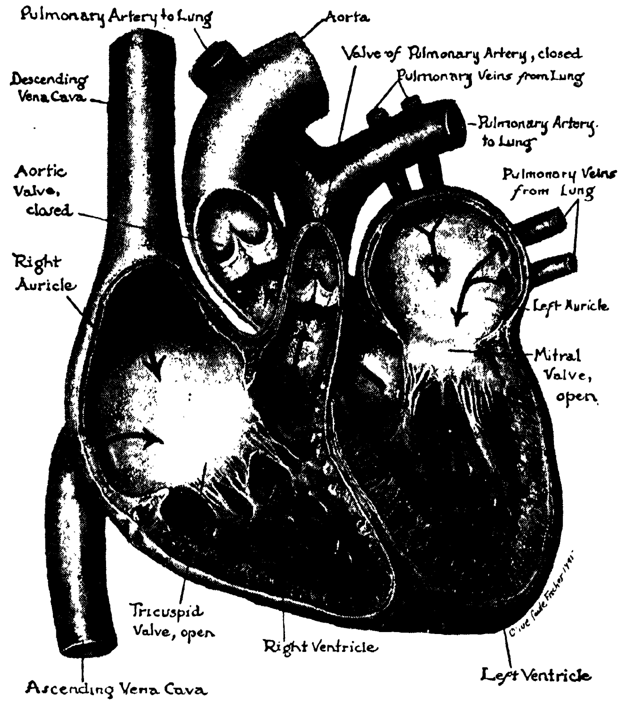
ance due to the load of digested food it carries.

Still another circle is that through the kidneys. In this case, arteries again divide into small capillaries in the kidneys and pour out a great variety of poisonous and waste products which have been carried out of tissues elsewhere in the body. These waste materials come from the breaking down, or wearing out, of tissue cells and from the parts of food which we can not use. If they were to remain in the body for a long time we would be made sick by them. Sometimes hardening of the arteries occurs, which means that there has been a degeneration, or wearing out, of the arteries. This may be related to changes in the kidney arteries so that the waste poisons accumulate until a dangerous condition, known as uremia, has been produced.

In asking ourselves how and why the heart is made to beat, we must think of it as a great muscle, somewhat different from other muscles in the body, but still a muscle. Now muscles never contract without being told to contract by the nerves. So we find that two sets of nerves run from the brain to the heart and through these nerves the brain is able to control much of the activity of the heart. Thus, when we are frightened by the sight of some strange object, the heart may beat very fast for a few minutes.

In a similar manner, the brain and nerves may control the blood circulation in any part of the body by acting on the muscle cells in the walls of the arteries. The muscle cells in the arteries are arranged in a circular fashion around the vessel so that when they contract they squeeze the artery and make it smaller; the result is that less blood can get through it. Thus the nerves, by telling the muscle cells to contract, can shut off part and sometimes nearly all of the blood supply to any one part of the body. This is often done in regulating the blood circulation. Therefore, on a hot day, much of the blood will be allowed to circulate in the skin so as to cool the blood. After a large meal we may often become sleepy because most of the blood is down in the region of the intestine where digestion is going on and very little is left in the brain. Many other strange occurrences may be explained in this way. After embarrassment some of us may blush and have the face turn red due to the rush of blood into the face; or on a very cold day the hands may become very pale because not enough blood is going to them.

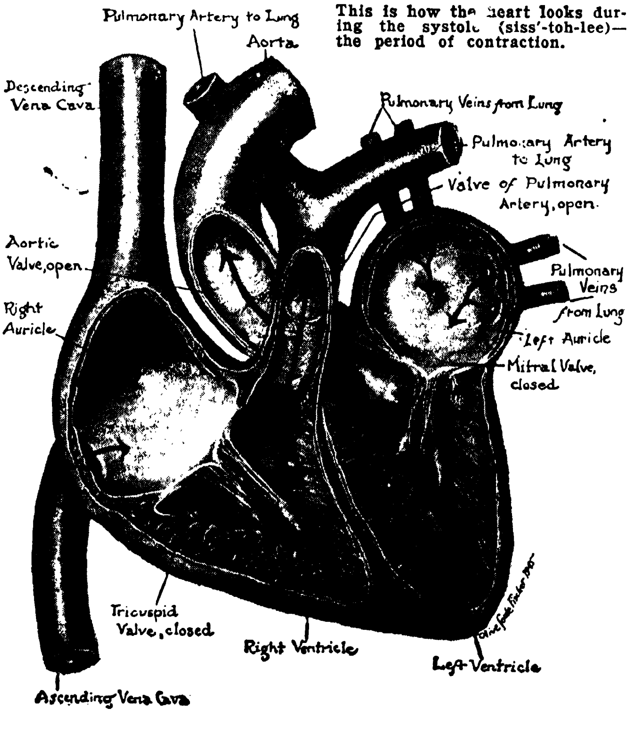
Other factors, in addition to the nerves from the brain, have something to do with the control of circulation. For instance, the heart is able to beat automatically and without any nerve messages from the brain because of internal stimulations which come from a special little nerve bundle located in the muscle of the heart itself. However, the brain can still make it beat faster or slower. Many of the glands in the body produce chemical substances which, when poured into the blood stream, will change the blood cir-



Here we see the heart during the period of relaxation. This period is called the diastole (dy-ass'-toh-lee).

culation in one way or another. The adrenal glands, located just above the kidneys, produce adrenalin, or epinephrin, a chemical substance which speeds up the heart and constricts the arteries. Numerous drugs, when injected into the body with a needle or taken by mouth, will bring about changes in the blood circulation. Some of these drugs, such as digitalis, have a beneficial effect when given to people with diseases of the heart.

We now see that the blood is a fluid which carries oxygen and digested food to the tissues; it carries waste products and carbon dioxide from the tissues to be expelled through the kidneys or lungs; it transports numerous internal chemicals from the glands of internal secretion and it helps to keep the temperature even

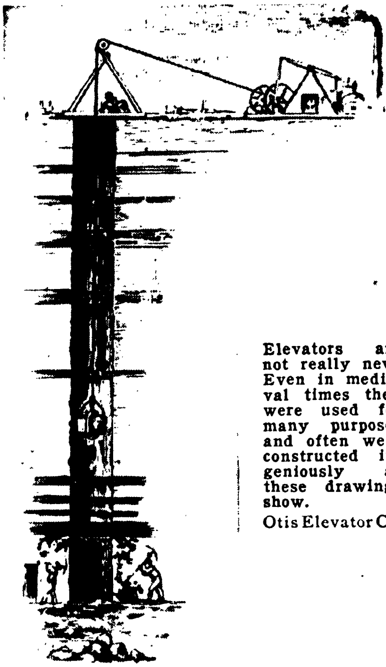


This is how the heart looks during the systole (siss'-toh-lee)—the period of contraction.

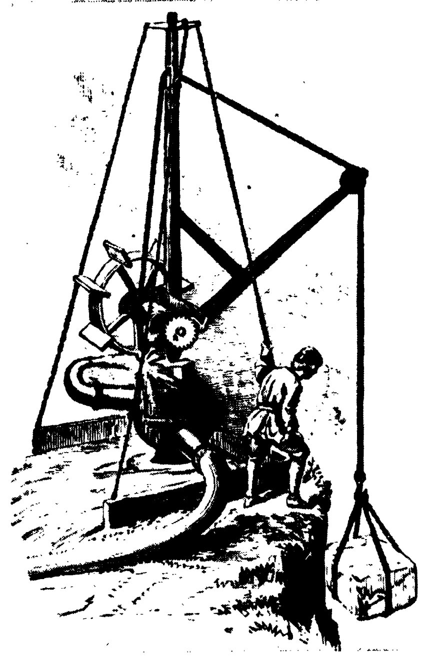
and the water distributed over the body. The blood vessels are the channels through which the blood moves to all areas of the body, even to the most distant cell. The vessels that carry the blood from the heart are called arteries; the vessels that carry the blood to the heart are called veins. The tiny hair-like vessels that are bridges between arteries and veins are called capillaries. The heart is the muscle which keeps the blood always moving through the tube-like blood vessels. If the nerves are like the telephone and telegraph lines reaching throughout the nation, the blood and blood vessels are like the trains and the trucks on the railroads and highways of the country, carrying materials to and from all parts. The heart is the great central station.

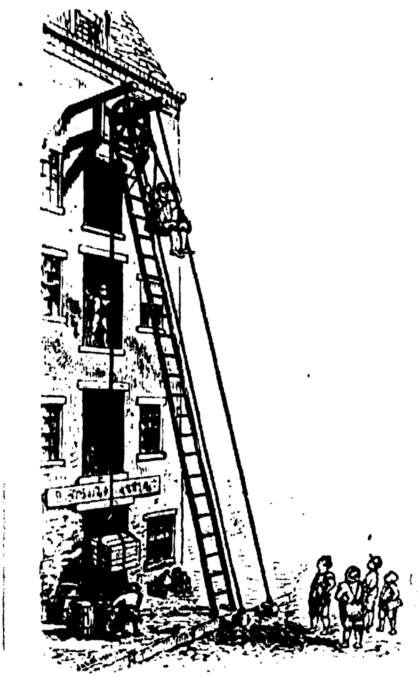
By ARTELL E. JOHNSON, M.D.

THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 1325.



Elevators are not really new. Even in medieval times they were used for many purposes and often were constructed ingeniously as these drawings show.
Otis Elevator Co.

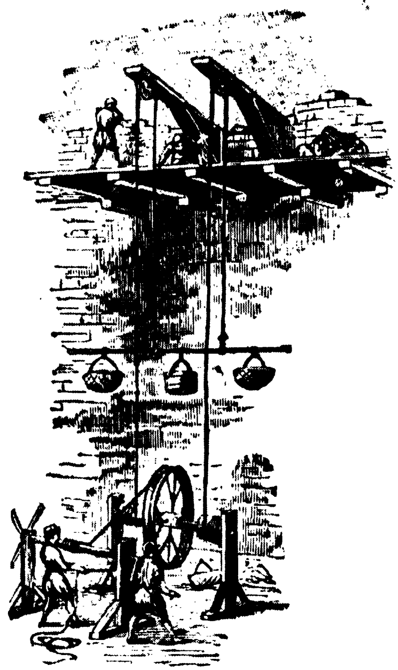




HOW ELEVATORS

FEW inventions of modern times mean more to people who live in cities than the high-speed elevator. Without it, our large cities would not be possible. If all the people who now live and work were forced to occupy buildings so low that the stairs could be climbed easily, the cities would necessarily be spread out over enormous distances. If men insisted on erecting high buildings, they could not be used if there were no elevators. Climbing up stairs uses up a great deal more energy than walking on the level. Even strong and active people would shrink from climbing thirty or forty flights of stairs several times a day.

If you go into a modern office building, you will see one, two, a dozen or even more elevators, depending upon the size and height of the building. The Empire State Building, in New York, the tallest building in the world, has fifty-eight main passenger elevators, but of course this is exceptional. Where there are a number of elevators, some stop at any floor to take passengers on or let them off; there are called local elevators.

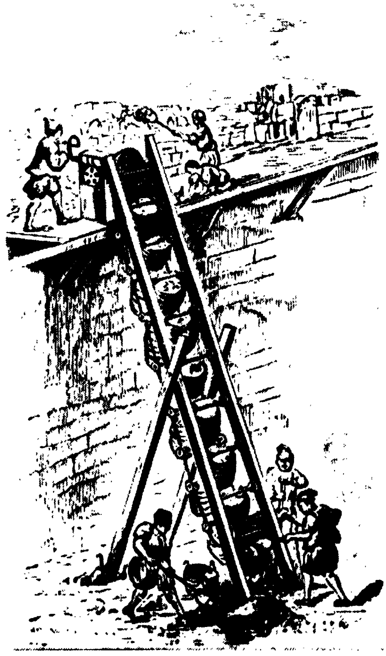


GO UP AND DOWN

Others shoot up ten or twenty or more stories before they stop; they are known as express elevators. People who go to the upper floors use expresses in order to save the time that would otherwise be taken up with in-between stops.

As each passenger enters the elevator car, he tells the elevator man what floor he wants. The elevator man presses a button for each floor at which the car is to stop. Then he pulls a small lever; the doors close automatically and the car speeds silently upward. It stops automatically at the exact level of the various floors, so that there is no danger of anyone tripping or stumbling at the landing. If you are on one of the upper floors and want to go down, you press a button beside the row of elevator doors. A light goes on above the door when a car is going to stop. If a green light shows, you know that the car is going up; if the light is red, you know that the car is going down.

Such is the modern high-speed elevator. It is the result of many years of experiment and progress. From early times men have felt



A SMALL PASSENGER WITH A BIG REACH

Westinghouse Electric Corp.

Working an automatic elevator (without an operator) is so simple, this little girl can do it herself.

the need of some sort of machinery to lift themselves or their possessions. In medieval times certain monasteries had no entrance on the level of the ground. Provisions and visitors were hoisted upward in a big basket. A rope attached to the basket passed over a pulley and was wound around a cylinder in the inside of the monastery. The monks made the cylinder turn by means of a hand-operated device. Elevators of this kind are still in use, though not to raise passengers. The bucket and windlass of a well really make up a sort of elevator, though we do not think of them as such.

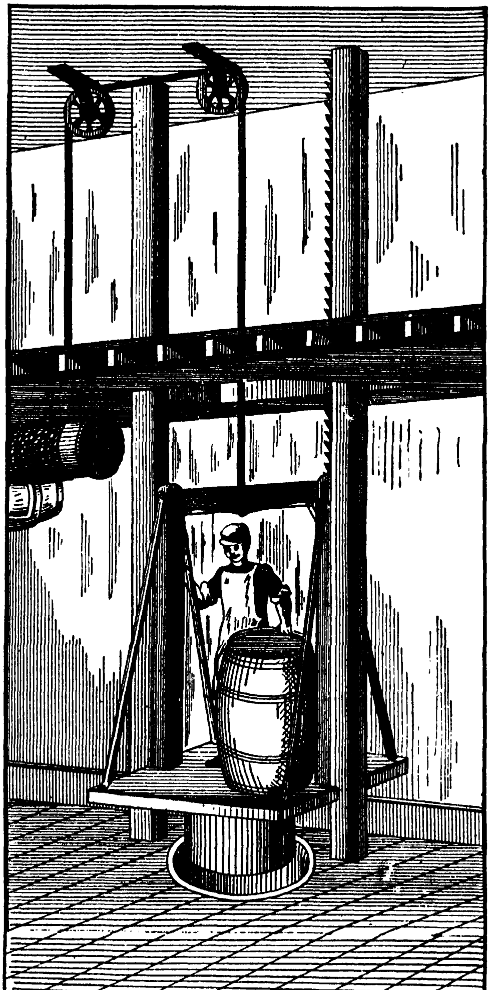
Elevators based on the same principle were run by steam power after the steam engine was invented. When the elevator was to be raised or lowered, the steam engine was started and it caused a large cylinder to turn in one direction or the other. A rope attached to the elevator car was wrapped around this cylinder. Of course, when the rope was being wound up around the cylinder, the car was raised; when the rope was being unwound, the car was lowered. Elevators operated in this way were not very satisfactory. They required two operators; one man had to run the engine and the other had to look after the car.

THE PLUNGER ELEVATOR—DRIVEN BY WATER POWER

In time these steam elevators were replaced by hydraulic (water-power) elevators. A popular form was the plunger elevator, which worked in this way: A strong pipe was sunk into the ground as deep as the building was high. A strong cylinder, which fitted tightly but smoothly, was placed in the large pipe, and the car was fastened on top of it. In the pipe were two openings, one to let water in, the other to let it out. If water was let into the pipe, it would force up cylinder, car and passengers. When the car had gone as far as desired, the water was cut off and the car came to a stop. When the operator wished to descend, he opened the outlet pipe and, as the water escaped, the car sank. All this was done from the car itself.

A few hydraulic passenger elevators of this type are in operation at the present time. A great many machines based on the same principle serve other purposes. Among them is the lift used in automobile service stations to raise a car so that an attendant may grease it.

Just as hydraulic elevators replaced steam-operated elevators, so they in their turn have been largely replaced by elevators run by electricity. The type used most widely at first had a cylinder, known as a drum, which was turned by an electric motor; the car was attached to the drum by a cable. As in earlier types of elevators, the cable was wound around the drum to raise the car, and unwound in order to lower it. A good many of these drum elevators are still in operation, but few are manufactured at the present time. Among other disadvantages, they can not be used in very high buildings, because only a limited amount of rope can be wound



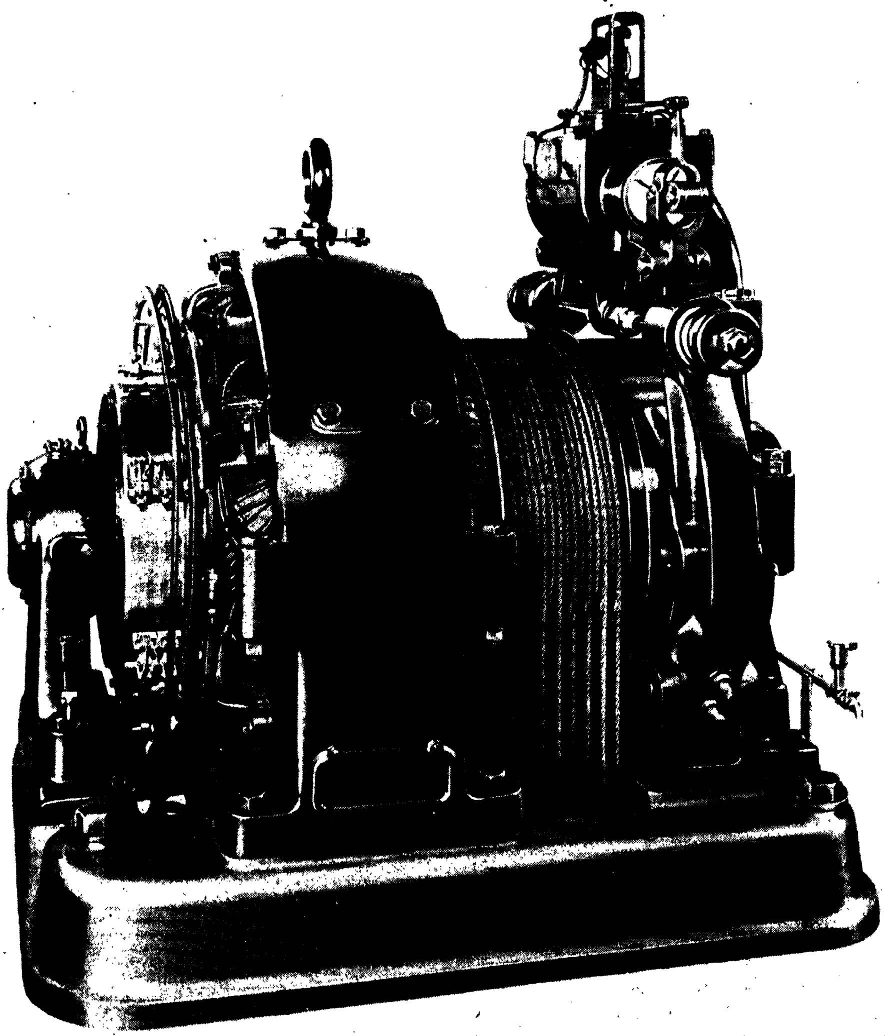
Culver Service

An old-fashioned hydraulic (water-power) elevator, which worked with a plunger device in a cylinder.

around the drum to form a single layer. In most towns, building regulations forbid winding more than a single layer of rope around the drum.

Drum elevators have been giving way to traction elevators, which work on a different principle. A motor is set at the top of the elevator shaft. On this motor there is a large wheel or pulley, called a sheave. Cables from the top of the car run over the sheave and down to a counterweight on the other side. As a result, the electric motor does not have to lift the whole weight of the car. In tall buildings cables also extend downward from the bottom of the car, pass around a pulley near the bottom of the shaft and are attached to the bottom of the counterweight. (See the picture on page 1219.) This helps to keep the weight of the car and the counterweight balanced, regardless of whether the car is at the top or the bottom of the elevator shaft.

What if one of these cars should fall? This happens very rarely indeed. In the first



Otis Elevator Co.

A motor for traction elevators. On the right you can see the sheave, with the cables running over it.

place, although one cable would be enough to hold the car, very often as many as eight are used. It would be almost impossible for all eight to break at the same time.

Suppose, however, something went wrong and the car began to descend at a dangerous rate of speed. In that case the overspeeding car would be stopped by an ingenious arrangement. A device called a governor is set at the top of the elevator shaft. If the elevator begins to travel down the shaft faster than its normal rate of speed, the governor opens a safety switch and cuts off the power. This causes a "service" brake to be applied automatically and it usually stops the car.

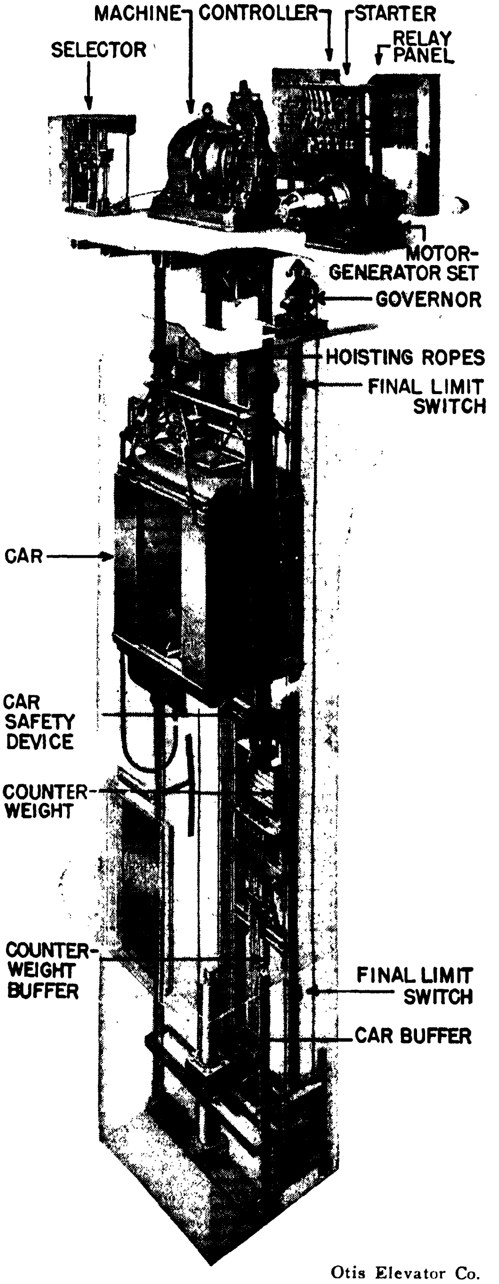
Suppose, however, the car continues to speed downward. In that case the governor automatically brings two safety clamps into operation. These are located one on either side of the bottom of the car frame. Each clamp has two steel jaws that just fit on the the guide rails along which the elevator runs. When the governor brings the clamps into play, the steel jaws grab the rails and the car is brought to a smooth, sliding stop.

If the car continued to descend at a normal rate of speed after passing the last landing, the governor would not operate. In that case, the force of the fall would be broken by an oil buffer set at the bottom of the shaft. (See the illustration on this page.) The descending car would strike a rubber contact block on top of a steel plunger, set in the buffer. The plunger would be driven into the oil-filled inner cylinder of the buffer. Some of the oil would be forced through holes in the cylinder as the plunger came down; the rest would slow up the car and finally bring it to a stop.

PRESS A BUTTON—AND THE SELF-SERVICE ELEVATOR STOPS AT YOUR FLOOR

In some buildings—especially apartment houses—there are electric self-service elevators. These work with no elevator attendant and with only the slightest effort on the part of the passenger. If the car is not at your floor, you press a button and the car comes up or down as the case may be. When it is exactly level with your floor, it stops; its doors slide back and permit you to walk in. You enter and press the numbered button for your floor. The doors close, the car starts by itself and you do nothing more until the car stops where you want it to, and the doors slide open again. After you leave the car, it answers other calls.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 1305.



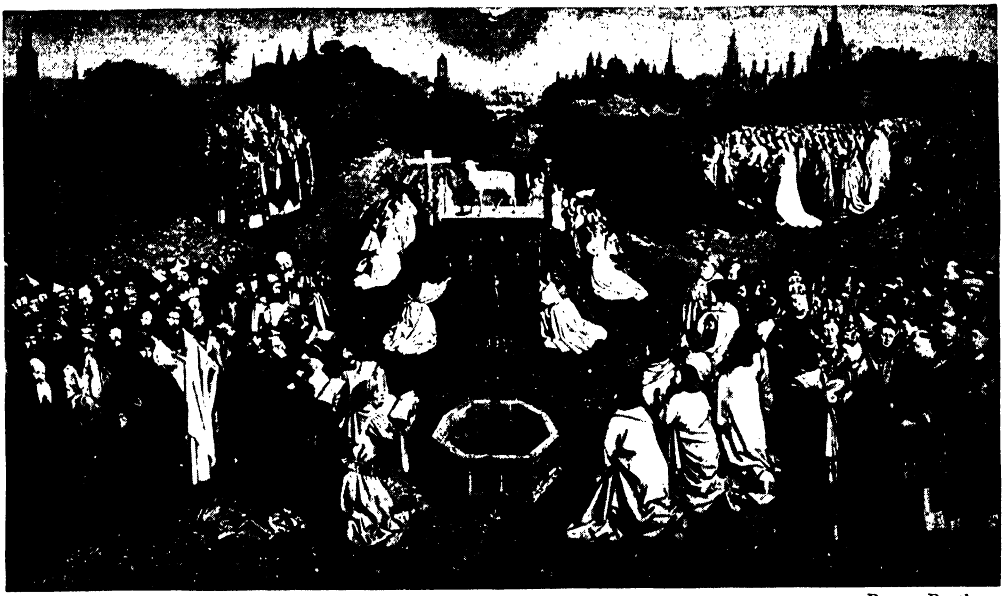
Otis Elevator Co.

A traction elevator, which takes advantage of friction. The motor, or machine, is set at the top; and the cables run over the sheave at the side in such a way that they can not easily slip. Such elevators are equipped with a number of safety devices: the governor, safety clamps on the car frame, and the buffers at the bottom of the shaft. In any position, the weight of the car and the counter-weight are balanced.

A VISION PAINTED IN FLANDERS

Courtesy, Metropolitan Museum of Art

The Annunciation, by Roger van der Weyden, is painted in glorious colors and with tender feeling.



Brown Brothers

The Adoration of the Lamb, painted by Hubert van Eyck as an altar-piece for a church in Ghent, Flanders.

THE ARTISTS *of* FLANDERS

ONE of the most delightful chapters in the history of medieval Europe is that telling of the interest taken by royal and other rich people in architecture, sculpture and painting. Thus art developed under patrons.

There are in the museums of Europe and America, as well as in many private collections, treasures of these early days in the form of illuminated missals, Bibles, books of the Psalms and other devotional volumes done by artists at the order of men who could afford to pay them for their labors. The English, Irish, Flemish and French manuscripts are foremost in artistic merit. Some good examples in color are on pages 477 to 480.

France was particularly fortunate in her rulers in the fourteenth century. Charles V and his son, the Duc du Berry, showed an intense enthusiasm for art and scholarship; and to work for them Flemish artists came to Paris and established, with the French painters, a kind of school there.

To this period belongs a charming array of illuminated manuscripts containing miniatures, initials and border designs which to this day keep their wonderful quality. Outstanding among these is the rich and exquisite Book of Hours of the Duc du Berry, illuminated by Pol de Limbourg and his brothers. A few years later a French artist, the famous Fouquet, painted about forty miniatures for a Book of Hours for Etienne Chevalier.

Beautiful work was being done in the meantime by the English illuminators, the best belonging to an earlier period than that of the Hours of the Duc du Berry. Generally speaking, the fourteenth and early fifteenth centuries saw the end of the finest of the illuminators in both England and France. The invention of the printing-press naturally brought this fascinating branch of the arts to an end.

The decoration of such rare volumes was one form of Flemish art expression. And Flemish art grew out of that same Gothic movement which had stirred the Sienese to paint their mystical saints and Madonnas.

Although we have been accustomed to think of Italy as the first home of men of genius in painting, we must not forget that during the same period the Low Countries were producing artists who were their rivals. There are certain critics who place the early Flemish before the Italians, others who give a different judgment. For ourselves, we have learned the story of Italian painting, and that is a great help in giving us a standard to work by. Then we must remember that artists were a traveling community. Many of the Florentines and Venetians had seen the Flemish at work and had been influenced by them, just as the Low Countries had been moved by the art of Italy. Thus the two great schools of Renaissance art were in practice really somewhat alike.

Yet there were very definite contrasts. First, there were differences of temperament. The Flemish, fixed firmly in their domain of strength and everyday facts, never had the soaring imagination of the Italians. In the art of the southern country there is always a note of the ideal; you never know when genius is going to take wing and fly above your head. In the Flemish, uninteresting everyday events and persons are made superbly great; genius sits firmly on a bench by the wall and is very content with things as they are.

Courtesy, Metropolitan Museum of Art

The portrait of Thomas Portinari, by Hans Memling, is an appealing example of this artist's work. It has simplicity of style and gentleness of feeling.

Then, too, there were the differences caused by climate and life in different towns. Venetian painters lived in what was then the crossroads of the world, in a city that was caught in a silver mesh between a radiant sky and a radiant sea. The climate was mild. Life, for those days, was easy-going. The Flemish, breathing their colder air, were more settled in fixed thoughts, and had a more frugal and commercial habit of life. They were a race of weavers, with a passionate love for the textures of silk and cloth.

When we think of their greatest expressions of art, we think of men and women heavily clothed, generally in dark material, from whose rich gloom a face and hands emerge. There is no need for laborious composition. The person is the picture, and the picture contains something immeasurably great because it holds the essence of humanity, the humanity that labors and contrives and is fixed to the earth.

The picture may be merely a man—a merchant—and a woman, his wife; but they are still and timeless and eternal. They are not just a particular man and a particular woman, who once lived, long years ago. They are types of manliness and womanliness that you see on the street today.

The first men who stamped the school of Flanders with this peculiar quality were the Van Eycks, two brothers, painters in Bruges. To Hubert the elder, who lived from 1366 to 1426, belongs the greater share of a piece of work which had a tremendous effect on the artists of the day. This was an altarpiece called The Adoration of the Lamb, painted for a church in Ghent. By studying the various panels, probably planned and perhaps painted by Hubert, we find in them the whole difference between the religious paintings of Flanders and those of Italy. The composition may not be so triumphant as much of that marking the southern schools, but we can see from the technique and character of the work that the brother-artists had no equals in that realm of painting.

Tradition says that painting in oils was invented by the Van Eycks. This medium was probably discovered before their day, but they perfected its use and learned many secrets of treatment and clear color which artists for hundreds of years have envied.

There is something statuesque and superb in Hubert van Eyck's angels and saints; they are reposeful, quiet people, the women grave and sweet, the draperies painted in the ringing tones that mark the Flemish school. The share of Jan van Eyck (1387-1440) in this work is uncertain, but as he was above all a portrait painter, it is probable that the pictures of the donors, in this splendid altarpiece, are his.

Jan van Eyck, indeed, stands out as the greatest portrait painter of Europe and the chief glory of the Flemish school. When he made portraits of ordinary men and women his powerful art rose to a superb height.

He was a portrait painter first of all. He was not concerned with idealism or philosophy. He did not show in a person's face the inner meaning of the character, as Leonardo da Vinci did; he was content with the face as it was, mirroring the thoughts and impulses which had stamped it. To this genius of faithful portrayal he added genius of technique, and the result is a series of portraits which even now, six hundred years later, hold us enthralled.

Of the many remarkable pictures painted by Jan van Eyck three portrait groups stand out: The merchant and his wife, in the National Gallery, London—one of the chief glories of that collection; the picture of Canon van de Paelen, and the portrait of the artist's wife, both at Bruges. New York and Philadelphia possess notable examples of this old master's painting.

Roger van der Weyden, who was born in 1400, was also an artist of Bruges; and though he shared their skill in technique, he was of a different cast from the Van Eycks. He was filled with visionary and mystic thoughts, and had a love for sad subjects and tragic places. The Descent from the Cross, in the Escurial in Spain, is a picture of beautiful sorrow. Philip le Bon, of the house of Valois, whom he painted, may have had some very happy hours, but Van der Weyden drew the prince with a face of pathetic endurance—as of a man with an anxious mind, who had to work very hard. In the Metropolitan Museum in New York there are several interesting paintings by Van der Weyden.

Thierry, or Dierick, Bouts (1410-75), a man of Haarlem who followed the Van Eycks and later worked under Van der Weyden, was another artist who had a leaning toward painting tragic-looking people. But there is a difference. Van der Weyden saw a mystic, dreamy beauty in suffering. Bouts was what we call a realist. He had a passion for drawing the harder side of life. He could not bear to gloss over or idealize any subject; and his treatment of color matched his crude but vigorous drawing.

Courtesy, Metropolitan Museum of Art

Marie, the wife of Thomas Portinari, painted by Memling. Notice the exquisite detail in the painting of the jewels and of the clasped hands.

A little graciousness and gentleness and a sense of beauty in composition might have made of Bouts a great artist. As it is, he falls short of greatness. His best pictures among those in existence are The Meeting of Abraham and Melchisedec, in Munich, and The Judgment of the Emperor Otto, in Brussels.

The Flemish school rose to great heights in the latter half of the fifteenth century. Among the number of less important names three or four stand out—Memling, Van der Goes, Gerard David, Quentin Massys and their followers.

Memling, who lived from about 1430 to 1494, sometimes called the Raphael of Flemish art, is one of the most famous names in the early history of the Low Countries. He was a portrait painter second only to Jan van Eyck. Although he was not quite so great a master in delineating features as was Van Eyck, he had a touch of imagination and romance that the other lacked.

Memling painted a number of beautiful religious pictures and portraits. There is all the feeling of medieval Europe in his paint-

Princess Elizabeth of Austria, by François Clouet.

Hans Memling's picture of the Virgin and Child.

The Adoration of the Child, by Gerard David.

ing The Arrival of St. Ursula at Cologne. This painting is also a piece of perfect composition. It is one of fourteen scenes giving the story of St. Ursula, painted on a shrine shaped like a Gothic chapel. Many interesting works of Memling are at Bruges. His pictures were popular, and were purchased in Italy, England, France and Spain as well as in the Low Countries.

THE RELIGIOUS SPIRIT OF VAN DER WEYDEN AND MEMLING

Only Van der Weyden, in this group of Flemish artists, was naturally a religious painter. Memling rendered sacred subjects with a kind of exquisite gentleness added to his strength of workmanship. The pictures of Christ being nailed to the Cross, and Christ being put into the tomb, are wonderful examples of his skill. To get the essence of Memling's genius we should study his portraits. Some of them are pictures to which, as to Jan van Eyck's, we return again and again, captivated by their poise, their calm and serene dignity.

We need not go to Europe to see Memling's pictures, as there are some fine portraits and religious paintings by him on our own continent, both in public museums and in private collections.

Hugo van der Goes (about 1435 to 1482) was another painter of beautiful religious subjects. In his picture of St. Magdalen and St. Margaret we have a composition in which solemn and gracious figures stand out before a background of winding roads, hills and trees. The women's faces, long and narrow, with every hair brushed back from their clear brows, have the sweet gravity which is one of the lovable qualities in Flemish portraiture of women.

Van der Goes's most famous picture is a huge Nativity, now in the Academy of Florence. In it angels and birds and beasts, and St. Joseph and the Blessed Virgin, robed in heavy Flemish material, are grouped round about the tiny Child.

THE PAINTERS WHO WERE INFLUENCED BY THE BROTHERS VAN EYCK

The influence of the Van Eycks is seen in the work of Quentin Massys (1466?-1530) and Gerard David (died 1523). It balanced the tendency to study and imitate the Italian painters which began to creep into Flemish art about this time. In the paintings of Massys the human figure holds great importance. His best known work is The Descent from the Cross, at Antwerp. In the Metropolitan Museum, New York, you may see his Adoration of the Kings.

Gerard David's most famous picture is The Virgin and Saints, in the Rouen Museum, France. A very different painting from this group of calm and worshiping women is his picture of The Prisoner and the Wicked Judge, at Bruges. Here we see a number of men surrounding a table where an unfortunate prisoner is stretched undergoing torment. Apart from the merit of the artist's work, this painting has the value of being a historical document, casting a light on the terrible state of the administration of justice in the fifteenth century. His work is particularly well represented in collections of art in the United States.

FLEMISH PAINTERS BEGAN TO IMITATE THE PAINTERS OF ITALY

With Quentin Massys and Gerard David, and perhaps Mabuse (Jan Gossaert), the early genius of the Flemish school is exhausted. Mabuse's style was very much influenced by the study of Italian painting. His picture of The Virgin and Child, in Berlin, shows the queer mixture of Italian and Flemish that he represents.

From about the beginning of the sixteenth century, art in the Netherlands went through a period of imitation and reaction and peculiarities. Among the second-rate painters of the period one or two masters stand out—like Hieronymus (Jerome) Bosch, who painted rather amusing groups; and Pieter Brueghel, the Elder (1520?-1569), whose claim to renown is much greater.

PIETER BREUGHEL PAINTED THE HUMBLE LIFE OF THE PEOPLE

Indeed there was a family of four Brueghels—two Pieters and two Jans—who were painters. Of them all, Pieter the Elder is the most individual and important. He is known as "Peasant Brueghel," and is called the father of peasant painting, or genre painting, as it is usually called. All famous artists of genre pictures look back to him as their forerunner. He painted some quaint, attractive pictures. The Children at Play tells us much about the life and amusements of little ones in the sixteenth-century Netherlands.

His pictures, humorous and sometimes coarse, show small figures set in landscape backgrounds. Pieter Brueghel loved the beauty of the Flemish landscape. In his Autumn, and in Winter, the dignity of nature takes the place of the dignity of the human form. In this branch of painting his son Jan (the Elder) followed him, becoming

The Blessed Virgin and Child, painted by Roger van der Weyden.

The Adoration of the Shepherds, by Hugo van der Goes, shows angels, birds, animals and shepherds all gathered reverently around the Holy Family.

The Blessed Virgin and Child, as painted by Quentin Massys.

noted for his landscapes, which hold an important place in the development of the art. His smooth technique won him the name of "Velvet Brueghel." He was an intimate friend of Rubens, and used to paint the landscapes in figure pictures for Rubens and other artists, while they in turn painted little figures in his landscapes. Pieter and Jan each had a son of his own name, well known as a painter, though neither of these sons was the equal of his more justly famous father.

Early French art, which was very closely allied to the art of Flanders, centered first in Paris, in the Franco-Flemish school. When civil war in 1410, followed by other national disturbances, broke up the peace of Paris, the young art made its home in Touraine, Burgundy and Provence. A hundred years before this time the court of the pope had been moved to Avignon, and that beautiful town on the Rhone River had gathered to itself a small company of artists. Several pictures of this Avignon school remain, such as La Vie de Saint Mitre. The masterpiece of the school is in the Louvre—a huge religious composition of the type called a Piéta, where the dead Christ rests on his sorrowing mother's knees.

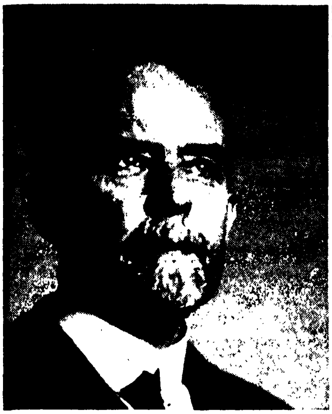
In the early fifteenth century an artist who is remembered as Nicholas Froment of Avignon did some very fine work there. His most famous picture, presenting a religious subject, The Burning Bush, is on the walls of the Cathedral of Aix-en-Provence, in southern France.

Jan van Eyck's portrait of a merchant and his wife is a famous example of this painter's devotion to realism in portraiture.

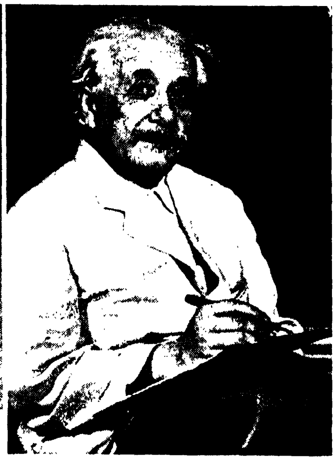
But Jean Fouquet (about 1411 to 1480) is truly the father of French art, although he shows the influence of the Van Eycks and also of Fra Angelico and other Florentines. His grave and dignified portraits in Berlin and Paris show his mastery over that branch of art, and his miniature paintings for missals are among the glories of the French nation. The tranquil and gentle skies and fields of Touraine gleam in the pages of these sacred books, and are more than backgrounds—they are the very soul of France.

France gave her peculiar spirit to the Clouets, Jean and Francois, late fifteenth- and sixteenth-century painters, who belonged to a Flemish family. These men were masters of portraiture. Their work combined the Flemish genius for honest recording of the character of the person and a peculiar grace and lightness of touch. This fine airiness, and avoidance of unnecessary detail, were what the Clouets learned in France. One can see in their work the beginnings of the great period in French art which was to dawn later.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 1287.



Science Service
Thomas Hunt Morgan.



U. S. Navy photo
Albert Einstein.

Science Service
Sir Ernest Rutherford.

MEN AND WOMEN OF SCIENCE

V. SCIENTISTS OF THE GOLDEN AGE

THE Golden Age of Science is right now. Since 1900 discoveries have come so thick and fast that we have room here only to mention some of the most interesting and important ones.

The story begins in the middle of the nineteenth century with the discovery that when an electric current is passed through a vacuum tube, strange rays occur in the tube. We call them cathode rays. Cathode rays were shown by Sir Joseph J. Thomson (1856-1940) of Cambridge University, England, to be streams of particles about $\frac{1}{1850}$ as heavy as a hydrogen atom. We call these particles electrons, and electrons we now know are bits of energized matter in atoms. Thomson found that all electrons are identically the same, no matter from what type of atom they come.

Before his death Thomson saw other men go on to do what had been believed for centuries to be impossible—change one atom into another. One of these men was Thomson's own student at Cambridge, a young New Zealander, Ernest Rutherford (1871-1937). Rutherford became professor of physics at McGill University in Montreal, Canada. In 1900 he found that the element thorium gave off a gas of its own accord. This meant that thorium was breaking up spontaneously. But what was the gas, and what was left behind? Frederick Soddy (1877-   ), a young chemist from Oxford University, helped to solve the riddle. Rutherford and Soddy then went to work on radium which is far more active than thorium. In 1900 they announced that as radium broke up it gave off three different kinds of rays: 1. positively charged alpha particles; 2. negatively charged beta particles (electrons); 3. gamma rays which did not consist of particles at all but were similar to light-waves, only much shorter. (Alpha, beta and gamma are the first three letters of the Greek alphabet. The names were given to the particles and rays for a quick way of "tagging" them.)

In England in 1907, Rutherford allowed alpha particles to enter a glass chamber from which the particles could not escape. Examining the chamber later, he found no alpha particles; but he found helium gas. The explanation was that the alpha particles were really the same thing as the nuclei of helium atoms—two protons and two neutrons. These positively charged nuclei attracted negatively charged electrons from the glass walls of the chamber and thus became helium atoms. This bore out Thomson's theory that every atom consists of a nucleus having a positive charge and surrounded by negatively charged electrons.

Rutherford reasoned—if all atoms consist of electrons surrounding a nucleus, could he change one atom into another by changing the nucleus? He knew that this takes place in nature in radioactive elements. Could he make this happen to other elements? He needed a bullet that could be shot into the nucleus of an atom. But where was there a bullet small enough and powerful enough? The answer was—the tiny alpha particles themselves, which travel at a speed of more than 10,000 miles a second.

In 1919 Rutherford bombarded nitrogen gas with alpha particles from radium rays. Some of the nitrogen atoms changed to oxygen! True, in 49,999 cases out of 50,000 the alpha particles sailed right through the nitrogen atoms without disturbing them. But in one case out of 50,000, the alpha particle crashed "just right" into the nitrogen nucleus and stayed there, at the same time knocking a proton from it. Thus the nucleus gained two protons and lost one, making a total gain of one, and changing its atomic number from 7 (nitrogen's number) to 8 (oxygen's number); but changing its atomic weight from 14 to 17. (The alpha particle contains two neutrons, remember, and a neutron has about the same weight as a proton.)

Science Service

Robert A. Millikan, physicist.

So, with Rutherford's wonderful experiment nitrogen had been changed to heavy oxygen! One element had been changed to another! What the alchemists had dreamed, Rutherford had accomplished! We have come to think of this operation as "smashing the atom."

In 1925 the process was actually photographed by a device called the cloud-chamber. In 1910, another Cambridge physicist, C. T. R. Wilson, had devised this chamber for the purpose of photographing the paths of ultramicroscopic charged particles, particles too small to be seen under the microscope. This is the way it helped. Sudden expansion of moist air which filled the chamber caused the temperature to drop, and water vapor condensed about any charged particles which happened to be in the chamber. The path of these particles could now be photographed, though not, of course, the particles themselves. By the time of Rutherford's death in 1937, several atom-smashing weapons were available for physicists.

Robert Andrews Millikan (1868-), the son of an Illinois preacher, achieved fame by isolating and measuring the electron. For this work he received the Nobel Prize in physics in 1923.

Now Millikan began to investigate certain mysterious rays of which physicists had begun to take note around 1900. Rutherford had found them annoying, because of their ability to penetrate thick screens of lead and otherwise upset perfectly planned experiments. Did these rays originate on earth? Millikan sent pilot balloons carrying instruments as high as ten miles. The mysterious rays were stronger even farther from earth. They finally were seven or eight times as strong as on earth. So the rays did not originate on the earth. In addition, the rays were equally strong, day or night. Evidently the rays did not come from the sun, either. Were they cosmic in origin? That is, did they come from the vast spaces among the stars?

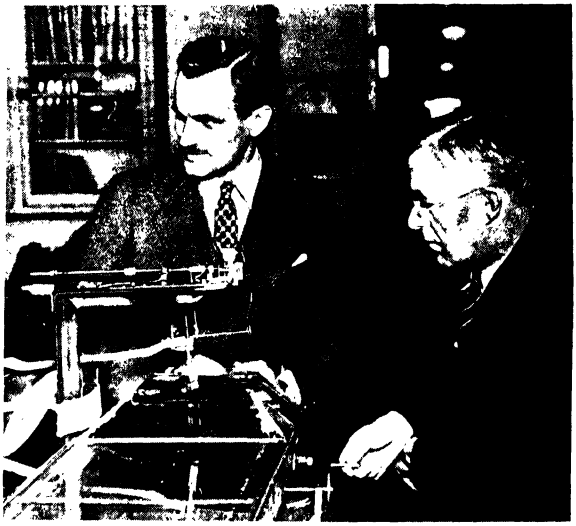
Millikan traveled to the far reaches of the earth to measure these cosmic rays. Everywhere he found cosmic rays: at the tops of mountains, in valleys, deep below the surface of lakes.

Another American scientist, Arthur Holly Compton (1892-), came to believe that cosmic rays were really charged particles traveling at terrific speeds.

The idea that electrons spin around the nucleus was worked out by the Dane, Niels Bohr (1885-). Two American scientists, Irving Langmuir (1881-) and Gilbert N. Lewis (1875-1946), continued the study of the structure of the atom.

You remember that Mendeleef classified the chemical elements according to their weights. A twenty-six-year-old Englishman, Henry G. J. Moseley (1887-1915), made a better arrangement—a table of elements according to atomic number. (Atomic number is the number of electrons in the atom—which is, of course, equal to the number of protons in its nucleus.) Moseley was killed at Gallipoli in World War I.

What is the matter? Before the time of Dalton most people thought that a piece of iron was solid all the way through. The atomic theory indicated that all matter is composed of particles called atoms, and that there are spaces between the atoms. J. J. Thomson, Rutherford, Bohr and the rest showed that the atom itself is mostly space. But what are the electrons and the protons and the other "bits" within the atom? Are they tiny hard solid bodies? The French scientist, Louis Victor, Prince de Broglie (1892-), suggested in 1924 that the electron itself must be thought of not only as being a tiny particle, but also as consisting of a group of waves similar to the waves of light! The Austrian, Erwin Schroedinger (1888-), and the German, Werner Heisenberg (1901-), have developed ideas like those of De Broglie.



Science Service

Arthur H. Compton, noted for work on cosmic rays; and Irving Langmuir, authority on the structure of atoms.

In 1913, F. W. Aston (one of J. J. Thomson's many brilliant pupils) discovered that in some elements not all of the atoms have the same weight. Atoms which do not follow the general rule are called *isotopes.* Aston discovered an isotope of the element neon. About 300 isotopes have been found since, including 11 for tin. Uranium has several isotopes. The famous one is uranium 235. Ordinary uranium has weight 238.

Another famous isotope, heavy hydrogen, was discovered by Harold C. Urey (1893-) at Columbia University in 1932. The atom of heavy hydrogen has an atomic weight of 2, twice that of ordinary hydrogen. Water in whose molecules heavy hydrogen takes the place of ordinary hydrogen is called heavy water. The heavy hydrogen is called deuterium, from the Greek word deuteros, meaning two.

Discovery of heavy hydrogen opened up a new field of research. If heavy hydrogen is substituted for ordinary hydrogen in fats, and the fats are fed to animals, we can later find out what happened to the fats in the animal's body by following the course of the heavy hydrogen molecules. Heavy hydrogen is called a "tracer element" because we can trace its course through the tissues of a plant or animal and in this way learn about some plant and animal life processes. Hundreds of radioactive tracer elements are now being made. They are widely used for studying plants and animals, especially in disease, and they are also useful in industry.

In 1934, Irene and Frédéric Joliot-Curie produced the first artificially made radioactive substances, including radioactive aluminum and nitrogen. Thus the Curie family continued to pioneer in the work in radioactivity, for Irene is the daughter of Marie and Pierre Curie.

Rutherford's work had opened the question of atomic energy. The force which holds atoms together is tremendous. If only a portion of this energy could be released for use, scientists figured we would no longer worry about using up all our coal and oil supplies, for in atoms we have an inexhaustible supply of power. Madame Curie had noticed that as radium broke up, energy was released. Rutherford and his co-workers had noticed that when they hit an atomic nucleus with an alpha particle, energy was released in large quantities.

Ernest Orlando Lawrence, an American physicist (1901-), used a 60-ton magnet, to which he added another 25 tons of equipment to build an 85-ton machine, called a cyclotron, for smashing atoms. In 1934 this cyclotron changed platinum to iridium and gold. When iron was bombarded some of it changed to cobalt and manganese, while some became radioactive. Some thirty-four different elements were subjected to the action of the cyclotron, and all were changed to something else.

But more than that, uncharged particles called neutrons were knocked out of the nuclei. A neutron is about as heavy as a proton—it is said that a thimble packed with neutrons would weigh a million tons—and since a neutron has no electric charge it makes a better bullet than an alpha particle. Why? Because the electric charge of the alpha particle sometimes proves a nuisance. The neutron carries no charge. (An alpha particle, being positively charged, meets some resistance from nuclei.)

For his work with this 85-ton cyclotron, Dr. Lawrence won the Nobel Prize in physics in 1939. By 1940 he had built a 225-ton cyclotron at the University of California.

THE VAN DE GRAAFF GENERATOR, WHICH ALSO SPLITS ATOMS

Another type of atom-smasher is the Van de Graaff generator developed by Robert Van de Graaff of Alabama (1901-). Both the cyclotron and the Van de Graaff generator, although they work in different ways, are designed to accelerate subatomic particles to great speeds for bombarding atoms.

Before World War II started in 1939, it was known that if a heavy atom like that of uranium could be completely broken up, enormous amounts of energy would be liberated. If the atom was even split in two (thus forming two new atoms of lighter chemical elements) the amount of energy released would still be fantastically great, although only a fraction of what would result from the complete destruction of the atom.

Now when energy is suddenly liberated, anything that stands in its way is pushed aside with such violence that we have an explosion. Some explosions are useful, as when we use them to run a gasoline engine. Other explosions are violently destructive as when the top of a volcano blows off or a B-29 drops its bomb load.

There was a fearful race between nazi scientists and those of Great Britain, Canada and the United States to develop the atomic bomb, which gets its titanic power from the smashing of atoms. There is poetic justice in the fact that among the most important scientists on the Allied side were distinguished exiles driven out of Germany and Italy by the Nazis and Fascists.

Up to 1939 more work had to be done to smash an atom than was released in the form of energy when the atom was smashed. But in 1939 German physicists, including Otto Hahn (1879-), fired neutrons at uranium atoms and scored a bull's eye. At first the scientists were not entirely sure of what their results meant, but they noticed that the element barium had appeared (which was not present before) and that enormous quantities of energy had been released. The energy production was on a scale far above anything noted before in atom-smashing. Lise Meitner (1878-) and R. O. Frisch (1904-), both soon to flee from Germany because of their Jewish ancestry, found the explanation. The uranium atom had split into two new atoms, one of barium and one of the rare gas krypton. More important was the fact that while the neutron that hit the uranium atom had one-thirtieth of a volt of energy, the uranium atom shot out 200,000,000 volts—six billion times as much energy as was put into it.

Fortunately for civilization two of Europe's greatest experts, Enrico Fermi, who had been exiled by Mussolini, and Niels Bohr of Denmark, who escaped during nazi occupation, were working at Columbia University. Dr. Frisch sent the news of the breaking-up of uranium to his father-in-law, Bohr.

As the life-and-death struggle in Europe got under way, President Roosevelt saw to it that American and British efforts were pooled. Many of the greatest scientists in both countries were involved in the work.

MAN MAKES TWO ELEMENTS NEVER FOUND IN NATURE

It was Fermi's idea that when the uranium (or other) atom was struck by a neutron and split, other neutrons would fly out from the broken neucleus. Now if these would hit still further atoms and split them, a "chain" reaction would take place, and the final explosion would be on a gigantic scale. It was found that ordinary uranium (weight 238) was not suitable, but that the rarer uranium 235 was. Before the work was completed two elements never found in nature had been made: neptunium and plutonium, both heavier than uranium 238. Most of the explosive material in the atomic bombs dropped on Japan was plutonium.

It has been said that if all the protons and electrons in one drop of water were to destroy each other, enough energy would be evolved to supply 2,400 horse-power for a month. When atomic energy is finally tamed for peaceful use, we may expect a revolution in industry as great as that produced by steam and electricity.

During the latter part of the nineteenth century scientists worked out the strange events which take place when the nucleus of the cell divides—the strange dances of the chromosomes called mitosis and reduction division. With this knowledge biologists were

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In their Paris laboratory, Irene Curie and her husband, Jean-Frédéric Joliot, continue the great work of Marie and Pierre Curie on radioactivity.

ready to carry on the work of Mendel when it was re-discovered in 1900. The English biologist, William Bateson (1861-1926), and his pupils showed that inheritance of the type described by Mendel takes place in mammals, birds and insects. W. L. Johannsen (1857-1927), the Danish physiologist, showed that selection alone would not produce a new type of organism.

William E. Castle (1867-), of Harvard University, found the ideal creature for experiments in heredity, the fruit fly, sometimes called the vinegar fly. The fruit fly grows from egg to adult in ten days, lives in perfect health in the laboratory, and has only four pairs of chromosomes. Every laboratory in the world where heredity is studied now has its rows of pint milk bottles housing hundreds of thousands of fruit flies.

Thomas Hunt Morgan, famous as the founder of the gene theory, was born in Lexington, Kentucky, in 1866, the year Mendel published his results. In 1909 Morgan studied thousands of fruit flies to see if any of them would show the mutations De Vries had written about. In 1910 a mutant white-eyed male fly suddenly appeared in a family of normal red-eyed flies. In the same year Morgan found that his flies produced fifteen mutations, that is, fifteen new types, different from any of their ancestors. Soon Morgan gathered a group of devoted students in his laboratories at Columbia University.

One of these students, Hermann J. Muller (1890-), produced artificial mutations in fruit flies by bombarding the parent flies with X rays. Soon after, two other American scientists, L. J. Stadler and T. H. Goodspeed, artificially produced mutations in plants. Man now was not only able to transmute chemical elements; he could also produce new types of organisms in one generation.

Back in 1901 the American scientist C. E. McClung (1870-1946) had argued that the sex of grasshoppers was determined by certain small chromosomes. Morgan's students, one of whom was his wife, Lillian V. Morgan, produced abundant evidence to bear out this theory. Mrs. Morgan helped explain the inheritance of sex-linked traits (the fact that women are rarely bald, for example, and the strange cases where a normal mother can transmit hemophilia, the bleeder's disease, to her sons, but not to her daughters).

Albert F. Blakeslee (1874-), of the Carnegie Institution, found that sometimes the chromosomes would fail to divide in a plant, with the result that new types were produced with double the ordinary number of chromosomes. The new plants with the extra number of chromosomes turned out to be very different in many cases from their parents. Soon it was found that by applying colchicine, a poisonous juice extracted from the autumn crocus, these chromosome doublings could be produced artificially. Hence new types of plants could be grown. (Of course, the scientist doesn't know in advance what the new type will be.)

Thanks to Morgan and his students, including Alfred H. Sturtevant (1891-), Calvin B. Bridges (1889-1938) and T. S. Painter (1889-), we now have "maps" of the tiny chromosomes of the fruit fly. These maps show the exact location of those mysterious structures along the chromosomes, which are called genes, and which determine hereditary characteristics, such as eye color, whether a fly will have wings or not, and other traits.

On May 29, 1919, parties of scientists were gathered in Africa and Brazil, at opposite sides of the world. Tension was high. All the apparatus was ready—the telescopes, the cameras, the spectroscopes. Now everything depended on the weather. Would it be clear? Or would clouds obscure the total eclipse of the sun which they waited?

At the same time Albert Einstein sat quietly at home in Berlin. He had every reason to be nervous, for these scientific expeditions were going to test his theory. If the eclipse was not obscured by clouds, photographs would be taken which would show once and for all whether Einstein was correct in stating that light rays bend as they pass close to a bulk like the sun. The photographs were taken, and Einstein was shown to be correct. He had started a revolution in the world of physics.

Albert Einstein was born at Ulm, Germany, May 14, 1879. In 1894 Albert went to Zurich, Switzerland, where he supported himself by teaching physics and mathematics while he studied at the university. He was a rather lonely man, and shy. He became a Swiss citizen, and took a position as patent examiner in Berne. He continued his studies at the University of Zurich and got his degree as a Doctor of Philosophy.

EINSTEIN'S FIRST THEORY ON RELATIVITY, ANNOUNCED IN 1905

In 1905 Einstein published his Special Theory of Relativity. This took the scientific world by storm, and his reputation was assured. In 1913, Berlin created a position for him—director of the Kaiser Wilhelm Physical Institute; and he was elected to the Royal Prussian Academy of Sciences.

In 1915 he published his General Theory of Relativity. When his theory was tested by scientists all over the world, many honors came to him, including the Nobel Prize in physics in 1921. Einstein's studies continued. He was trying to find a way to explain the basic facts of our universe—space, time and motion—in exact mathematical figures, a thing no scientist had ever been able to do. For years few minds were able to grasp his problems, or to follow his thinking very closely, and even today it takes a student of advanced physics to have a clear understanding of his theories.

Einstein and others have shown that Isaac Newton's Law of Gravitation has certain tiny defects when applied to matter in outer space. These modern scientists have made suggestions for changes in Newton's physics. The really great thing Einstein has done has been to keep scientists aware of the magnitude of their subject. "We are just at the open doorway of Knowledge," he seems to say. "Let us not be afraid to enter the wonderful house and explore its many rooms."

In the days when the Nazis ruled Germany, Albert Einstein was driven from the country and stripped of all his belongings. He made his way to the United States, and from 1933 to 1945 he taught mathematics at Princeton University. He became a naturalized citizen of the United States.

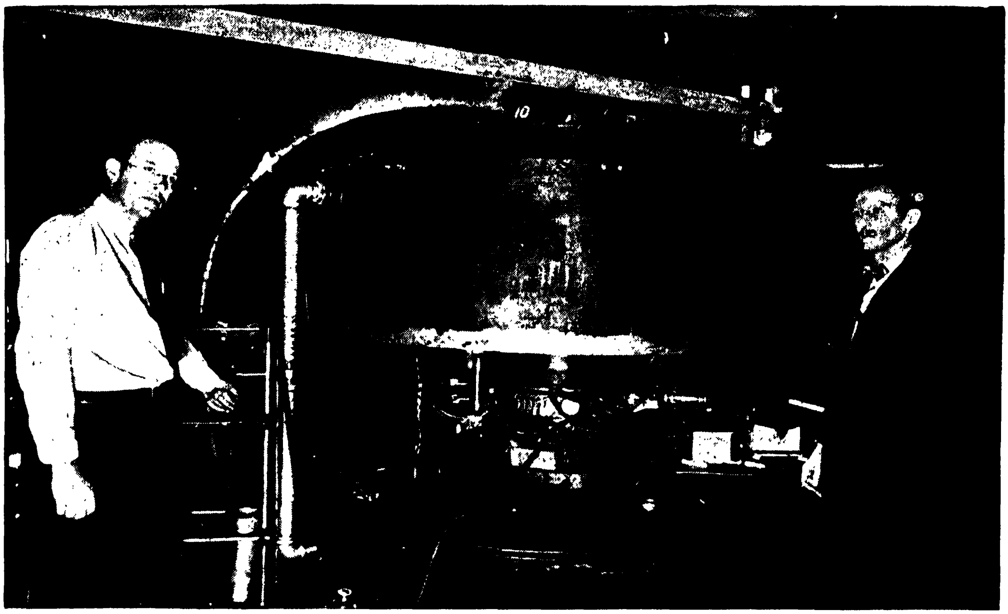
STUDY OF THE HUMAN BODY HAS KEPT PACE WITH THE OTHER SCIENCES

Where are we today in biology? So much has been learned about the workings of the body in this twentieth century that the reader must turn to other parts of THE BOOK OF KNOWLEDGE for developments in the study of vitamins, diseases and the way our nervous, digestive and other systems operate. One of the most fascinating developments has been the study of hormones, those secretions produced by glands which make people grow tall or short, fat or thin, active or inactive. By means of thyroid extract the type of idiot called cretin has been made mentally normal; while other hormones have been used actually to change the sex of animals—hens into roosters, for example.

More and more we are probing into the secrets of the living cell. On January 17, 1912, Dr. Alexis Carrel (1873-1944), a French scientist who had come to the United States, opened a hen's egg and cut out a tiny fragment of tissue from the heart of the developing chicken. Today that piece of heart tissue is still alive and in the best of health. It grows so fast that half of it is cut off and thrown away twice a week. Other biologists have discovered how to graft parts of various lower animals, so that they can take the leg of one species of young salamander and graft it in place of an amputated leg.

Almost every day the newspapers carry accounts of new discoveries in the field of drugs and vitamins. A wonderful discovery was penicillin, the drug developed from a mold, which checks the growth of harmful bacteria. It has been discovered that many plants (including the buttercup, the pine tree and many fungi) produce antiseptics which render a similar service.

In the field of chemistry, new materials



Science Service

The 85-ton cyclotron (or "atom-smasher") with its creator, Ernest Orlando Lawrence, on the left, and Donald Cooksey. One use of the cyclotron is to make radioactive sodium, used in treating cancer.

such as new plastics, rubber-like materials, synthetic precious stones and new metal alloys are announced frequently. Among the most marvelous of the recent inventions is the electron microscope which focuses streams of electrons instead of light-waves and enables us to make pictures of objects one-fiftieth the size of the smallest thing visible with the best light microscope.

We must remember that the findings of science can be used for man's destruction as well as for his benefit. Due to science men no longer die like flies in great epidemics of plague and yellow fever and they need not suffer from many ills which were common only yesterday. But science also makes it easier for men to kill each other and to wreck cities and whole countries with a speed undreamed of until recently.

The great questions as to the ultimate nature of matter and energy remain questions, and it is here that the language of the specialist is probably most difficult for the student to understand. When we get to the smallest particles of matter, the electron and the proton, we find it hard to say just what they are. They have what the physicist calls mass and they have electric charges. Another fundamental particle, the neutron, has mass but no electric charge. We used to believe that matter was very definitely one thing and energy something else—yet now we find the distinction between matter and energy breaking down.

In living bodies it has been found that many (perhaps all) life-processes are closely tied up with electric changes. All nerve action involves electricity. Hence the doctor can tell an epileptic from a normal person by differences in the electrical waves of the brain. Absorption of materials through living cell membranes seems to have some electrical basis.

In chemistry it has been found that matter is electrical in nature. The electrical nature of atoms accounts for their ability to combine into molecules. Atoms of one element have been transmuted into atoms of different kinds, merely by adding or subtracting electrically charged particles in the nucleus, as we have seen.

Radio waves, light rays, ultraviolet rays, X-rays, gamma rays, are all electromagnetic disturbances, differing from each other only in wave length and frequency of oscillation.

All this seems to support a oneness about the universe, a unity in the natural laws under which the universe operates. There will always be work for the young scientist to do, and the honor roll of scientists has no end. On the following page are the names of a few of the great scientists of the golden age.

By Thomas Gordon Lawrence, and Others.

SCIENTISTS OF THE GOLDEN AGE

Sir Joseph J. Thomson (1856-1940), English. Discovered the nature of cathode rays. Made important contributions to electron theory.
Henry Fairfield Osborn (1857-1935), American. Studied prehistoric man and extinct mammals.
Max Planck (1858-1947), German. His quantum theory states that the energy in light and other electromagnetic waves exists in separate pockets, or bundles. Won Nobel Prize in physics, 1918.
Sir William Henry Bragg (1862-1942), and his son, **William Lawrence Bragg** (1890-), English. Investigated the arrangement of atoms in crystals. Joint winners of Nobel Prize in physics, 1915.
George Washington Carver (1864-1942), American biochemist. Made many useful products from peanuts, sweet potatoes, other vegetables, fruits.
Thomas Hunt Morgan (1866-1945), American. Founder of the gene theory of heredity. Won Nobel Prize in Medicine, 1933.
Theodore William Richards (1868-1928), American. Determined atomic weights of chemical elements much more accurately than had ever been done before. Also conducted important investigations in physical chemistry, especially the action and effects of heat. Won Nobel Prize in chemistry, 1914.
Robert Andrews Millikan (1868-), American. Measured charge on the electron. Worked with cosmic rays. Won Nobel Prize in physics, 1923.
C. T. R. Wilson (1869-), Scottish. Invented cloud-chamber which makes it possible to photograph the trail of an electron or other subatomic particle. Won Nobel Prize in physics, 1927.
Ernest Rutherford (1871-1937), New Zealander. Important experiments on nucleus of atom. Changed one element into another. Won Nobel Prize in chemistry, 1908.
Walter B. Cannon (1871-1945), American. Studied work of glands and relation between emotions and vital functions.
Alexis Carrel (1873-1944), French. Kept chicken-heart tissue alive for many years. Won Nobel Prize in medicine, 1912.
William D. Harkins (1873-), American. Predicted discovery of the neutron.
Albert F. Blakeslee (1874-), American. Experimented on heredity in plants.
Charles William Beebe (1877-), American. Explored undersea life in bathysphere. Authority on birds.
Frederick Soddy (1877-), English. With Rutherford discovered three different kinds of rays given off by radium. Won Nobel Prize in chemistry, 1921.
Lise Meitner (1878-), born in Germany. Cooperated in splitting uranium.
Albert Einstein (1879-), born in Germany, now an American citizen. His theories have caused a revision of fundamental ideas about the universe. Won Nobel Prize in physics, 1921.
Otto Hahn (1879-), born in Germany. Discovered (1918, with Lise Meitner) radioactive element protoactinium. Won Nobel Prize in chemistry, 1944.
Clinton J. Davisson (1881-), American. Known for researches in electricity, magnetism and radiant energy; discovered (with L. H. Germer) the diffraction of electrons by crystals (1927). Shared Nobel Prize in physics, 1937.
Sir Alexander Fleming (1881-), English. Discovered penicillin in 1928. Shared Nobel Prize in physiology and medicine, 1945.
Irving Langmuir (1881-), American. Helped to develop the electron theory. Won Nobel Prize in chemistry, 1932.
Herbert McLean Evans (1882-), American. Important work with hormones and vitamins.
Roy Chapman Andrews (1884-), American. Discovered dinosaurs' eggs and other fossils.
Niels Bohr (1885-), Danish. Worked out a theory of atomic structure. Won Nobel Prize in physics, 1922.
Henry G. J. Moseley (1887-1915), English. Established table of atomic numbers of elements from the action of X-rays.
Erwin Schroedinger (1888-), Austrian. Developed idea that matter may be thought of as consisting of waves. Won Nobel Prize in physics, 1933.
Hermann J. Muller (1890-), American. Produced artificial mutations in fruit flies.
James Chadwick (1891-), English. Discovered the neutron. Won Nobel Prize in physics, 1935.
Prince Louis Victor de Broglie (1892-), French. First to state that the electron may consist of waves. Won Nobel Prize in physics, 1929.
Arthur H. Compton (1892-), American. Worked with cosmic rays. Studied effects of X rays on electrons. Won Nobel Prize in physics, 1927.
George P. Thomson (1892-), English. Son of Joseph J. Thomson. Showed that electrons behave like waves. Shared Nobel Prize in physics, 1937.
Harold Urey (1893-), American. Investigated heavy hydrogen and heavy water. Winner of Nobel Prize in chemistry, 1934.
Artturi I. Virtanen (1895-), Finnish. Important work on process of preserving fodder in a silo (ensilage). Won Nobel Prize in chemistry, 1945.
Sir Howard W. Florey (1898-), English. Organized intensive study of penicillin in 1939. Shared Nobel Prize in physiology and medicine, 1945.
Isador I. Rabi (1898-), American. Made an estimate of the diameter of the neutron. Won Nobel Prize in physics, 1944.
Jean-Fréderic Joliot (1900-) and **Irene Curie** (1897-), French. Artificially produced radioactive elements. Joint winners of Nobel Prize in chemistry, 1935.
Wolfgang Pauli (1900-), born in Austria. Developed "Pauli exclusion principle" used in atomic research. Won Nobel Prize in physics, 1945.
Werner Heisenberg (1901-), German. Discovered the "principle of uncertainty." This means that science can not know both the exact velocity and the exact position of an electron at the same time. Won Nobel Prize in physics, 1932.
Ernest O. Lawrence (1901-), American. Developed the cyclotron, the "atom-smasher." Won Nobel Prize in physics, 1939.
Enrico Fermi (1901-), Italian. Important work in development of atomic bomb.
Wendell M. Stanley (1904-), American. Discovered that certain disease-causing viruses are actually crystalline proteins.
J. Robert Oppenheimer (1904-), American. Directed atomic-bomb research in New Mexico.
Carl D. Anderson (1905-), American. Discovered the positron (or positive electron), a particle of the same mass as the electron, but with a positive electric charge. Won Nobel Prize in physics, 1936.
Ernst Boris Chain (1906-), born in Germany. Important work on living tissues; penicillin. Shared Nobel Prize in physiology and medicine, 1945.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 1360.

JOHN MILTON AND HIS POEMS

CHAUCER, Spenser, Shakespeare—those three we have considered as giants in the story of English literature. They were supermen among all who wrote English poetry and prose up to the first quarter of the seventeenth century. Now we must go forward some years, to the time of John Milton, the next literary superman in the history of English writing.

Spenser died in 1599. Shakespeare died in 1618. Milton was born December 9, 1608; as a lad of ten he may have heard the news of Shakespeare's passing, or may even have seen the playwright. Milton was born, and spent his childhood, in Bread Street, Cheapside, London, the very street on which stood the Mermaid Tavern where Shakespeare used to meet his friends of the theater. Shakespeare, to be sure, had retired to his country home at Stratford before John Milton was born; yet who can say the great dramatist did not come to town occasionally for a chat about old times with his friends?

Milton's father was a scrivener, that is to say, he drew wills, prepared other documents and did much work that in our day is done by lawyers. He was a well-educated man of good family, prosperous, a music lover, with a cultivated taste in art and literature. He and his wife were deeply religious. They were Puritans—that is, they belonged to the large group of serious English people who wished to "purify" the state religion and reorganize the worship on more austere lines. The most important thing to remember about John Milton's childhood is that it was spent in a Puritan household.

The Miltons had several other children, but only two of them lived to grow up: a sister Ann, several years older than John; and a younger brother, Christopher.

From childhood John was a good student, an eager reader and a lover of poetry. He was sent to a school in Essex, later had a tutor at home, and when he was twelve he started going to St. Paul's School in London, which was noted for its teaching of Latin and Greek. At the age of sixteen he became a student at Christ's College, Cambridge University, the same college which the poet Spenser had attended. There young Milton spent seven years of deep study.

The cottage at Chalfont St. Giles, in Buckinghamshire, where Milton lived while the plague raged in London.

He was known at the university as a scholar and poet; and, indeed, before he was twenty he had produced much passable Latin verse. The hymn

> Let us with a gladsome mind
> Praise the Lord, for he is kind

a paraphrase of the 136th PSALM, had been written by Milton when he was a lad of fifteen. And on Christmas Eve, 1629, when he had just turned twenty-one, he had produced the beautiful ODE ON THE MORNING OF CHRIST'S NATIVITY, which contains these tender lines:

> And Kings sat still with awful eye
> As if they surely knew their sovran Lord was by.
> But peaceful was the night
> Wherein the Prince of Light
> His reign of Peace Upon the Earth began,
> The winds with wonder whist
> Smoothly the waters kissed . . .

In 1632 Milton left Cambridge, with the degree of Master of Arts, and went to his father's country house in Buckinghamshire, where five years more of his life rolled on in the study of books and nature and the writing of poems, some of which rank among the finest in the world.

One piece written at this period was ARCADES, a masque (a kind of half-drama, half-poem, to be recited or sung by actors wearing masks). It was set to music by Henry Lawes, one of the King's musicians. It was a slight piece, suitable for open-air performance, at that time fashionable.

COMUS, another masque, was also written during this time. The theme of COMUS is that Virtue may pass unscathed through temptation; and this we may take as the theme of John Milton's whole personal life. Sternly he followed his ideal of the upright life, though possibly he felt little temptation to stray from the path, for John Milton was in love with the Puritan way.

It will help you to understand Milton if you see him in his proper place in the great world-drama that we call history. Queen Elizabeth had died five years before Milton was born. His childhood and youth were spent in the reign of James I, the son of Mary Queen of Scots. James died at the time when Milton was beginning his studies in college. Charles I, who followed James, was the unlucky monarch who lost his head because he could not understand and would not give in to England's growing determination to have a more democratic government. Milton was forty-one years old when Charles I was beheaded. There followed (from 1649 to 1658) a period when Cromwell the Puritan was the real ruler of England, part of the time aided by a Puritan Parliament, part of the time without the backing of Parliament. From the middle of Elizabeth's reign to the beginning of Cromwell's administration, Puritan strength had been building up in England.

In politics, the Puritans were for democracy, thrift and honesty. They were against favoritism, alliances with other European powers, foreign wars, and all kinds of public display and extravagance. In private life they were upright, stern and bigoted, willing to die for their beliefs but not always willing to tolerate people with opposing beliefs. They hated elaborate dress and ceremonious manners. The only book that many of them ever knew was the BIBLE, but they did know their BIBLE, its ringing prose, its magnificent poetry, its history and stories, the examples of its saints, its precepts, its warm comfort. They went to it with their joys and their sorrows and it never failed to give back, for their devotion, rich spiritual rewards.

And so, through the ending years of Elizabeth and all the years of James I and Charles I, the Puritans were growing in strength. The movement was like a slow, sure tide, creeping forward.

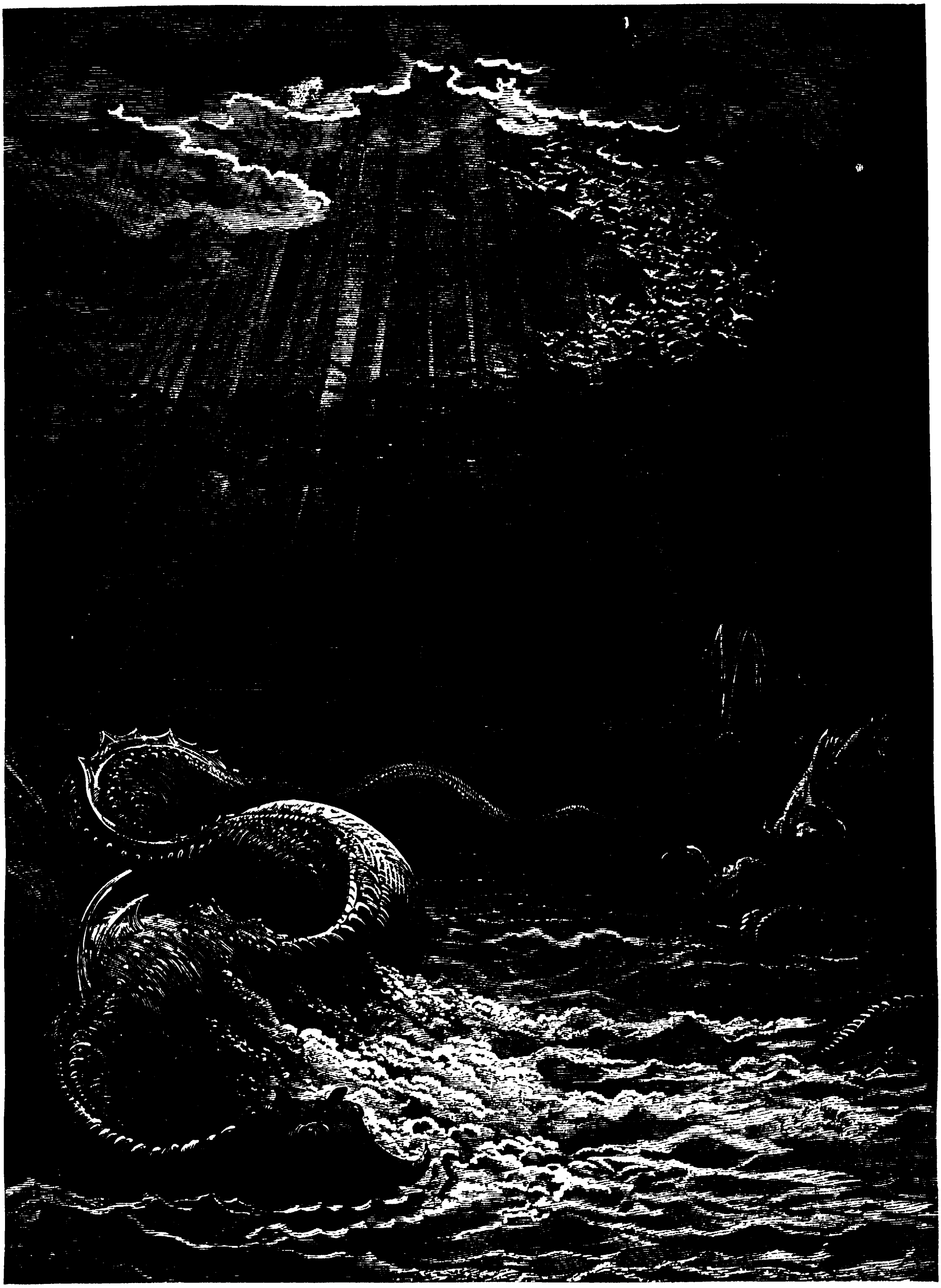
MILTON'S GREATEST WORK WAS BASED ON THE BIBLE

John Milton, as we have seen, was born into a Puritan home when the tide was strong, and he went with it. Though he was a scholar in the classics, and some Puritans despised Latin and Greek; though he was a musician, and many Puritans thought little of music; though he wrote plays of a sort, and entertainment was but a form of temptation to more than one good Puritan—yet Milton was a shining example of Puritan ideas professed and lived. The greatest work of his life, the poem that will make his name remembered as long as men read English, is PARADISE LOST, based upon the BIBLE.

Let us return now to some of his early poems. L'ALLEGRO is a happy one, about the cheerful mood of a man. IL PENSEROSO tells of a thoughtful mood. These are philosophical works, embroidered with references to ancient myths and "modern" folklore.

A form of Milton's lovely gift of song was his way of using the sound and sway of words to help bring out the thought; so L'ALLEGRO, with short, bright words and a tripping measure, sounds gay; and IL PENSEROSO, with statelier measure, sounds thoughtful.

Another of his earlier poems was LYCIDAS,



This is one of Gustave Doré's famous illustrations for PARADISE LOST. It shows that stage of the creation of the world which is described by Milton in the following lines: "And God said: 'Let the waters generate Reptile with spawn abundant, living soul; And let fowl fly above the earth.' "

a lament for a college friend, Edward King, who was drowned on a boat trip to Ireland. Edward King was himself a poet, as these lines from LYCIDAS show:

> For Lycidas is dead, dead ere his prime,
> Young Lycidas, and hath not left his peer.
> Who would not sing for Lycidas? He knew
> Himself to sing, and build the lofty rhyme.

His mother's failing health had kept young Milton at home. She died in 1637, and the following year he set out to see for himself the countries and towns of the Continent whose literature, history and art he knew so well. For about fifteen months he wandered among the storied towns of Italy and France, and the influence of this journey did much to shape his thoughts toward the later poetical achievements of his life. He made many friends, especially in Florence, and paid a visit to the famous Galileo, at that time an old man, and blind. He had meant to spend a longer time in Italy, but the news of the political troubles in England called him home.

This portrait of Milton shows the poet in his youth, before he became blind.

Milton returned to London in 1639. The struggle between the people and the King (Charles I) had become so serious that the whole country was unsettled. Milton took small part in the agitation, except for writing bitter attacks upon the bishops who were supporting the King.

For a number of years Milton had a sort of boarding-school in London, where he lived, remote from public affairs. But the bitterness of the struggle which was going on in these unhappy days entered the poet's life in a strange way. In 1643 he married Mary Powell, a very young girl who belonged to a Royalist family and had been brought up with the gay manners of the Cavaliers, as the Royalists were called.

Milton was twice his wife's age; and he was, in his way of life, the gravest and most frugal of Puritans. It was not likely that he and his young wife could immediately find happiness together. After a few weeks she returned to her father's home. Two years later, however, she went back to her husband.

Milton, in the meanwhile, had been writing, not poetry, but prose. His finest work of this period is AREOPAGITICA. The title is a Greek word for an oration addressed to the ancient Council of Athens, which was known as the Areopagus. Milton gave the title to his work because it was addressed to the Parliament of his own country. The AREOPAGITICA is a noble plea for liberty of thought, and the right to publish in print one's honest opinions. Though its prose is difficult and wordy, it is inspired by fine feeling.

After the execution of Charles I, Milton wrote another important prose work, defending the execution (for there were still many in the country who believed that subjects had no right to put their king to death).

This defense by Milton pleased the new Puritan government, and the poet was given a government post at a handsome salary. His work was to draft the correspondence of the Government with foreign powers, which was then carried on in the Latin language.

A new period of the poet's life now began. He became eminent in the public life of his day. His great literary powers were employed, not only in translating state correspondence, but in defending the government of Cromwell against its foreign critics.

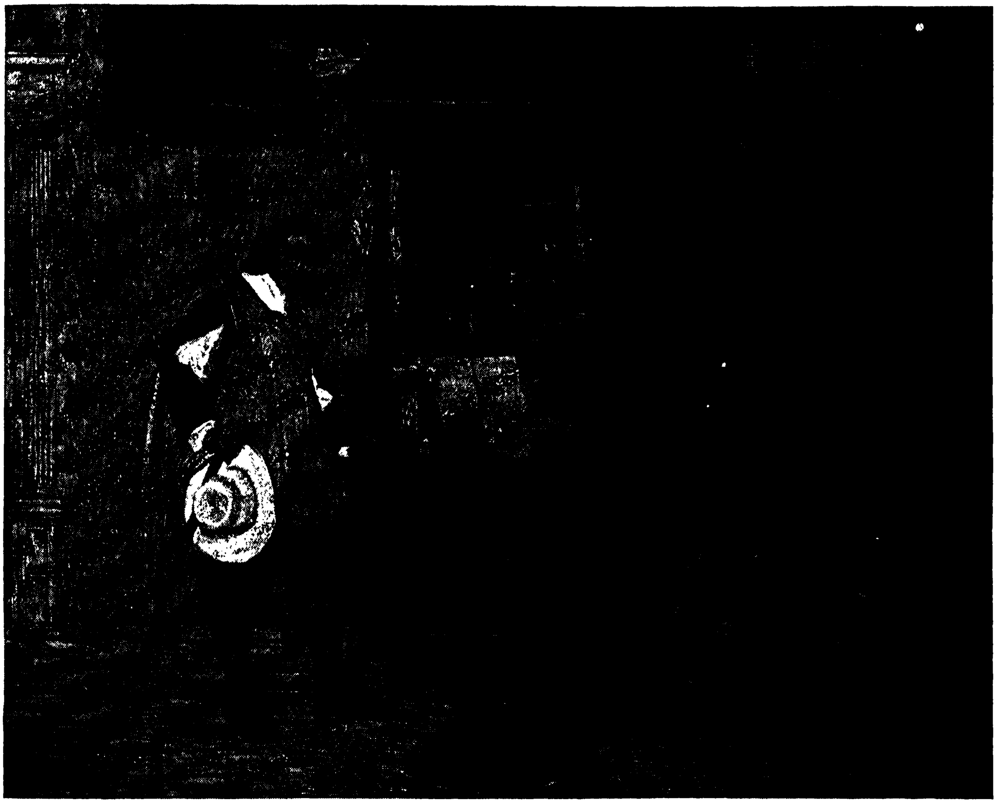
In 1653 his wife, Mary Milton, died, leaving him with three young daughters to look after. A still heavier tragedy came to him at this time. His eyes, which had been weak from boyhood, now failed him completely, and the poet became blind. Still he bravely faced his work as Latin Secretary, first with an assistant, and afterward with the aid of a colleague, Andrew Marvell, who was himself a poet of power and sweetness and a man of fine character. Milton's independent writing of prose and verse (chiefly sonnets) continued, in spite of his blindness; and he had in mind still the dearest project of his life, an epic poem on the creation of man, which he called PARADISE LOST.

In 1656 he married again, a woman of charm who brought him much happiness for a short time; but in fifteen months she died, leaving him and his three little girls once more desolate.

In 1658 Oliver Cromwell died, and the days of the Puritans as governors of England were numbered. Cromwell's son Richard lasted as Protector of the Realm only two years. Richard himself seems to have been more Royalist than Puritan in his sympathies. Royalist strength had been growing in the land for some time, partly because the different factions of Puritans had not always been able to agree on the kind of government that would be best for England; partly, perhaps, because the Puritan sternness was foreign to the laughter-loving English.

In 1660 the Royalists were strong enough to have their way. Charles, oldest son of King Charles the First, was called back from exile and made a triumphant entry into London, where he was later crowned Charles II. His reign is known as the Restoration (restoration of the monarchy).

It was a bitter day for Milton when Charles returned to London. The Puritan office-holders were, of course, deprived of their offices, and Milton, along with many others, went into hiding. It was indeed a wonder that he was not found and hanged, for he had been the most eloquent mouthpiece of the Puritans against the Royalists.



Oliver Cromwell, Lord Protector of England, visits Milton. The poet had many friends among the Puritan leaders.

Some say that Andrew Marvell pleaded for him. At all events Milton won a pardon from the new king, for his past activities. He could come out of hiding. But now he was not one of the honored, well-paid government men. He was a degraded member of the opposition, alive through the generosity of the King. He was, as he wrote,

> "fallen on evil days,
> On evil days though fallen, and evil tongues,
> In darkness, and with dangers compassed round,
> And solitude."

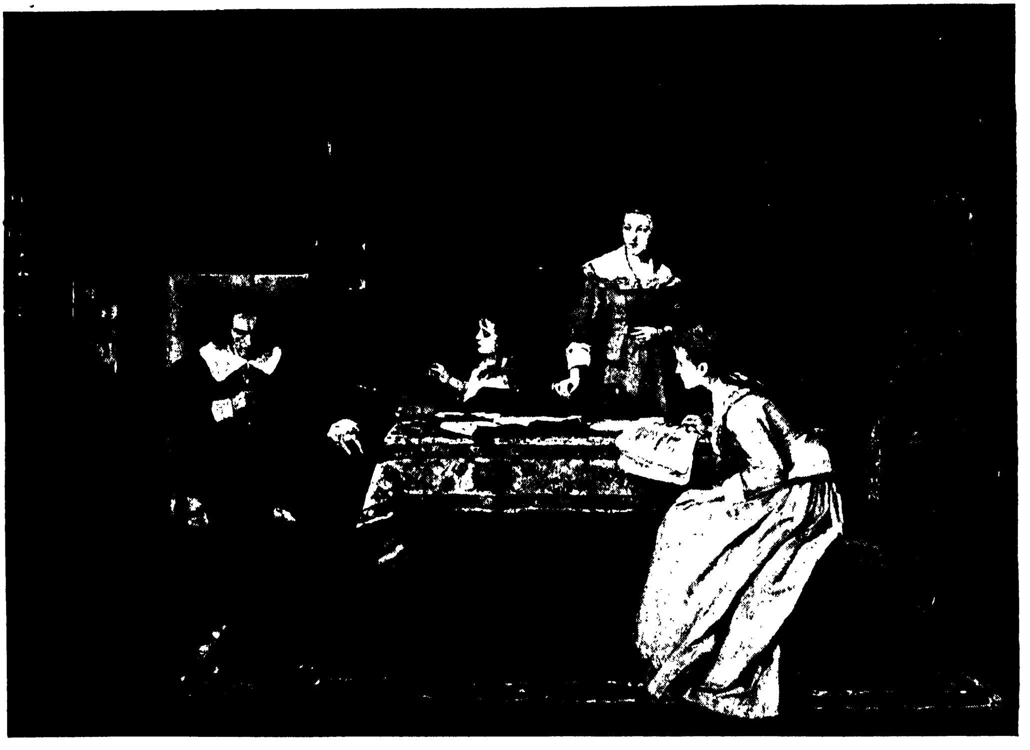
Yes, evil days had fallen upon Milton. Added to all his other sorrows were home troubles. His three daughters, brought up by a blind father who was passionately absorbed in his own work, grew into ill-mannered, badly educated, selfish girls. They hated to spend long hours reading to their father or writing at his dictation, and they took no pains to hide their impatience. The poet was embarked upon his major work, PARADISE LOST, and he needed help.

In 1662 Milton, being then in his fifty-fifth year, married his third wife, Elizabeth Minshull, in her twenty-fifth year. It was a good marriage. Elizabeth brought order and a degree of happiness into that unhappy household.

Just when PARADISE LOST was finished we do not know. But this we do know: In 1665 the Great Plague visited London, mowing down about 100,000 people. All who could fled from the infection by moving out of London. Milton and his family went to a cottage in Chalfont St. Giles, in Buckinghamshire, and the completed manuscript of PARADISE LOST was taken along for safekeeping.

After the Plague came the Great Fire of London, in 1666, and for some time afterward business was nearly at a standstill. Not till 1667 was PARADISE LOST published. Milton received around $50 for the poem. The price for a printed copy of the book was around seventy-five cents.

It is impossible to describe the excitement that broke out among other writers and learned men when the first edition of 1,300 copies was offered to English readers. Friend and foe paid tribute to Milton's genius. No matter what his past political connections had been, he was recognized as a great writer. He became celebrated once more, overnight.



The blind poet dictating PARADISE LOST to his daughters. From the painting by M. Munkacsy in the New York Public Library. Milton received only fifty dollars for this great work, but it brought him undying fame.

What of this poem, one of the masterpieces of our language? The author's aim was to "justify the ways of God to man," and he began by humbly asking the Divine Spirit to instruct him while he told of the fall of angels and of man. A spirit of profound reverence, which suits well the dignity of the blank verse, is preserved throughout. The tone of the poem is lofty, majestic and pure.

Few other poets have such power of imagination, creating scenes and beings beyond the reach of human experience, and by the dignity of his verse preserving all their mystery.

The great epic tells the story of the angels who fell from heaven and the temptation and fall of man. The rebel angels, cast "with hideous ruin and combustion down to bottomless perdition," regain their steadfastness of mind in the midst of the fiery gulf. Satan, the great rebel chief, is the first to recover himself and make his way to the shore of the "inflamed sea." There he calls his hosts around him in orderly array. Here is the picture of the bad, sorrowful angel as he prepares to speak to his downcast host of followers:

> He, above the rest
> In shape and gesture proudly eminent,
> Stood like a tower. His form had not yet lost
> All its original brightness, nor appeared
> Less than an Archangel ruined, and the excess
> Of glory obscured: as when the sun, new-risen,
> Looks through the horizontal misty air
> Shorn of his beams, or, from behind the moon,
> In dim eclipse, disastrous twilight sheds
> On half the nations, and with fear of change
> Perplexes monarchs. Darkened so, yet shone
> Above them all the Archangel. But his face
> Deep scars of thunder had intrenched, and care
> Sat on his faded cheek, but under brows
> Of dauntless courage and considerate pride,
> Waiting revenge.

This great chieftain of the underworld then speaks to his comrades in guilt and excites them to further war, but war by guile, against man, that thereby God may be grieved.

The exiled fiends now proceed to build themselves a gorgeous palace-home, Pandemonium, and there they sit plotting—

> A thousand demi-gods in golden seats.

They resolve that they will try to injure man, of whose creation in the Garden of Eden they have heard rumors.

This picture, from the painting by George H. Boughton, shows the poet Andrew Marvell shaking hands with Milton.

Satan volunteers to go in search of the new world, and, aided by Sin and Death, comes at last through dreadful chaos to where the earth hangs suspended from heaven by a golden chain.

At this point the poet bursts into an invocation to Light as a prelude to a picture of heaven, and pitifully laments his own blindness.

> With the year
> Seasons return; but not to me returns
> Day, or the sweet approach of even or morn,
> Or sight of vernal bloom, or summer's rose,
> Or flocks, or herds, or human face divine;
> But cloud instead, and ever-during dark
> Surrounds me, from the cheerful ways of men
> Cut off.

In heaven God sees Satan approaching the world, and foretells to His only Son how man will be tempted and will fall, but the

Son declares that He will become man and bring salvation to the race.

Satan, flying toward the earth disguised as a stripling cherub, meets the archangel Uriel, and though Uriel is "the sharpest-sighted spirit of all in heaven," Satan deceives him into pointing out the way to Adam in Paradise.

Lovely descriptions of Paradise follow. So sweet is the place, and so noble are Adam and Eve, "God-like erect, with native honour clad," as they pass hand in hand, that Satan himself almost relents, and grieves over the evil work he has come to do. Meantime, Uriel descends and warns Gabriel, chief of the angelic guards of Paradise, to keep careful watch.

One of the loveliest passages in the poem is that in which Eve says to Adam:

> With thee conversing, I forget all time,
> All seasons, and their change, all please alike.
> Sweet is the breath of morn, her rising sweet,
> With charm of earliest birds; pleasant the sun,
> When first on this delightful land he spreads
> His orient beams, on herb, tree, fruit, and flower,
> Glistening with dew; fragrant the fertile earth. . . .

Adam and Eve retire to rest, and the angel-guards, Ithuriel and Zephon, searching the garden, find Satan squatting like a toad close to Eve's ear to taint her dreams.

> Him thus intent Ithuriel with his spear
> Touched lightly; for no falsehood can endure
> Touch of celestial temper, but returns
> Of force to its own likeness.

So Satan changes into his own form "of regal port, but faded splendor wan," and, after some altercation with his captors, flies away and hides himself for seven nights, circling round and round in the shadow of the earth.

The Almighty sends to Eden the archangel Raphael, who warns Adam of his danger, and tells him the story of Satan's disobedience and fall. He also tells how the earth began, and why—in order that another race, that of man, might take in heaven the places of the outcast angels, lest Satan should feel a pride in having "dispeopled heaven."

Satan now returns and takes the form of a serpent. Eve in the morning suggests to Adam that they shall work apart in the garden till noon; he doubts the wisdom of it, but after urging her to be watchful at last gives way.

Searching through the garden, Satan discovers her alone, and by flattery persuades her to disobey the command of God and eat of the forbidden Tree of Knowledge. Fearing the effect may be separation from Adam, she resolves that he, too, shall eat, that they may live or die together; and

> He scrupled not to eat
> Against his better knowledge, not deceived,
> But fondly overcome by female charms.

The guilty pair soon become remorseful, unhappy and quarrelsome. Satan, returning to Pandemonium, is received with loud applause by all his followers, which changes into a hiss as he and all his hosts are turned into crawling snakes.

After a time both Adam and Eve feel "sorrow unfeigned and humiliation meek" for their fault, and the archangel Michael is sent to tell them that their repentance will be accepted by God, and that at last the race will be redeemed; but meantime Paradise can no longer be their home. The angel having led them forth,

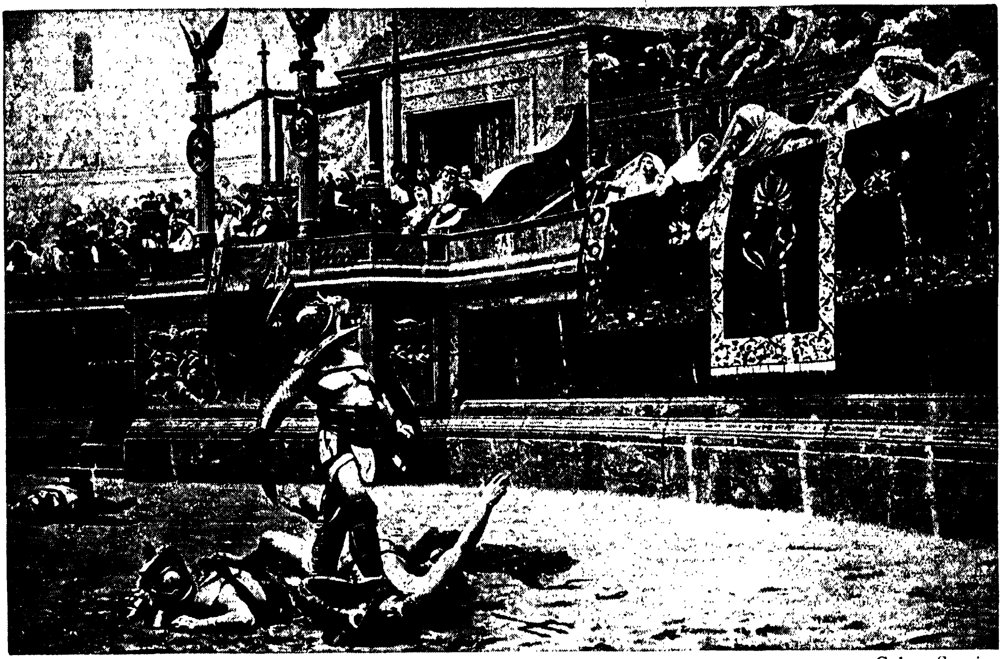
> Some natural tears they dropped, but wiped them soon,
> The world was all before them, where to choose
> Their place of rest, and Providence their Guide.
> They hand in hand, with wandering steps and slow
> Through Eden took their solitary way.

After writing his masterpiece, Milton, as a sequel, added PARADISE REGAINED, picturing the final defeat of Satan through our Lord's resistance of his temptations in the wilderness. This poem was printed in 1671.

With PARADISE REGAINED was included SAMSON AGONISTES, the last of Milton's writings, a drama modeled on the Greek style, which tells the Biblical story of Samson with profound pathos. The picture of Samson, shorn, blind, in the midst of his enemies, with the religious hopes of his nation beclouded, is a picture of Milton himself in his latter days. The story is nobly told.

Three years after the publication of SAMSON, Milton died, not an old man, as we count age now, not yet sixty-six, but his strenuous life passed and his noble youthful ambitions fulfilled. He is buried in St. Giles's Church, Cripplegate, London.

THE NEXT STORY OF LITERATURE IS ON PAGE 1477.



Culver Service

This painting by the French artist Gérôme shows a contest of gladiators in the arena at Rome.

THE STORY OF ANCIENT ROME

II. THE ROMAN EMPIRE

THE year 27 B.C. is generally held to be the last year of the Roman Republic. It was then that a government was set up in which the power was in the hands of a single man—Octavian. In certain respects, indeed, things did not seem to be greatly changed. There were still two consuls, elected by an assembly of Roman citizens. There was still a senate. No new offices or titles were created for Octavian's benefit. He served together with various lawfully elected officials of the state.

And yet, though Rome kept so many of her old institutions, she was subject to the will of Octavian. He held all the important offices of the state. He was the *imperator,* or commander-in-chief of the Roman armies; he had the power to raise troops, make war and peace and sign treaties. He was the governor of the provinces in which most of the troops were stationed. As tribune of the people, he could veto any act of the public officers or of the senate. As the censor, he directed the finances of the state and was the guardian of morals. In time he even became the *pontifex maximus,* or high priest of the Roman religion.

The senate still had a certain amount of power, but it was overshadowed by the supreme ruler. The citizens of Rome still voted for the consuls and other officials; but they were allowed to vote only for candidates carefully selected by Octavian—men upon whose loyalty he could count.

Octavian had several official titles. He was the *princeps civitatis,* or first citizen of the state; as we have seen, he was also the *imperator,* or commander-in-chief. It was as the *imperator,* or emperor, as we say in English, that the master of Rome came to be known. The country over which he ruled received the name of the Roman Empire.

The senate had given Octavian the surname, or additional name, of Augustus (aw-gus′-tus), which in Latin means Highly Honored. When modern historians tell of the doings of Octavian after the year 27, they usually refer to him, not as Octavian, but as the emperor Augustus, or simply as Augustus.

Octavian, or Augustus, as we shall call him from now on, was one of the greatest rulers of Rome. Like Julius Cæsar, he was a generous conqueror, who pardoned many of his former enemies and healed the wounds of civil war. In his long reign (27 B.C.-14 A.D.) he did many useful things. He reorganized the army; he drove corrupt men from public office; he reformed the administration of the provinces. He erected many fine public buildings. He is said to have boasted that he found Rome a city of brick and left it a city of marble.

There was peace in Italy during his reign, but outside of the peninsula the Roman armies had plenty to do. They fought the enemies of Rome in northern Africa, Spain, Gaul, Germany and the East. Almost everywhere they were victorious, and a number of new provinces were added to the Empire. The only serious defeat the Romans suffered was in the battle of the Teutoburger Forest (9 A.D.). In this battle the Germans under Arminius, or Hermann, cut to pieces three Roman legions, numbering over 15,000 men.

One of the most important events in the reign of Augustus aroused no public interest at all at the time it happened. This was the birth of Jesus in a stable at Bethlehem, in what is to-day Palestine. The Christian religion, inspired by the teachings of Jesus, was to become in time the official faith of the mighty Roman Empire.

Augustus breathed his last in 14 A.D.; he was succeeded by his son-in-law, Tiberius (ty-bee′-ri-us). Tiberius was a successful general, who had won many victories in Gaul and Germany; he proved to be a strong ruler. He set up a good system of taxation; he governed the provinces justly; he kept the enemies of Rome at bay. Yet he was unpopular among almost all the people.

Nero began his reign well, but became one of Rome's worst emperors.

He despised the people and made no effort to court their favor by means of gifts or entertainment. He took away from them the right to elect consuls and other officers. When they complained, he held them in check by means of his bodyguard, the famous Prætorian (pree-toh′-ri-an) Guard. Nor did he show much more respect for the senate, which showered him with slavish flattery.

Naturally this unpopular monarch had many enemies. To keep himself informed about them, Tiberius kept an army of spies and informers. These miserable creatures poisoned the mind of their master with accusations, many of them unfounded, against all kinds of people. As for the Emperor, he behaved with great cruelty toward those whom he suspected of plotting against him.

In 26 A.D., wearying of the cares of state, Tiberius retired to the beautiful island of Capri, near Naples. Here he lived a carefree life, while unworthy ministers governed in his name at Rome. In 37 he died, smothered, so it is said, by his servants.

It was in the reign of Tiberius that Jesus Christ died upon the Cross. His followers kept alive His memory and followed His teachings. At first these Christians, as the disciples of Christ were called, formed a small and unimportant group. But in time their numbers grew and they came to the attention of the Roman authorities. They soon knew terrible persecution.

Tiberius was followed on the throne by Gaius Germanicus. He was generally called Caligula (ca-li′-goo-la), because as a boy he had worn the *caligulæ*, or boots, commonly used by the soldiers. For the first eight months of his reign, Caligula was a good king. Then he fell ill. It is thought that his sickness affected his mind, for when he recovered his health he acted like a bloodthirsty madman.

He slew many Romans. In fact he once said that he wished the Roman people had but one head, so that he might cut it off with a single blow. Yet this unnatural monster was convinced that he was a god and he had temples built in his own honor. At last the Romans could no longer put up with him. He was assassinated in 41 by a band of conspirators, led by two officers of his army.

The soldiers of his bodyguard were looting the palace after their master's assassination when they came upon Claudius (claw′-di-us), a member of the royal family, hiding in a corner. This Claudius was quite a learned man, having written a number of books in Greek and Latin. But he was an ugly little creature, who stammered very badly, and nobody took him seriously. For some reason or other the soldiers decided to drag Claudius out of his hiding place and to proclaim him emperor.

The best that one can say of Claudius as a ruler is that he meant well. He allowed certain people whom Caligula had exiled to return to Rome. He made the city more beautiful with many fine buildings. In his reign Mauretania (now Morocco) was conquered and became a Roman province. Southern Britain was also added to the Empire.

Unfortunately, Claudius was greatly influenced by wicked advisers, who sold public offices to the highest bidders and committed many outrages. Toward the end of his reign he was also influenced by his second wife, Agrippina (ag-ri-py′-na). This ambitious woman, who stopped at nothing to carry out her plans, persuaded the emperor to adopt Nero (nee′-roh), her son by a former marriage. Then she succeeded in having Nero made heir to the throne instead of Britannicus, the emperor's own son. In 54 A.D. Claudius died. Some people think that he was poisoned by Agrippa, who was anxious to see her son on the throne.

Nero succeeded his stepfather when he was only seventeen years old. Agrippina had provided him with excellent tutors, one of whom was the famous writer Seneca (sen′-e-ca). The young Emperor seemed to profit by the advice of his teachers and at first he governed well. But then the possession of unlimited power proved to be too much for him and he did many wicked things.

He put to death his stepbrother Britannicus, his mother Agrippina and many others; he drove his old teacher Seneca to take his own life. And yet this cruel monarch loved art and literature and music and the beautiful things of life. He thought himself a great poet, actor and musician; and many of his followers eagerly hailed him as such.

The Prætorian Guards announcing by force their choice of emperor

In 64 A.D. a great fire broke out at Rome. It lasted for a week; a good part of the city was burned to the ground. It was generally believed at the time that Nero had set the fire himself in order to have a good background for a play based on the burning of Troy—a play in which he himself was to act. It is not certain that Nero had anything to do with the fire. At any rate he cast the blame for it upon the Christians, and he caused them to be cruelly persecuted during the rest of his reign.

THE DEATH OF NERO AT THE HAND OF A SLAVE

Finally Nero, like Caligula before him, exhausted the patience of the Romans. In 68 Galba, the governor of Spain, revolted against him and the revolt spread rapidly. The Prætorian Guard at Rome declared for Galba; the senate pronounced sentence of death upon the Emperor. Realizing that he was lost, Nero had one of his slaves run him through with a sword. His last words are said to have been: "What a great actor Rome loses in my death!" Galba was proclaimed emperor in his place.

Galba did not rule very long. He was slain in January, 69, by his former friend Otho, who then became emperor. After a few months Otho was overthrown in his turn by Vitellius, who commanded the Roman armies in Germany. But the troops in the East would not accept Vitellius as emperor; they declared in favor of their beloved leader, old Vespasian (ves-pay'-zhi-an). And before the year 69 came to an end, Vitellius, deserted by all, was murdered by a common soldier and the venerable Vespasian became emperor.

Vespasian ruled well. He brought about many economies in the government; he restored discipline in the army. He often served as a judge himself, so that his people might be assured of justice. In the second year of his reign Jerusalem, the holy city of the Jews, was captured by Titus (ty'-tus), the Emperor's son, after a famous siege in the year 70.

Titus succeeded to the throne after the death of his father in 79. He was a kindly man and was greatly beloved by the people. When a day passed without his having done a good deed, he would exclaim: "I have lost a day!" In the reign of Titus there was a violent eruption of the volcano Mount Vesuvius, which buried the towns of Pompeii and Herculaneum under mountains of ash and cinders (79). In modern times the two towns have been dug up, in large part, from their covering of ash and soil. They give us intimate glimpses into the everyday life of the old Romans.

Titus died in 81 after a short reign of two years. He was succeeded as emperor by his cruel brother Domitian (doh-mish'-an), who followed in the footsteps of Caligula and Nero. Domitian combined a great love of pleasure with a suspicious nature that led him to consider all men as his enemies. He put many citizens to death and in time no man felt safe from the despot. In the year 96 this wicked emperor was killed by a freedman (that is, a slave who had received his liberty).

THE GOOD EMPERORS WHO FOLLOWED THE CRUEL DOMITIAN

For almost a century after the death of Domitian, Rome had a succession of good and wise rulers. The first of these was a senator, Nerva, who came to the throne at the ripe age of sixty-four and who ruled for two years. He carried out many useful reforms, but he was hampered by the Prætorian Guard, which had become very haughty. Nerva decided that a strong man was needed as emperor. He therefore adopted as his son Trajan (tray'-jan), a skillful general, and made him the heir to the throne.

Trajan was a strong man, indeed, and a very fine ruler. He did away with the spies and informers who had flourished under some of the former emperors. He enforced the wise laws of Nerva; he kept the rebellious Prætorian Guard under control. He encouraged the cause of learning and founded a number of libraries.

UNDER TRAJAN THE ROMAN EMPIRE REACHED ITS GREATEST EXTENT

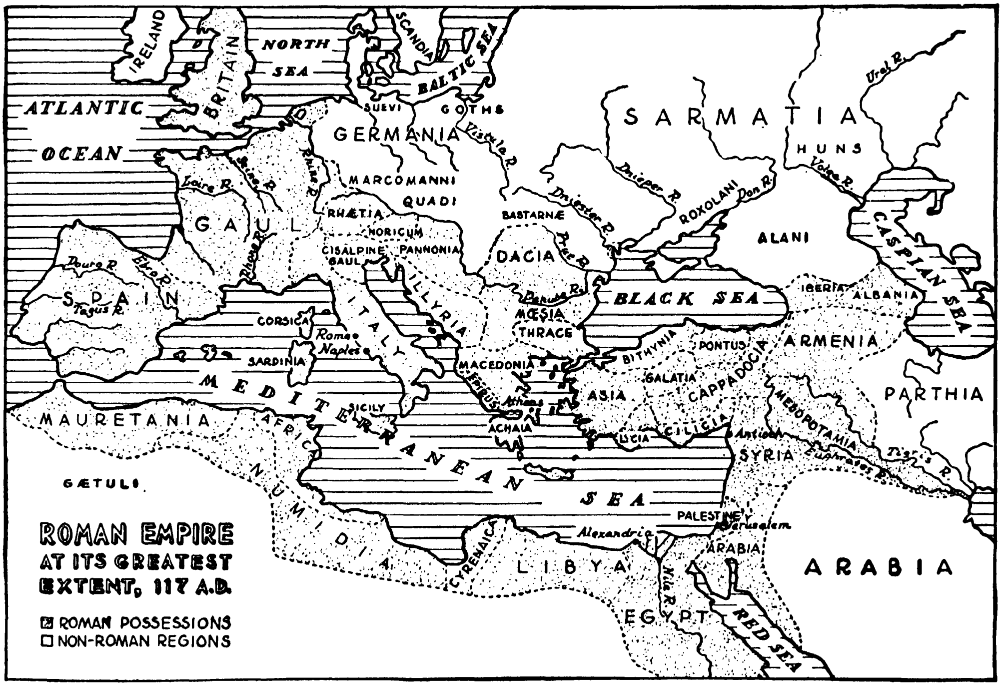
He was not only a good ruler but a great conqueror; under him the Roman Empire reached its greatest extent (see the map on page 1247). He fought two wars with Dacia (modern Rumania) and finally made a Roman province of that land. The Emperor also invaded the powerful state of Parthia, in the East, and he won for Rome the Parthian territories of Armenia, Mesopotamia and Assyria.

The Parthians continued to threaten, however, and Trajan's last campaign against them was not very successful. Worn out by constant fighting, the Emperor had to leave his armies. He started for Rome, but before he could reach the city he died, in the year 117. There was widespread mourning at the death of Trajan, who had been given the title of Optimus, or Best, by the senate. For many years thereafter, when a new emperor mounted the throne, the senators were accustomed to wish that he might be more fortunate than Augustus and better than Trajan.

Trajan's nephew, Hadrian (hay′-dri-an), succeeded him as emperor. Hadrian adopted a prudent foreign policy. He believed that it would be difficult for the Empire to defend its greatly extended boundaries. Therefore he gave up some of Trajan's conquests —Armenia, Mesopotamia and Assyria—and made peace with the Parthians. He had no difficulty in defending the new boundaries in his reign.

In the year 119 he set out to visit the various regions of the Empire. He went on foot whenever possible, marching twenty miles a day and sharing cheerfully the fare of the humblest soldier of his escort. He visited Gaul, Germany, Britain, Spain, Mauretania, Egypt, Asia Minor and Greece. While in Britain, he built a famous series of fortifications, known as Hadrian's Wall, a little to the south of the present boundary between England and Scotland. Traces of Hadrian's Wall still remain.

Hadrian was followed on the throne in 138 by Titus Aurelius Antoninus, who is generally known to history as Antoninus Pius (an-toh-ny′-nus py′-us; *pius* means dutiful in Latin). He was a splendid ruler, who devoted himself to the welfare of Italy and the provinces. The Empire was peaceful and prosperous in his reign. He adopted as his son and successor a brilliant young scholar, Marcus Annius Verus, who took the name of Marcus Aurelius Antoninus. No monarch ever made a wiser choice.



In Trajan's reign, the Roman Empire stretched from Britain on the west to the Caspian Sea on the east.

Marcus Aurelius Antoninus, or Marcus Aurelius (oh-ree′-li-us), as he is generally called, was perhaps the noblest of the pagan emperors. He was a Stoic philosopher, who thought of duty as something sacred (see page 1865). Certainly no monarch ever worked more unselfishly to make his people happy. He reformed the criminal laws, which had provided terribly severe punishments for crimes great and small. He made promotion in public office depend on merit alone and not on rank. He did much for the slaves, for children, for the poor. To help those who were overburdened with taxation, he caused all tax claims to be heaped in the Forum (public square) and burned.

Rome's borders were seriously threatened in this reign. The Parthians invaded the Roman possessions in the East and they were beaten only after years of hard fighting. Then a number of German tribes—the Marcomanni and the Quadi among others—broke into the Empire from the north. The Emperor led his armies against them and won many victories. Yet he never succeeded in driving out these barbarians altogether. He had to let a number of them settle in the northern provinces of the Empire.

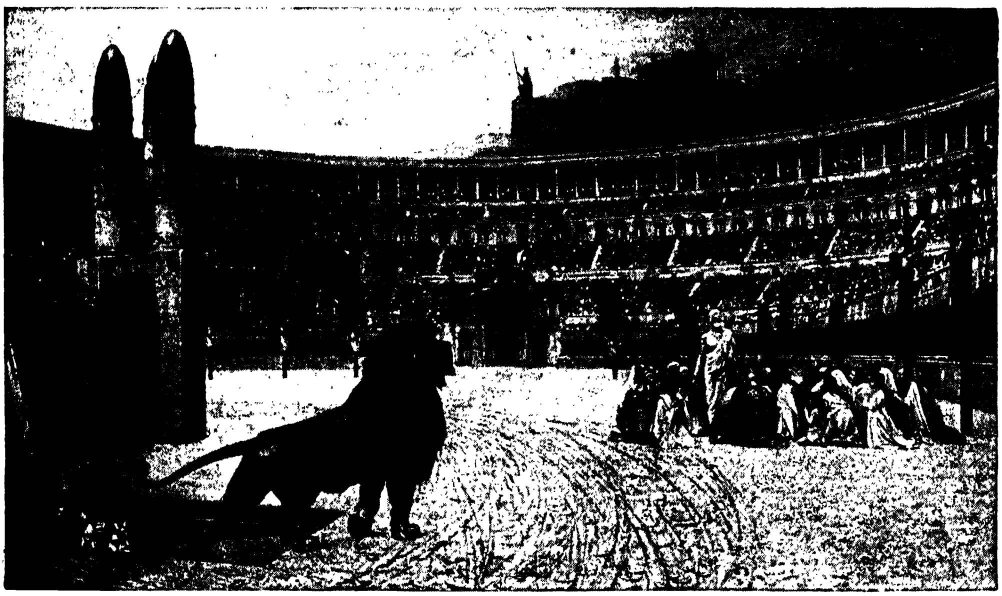
It seems strange, indeed, that this good emperor was one of the sternest foes of Christianity. He shared the belief, generally held among pagans, that the Christians were engaged in a secret conspiracy against the Empire. He thought, therefore, that he was doing his duty as a ruler in issuing a number of severe edicts against them.

The death of Marcus Aurelius in 180 brought to an end the golden era of the Roman Empire—an era that began with the rule of Nerva in 96. It was one of the happiest periods in the history of mankind. The barbarians who often attacked the outer boundaries of the Empire were held in check. There was peace at home. All citizens were assured of justice. The provinces were fairly treated; they were no longer left to the mercy of cruel governors and greedy tax collectors, as had often been the case in the last century of the Republic.

Roman civilization reached an advanced state. Commerce flourished. Hundreds of ships plied the Mediterranean Sea in every direction. There were wonderful roads in all parts of Italy and in many of the provinces, too. Aqueducts brought fresh water to cities from outlying hills and mountains. There were fine temples, schools, libraries, baths and amphitheatres.

But the Empire, alas! had certain serious weaknesses. For one thing, it rested on the foundation of human slavery. It is true that slaves were treated better under the Empire than in the days of the Republic. Some of them managed to put aside money, with which they bought their freedom; others were freed by provisions of their masters' wills. But the lot of the slaves was hard, nevertheless. They were sometimes brutally treated by cruel masters. When they had to testify in court, they were often tortured.

Slavery was also a bad thing for slave-owners and indeed for all the free men of the Empire. The wealthy citizens, attended by armies of slaves, became lazy creatures who never did anything for themselves. As for the poor, they found it hard to meet the competition of slave labor in industry and in agriculture. Many gave up the struggle to make a living and joined the idle mobs of Rome and the other large cities. Here, at



Culver Service

Christian prisoners in the Colosseum at Rome thrown to wild beasts, while pagan Romans enjoy the spectacle. Persecution of Christians burned fiercely at times during the first and second centuries. This picture is by Gérôme.

Culver Service

A slave market in Rome. The figure in front, with a whip over his arm, is himself a slave, whose brutal task it is to keep the others in order. Slavery was one of the weaknesses of the Roman Empire. It made the people lazy and cruel and unfit, and in the end contributed to the fall of the Empire.

least, they could have "bread and circuses," as the great Roman poet Juvenal put it—that is, free grain and free admission to the sports of the arena.

Some of these so-called sports were a blot upon a great civilization. Often men called gladiators fought each other to the death for the entertainment of the spectators. On other occasions condemned criminals were torn to pieces by lions and tigers and leopards. (Some of these condemned criminals were wicked men and women; others were innocent people, who, like the Christians, were persecuted by the authorities.) Spectacles like these made heartless brutes of those who watched them.

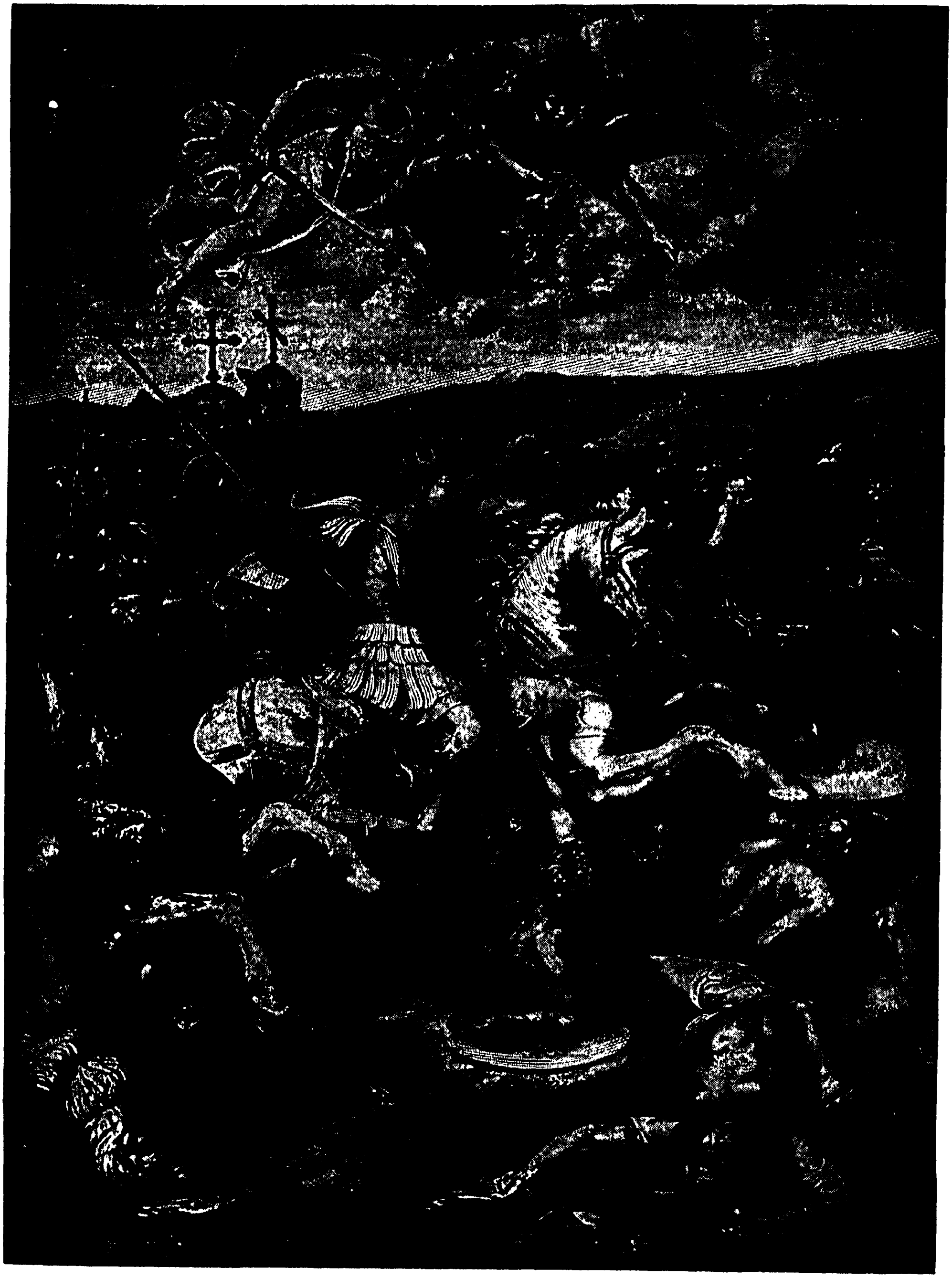
There was a time when the men of Rome and of Italy were reckoned among the finest soldiers of the world. In the days of the Empire, however, neither the idle rich nor the idle poor were good soldier material. More and more the Roman armies had to be recruited from the comparatively unspoiled men of the conquered provinces — Gaul, Spain, Africa, Syria. In time the emperors enrolled under their banners the fierce Germanic tribes of the north and the even fiercer Huns of central Asia.

Now these men were not stirred by the patriotism that had led the Romans of the Republic to fight to the death against Pyrrhus and Hannibal. They gave obedience only to their leaders and sometimes not even to their leaders. As time went on, they made and unmade emperors. They contributed much to the growing anarchy that finally resulted in the fall of the Empire.

The successor of Marcus Aurelius was his unworthy son, Commodus (com′-oh-dus), who reigned from 180 to 192. He was a cruel man, who did many wicked things. Yet he won the favor of the people by providing brilliant spectacles in the amphitheatres of Rome. In fact he himself took part in the sports of the arena, clad in a lion skin like the mythical hero Hercules. Commodus was slain in 192 by some of his followers.

The senate named Pertinax, one of their body, as the successor of Commodus. The soldiers of the Prætorian Guard now decided to take matters into their own hands. They deposed Pertinax and had him put to death. Then they put the throne of the Empire up at auction and sold it to the highest bidder—the senator Didius Julianus. The Roman armies in the field refused to obey this corrupt creature. Soon three claimants to the throne were busily fighting one another.

CONSTANTINE AND HIS TROOPS IN BATTLE



When Diocletian gave up his throne, great strife soon arose in Rome as to who should be emperor, and the victor was Constantine the Great. Constantine is famous in the world for many things. He was the first emperor to accept Christianity. Diocletian had tried to destroy it; Constantine made it the state religion of the empire. He built Constantinople, and made it the centre of his government. Here was built up a new empire, which took to itself the power of Rome when Rome's greatness passed away. Constantine's father lived in Britain as a Roman soldier before he came to the throne, and it is said that he married the daughter of an inn-keeper, who became Constantine's mother, and who now lies in a beautiful tomb among the glorious sculptures and paintings in the palace of the pope at Rome.

The successful claimant, Septimius Severus (se-vee′-rus), an African general, was a strong ruler, who restored law and order. Unfortunately he granted all sorts of favors to his soldiers, who had helped him win his crown. This unwise policy was a bad thing for discipline. It made the soldiers feel that they were a privileged class, set above the laws.

Severus was succeeded in 211 by his son Caracalla (ca-ra-cal′-lah), an evil tyrant. His reign was chiefly noteworthy because an edict of 213 gave the right of Roman citizenship to the inhabitants of all the provinces. Caracalla's object in issuing the edict was a selfish one; he aimed only to add to the great army of citizen taxpayers.

Following the assassination of Caracalla in 217, the Empire entered upon a period of wild confusion. In the next seventy years there were more than twenty emperors, to say nothing of usurpers who arose in many of the provinces. Almost all these rulers were chosen by the Prætorian Guard or by the armies in the provinces. Civil war became the normal condition in the Empire at this time.

Culver Service

Attila, leader of the Huns.

The enemies of Rome took advantage of the unrest in the Empire to burst in upon its frontiers. In the north and northeast these invaders included the Germanic tribes of the Alemanni, the Franks and the Goths. In the east there was the newly restored Persian kingdom, which claimed for its own all the Asiatic possessions of Rome. The Roman armies gave way everywhere; it seemed that all was lost. To add to the distress of the times, a pestilence that raged for some fifteen years (251-65) carried off half the people of the Empire.

In 270 the fortunes of the Empire revived somewhat when the brave general Aurelian (oh-ree′-li-an) mounted the throne. He accomplished a good deal in the five short years of his reign. He drove the barbarians beyond the Danube River; and he overthrew the kingdom of Palmyra, which had seized some of Rome's eastern provinces.

In 284 another able ruler came to the fore. This was the emperor Diocletian (dy-oh-clee′-shan), a man of humble birth. Diocletian introduced some of the ceremonies of an Oriental court. He took the title of Dominus or Lord; he wore a royal diadem. Those approaching him had to kneel and bow their heads to the ground.

He decided after a time that he could not rule all by himself, and so he named another man, Maximian, as co-emperor (fellow-emperor). The two rulers were known as Augusti (aw-gus′-ty; the plural form of Augustus in Latin). Later Diocletian named Constantius and Galerius as Cæsars—junior emperors, so to speak. The Empire was now divided into four parts, each with its own ruler. In theory Diocletian was only one of four monarchs; but he managed to keep most of the power in his own hands.

Diocletian's reign was marked by fierce persecution of the Christians. Yet on the whole his rule was beneficial. He improved the administration of the Empire; he reformed the system of coinage; he encouraged trade and commerce. In 301 he issued an edict fixing the maximum price that could be charged for various goods and also setting up a maximum rate of wages—a forerunner of the price and wage ceilings established in World War II. This edict did not work out particularly well in practice.

In 305 Diocletian resigned his emperial throne and forced his fellow-emperor to do likewise. They were succeeded by the two Cæsars, Constantius and Galerius, who became Augusti, and two new Cæsars were created. A period of great disorder followed; at one time there were six Augusti in the field. At last, in 324, Constantine I, son of Constantius, united the Empire under his rule.

This monarch, who is known as Constantine the Great, ruled wisely. Like Diocletian before him, he patched up the Empire and enabled it to survive for a while longer. His reign is particularly important because it was then that Christianity became the official religion of the Empire. From that time on, except for a brief period of two years (361-63), all the emperors were Christians. It was now the turn of the pagan religions to undergo fierce persecution.

It is interesting to note that Constantine, who did more for the Christians than any other emperor, was not a very firm believer in Christianity. He acted as *pontifex maximus,* or leader of the pagan faith, during a large part of his reign; he became a Christian himself only when he was on his deathbed. He seems to have advanced the interests of Christianity because he felt that it would help to preserve the tottering Empire.

Constantine built a new capital city on the site of the old town of Byzantium, on the European side of the Bosporus. He called this city Constantinople (City of Constantine, in Greek); it was also known for a time as Nova Roma or New Rome. The city of Rome was no longer the centre of the Empire. It continued to be important, however, as the seat of the powerful bishop of Rome, the most important Christian leader in the West. Under the title of pope, the bishop of Rome was to become the head of the Roman Catholic Church.

Upon the death of Constantine, the Empire was divided up among his three sons, Constantine, Constantius and Constans. The old story of civil war and disunion was repeated, until, in 350, the Empire was again in the hands of a single ruler, Constantius II. In 355 Constantius made his cousin Julian a Cæsar and placed him in charge in Gaul, where a pretender to the throne had raised an army. After a time Constantius quarreled with Julian and civil war was about to break out. But before the two men could come to blows, the Emperor died and he was succeeded by Julian (361).

Julian is generally known as the Apostate. An apostate (ah-pos′-tate) is a man who abandons his faith; Julian received this name because he had been brought up as a Christian and had later turned to the worship of the pagan gods. Though Julian did not persecute the Christians, he did what he could to restore pagan worship. He was killed in the year 363 while leading an army against the Persians.

Things went from bad to worse under the following emperors. The barbarians from the north and northeast kept pouring into the Empire. At first the emperors tried to appease them by enrolling them in their own armies and by giving their leaders military command. This policy did not work out well in the long run. The leaders of the barbarians were not content to be the servants of the emperors; they became the real masters of the Roman state.

Culver Service

The entrance into Rome of Alaric the Visigoth, in the year 410. Alaric's men looted the city.

The end of the western part of the Roman Empire. Augustulus, the boy emperor, stands by as a kneeling servant yields up the crown to Odoacer the barbarian. The year is 476.

The onrush of the barbarians was halted for a time by Theodosius (thee-oh-doh'-shi-us) the Great, who was a co-emperor from 379 to 392 and sole emperor from 392 to his death, in 395. Theodosius defeated the Visigoths, or West Goths, in several pitched battles, but he did not succeed in driving them from the Empire. He permitted them to settle south of the Danube River, and they became, for the time being, the allies of the Roman Empire.

When Theodosius died in 395, the Empire was divided among his two sons, Honorius and Arcadius; Honorius was given the West, and Arcadius, the East. From this time on the two parts of the Empire became separate states, to all intents and purposes; rarely did their paths meet again. We must follow them separately.

The Eastern Empire, with its capital at Constantinople, continued to exist for many centuries to come; it became known as the Byzantine Empire. It was really rather a Greek than a Roman state; its official language came to be not Latin, but Greek. We tell you the story of the Byzantine Empire in another article.

As for the Western Empire, its days were numbered. The barbarians who had settled within its boundaries kept pressing toward Italy and Rome itself. The tide of invasion was checked for a time by the brave Stilicho (stil'-i-coh), himself a man of German descent, adviser to the emperor Honorius.

After Stilicho's death, the Germans overran Italy. In the year 410 Rome was captured by the Visigoths under Alaric (al'-a-ric), whose men robbed and ravaged the city. The Visigoths then passed on to Gaul and set up a kingdom there. Other Germanic hordes settled in Spain. The troops of the Empire were withdrawn from England.

Poor, weak Honorius died in 423 and was succeeded by Valentinian III, who ruled until 455. Africa was now lost to the Empire; it was conquered by the Vandals, a German tribe. Toward the end of this reign the Empire was invaded by the Huns, a savage Asiatic people, led by the bloodthirsty Attila (at'-i-la). A Roman general called Ætius (ay-ee'-shi-us) led a mixed army of Romans and Visigoths against the Huns and routed them in the great battle of Châlons (451). It was the last important military triumph of the Western Roman Empire.

Valentinian was murdered in 455. For the next twenty years there was a succession of puppet emperors. They were made and unmade by two powerful military leaders—Ricimer and, after him, Orestes. In 475 Orestes dethroned the ruling emperor, Julius Nepos, and put his own little son, Romulus Augustulus, on the throne.

The boy emperor did not rule long. A band of barbarian soldiers under Odoacer (oh-doh-ay'-ser) revolted in 476 against the boy ruler and his ambitious father. Orestes was slain; little Romulus was retired to private life. Odoacer cared nothing for the showy title of emperor, which had come to mean so little in the West. He proclaimed himself, not emperor of Rome, but king of Italy. Furthermore, he acknowledged the Eastern emperor at Constantinople as his master. And so, with the coming of Odoacer, the Western Roman Empire disappears from the pages of history.

For many centuries ancient Rome has been only a memory; yet this remarkable state has continued to influence the nations of Europe and of the Americas. Our laws, our systems of government, our architecture and our literature owe much to those of the old Romans. Latin, the language of Rome, has always been the official tongue of the Roman Catholic Church. Furthermore it has left its mark upon practically all the languages of the Western world. Some of these, such as French, Spanish, Portuguese and Italian, represent modern developments of Latin. Their name—the Romance languages—shows that this is so, for Romance comes from the Old French *romanz:* "in the Roman tongue." Others, including our own English, have borrowed a great deal from the language of the ancient Romans.

Countless monuments and relics of all kinds bear witness to the greatness of the Roman state. They are to be found in many lands—in Italy, Germany, France, Spain, England, even in northern Africa. These temples and aqueducts and amphitheatres and statues constantly remind us that even the greatest empires must some day perish.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 1315.

REIGNS OF THE ROMAN EMPERORS

B.C. 27–A.D. 14. Augustus.
A.D. 14–37. Tiberius.
37–41. Gaius Germanicus (called Caligula).
41–54. Claudius.
54–68. Nero.
68–69. Galba.
69. Otho.
69. Vitellius.
69–79. Vespasian.
79–81. Titus.
81–96. Domitian.
96–98. Nerva.
98–117. Trajan.
117–38. Hadrian.
138–61. Antoninus Pius.
161–80. Marcus Aurelius.
180–92. Commodus.
192–93. Pertinax.
193. Didius Julianus.
193–211. Septimius Severus.
211–17. Caracalla.
217–18. Macrinus.
218–22. Elagabalus.
222–35. Alexander Severus.
235–38. Maximinus.
238. Gordian I and Gordian II.
238. Papienus and Balbinus.
238–44. Gordian III.
244–49. Philip.
249–51. Decius.
251–53. Gallus.
253–60. Æmilianus.
260. Valerian.
260–68. Gallienus.
268–70. Claudius.
270. Quintilius.
270–75. Aurelian.
275–76. Tacitus.
276–82. Probus.
282–83. Carus.
283–84. Carinus and Numerian.
284–305. Diocletian; associated after 286 with Maximian.
305–11. Constantius I and Galerius.
311–24. Constantine I and Licinius.
324–37. Constantine I (sole emperor).
337–50. Constantine II, Constantius II and Constans.
350–61. Constantius II (sole emperor).
361–63. Julian.
363–64. Jovian.

Western Empire

364–75. Valentinian I.
375–83. Gratian and Valentinian II.
383–92. Valentinian II.

Eastern Empire

364–79. Valens.
379–92. Theodosius I.

392–95. Theodosius I (sole emperor).

Western Empire

395–423. Honorius.
423–55. Valentinian III.
455. Maximus.
455–57. Avitus.
457–61. Majorian.
461–67. Severus.
467–72. Anthemius.
472–73. Olybrius.
473–74. Glycerius.
474–75. Julius Nepos.
475–76. Romulus Augustulus.

Eastern Empire

395–408. Arcadius.
408–50. Theodosius II.
450–57. Marcian.
457–74. Leo I.
474. Leo II.
474–91. Zeno.

(The Eastern Empire continued to survive, as the Byzantine Empire, until 1453.)

THE STORY OF DAVID

Illustrated by James Daugherty

DOWN from the hills of Bethlehem in the ancient land of the Israelites came David, a young shepherd. The king of this land, Saul, driven to despair by an evil spirit sent by God to plague him, had searched for something, for somebody, to relieve his misery. When he had heard of David and the skill with which he played on the harp, Saul had ordered his servants to summon the lad to him, and David came. The young shepherd played for Saul, and the evil spirits vanished. The King was happy again. Now he kept David with him at his court; and he loved the boy.

But there came threats of war to the land of Israel, from the Philistines.

Now the Philistines gathered together their armies to battle. And Saul and the men of Israel were gathered together. And the Philistines stood on a mountain on the one side, and Israel stood on a mountain on the other side: and there was a valley between them.

And there went out a champion out of the camp of the Philistines, named Goliath, of Gath, whose height was six cubits and a span (over ten feet). And he had a helmet of brass upon his head, and he was armed with a coat of mail. And he stood and cried out unto the armies of Israel:

"Why are ye come out to set your battle in array? Choose you a man for you, and let him come down to me. If he be able to fight with me, and to kill me, then will we be your servants; but if I prevail against him, and kill him, then shall ye be our servants, and serve us. Give me a man that we may fight together."

When Saul and all Israel heard those words of the Philistine, they were dismayed and greatly afraid.

Now David was the son of Jesse; and the three eldest sons of Jesse followed Saul to the battle, but David returned to feed his father's sheep at Bethlehem.

And Jesse said unto David, his son: "Take now for thy brethren an ephah (six gallons) of this parched corn, and these ten loaves, and run to the camp of thy brethren."

And David rose up early in the morning, and left the sheep with a keeper, and went as Jesse had commanded him, and he came to the trench and saluted his brethren.

And as he talked with them, behold, there came up the champion, Goliath, and spake according to the same words: and David heard them. And all the men of Israel, when they saw the man, fled from him, and were sore afraid.

And David said to Saul, the king: "Let no man's heart fail because of him; thy servant will go and fight with this Philistine."

And Saul said to David: "Thou art not able to go against this Philistine to fight with him; for thou are but a youth, and he a man of war from his youth."

And David said unto Saul: "Thy servant kept his father's sheep, and there came a lion, and a bear, and took a lamb out of the flock. And I went out after him, and smote him, and delivered it out of his mouth; and when he arose against me, I caught him by his beard, and smote him, and slew him.

"Thy servant slew both the lion and the bear; and this Philistine shall be as one of them, seeing he hath defied the armies of the living God."

And Saul said unto David: "Go, and the Lord be with thee."

And Saul armed David with his armor, and he put an helmet of brass upon his head; also he armed him with a coat of mail.

And David said unto Saul: "I cannot go with these."

But David took his staff in his hand, and chose him five smooth stones out of the brook, and put them

After young David had killed Goliath with his slingshot, he wielded the giant Philistine's great sword.

in a shepherd's bag which he had; and his sling was in his hand: and he drew near to the Philistine.

And when the Philistine looked about and saw David, he disdained him: for he was but a youth and of a fair countenance. And the Philistine said unto David: "Am I a dog, that thou comest to me with staves?"

And the Philistine cursed David by his gods. And the Philistine said to David: "Come to me, and I will give thy flesh unto the fowls of the air, and to the beasts of the field."

Then said David to the Philistine: "Thou comest to me with a sword, and with a spear, and with a shield: but I come to thee in the name of the Lord of hosts, the God of the armies of Israel, whom thou hast defied."

And it came to pass, when the Philistine arose, and came and drew nigh to meet David, that David hasted, and ran toward the army to meet the Philistine.

And David put his hand in his bag, and took thence a stone, and slang it, and smote the Philistine in his forehead, that the stone sunk into his forehead: and he fell upon his face to the earth.

So David prevailed over the Philistine with a sling and a stone, and smote the Philistine, and slew him.*

THE GREAT FRIENDSHIP OF DAVID AND THE KING'S SON

Jonathan, the son of Saul, admired the courage of this young warrior. The two made a vow of friendship, and Jonathan gave to David his robe, his sword, his bow, and his jeweled belt. He loved the shepherd boy as his own soul.

At first Saul, too, loved David, but his love turned to jealousy. Passing through the city, he heard the people shouting, "Saul hath slain his thousands, and David his ten thousands." This aroused the evil spirit within him once more, and he tried to slay David with his javelin. When the attempt failed, he ordered Jonathan to kill David. Jonathan, disobeying his father, refused to harm his friend; but he advised David to flee into the desert to escape the wrath of Saul, the king; and David fled.

Many men gathered around David and formed an army to help the persecuted and the troubled in the land. When Saul learned this, his anger became greater. He led his army on David's trail, but God was with David and protected him. Still Jonathan remained loyal to his friend and repeated his vows of friendship. He said to him, "Fear not: for the hand of Saul my father shall not find thee; and thou shalt be king over Israel and I shall be next unto thee; and that also my father knoweth."

DAVID LAMENTS THE DEATH OF SAUL AND JONATHAN

David passed with his army into Gath, the land of the Philistines. Their king had great faith in David and asked him to join with the Philistines against Saul. But many of the Philistines did not trust David and would not allow him to go up with them to the battle. As he waited for reports of the fighting, a messenger of the Philistines rushed into camp and breathlessly spoke these words, "The people are fled from the battle, and many of the people also are fallen and dead; and Saul and Jonathan his son are dead also."

And David said to him, "How knowest thou that Saul and Jonathan his son be dead?"

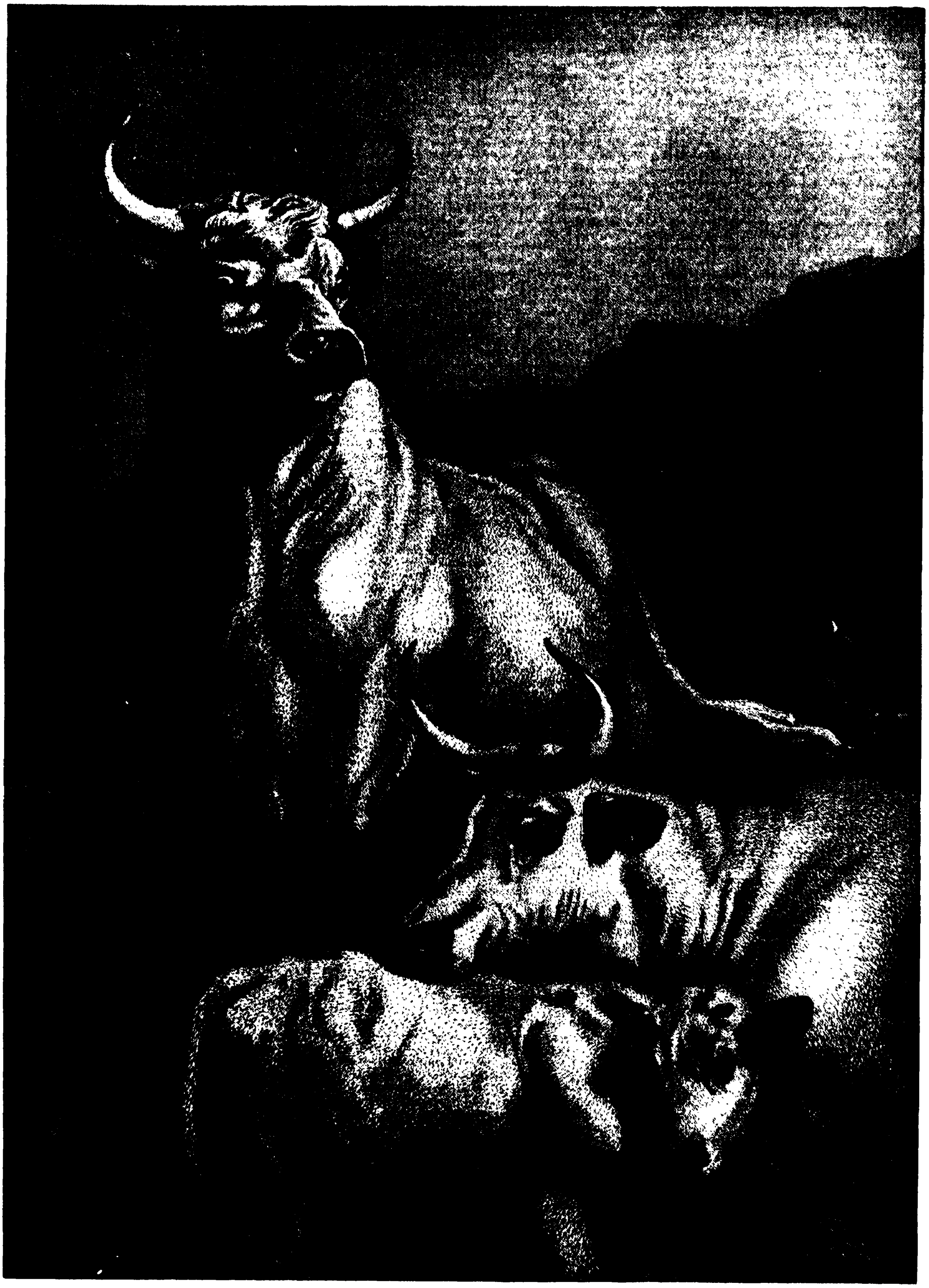
When the messenger swore that he had seen Jonathan fall, that he himself had slain Saul, David ordered him put to death.

Then David lamented over his king and Jonathan his friend, for he could not hate the man who hated him, and his love for Jonathan would never be forgotten:

> "The beauty of Israel is slain upon thy high places: how are the mighty fallen! From the blood of the slain, from the fat of the mighty, the bow of Jonathan turned not back, and the sword of Saul returned not empty. Saul and Jonathan were lovely and pleasant in their lives, and in their death they were not divided: they were swifter than eagles, they were stronger than lions. How are the mighty fallen in the midst of the battle! O Jonathan, thou wast slain in thine high places. I am distressed for thee, my brother Jonathan: very pleasant hast thou been unto me: thy love to me was wonderful, passing the love of women. How are the mighty fallen, and the weapons of war perished!"*

*Condensed from the Old Testament, First Samuel, XVII.

THE NEXT GOLDEN DEEDS ARE ON PAGE 1610.



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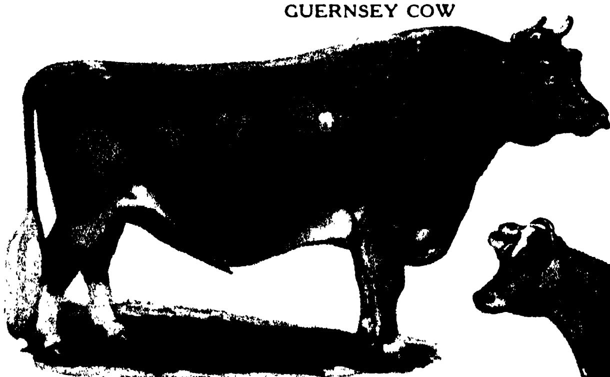
are in England, protected in enclosures, a few herds of these partly wild cattle, but they are not much like the original aurochs. Careful control of the breeding stock has changed their color from dun to white, although dark-colored calves are born from time to time. Centuries ago there were herds of wild cattle in many parts of Europe; and it was considered great sport to hunt them. They disappeared from Central Europe only within the last half-century.

SOME FAMOUS DAIRY BREEDS

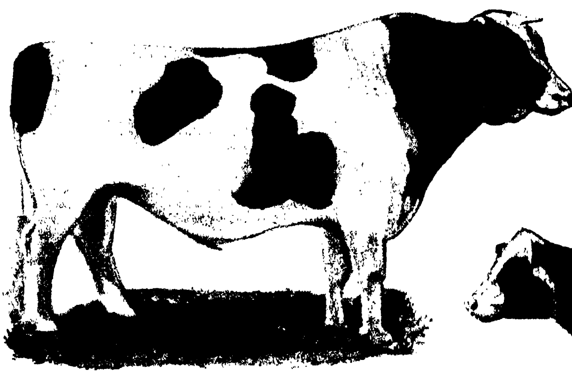
GUERNSEY COW

GUERNSEY BULL



JERSEY BULL

JERSEY COW



HOLSTEIN BULL

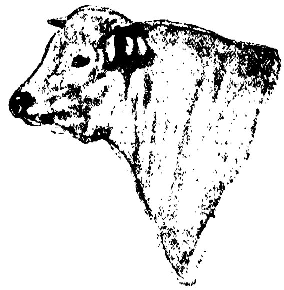
HOLSTEIN COW

Cattle are divided into beef and dairy breeds. Guernseys and Jerseys came from the islands of the same names, in the English Channel, between England and France, but are now found everywhere. Their milk is very rich. Holsteins, or Holstein-Friesians, much larger cattle, originated in the Netherlands. They give more milk, but it is not so rich as that of some other breeds.

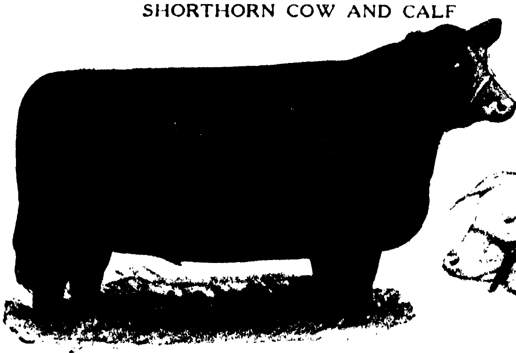
Pictures by courtesy of The Field.

BREEDS ORIGINATING IN GREAT BRITAIN

SHORTHORN COW AND CALF



SHORTHORN BULL



ABERDEEN-ANGUS

HEREFORD

AYRSHIRE BULL

AYRSHIRE COW

These are chiefly beef cattle and all were developed in Great Britain, though some of the best specimens are now bred in Canada and the United States. Some families of Shorthorns are good milkers. The Aberdeen-Angus and the Herefords furnish excellent beef. The Ayrshire, one of the best dairy breeds, originated in Scotland.

Pictures by courtesy of The Field.

C. I. A. A. Photo

Plowing a mountain field with oxen not far from Caracas, Venezuela.

CATTLE, TAME AND WILD

LONG ago all men lived by hunting, fishing, gathering the fruits of the forest and digging wild roots and bulbs. There were only a few people then, as compared with now, and they did not generally live so long. One reason for this was that when anything happened to the natural crops or the game, many died of starvation. Then one day someone tamed a young wolf and trained it to help in the hunt. The wolf-dog was the first of the wild animals to come into man's home and help him to get food.

After dogs had been tamed and trained for a time, another man decided that cattle could be tamed, too. It would be a good thing, he thought, to keep a few calves until they grew large and until a time of need came. But this was not easy. The wild cattle of Europe and Asia were great, fierce animals. The bulls would fight lions and bears, and they were dangerous game for the poorly armed men, even when the men were helped by dogs. Perhaps the first calf in captivity was secured when a cow was killed and the partly grown calf stayed with its mother when the herd ran away. Later other calves were caught in this way, and so men learned to keep herds and breed cattle.

A long period of human history followed when the most civilized groups of men depended greatly on their herds of cattle and other animals. They lived in tents and moved from pasture to pasture. They learned to use milk and make cheese and butter. They lived largely on these products and on the flesh of their herds. Clothing was made out of the skin of their animals and their dogs were trained to help keep the herds together and protect the beasts from wild animals. The Biblical Fathers—Abraham, Isaac and Jacob —lived this pastoral life and even recently many peoples in the East and in Africa have known no other existence. The herds were the first property of importance. An ox was considered almost as valuable as a man and stealing or killing one was among the worst of crimes.

While some men had herds of cattle, others in the favorable parts of the world began cultivating the plants that were good to eat. At first all work was done with a hoe or a sharp, bent stick which could be pulled through the earth by one person while another held it down—the first plow. The idea came to somebody to make the cattle do this hard work, for cattle are strong; so an ox was tied to the plow and was led around the field dragging the crude implement. The yoke, a wooden collar that fitted against the shoulders without choking the animal, improved the way the ox could pull; it was invented early in historical times. The use of these powerful animals made plowing easier and much more land could be prepared for planting during the proper season. People learned to train the oxen, to guide them by shouts or by a rope attached to a ring set in the sensitive nose. A sharp-pointed stick was used to urge them on when they were lazy.

OXEN WERE THE CHIEF WORK-ANIMALS OF THE MIDDLE AGES

Two or more oxen were trained to work together when plows were made larger and heavier, and to pull loaded wagons. Throughout olden times and in the Middle Ages, even until the middle of the nineteenth century, most work on the land was done by yoked oxen. To-day there are some places where you may still see oxen pulling plows or wagons with the patience and strength for which they are noted.

The earliest development of agriculture and the use of oxen for this purpose was probably in the Mediterranean region, in Mesopotamia (Iraq) and Egypt. From there it spread to the various parts of the world where soil and rainfall permitted farming. Plows were improved, iron and then steel plows were invented. With these better plows horses could be used; horses were much quicker, but for many years oxen were preferred for they were cheaper to keep and after they had done their work they could be used for beef.

Early in the history of domestic cattle various breeds developed, these differing chiefly in color and horns. Some were wanted for all-round use, some chiefly for work, others for meat, for milk, or for gentleness and ability to learn. When various tribes in Europe and Asia conquered others, the breeds of cattle were mixed. However, this casual mixing brought about no improvement. Most of the special breeds have been developed during the last hundred and fifty years.

Nowadays the cattle are of two sorts, breeds chiefly useful for beef or chiefly for milk. Most of the good beef breeds originated in Great Britain, and they have been greatly improved for this purpose. By keeping the best animals for breeding man can change animals a great deal in a few generations. For instance, horns are not very useful to cattle now that most of the wild animals they had to fight off—wolves and bears—are not common, and horned cattle often injure one another. "Muleys," that is, hornless cows are born now and then. By breeding from these, it is possible to produce a breed of catttle that have no horns. This has been done with the Aberdeen-Angus breed.

Similarly, cows that give an extra quality of milk or a large amount of milk are kept for breeding. Their descendants are usually good milkers and by keeping the best of each generation the improvement is rapid. Some cattle are more thrifty than others—they grow fat on food that is barely enough for ordinary cattle. If they are used for breeding, the chances are good that their offspring will have the same fine qualities. That is how breeds are improved.

The shorthorn, or Durham, is a popular breed in England and the British Dominions, especially on small farms or where the farmers grow crops and have only a few cows. They are large animals, usually white, reddish or a mixture of these colors, and they make fine beef. Some varieties are also good producers of milk and are known as dual-purpose cattle.

The Herefords, called after the English county of that name, were originally plow-oxen. Now they are red cattle, with white faces, a white stripe down the back and white undersides. They were once black with white markings. Wherever beef cattle are raised exclusively this breed is the favorite and most of the cattle on North American western ranches to-day are Herefords or part Herefords.

The Aberdeen-Angus breed, shining black cattle without horns, originated in Scotland. They are a fine breed for beef and seem to do best on smaller ranches. They are muleys, as we have said, and they generally have more gentle dispositions than other brands.

Many other beef breeds are popular in certain sections. A large fat steer may weigh as much as a ton, but most animals are marketed before they are fully grown. The flavor of young beef, animals between one and two years old, is better than that of older animals and the meat is more tender. The meat of the milk breeds is never so choice as that of the beef cattle.

DAIRY COWS THAT GIVE MUCH MILK AND BREEDS THAT GIVE RICH MILK

Dairy cattle are more bony and lanky-limbed than beef cattle, with less chunky appearance, but their bodies are large, with plenty of storage for food. The most highly developed breeds are little more than milk factories.

One of the best known is the Holstein, or Holstein-Friesian breed. These cattle are black and white, with fairly long horns. They are large animals. The cows give great quantities of milk, several on record have given more than 3,000 gallons in a year. The Holstein breed came from the Netherlands.

Jersey and Guernsey cattle come from the islands of these names in the English Channel. The Jerseys are small, delicately built cattle, usually fawn or dun colored, but they may be gray, cream, white or even black. They produce less milk than some breeds, but it is extremely rich in butterfat. Farmers who sell butter or cream usually keep Jerseys. Dairies that sell milk often keep a few Jerseys and mix the rich milk with the poorer but more bountiful product of their Holsteins. Guernsey cattle are usually brown and white and are a little larger than the Jersey breed; they give more milk than the Jerseys and it is almost as rich.

© Three Lions

A yoke of zebu, or Indian humped cattle, pulling a cart. This species has a fatty hump and an enormous dewlap (fold of skin hanging down in front).

The Ayrshire is a fine breed, larger than most dairy breeds and giving more milk, although never equaling the Holsteins. Ayrshires are very thrifty and do well on poorer land than the other dairy breeds.

A number of other dairy cattle exist and each has its supporters who prefer it to all other kinds. The Brown Swiss is much like the Jersey but it is larger, with longer horns. Dutch belted cattle are black with a white band around the middle. They resemble the Holstein breed but are smaller. Kerry cattle come from Ireland; they are small, hardy cattle and good milkers. Dexter cattle were derived from the Kerry, and are even smaller.

It is possible that the humped cattle of India are descended from a different species of wild cattle, possibly the banting. With their dewlaps and drooping necks, they are very different from European cattle. Some varieties have drooping ears and others have unusual horns, curving backward. These cattle are called by the common name of zebu and they have been imported into many warm parts of the world. In the United States, some ranches in Florida and Texas have imported fine specimens of the Brahmin breed to improve the range cattle. Fine beef and freedom from tick disease are some of the advantages of this cross-breeding.

Cattle are sacred animals to the Hindus, the more ignorant of whom believe that minor sins are washed away in water mixed with cow dung. A good Hindu would not kill a cow or eat beef, and one of the causes of trouble between the Hindus and their Mohammedan countrymen is that the latter kill and eat cattle.

The Bantu peoples of Africa are great cattle-raisers. In eastern Africa there are humped cattle, like those of India; elsewhere some strange breeds have developed. In the Ruanda highlands the cattle have enormous horns, five and six feet long and very massive. The Assai and related tribes of East Africa live partly on the blood drawn from the living cattle, mixed with milk. In other parts where tsetse flies and the disease they carry prevent the use of horses, cattle are used for riding. Great teams of oxen, forty or more, pull boats around the rapids of the upper Zambezi in Northern Rhodesia.

The banting is a little larger than our domestic cattle, but it looks much like them. This species is found from northern Burma to Java and Borneo. In this region the natives have partly domesticated it for beef, but do not milk or work the animals. The cows and the young animals are brownish in color, with white "stockings," while the old bulls are darker, often almost black.

The gaur or seladang is a larger species than the banting, but resembles it in appearance. It is found in India, Burma and the Malay Peninsula, usually living in small bands but rarely as many as twenty are seen. The bulls reach more than six feet in height at the shoulder, with massive horns twenty or thirty inches in length. In color gaurs are usually almost black, with white "stockings" on the lower parts of their legs. Some gaurs have been known to charge without provocation, but unless they are wounded they usually flee, and they run with remarkable speed over the brush-covered hills where they live.

Gaurs have never been tamed in India, but the half-tame gayal of the Malay region may be a variety of gaur. It has short legs and stout, almost straight horns, but its other features are the same as the gaur. Like the banting, the gayal is used only for beef.

A few years ago a new species of wild ox was discovered in Indo-China, known to the natives as the kouprey. It has a large dewlap and is blackish in color, with horns like some breeds of domestic cattle, but frazzled near the tip. Only a few specimens have been seen by white men, but the kouprey is thought to be related to both banting and cattle.

THE HAIRY YAK THAT THRIVES IN THE COLD, HIGH MOUNTAINS OF CENTRAL ASIA

Wild yak live on the cold plateau regions of Tibet, China and Kashmir. They are larger than tame yak and are blackish brown in color. The body is covered with hair of moderate length but a long fringe runs along the flanks and across the chest and thighs. The tail has an enormous tuft of long hair, and yak tails are used in India as fly whips. Domestic breeds are usually black, or black and white. Some have no horns. Yaks from relatively low elevations are the only ones that can stand the heat of India, and these are the ones that have been taken abroad for zoos and circuses. Most yak live at high elevations, 15,000 or 20,000 feet. Here other domestic animals can not endure the climate, and the Tibetans depend on the yak, riding them over the rocky passes and glaciers, using them for pack animals to transport trade goods to and from the markets of India. Common foods of the Tibetans are milk and strong rancid butter made from it. These strange-looking cattle do not eat grain and must be fed hay or allowed to graze on the coarse mountain grass.

The American bison or "buffalo" is the only representative of wild cattle in the New World. It came here late, during the Ice Age, perhaps only a little while before men came. It is not a true buffalo, but has a close relative in the nearly extinct European bison or wisent. The bison roamed the American prairies and great plains in millions, from Mexico to northern Canada, and from the Rockies to the Appalachian Mountains in the East. The great herds moved south in the autumn and traveled north in the spring. Many traces of their old trails and wallowing places still can be seen on the plains.

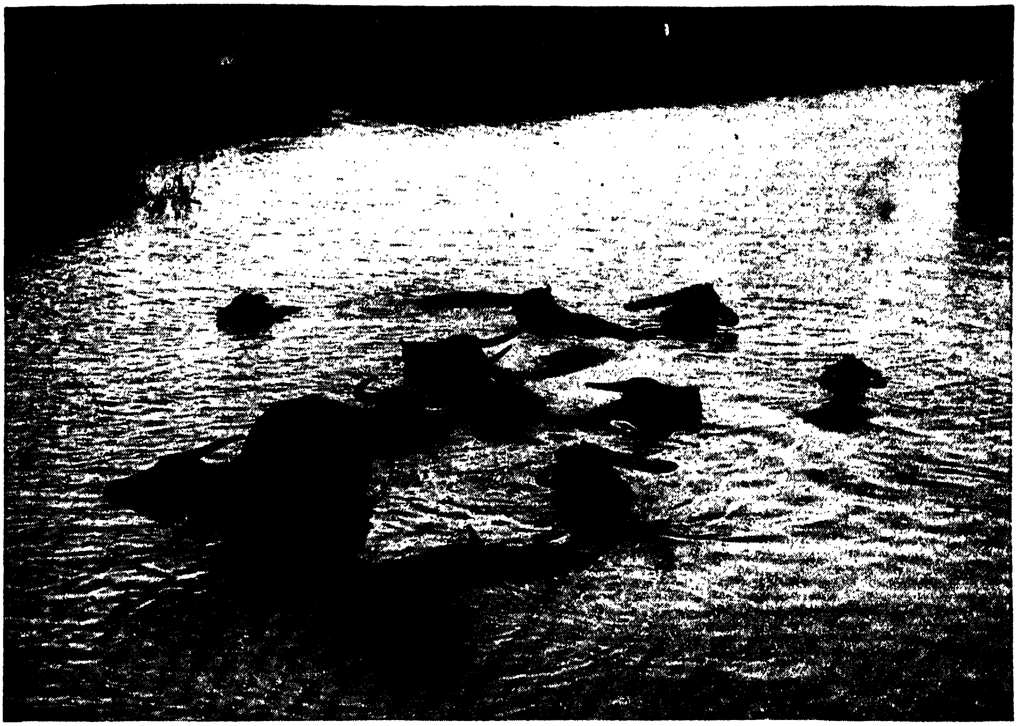
Bison are high at the shoulders and fall away toward the hind quarters; the head is massive and the horns are rather short, half-moon-shaped. The hair on the head, shoulders and front legs is much longer than that over the rest of the body. Their eyes are large, but they look small in the large head and peeping through so much hair. The bulls often weigh a ton, or once and a half as much as the cows. Their coats of woolly fur are dark brown in color when new, but this fades with sun and weather.

Only the grizzly bears and the wolves dared to tackle these great beasts, and then only if one or two strayed from the herd, or if they were young or wounded or old and feeble. While the others fed, an old cow usually stood on guard, and she was quick to see moving objects. A man on horseback was for some strange reason never considered an enemy and it was possible to ride right into the herd, but it was not safe to approach on foot.

The bulls often fight with one another, backing away and then charging together with a monstrous thud, pushing forehead to forehead. They keep this up until one is tired and runs away, or falls and can not rise again. Bison run quickly—it takes a good horse to keep up with a stampeding herd; and they are good swimmers, plunging into rivers to reach new feeding grounds or to escape an enemy.

THE BISON FURNISHED THE PLAINS INDIANS FOOD, CLOTHING, SHELTER AND BLANKETS

The Indians hunted the bison, killing them with bow and arrow before white men brought firearms. Sometimes they used to stampede a whole herd in the direction of a cliff, and many would fall over the cliff and be killed. A large number of Indians would work together on this project to lay in meat for the winter. The squaws would cut the meat up and dry it in the sun, then pound it up, mix it with fat and store it in bags of skin; this was called pemmican. The hides were used for clothing, for bedding and to make the *tipi* (teepees), which were cone-shaped tents in which the Indians lived. Their hunting did not diminish the herds, but when white men came they killed millions. The settlers tried to destroy the herds to ruin the Indians



Fenno Jacobs from Three Lions
Water buffaloes wallowing in a muddy stream. These are beasts of burden in southern Asia and the Pacific Islands.

and to keep the grass for their own herds of cattle. A few years before the end of the nineteenth century the bison had almost vanished, only a few were left and these were mostly privately owned. The Canadian and American governments purchased these few and put them on reserves. The bison soon began to increase, in many cases they became too many for the range they were given. For a number of years several hundred animals were sold for meat in Canada, but there remained some 10,000 head. In the United States the largest herd is in the Yellowstone National Park, where they live in almost natural conditions. There are a number of smaller herds in other places. Most zoos on this continent have several bison or a small herd and some have been sent to European zoos and parks.

The European bison, or wisent, is much like the American species, but it has less of a hump. The hind quarters are nearly as high as the shoulders. The hair of the head and forequarters, so shaggy in the American bison, is shorter and less noticeable. At the time of Julius Cæsar bison were common in the Black Forest of Germany, but during and after the Middle Ages they were gradually exterminated, except in eastern Europe. There may be a few in the Caucasus region to-day, but the last of the Lithuanian bison were killed before 1918.

Although we often call the American bison the buffalo, it would be better to use this name for its distant relatives, the Asiatic and African buffaloes. These are less closely related to our cattle than the wild oxen we have considered so far.

Water buffaloes live in India and other parts of the East, but only a few are now found still in the wild state. They are blackish in color, with only a little hair. Their horns are massive, flattened and curved gracefully backward. They stand about five feet high at the shoulder. Some bulls are even higher. Water buffaloes are enormously strong and they can be very quick on their feet. In a charge they have been known to knock down full-grown elephants weighing four tons.

Buffaloes like to wallow in the swampy places and then, their skins coated with mud, they feed on the tall grass of the lowlands. One old animal stands on guard while the others eat and if an enemy, such as a tiger, comes near they charge. One catches the cat on its horns, tossing it into the air. When it falls the herd runs over it, stamping it to death. Even if not molested a bull may charge. No animal is more respected by the hunter.

THE LITTLE WHITE BIRD THAT IS THE BUFFALOES' FRIEND

These big animals have a small white bird for a friend, the "cow heron" as it is called. It follows them around, perching on their backs to hunt for ticks and insects that annoy the buffaloes.

The people of India and the Malay countries have tamed the beasts and use them for milk and for work. Buffaloes have been imported into southern Europe, China, Egypt and even northern Australia. On all the islands from Sumatra to New Guinea and the Philippines, buffaloes are used for most of the work. In some of these places animals have gone wild and live like their ancestors.

The tamarao of Mindoro Island, one of the Philippines, is a small species of the Asiatic buffalo. Its horns are much smaller, but the animal is quite as fierce as the wild Indian kind. The dwarf anoa of Celebes is only a little over three feet at the shoulder and built more like a deer than any of the other cattle. Its horns are almost straight and slant back in line with the sloping face.

The African buffalo looks very different from the water buffalo and no one has ever tamed it for domestic use. The Cape or black buffalo is heavier than the Asiatic species but does not stand so high. Its massive horns meet on the forehead and curve like an old-fashioned handlebar mustache; they are shorter than the horns of its relative. The Cape buffalo is found from the Sudan to the Union of South Africa, but it has been exterminated over much of its old range. Large herds, of a hundred or more, still are found in parts of East Africa. They often spend most of the day in swampy places, wallowing in the mud to escape insect pests, then as evening falls they come out on the plains to feed on the coarse grass. Frequently they are accompanied by white "cow herons" and by a starling-like "buffalo-bird." Both of these pick ticks and insects and often give warning of the approach of enemies.

Men and lions are the only enemies of these powerful and dangerous animals. In many places the lions leave them alone and prey on animals less able to defend themselves, but in other places lions work together and several attack a single buffalo and drag it down. A herd is relatively safe, for even men armed with heavy rifles do not want twenty or thirty fierce buffaloes stampeding in their direction.

Other African buffaloes are closely related to the black buffalo. In West Africa and the Congo the buffaloes are red in color and much smaller. Intermediate forms, such as the brown buffaloes of the Chad region, connect the "red cow" of the rain forest with the great black buffalo of East and South Africa.

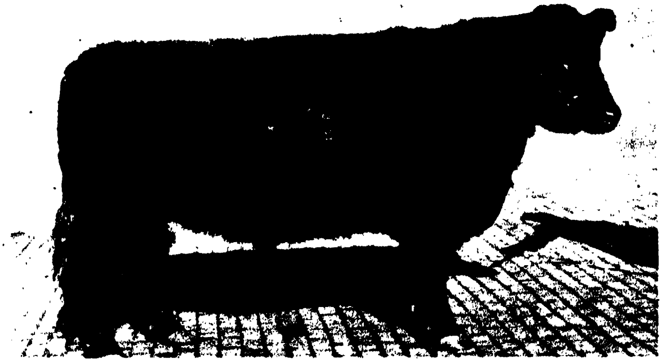
The animals described in this chapter—the tame cattle and the wild—belong to a large order of mammals, the *Artiodactyla,* or even-toed ungulates. These are said to have divided hoofs, because they have two main toes, instead of a central toe like the horse. These two main toes together bear the weight of the body. The hooves are toenails that are large and shoe-like to protect the tips of the toes, for the hoofed mammals walk on their tip-toes, not on the flat of their feet like the bears. On each side of the main pair of toes there may be a smaller toe, but in some of these animals the side toes are missing.

THE WONDERFUL STOMACH OF THE CATTLE AND OTHER CUD-CHEWERS

Within this great order of *Artiodactyla* is a group known as ruminants. The cattle, sheep, goats, the deer and antelopes, the camels and their relatives and the giraffes, are ruminants, or cud-chewers. They all eat grass and leaves; that food is hard to digest, and so they have a very special stomach. It has four chambers in the true ruminants; the camels and mouse-deer have simpler, three-chambered stomachs. The first chamber, or paunch, is a big sack which serves to store the food that is hurriedly swallowed. Near this is a round chamber, the walls of which have a honeycomb structure; in this honeycomb bag the food is formed into balls and sent back up the gullet for thorough chewing when the animal is resting. The second time the food is swallowed it goes to a third chamber; this is almost filled with thin folds of tissue, like the leaves of a book, and is called the manyplies. The food filters past these folds and enters the last chamber which is much like our stomach in shape and in the work it does. The ruminants all have crescent-shaped folds of enamel on the grinding surface of their chewing teeth. The softer material between these folds wears away more rapidly than the enamel, leaving ridges on the teeth like those on a millstone or file, and the food can be ground very fine so that it can be digested easily.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 1369.

FOUR BREEDS OF BEEF CATTLE



A GALLOWAY STEER. GALLOWAYS ARE BLACK AND HORNLESS. THE BREED COMES FROM SCOTLAND.

Picture of Hereford from Kaufmann and Fabry Co., Chicago. Others from J. F. Abernathy, Chicago.

A FINE HEREFORD, RED WITH WHITE FACE AND WHITE MARKINGS.

ABOVE, A SHORTHORN. IN COLOR THIS BREED MAY BE RED, WHITE, ROAN OR RED WITH WHITE MARKINGS. RIGHT, A BLACK ANGUS, OR ABERDEEN-ANGUS.

A MOTHER YAK WITH ITS LITTLE ONE.

Pictures, New York Zoological Park

EUROPEAN BISON, SMALLER THAN AMERICAN BISON.

AMERICAN BISON ("BUFFALOES") IN BANFF NATIONAL PARK, CANADA. THIS ANIMAL IS NOT A TRUE BUFFALO.

BISON, OR GAURS, FOUND CHIEFLY IN INDIA, BURMA AND MALAYA.

THE GAYAL OF BURMA, A HALF-TAMED FORM OF THE GAUR. IT IS USED FOR BEEF.

Top picture, American Museum of Natural History, New York; others, New York Zoological Park, New York.

THE ANOA OF CELEBES, SCARCELY MORE THAN THREE FEET HIGH IS A DWARF BUFFALO.

THE CAPE, OR BLACK, BUFFALO OF AFRICA IS A POWERFUL ANIMAL, RESPECTED EVEN BY THE LIONS.

THE BANTING OF EASTERN ASIA, JAVA AND BORNEO LOOKS MUCH LIKE OUR CATTLE, THOUGH LARGER.

STARSHINE AND DREAMS

Illustrated by Roger Vernam

Night

By William Blake (1757-1827)

The sun descending in the west,
  The evening star does shine;
The birds are silent in their nest,
And I must seek for mine.
  The moon, like a flower,
  In heaven's high bower,
  With silent delight
  Sits and smiles on the night.

Farewell green fields and happy groves,
Where flocks have took delight.
Where lambs have nibbled, silent moves
The feet of angels bright;
  Unseen they pour blessing,
  And joy without ceasing,
  On each bud and blossom,
  And each sleeping bosom.

They look in every thoughtless nest,
Where birds are covered warm;
They visit caves of every beast,
To keep them all from harm.
  If they see any weeping,
  That should have been sleeping,
  They pour sleep on their head,
  And sit down by their bed.

Bed in Summer

By Robert Louis Stevenson
(1850-1894)

In winter I get up at night
  And dress by yellow candle-light.
In summer, quite the other way,
I have to go to bed by day.

I have to go to bed and see
The birds still hopping on the tree,
Or hear the grown-up people's feet
Still going past me in the street.

And does it not seem hard to you
When all the sky is clear and blue,
And I should so much like to play,
To have to go to bed by day?

Dream-Pedlary

By Thomas Lovell Beddoes
(1803-1849)

If there were dreams to sell,
  What would you buy?
Some cost a passing bell;
  Some a light sigh,
That shakes from Life's fresh crown
Only a rose-leaf down.
If there were dreams to sell,
Merry and sad to tell,
And the crier rang the bell,
  What would you buy?

A cottage lone and still,
  With bowers nigh,
Shadowy, my woes to still,
  Until I die.
Such peace from Life's fresh crown
Fain would I shake me down.
Were dreams to have at will,
This would best heal my ill,
  This would I buy.

Stopping by Woods on a Snowy Evening*

By Robert Frost (1875-   )

Whose woods these are I think I know.
  His house is in the village though;
He will not see me stopping here
To watch his woods fill up with snow.

My little horse must think it queer
To stop without a farmhouse near
Between the woods and frozen lake
The darkest evening of the year.

He gives his harness bells a shake
To ask if there is some mistake.
The only other sound's the sweep
Of easy wind and downy flake.

The woods are lovely, dark and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep.

*Reprinted from Collected Poems, by Robert Frost, by special permission of the publishers, Henry Holt & Company, Inc.

To The Night

By Percy Bysshe Shelley (1792-1822)

Swiftly walk over the western wave,
Spirit of Night!
Out of the misty eastern cave,
Where, all the long and lone daylight,
Thou wovest dreams of joy and fear,
Which make thee terrible and dear,—
Swift be thy flight!

Wrap thy form in a mantle gray,
Star-inwrought;
Blind with thine hair the eyes of Day;
Kiss her until she be wearied out,
Then wander o'er city, and sea, and land,
Touching all with thine opiate wand—
Come, long-sought!

When I arose and saw the dawn,
I sighed for thee;
When light rode high, and the dew was gone,
And noon lay heavy on flower and tree,
And the weary Day turned to his rest,
Lingering like an unloved guest,
I sighed for thee.

Thy brother Death came, and cried,
Wouldst thou me?
Thy sweet child Sleep, the filmy-eyed,
Murmured like a noon-tide bee,
Shall I nestle near thy side?
Wouldst thou me?—And I replied
No, not thee!

Death will come when thou art dead,
Soon, too soon—
Sleep will come when thou art fled;
Of neither would I ask the boon
I ask of thee, beloved Night—
Swift be thine approaching flight,
Come soon, soon!

The Night-Piece

By Robert Herrick (1591-1674)

Her eyes the Glow-worme lend thee,
The Shooting Starres attend thee;
And the Elves also,
Whose little eyes glow,
Like the sparks of fire, befriend thee.

No will-o'-th'-Wispe mis-light thee;
Nor Snake, or Slow-worme bite thee:
But on, on thy way
Not making a stay,
Since Ghost there's none to affright thee.

Let not the darke thee cumber;
What though the Moon does slumber?
The Starres of the night
Will lend thee their light,
Like Tapers cleare without number. . . .

We'll Go No More A-Roving

By Lord Byron (1788-1824)

So, we'll go no more a-roving
So late into the night,
Though the heart be still as loving,
And the moon be still as bright.

For the sword outwears its sheath,
And the soul wears out the breast,
And the heart must pause to breathe,
And love itself have rest.

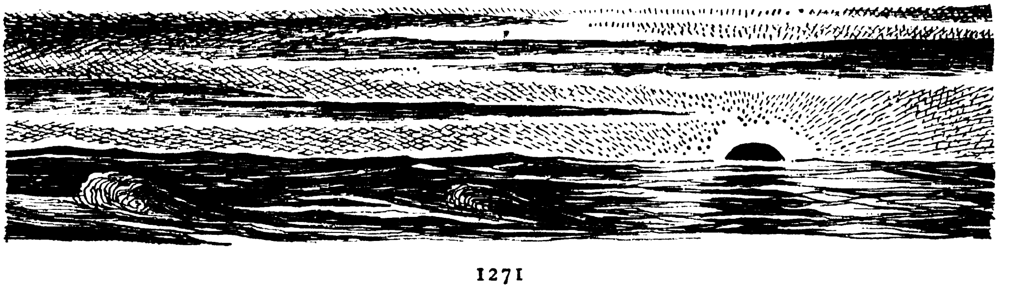
Though the night was made for loving,
And the day returns too soon,
Yet we'll go no more a-roving
By the light of the moon.

The Listeners*

By Walter de la Mare
(1873-)

"Is there anybody there?" said the Traveler,
Knocking on the moonlit door,
And his horse in the silence champed the grasses
Of the forest's ferny floor.
And a bird flew up out of the turret,
Above the Traveler's head:
And he smote upon the door again a second time;
"Is there anybody there?" he said.
But no one descended to the Traveler;
No head from the leaf-fringed sill
Leaned over and looked into his gray eyes,
Where he stood perplexed and still.
But only a host of phantom listeners
That dwelt in the lone house then
Stood listening in the quiet of the moonlight
To that voice from the world of men:
Stood thronging the faint moonbeams on the dark stair
That goes down to the empty hall,
Hearkening in an air stirred and shaken
By the lonely Traveler's call.
And he felt in his heart their strangeness,
Their stillness answering his cry,
While his horse moved, cropping the dark turf,
'Neath the starred and leafy sky;
For he suddenly smote on the door, even
Louder, and lifted his head:—
"Tell them I came, and no one answered,
That I kept my word," he said.
Never the least stir made the listeners,
Though every word he spake
Fell echoing through the shadowiness of the still house
From the one man left awake:
Aye, they heard his foot upon the stirrup,
And the sound of iron on stone,
And how the silence surged softly backward,
When the plunging hoofs were gone.

*From Collected Poems, by Walter de la Mare; reprinted by permission of the publishers, Henry Holt & Co., Inc.



The Fly-Away Horse*

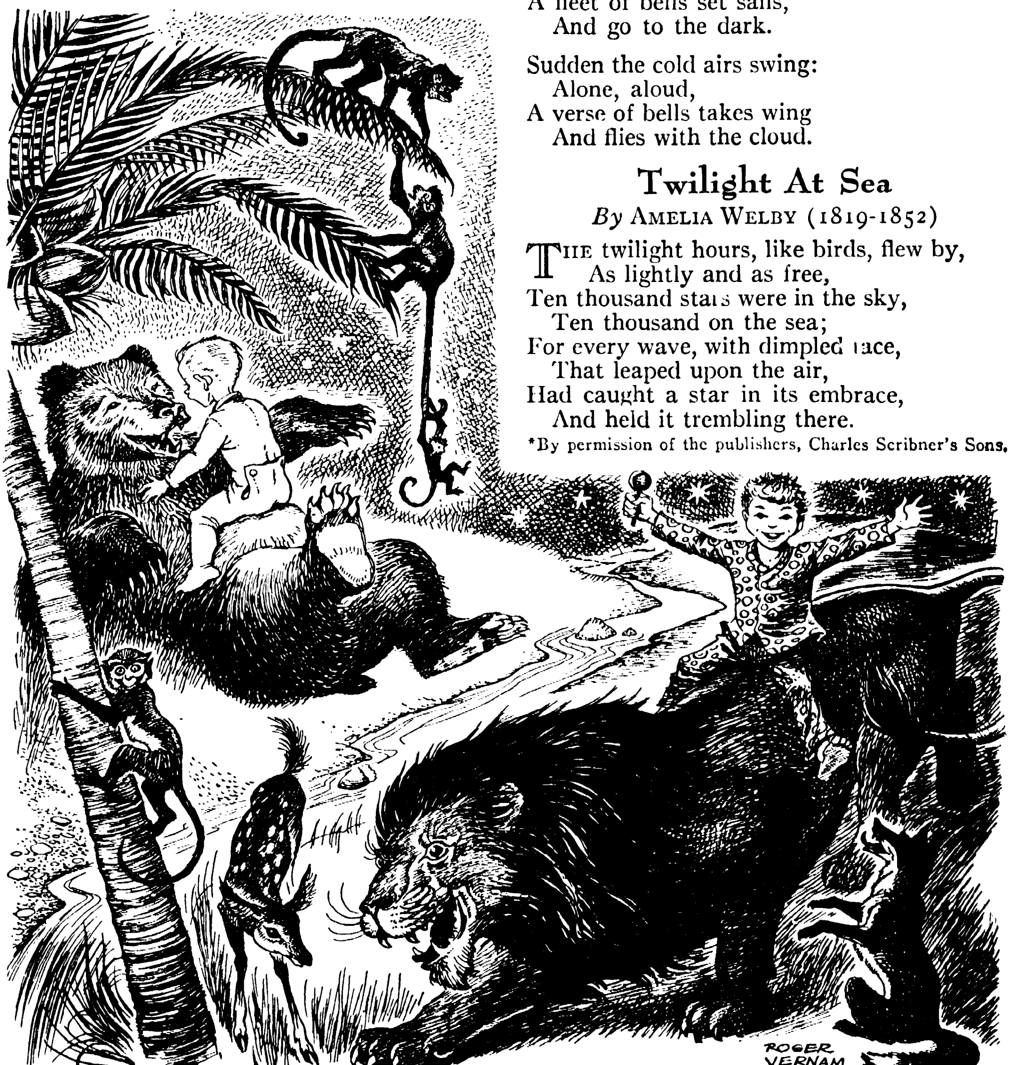
By EUGENE FIELD (1850-1895)

OH, a wonderful horse is the Fly-Away
Horse,
Perhaps you have seen him before;
Perhaps while you slept his shadow has swept
Through the moonlight that floats on the
floor.
For it's only at night, when the stars twinkle
bright,
That the Fly-Away Horse, with a neigh
And a pull at his rein and a toss of his mane,
Is up on his heels and away!
The moon in the sky,
As he gallopeth by,
Cries: "Oh! what a marvelous sight!"
And the stars in dismay
Hide their faces away
In the lap of old Grandmother Night.

It is yonder, out yonder, the Fly-Away Horse
Speedeth ever and ever away—
Over meadows and lanes, over mountains and
plains,
Over streamlets that sing at their play;
And he speedeth so fast that the men at the
mast
Adjudge him some portent of woe.
"What ho there!" they cry,
As he flourishes by
With a whisk of his beautiful tail;
And the fish in the sea
Are as scared as can be,
From the nautilus up to the whale!

And the Fly-Away Horse seeks those far-
away lands
You little folk dream of at night -
Where candy-trees grow, and honey brooks
flow,
And corn-fields with popcorn are white;
And the beasts in the wood are ever so good
To children who visit them there—
What glory astride of a lion to ride,
Or to wrestle around with a bear!
The monkeys, they say:
"Come on, let us play,"
And they frisk in the coconut trees;
While the parrots that cling
To the peanut vines sing
Or converse with comparative ease!

Off scamper to bed—you shall ride him
to-night,
For as soon as you've fallen asleep,
With a jubilant neigh he will bear you
away
Over forest and hillside and deep!
But tell us, my dear, all you see and you
hear
In those beautiful lands over there,
Where the Fly-Away Horse wings his far-
away course
With the wee one consigned to his care.
Then grandma will cry
In amazement; "Oh, my!"
And she'll think it could never be so;
And only we two
Shall know it is true—
You and I, little precious, shall know!



Chimes*

By ALICE MEYNELL (1850-1922)

BRIEF on a flying night,
From the shaken tower,
A flock of bells take flight,
And go with the hour.

Like birds from the cote to the gales,
Abrupt—oh, hark!—
A fleet of bells set sails,
And go to the dark.

Sudden the cold airs swing:
Alone, aloud,
A verse of bells takes wing
And flies with the cloud.

Twilight At Sea

By AMELIA WELBY (1819-1852)

THE twilight hours, like birds, flew by,
As lightly and as free,
Ten thousand stars were in the sky,
Ten thousand on the sea;
For every wave, with dimpled face,
That leaped upon the air,
Had caught a star in its embrace,
And held it trembling there.

*By permission of the publishers, Charles Scribner's Sons.

A Story For A Child

By Bayard Taylor (1825-1878)

Little one, come to my knee!
  Hark, how the rain is pouring
Over the roof, in the pitch-black night,
  And the wind in the woods a-roaring!

Hush, my darling, and listen,
  Then pay for the story with kisses;
Father was lost in the pitch-black night,
  In just such a storm as this is!

High up on the lonely mountains,
  Where the wild men watched and waited;
Wolves in the forest, and bears in the bush,
  And I on my path belated.

The rain and the night together
  Came down, and the wind came after,
Bending the props of the pine-tree roof,
  And snapping many a rafter.

I crept along in the darkness,
  Stunned, and bruised, and blinded,—
Crept to a fir with thick-set boughs,
  And a sheltering rock behind it.

There, from the blowing and raining,
  Crouching, I sought to hide me:
Something rustled, two green eyes shone,
  And a wolf lay down beside me.

Little one, be not frightened;
  I and the wolf together,
Side by side, through the long, long night,
  Hid from the awful weather.

His wet fur pressed against me;
  Each of us warmed the other;
Each of us felt, in the stormy dark,
  That beast and man was brother.

And when the falling forest
  No longer crashed in warning,
Each of us went from our hiding-place
  Forth in the wild, wet morning.

Darling, kiss me in payment!
  Hark, how the wind is roaring;
Father's house is a better place
  When the stormy rain is pouring!

The Day Is Done

By Henry W. Longfellow (1807-1882)

The day is done, and the darkness
  Falls from the wings of Night,
As a feather is wafted downward
  From an eagle in his flight.

I see the lights of the village
  Gleam through the rain and the mist,
And a feeling of sadness comes o'er me
  That my soul cannot resist:

A feeling of sadness and longing,
  That is not akin to pain,
And resembles sorrow only
  As the mist resembles the rain.

Come, read to me some poem,
  Some simple and heartfelt lay,
That shall soothe this restless feeling,
  And banish the thoughts of day.

Not from the grand old masters,
  Not from the bards sublime,
Whose distant footsteps echo
  Through the corridors of Time.

For, like strains of martial music,
  Their mighty thoughts suggest
Life's endless toil and endeavor;
  And to-night I long for rest.

Read from some humbler poet,
  Whose songs gushed from his heart,
As showers from the clouds of summer,
  Or tears from the eyelids start;

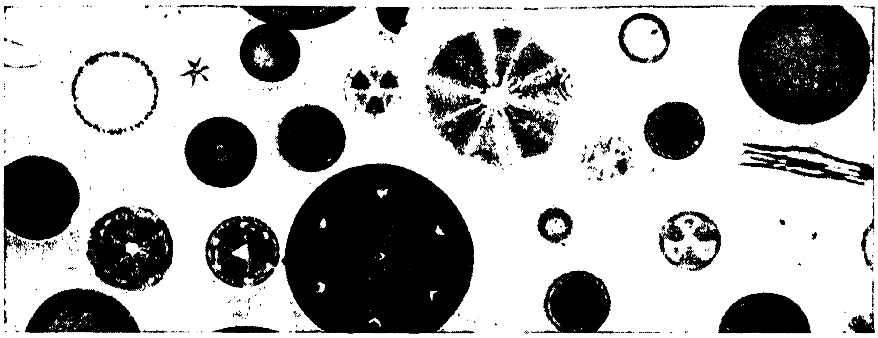
Who, through long days of labor,
  And nights devoid of ease,
Still heard in his soul the music
  Of wonderful melodies.

Such songs have power to quiet
  The restless pulse of care,
And come like the benediction
  That follows after prayer.

Then read from the treasured volume
  The poem of thy choice,
And lend to the rime of the poet
  The beauty of thy voice.

And the night shall be filled with music,
  And the cares, that infest the day,
Shall fold their tents, like the Arabs,
  And as silently steal away.

THE NEXT POEMS ARE ON PAGE 1379.



A highly magnified group of the flinty coverings of diatoms, tiny one-celled plants.

PLANTS IN THEIR HOMES

PLANTS have such great powers of spreading over land and sea that we cannot wonder that there is no vacant corner anywhere.

Many of the scattered seeds come to nothing, for some fall on stony ground, others are choked, and others are devoured; but the plant makes up for these risks by producing countless seeds that are not needed. As Tennyson wrote of nature, "of fifty seeds she often brings but one to bear"; and he afterward thought he should have written "myriad" instead of "fifty."

Linnæus, whom we call the "father of modern botany," calculated that if an annual plant—dying within the year—produced only two seeds, and if the seedlings next year grew up into plants, producing two seeds each, and so on, there would be in twenty years a million plants. But this calculation started from a very slow rate of multiplication—only two seeds at a time; whereas in a single season the number of seeds produced, say, by an average radish, is 10,000; by a shepherd's purse, 64,000; by a tobacco plant, 360,000; by a false flax plant, 730,000.

The flower of a grass has only one seed, but a single flower of one of the orchids may have 1,756,440 seeds in its seed-box. Another of the orchids is said to produce 74,000,000 seeds from the plant considered as a whole.

Thus, we see that the plant can often afford to lose many of its seeds. Or, to put it in another way, those plants have succeeded well which have a safe margin of seeds in proportion to their chances of failure. A false flax plant with about three-quarters of a million seeds in a year, would cover the whole land surface of the earth in three years. This does not happen, because the chances of death are so great and because many localities are quite impossible for this kind of plant.

In connection with the power of spreading that many plants have, a practical point of great importance is the invasion of a country by weeds.

What usually happens is that man introduces a strange plant into a new country, where it runs riot. It may find many empty niches to fill, and it may be free from the competition that kept it within bounds at home. Thus, the nettle, the shepherd's purse and the greater plantain have followed man wherever he has gone—like rats! An English botanist tells us that one of three British nettles is reported to have been brought to Britain by the Romans, but it still grows only near some of the villages of the south coast of England. Parkinson, the author of one of the great herbals, tells us that Roman soldiers brought the seed with them and sowed it at Romney for their own use—to rub and chafe their limbs when, through extreme cold, they were stiff and benumbed. A North American kind of feverfew has, in recent times, established itself around many east-coast fishing villages in Britain, and has become, in some places, more abundant than the native species.

HOW THE PLANTS GO OUT INTO THE WORLD AND SEEK NEW KINGDOMS

This sort of thing is continually happening. Sometimes, as with the prickly-pear in Australia, the invasion is a calamity. It is very striking to read that 550 kinds of plants have been introduced into New Zealand, which has a native flora of 750 species; and the new-comers often tend to oust the natives on grazed, cultivated and cleared ground. The same thing is true when new animals are introduced.

Darwin called attention to the case of the cardoon thistle, which was introduced from Spain to La Plata, where it soon spread over enormous tracts of country, ousting other plants. Professor Bower gives an example of a native plant of Mexico which was introduced into Ceylon as a garden plant in 1828 and has spread all over the island, taking up waste land to the exclusion of other plants. The cardoon thistle is spread by the wind which wafts the down everywhere, but the Mexican plant is spread by birds.

While plants have this great power of spreading, and are always, so to speak, looking out for new kingdoms to conquer, the other great fact is that certain kinds of plants are found living together in certain localities. The conditions of life are very different in different places, and each locality has its own type of plant life or vegetation. Many kinds of plants are so well suited for particular surroundings that if the seeds are sown somewhere else, they do not sprout, or if they sprout, the seedlings do not flourish. Many run riot for a year and then vanish.

THE RICH AND BEAUTIFUL SEAWEED AND ITS GRACEFUL FORMS

If we ask what are the great haunts of life for animals, the answer must be: the shore of the sea, the open sea, the deep sea, the fresh waters, the dry land and the air. Let us first inquire how this general grouping applies to plants; and then we can pass to the different kinds of plant associations found on dry land.

There is a rich and beautiful vegetation of seaweed in the shallow waters near the shore, extending up to the space between the tide-marks. Fastened to rocks and stones and big shells, and also to other seaweeds, there are hundreds of different kinds of graceful forms, from minute growths to great pennons many yards long. If there is a sloping shore the seaweeds extend down and down till there is not enough light to allow them to flourish. All of them have the green pigment called chlorophyl, which enables them to utilize the sunlight as a source of power; but in the brown and red seaweeds the green is veiled by other colors. It is believed by some botanists that the brown seaweeds can make more use of the light than the green ones can, and that the red ones can get along with scantier light than the brown ones. In any case, the green ones are usually highest up, and the red ones lowest down in the water.

Seaweeds absorb air, water and salts by the general surface of their fronds; they have no roots in the true sense, only holdfasts or anchors; they are very tough and very pliable, so that they are not readily broken by the waves, and they often have gas-reservoirs, as we see in the common bladder-wrack, which buoy them up.

PLANTS OF THE SEA AS COUNTLESS AS THE STARS IN THE SKY

Often among the seaweeds grows the sea-grass, which is a true flowering plant. Its dry leaves are familiar to us in the cases sometimes woven round bottles of olive oil. In localities where it flourishes its fragments form an important part of the vegetable sea-dust that is wafted down the slope and is the chief food of many of the animals living on the shore area.

The plants of the open sea, away from the shore, are generally very minute, but they are countless. There may be more of them in a bucket of water than we can see of stars on a clear night. They are sometimes so multitudinous that the water has a distinct plant-smell. Most of them are microscopic seaweeds, such as diatoms, but they form what Sir John Murray called the floating sea-meadows. They sometimes make the surface waters like a vegetable soup, so numerous are they; and they form the main food supply of those open-sea animals that are vegetarians. The great drifting beds of sar-

HOW A PLANT RISES IN THE WORLD

The European frogbit, with two winter buds lying at the bottom of a pond.

THE BUD OF A WATER FROGBIT IN SUCCESSIVE STAGES OF DEVELOPMENT
The aquatic frogbit, which spreads along the surface of ponds, has no seeds, and multiplies by buds which drop to the bottom and lie there all winter. In spring the buds rise to the surface and quickly develop.

gasso weed in the Atlantic Ocean are impressive, and have an animal population of their own; but the seaweeds composing them have generally been torn by storms and currents from distant shores. As is so often the case, the more prominent things like the sargasso banks are not nearly so important as the small things. Especially we must remember the invisible bacteria of the Open Sea, which play a great part in the constant circulation of matter.

As for the Deep Sea, there are no plants which live there, for, apart from luminescent animals, it is a world of darkness. There do not even seem to be bacteria in the great abysses, so that there can be no rotting. Of course there are the remains of surface plants, like diatoms, which have died or have been killed in the Open Sea and have sunk slowly down to the great depths—a contribution to the scanty rations there.

THE FLOATING MEADOWS ON THE WATER OF A LAKE

In the open waters of a lake there are often "floating meadows" of very tiny plants, such as diatoms, desmids and blue-green algæ. These are devoured by small crustaceans, and these, again, by fresh-water fishes, often with several transformations between. It is in this way that the world is kept going. At certain times, especially in spring, the multiplication of tiny water-plants may be so prolific that the water of the pond comes to look like living soup.

But there are plants of higher degree which also float quite freely. Thus, near the shore in sheltered nooks the surface of the water is often covered with the familiar duckweed. What look like leaves are flattened shoots, very buoyant and difficult to wet. On the under-side are delicate white roots, used in absorbing water, and on the edge of some of the disks there are very small flowers. There is another kind of duckweed (*Wolffia arrhiza*) which has still smaller flowers and no roots. This is probably the smallest flowering plant to be found in nature.

Another unattached plant, widely distributed in ponds and lakes, is the bladderwort, with beautiful golden flowers that are lifted out of the water on rather long stalks about midsummer. It has no roots, and the long floating stems are beset with small traps—apparently transformed leaves which catch many tiny water-animals. Duckweed, bladderwort and frogbit form store-buds in late summer, which sink to the bottom, remain as if asleep through the winter, and float up again in spring to the surface, where they start new plants. This is their way of multiplying—by detaching buds; but both these plants are also able to multiply by seeds.

THE FLOWERING PLANTS OF THE LAKE AND HOW THEY GROW

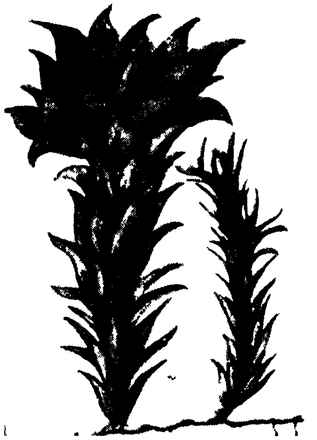
But only a very few of the flowering plants of a lake are unattached. The great majority are rooted on the floor and have their leaves on or near the surface. The water-lily is a good example. It is a perennial, rooted in the mud, with a long buoyant shoot, and with broad leaves floating on the surface, as is also true, in some species, of the beautiful flowers. The little openings—stomata—which allow of exchange of gases with the atmosphere, and also regulate the giving-off of water-vapor from the plant, are in ordinary leaves chiefly or entirely on the under-surface; but in the water-lily they are all on the upper surface. This is a kind of special fitness that explains itself, for little openings would not be of any use on a surface which is continually washed with water.

The pondweeds, with their glossy leaves, are very common fresh-water plants, and it is interesting to find that, while some kinds have leaves that float and leaves that live below the water, there are others whose leaves are all submerged, only the flowers coming to the top. There are other submerged fresh-water plants, such as the gritty stoneworts and water-nymph, found in lakes with much lime in the water, which may cover the floor for large areas and extend downward to a depth of about a hundred feet. The stoneworts are a kind of algæ.

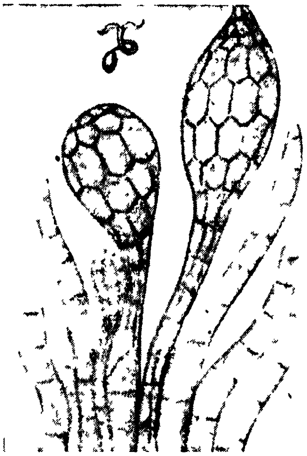
THE HOMES OF THE LAND-PLANTS AND THEIR TENANTS

In similar fresh-water basins we find similar plants, and they have certain characters in common. The flowering plants (not the algæ) have evidently taken to the water from the land, and many of them have lost some things they once had. Their roots are often less important than those of land-plants, and they may be absent altogether; they are thin-skinned, for they often absorb by their whole surface; they are lightly built, for they are

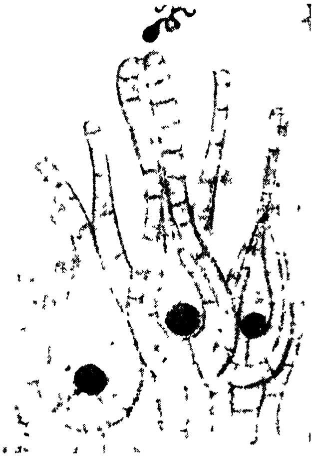
THE LIFE-STORY OF A FAMILIAR MOSS



1. These pictures show the life-story of hair-cap moss, which has its male and female parts on separate plants.



2. Here we see the sperm-bearing organs highly magnified. These break and release small sperms which are curved.



3. The sperm enters the flask-shaped receptacle, here shown highly magnified, and works its way down the neck to the egg-cell.

4. The union of the sperm and egg results in the formation of a long-stalked capsule, shown here greatly enlarged.

5. When not yet ripe the capsule is green and is covered by a brown, hairy cover, which later becomes detached.

6. When the capsule ripens, the lid is cast off and teeth are seen, closing up tiny openings; but in dry weather these shrivel.

7. The spores germinate and produce thread-like growths, here seen at successive stages.

8. A bud forms on the thread, as shown here, and develops into a perfect moss plant, either male or female, like those in the first picture. Nearly all our pictures are greatly magnified.

supported by the water; they often have spaces full of air which make them buoyant. In these and many other ways they are fitted to live in their home.

It may seem absurd to speak of plants in the air, yet we have to remember that there are many perched plants which live off the ground altogether, on the stems and branches of other plants.

Many of the orchids do not touch earth at all, and they must get water from the rain or by condensing the vapor in the moist atmosphere. The pitcher-plants grow in bogs, and capture insects as food.

It must also be noted that many bacteria spend part of their life floating in the air; and perhaps it is not far-fetched to remind ourselves of the air journeys of spores and pollen-grains and wind-sweep seeds.

The homes of the land-plants are very varied, and each has tenants in some measure suited to the particular conditions.

Communities whose members have a good deal in common are called plant associations. Thus there are associations suited for the bog, the marsh, the moor, the high mountains, the desert, the forest country, the seashore, the barren grounds, or tundras, of the Far North, the sand-dunes, and so on. This does not mean that the desert plants of one dry and parched land need be exactly the same as those in another similar region two thousand miles away; what is meant is that the vegetation in the two arid regions will show similar fitnesses, or adaptations, to the peculiar conditions of life. The Alpine plants of Mont Blanc may be very different from those of Mount Everest, but they are sure to show some similarities of appearance. And, of course, there are many instances of closely related plants, such as the groundsels, occurring in similar places far apart.

The beautiful Yucca plant, a native of America, which has been carried to Europe.

Let us take some examples of different vegetations. One of the poorest is that of the tundra, as the barren grounds to the north of Europe and Asia are generally called.

The deeper parts of the soil there remain permanently frozen, and it is hard for any plant to make a living, so that there is in the worst places little beyond mosses and lichens. It is the same sort of scanty vegetation that we see growing on the tops of the mountains that are not snow-covered.

On more favorable ground in the Far North there may be dwarf willows and hardy grasses, and sometimes there are bulbous plants like tulips which make the desert blossom like the rose in the short period of the springtime.

Gradually the tundra passes into moorland, with grasses and sedges, cranberries and crowberries, willows and birches. There is probably much heather, which succeeds so well because it has entered into partnership with a fungus. In wet places we may perhaps find great stretches of bog-moss, which, along with other bog-plants, forms peat.

Where the ground is less water-logged, and where the water is less sour than in the peat-bog, there is a wealth of cotton-grass or sedge, with its white flags, the fragrant bog-myrtle, the beautiful Grass of Parnassus, and the delicate bog-pimpernel. Where the earthworms have been able to make more than a little soil, and where there is some drainage, we reach what may be called pasture land.

On another line is the steppe country, such as we may find in our North American prairies. The prevalent plants are suited to survive a long summer drought, and it is not often that there are trees. Where the soil is better and the dry season less severe and prolonged, the steppe may give place to meadow lands with a rich grassy vegetation. The long parallel leaves of the grass make it possible for the plants to live in dense crowds without hopelessly overshadowing one another.

On another line are the natural forests. These are great societies of trees, and their extension is limited by conditions of temperature. For there cannot be forests where the average temperature in the growing and leafing season of the year falls below 46° Fahrenheit. But the variety of forests is a long story in itself; there are pine forests and tropical forests; there are palm groves and jungles, and many more; and besides the trees there is the ground-vegetation of shade-loving plants.

THE TRANSFORMATION SCENES IN THE LIFE OF PLANTS

We may pass through many different types of vegetation in a day's walk, for we may begin with a sort of desert country on the sand-dunes, and pass into meadow land; we go on to climb the lower slopes of the mountain through the forest zone and then get into upland pasture like steppe land; we skirt the bogs and tramp through the heather-covered moor; we climb to the top and find ourselves in a tundra with nothing but lichens and moss.

It is interesting to discover near at home the miniature kinds of vegetation that in some parts of the world spread over enormous tracts of country. Thus, where the sand has been swept from the shore on to the inland flats, and has smothered many of the plants, we have a hint of the great desert. The rich meadow is a little savanna, and an untended thicket with brambles and honeysuckle is an image of the jungle. Another point is that one vegetation frequently gives place to another, for all things flow. As the tree-stumps often show, the area of the peat-bog may once have been occupied by a forest. The peat-bog itself may become a meadow in the course of time, and the heather-covered moor may come to be covered with grass.

It must be understood that each of the great kinds of vegetations can be divided again into smaller associations. Thus, in an upland moor the botanist would distinguish several zones marked by distinctive plants. There is a bog-moss association, a cotton-grass association, a sedge association, a bilberry association and a heather association. In that order they correspond to a gradually decreasing amount of soil-water.

HOW PLANTS SOLVE THE DROUGHT PROBLEM IN DRY PLACES

The most interesting question in regard to the various haunts and homes of plants is the way the difficulties or peculiarities of the situation in which they live are met and overcome. This is the study of fitness, or adaptation. Let us take as an example those plants that live in very dry places or in places where there is a long dry season. The problem is to make the most of a limited water supply, and there are various solutions. One is to reduce the leaf-area; a cactus, for instance, may do without leaves altogether and form a big globular green stem. Another solution is to have juicy tissues, as in a stonecrop on the wall or an onion in the dry, sandy soil. The juicy interior means a capacity for storing water.

Another way in which plants solve the water problem is to have very deep-growing roots or roots with a very large number of rootlets, for this increases the chances of getting at more of the soil-water. Still another solution is to have a thickened outer skin which will prevent too much evaporation of water, and if this is varnished over with wax, as in some glistening leaves, so much the better. A woolly surface solves the problem in such plants as the mullein.

THE REMARKABLE POWER OF THE EUCALYPTUS OF AUSTRALIA

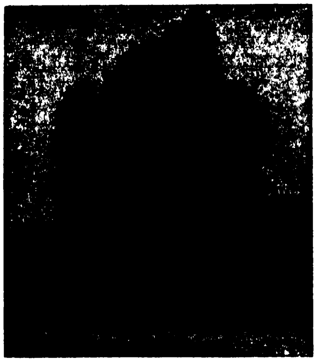
They say that the fragrant oils produced by plants like lavender and rosemary also serve as heat-screens. And how remarkable is the adaptation in the eucalyptus, or blue-gum, tree of Australia. Its leaves do not expose a flat surface to the sky, but hang down with only their edge turned up.

What is true of plants living in dry conditions is true of plants living in wet conditions; they are rich in fitnesses, but these fitnesses are different in each case. How did they become established?

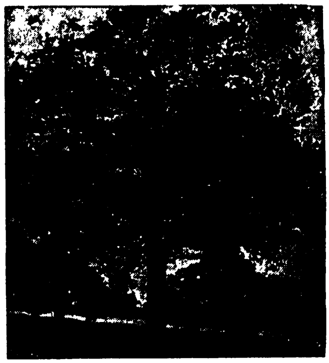
THE NEXT STORY OF PLANT LIFE IS ON PAGE 1387.

TELLING SOME TREES BY THEIR SHAPES

Beech.



White Poplar.



Oak.

American Elm.

Tulip Tree.

From Blakeslee & Jarvis' *Trees in Winter*, by permission of The Macmillan Co., publishers.

Sugar Maple.

White Ash.

Shagbark Hickory.

HOW TO PLAY CATEGORY

CATEGORY is easy to learn and interesting to young and old alike. What is best, all can play it together with equal enjoyment. Any number may take part.

Very little is required in the way of equipment—a sheet of blank paper and a pencil for each person. Each rules lines on his paper like the example shown.

	W	A	T	E	R
Animal					
City					
Flower					
Sport					
Character in History					

Now, the game begins. Someone, whom you choose, gives a five- or six-letter word such as WATER (See diagram), BREAD, or FATHER, or any word that does not repeat a letter, avoiding, however, those words that have X, Y, or Z in them. Or, you may simply ask each player to name a letter of the alphabet, placing one in each little space across the top. Tell the players that each must think of some class of things, or category, such as animals, cities, flowers, etc., and be ready to name it when his turn comes. Five or six categories are usually enough for one game.

The object of the game is to think of a name in each category that begins with the letter in the top space. For example, in the diagram shown above, appropriate names in the animal category under the letter *W* would be *wolf, wombat, wolverine, walrus, wart-hog, wapiti, wildebeest* and so on.

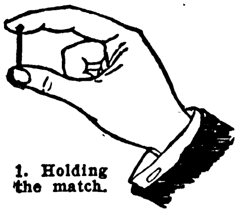
Someone should be timekeeper and he will give the signal so that all may begin at the same time. Twenty, or perhaps, twenty-five, minutes might be allowed for the game given here. Of course, two people must not work together and no one is allowed to receive help. It is more fun and it counts more towards your score to think of unusual names, and you may put down more than one.

When the time is up, each in turn tells what he has put down for an answer in the first space. If he has answered correctly and no one else has the same answer, he gives himself 10 in that space; if two players have thought of the same name, allow 8; if three, allow 4; if four, allow 3; if five or more, allow 2. In case you have failed to get one or have given an incorrect name, the score is zero. Continue until all the items are scored.

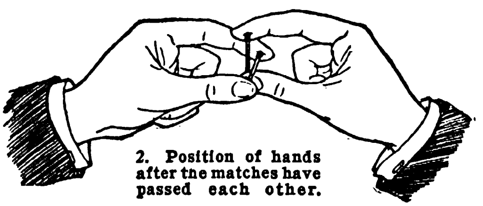
If you have two or three names in the space and someone calls one of them before your turn comes, you can call one of the others, and perhaps get a larger score. At the end, scores are added and the one who has the highest is, of course, the winner.

PULLING ONE STICK THROUGH ANOTHER

IN this trick the performer takes a burnt match or small stick in each hand, held lengthwise between forefinger and thumb, as in picture 1. He brings his hands together, holding them so that the matches are crosswise to each other. Strange to say, instead of clashing the one against the other when they meet, the one passes right through the other,



1. Holding the match.



2. Position of hands after the matches have passed each other.

and the two hands are thereby linked together, each match being now *within* the space inclosed by the match, thumb and forefinger of the opposite hand. It would seem as though they could not possibly be again separated without dropping one or other of the matches. And yet the performer, by virtue of his magic power, disengages them with the greatest ease, drawing the hands freely apart, quickly or slowly, as may be desired, and re-engages them in like manner, the matches remaining throughout undisturbed between finger and thumb as at first. The trick depends partly upon the kind of match used, and partly upon a little cleverness. Though by no means difficult, the trick must be practiced diligently before the operator ventures to use it in public before an alert audience.

There is nothing that spoils the effect of a trick more than hesitancy on the part of the performer. If you will study the performances of professional magicians, you will note that absolute assurance and ease mark their routine. Assurance and ease should also mark the efforts of the amateur as he goes through the simple tricks in his own repertoire.

The matches used are those known as phosphorus matches, which we ordinarily use in the house. These are not of the "safety" kind, but have large red heads, into the composition of which a good deal of *glue* enters. The performer prepares for the trick by privately moistening the tip of each forefinger; and, in taking the matches between finger and thumb, he places the "head" end next the moistened forefinger. A gentle pressure makes the match adhere to the finger strongly enough to carry its own weight. When he brings the hands together, he does so in such a manner that the match in the left hand comes into contact with that in the right close to the lower, or non-adhesive, end. A slight relaxation of the pressure of the right forefinger lifts the match in that hand away from the thumb in a very minute degree, and allows the match in the opposite hand to pass through the gap thus created. As soon as it has passed, the thumb closes on the end of the match as before. The matches are separated in like manner.

SUGGESTED RECIPES—POTATOES

BAKED POTATOES WITH CHEESE

First, select medium-sized potatoes, scrub them well, and dry them. Place them in a moderately hot oven and bake until soft (usually requires about 45 minutes). Turn them occasionally so that they may be baked evenly. When soft, press them between the fingers, and break the skin a very little to let steam escape. Then cut the potato in half lengthwise; scoop out the potato inside and mash it. Next add some hot milk, butter, salt and pepper, and beat all thoroughly. Now return this to the potato shells. Then sprinkle grated cheese over the top and return to the oven just long enough to melt the cheese and brown the potato. If desired, a little paprika may be added just before serving.

CREAMED POTATOES

First, cut cold boiled potatoes into about one-half inch cubes. Next add white sauce and stir until the potatoes are thoroughly heated. Then sprinkle with finely cut parsley and serve. The white sauce is made as follows:

2 tablespoons butter 1 cup scalded milk
2 tablespoons flour ½ teaspoon salt
few grains pepper

The butter is placed in the saucepan and stirred until it is melted. Then add the flour, which is mixed with the seasonings, and stir until it is thoroughly blended. Now gradually pour on the milk by adding about one-third of it at a time and by stirring until well mixed. This should be cooked until the sauce boils, when it may be used as already explained.

CARPET WARP POT HOLDERS

These practical pot holders are made of carpet warp and fashioned in a block design. Crochet two thicknesses, a back and a front, making them exactly alike. Then crochet them together with a contrasting color. Those in the picture are of natural-color warp finished with green. It is well to match the kitchen colors, in choosing colors for the pads.

The directions below are for a five-inch pad, or five and a half inches square when the edging is put on. It is a good thing to have these pads made up in sets of three, each one made an inch larger than the other. You do this by making your original chain strand nine stitches longer for each inch added. An 800-yard spool of carpet warp will make eleven five-inch pot holders of double thickness. Use a Number 8 steel crochet hook.

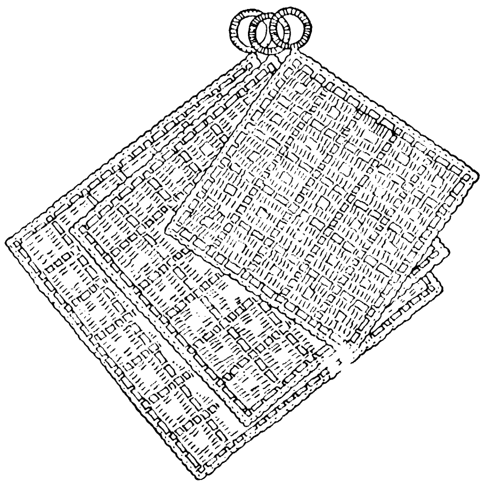
Code: Ch—chain; s.c.—single crochet; d.c.—double crochet; sl. st.—slip stitch.

Make a chain of 46 stitches for a five-inch pad.

Row 1: Ch 3; d.c. in third ch st.; d.c. six times; ch 2; d.c. 7; ch 2; d.c. 7; ch 2; d.c. 7; ch 2; d.c. 7.

Row 2: Ch 3; d.c. 2; ch 1; d.c. 3; ch 2; d.c. 3; ch 4; d.c. 3; ch 2; d.c. 3; ch 1; d.c. 3; ch 2; d.c. 3; ch 1; d.c. 3; ch 2; d.c. 3; ch 1; d.c. 3.

Row 3: Ch 3; d.c. 6; ch 2; d.c. 7; ch 2; d.c. 7; ch 2; d.c. 7; ch 2; d.c. 7.



Courtesy, January and Wood Co., Maysville, Ky.
Completed pot holders.

Row 4: Ch 5; d.c. 1 between third and fourth stitch; ch 2; d.c. in seventh stitch; ch 2; d.c. in first d.c. of lower block. Continue making square mesh to end of row.

You now have a complete pattern. Make five sets of blocks to give you a square of five blocks each way.

Crochet a simple edging around the mat if you wish.

LITTLE PROBLEMS FOR CLEVER PEOPLE

WHAT DID THE HANDKERCHIEFS COST?

1. A merchant sold handkerchiefs at 9 cents each, or three for 24 cents. One day he saw his assistant sell a lady one handkerchief, and he said, "Why did you not sell the lady three handkerchiefs?" "Because," said the assistant, "you have the same profit on one as you have on three."

What did the handkerchiefs cost the merchant whose assistant was so ingenious?

HOW MANY PASSENGERS?

2. "I will take you for 25 cents each," said the boatman at the ferry. "Will you take two more and make it 20 cents each?" asked a passenger. "Yes," answered the boatman; "I shall make 10 cents more if I do."

How many passengers were taken altogether?

HOW MUCH BAGGAGE ALLOWED?

3. "My excess baggage will cost me $1.50," said Brown, waiting for the train with his friend Smith. "Let me take some of it for you," said Smith, and he took 120 pounds of it. Smith was charged 20 cents excess, and Brown for his share paid 30 cents excess.

How much baggage was allowed free, and what was the total weight of baggage?

WHAT WAS THE PRICE OF BACON?

4. "Take this piece of bacon and 50 eggs for $1.60," said the provision dealer. "I have only 80 cents," said the boy. "Well, take half of the bacon and 25 eggs," replied the man. "No," said the boy, "I will take the whole of the bacon and 10 eggs." The provision dealer agreed to this arrangement.

What was the price of the bacon?

WHAT IS THE QUESTION?

5. "There is one question to which you must always answer 'Yes' if your answer is correct," said George.

What is the question?

WHAT WAS ITS PRICE?

6. "During sale week," said the merchant to a customer, "we will allow 20 per cent off the prices marked on the goods, but next week, after the sale is over, we will allow only 5 per cent discount." After the sale was over the lady bought something, and paid for it $3 more than it would have cost during the sale.

What was the marked price?

THE ANSWERS TO THESE PROBLEMS ARE ON PAGE 1394.

HOW TO FIND YOUR WAY IN A FOREST

MOST of us at some time or other during our holiday rambles have been lost in a forest or wood. Perhaps it is raining very hard and we are hurrying to find shelter, or else we want to catch a train, and, in our endeavor to save time, we have left the pathway. Or perhaps some interesting plants or insects have caused us to roam further and further from the beaten track. What a predicament to be in! Unless we have a compass or know how to read nature's signposts, we may wander about aimlessly for hours.

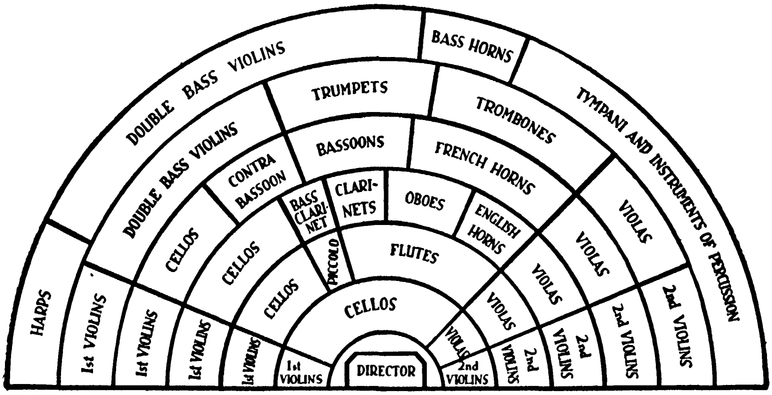
But we need not be lost in the wood, for nature has supplied us with unfailing signs, which, if known and studied, show us the north, south, east and west as clearly and truly as any compass.

Find a full-grown tree that stands slightly apart from its fellows. Now carefully look at the bark. It will be harder, lighter and drier on the south side; while on the north side it will be considerably darker in tone, and often at the roots on the north side we shall find a clump of moss. Nearly all hardwood trees, such as the oak, the ash and the elm, have moss growing on the north side; while on that side the leaves are longer, of darker green, and have lighter veins than those found on the south side. Try to find a sawn or cut stump. The rings of wood in the section will be found thicker on the south side than on the north, so that the heart of the stump is nearer the north side.

Stones that have rested in the same spot for some time usually have moss on the side facing north, while at best on the south side we shall find only a thin covering of harsh, half-dried moss. On the north side of a hill, ferns, mosses and late flowers grow, and this side is at all times greener with vegetation. In winter nests of insects will be found in the crevices on the south side of trees with rough bark.

If we are on a marsh, small bushes will act as compasses, their leaves and limbs showing the same differences as we have seen on the trees in the wood. The main thing is to have confidence in ourselves and keep from becoming panicky. If we remember these simple rules, and keep on in one direction, we shall soon get out of the wood.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 1391.



SYMPHONY ORCHESTRA

Seating plan for an orchestra. Variations of this plan are often used.

THE MODERN SYMPHONY ORCHESTRA

LUDWIG van Beethoven died in 1827, not so very long before our own times, yet he was the first musician to "sit above the salt." In feudal times a great salt cellar was used on the long tables as a social boundary. At the banquets the lords and ladies sat above, and the common folk below the mark. Composers and performers were placed below the salt because they were really considered as servants.

To-day musicians are in the "professional" class, and society leaders feel almost as honored by the presence of a great violinist such as Heifetz or a great pianist like Horowitz as they would be by royalty. The public will crowd a concert hall and pay well to hear some world-renowned conductor, such as Sergei Koussevitzky or Leopold Stokowski, "read," or interpret, through an orchestra, the music written many years ago by masters who scarcely made enough money to keep body and soul together.

For a long time any group of instruments played together was called a "band," simply because the players were banded together to play the same compositions. These bands sometimes included groups of stringed instruments that to-day are in what we call orchestras.

In the ancient Greek language, the word orchestra means "dancing place." It used to refer to the space between the stage and the spectators' seats; in this space the chorus of Greek plays sang or danced. Nowadays, in the case of grand opera, musical comedy performances and the like, the word orchestra or more exactly orchestra pit, is still used for the space between the stage and the audience. Now, however, this space is occupied, not by singers or dancers, but by musicians performing on instruments. The word orchestra is also used very often to refer to the entire floor section of a theatre.

In modern times, too, the word has come to be applied to a group of musicians who sit in the orchestra pit or on the stage itself and who play for an audience. How did this change in meaning come about? The explanation seems to be that the musicians who played in the orchestra pit or orchestra were known first as "men of the orchestra" and then simply as "the orchestra." In much the same way we give the name of House to the body of law-makers who meet in the House of Representatives in Washington, or Commons to members of the House of Commons in Ottawa.

Formerly, as we have seen, the word band was used in the sense in which we use orchestra to-day. The two words now mean different things. A band, generally speaking, is a musical organization made up entirely, or for the most part, of players of instruments upon which one blows (like trumpets and clarinets) or which one strikes (like drums and cymbals). In an orchestra there are also instruments upon which one blows and others which one strikes; but the backbone of the orchestra is formed by stringed instruments such as violins and cellos.

HOW THE VIOLIN CAME TO BE A MEMBER OF THE ORCHESTRA

The history of the orchestra really dates from the performance of the first opera at Florence, Italy, about 1600, when instruments were brought together to accompany the singers. In those days the main instruments were of the harpsichord and small organ class, as well as the lute types from which our mandolin and guitar are descended. The need for an instrument which could support the highest voices brought about the perfection of the violin, about 1650. Claudio Monteverde (1567–1643) was one of the first composers who relied chiefly on the stringed instruments. His orchestra also included trumpets, drums, cornets, trombones and flutes, though perhaps his chief contribution to music was in establishing the violin as a regular member of the orchestra.

Johann Sebastian Bach (1685–1750) wrote every kind of music except opera and he treated each instrument separately, so that his contribution to the orchestra was in preparing the way for instrumental solo parts. Bach is sometimes regarded by musicians as a bridge between the old music and the new. Much of the music he wrote was for instruments no longer used, such as the viola da gamba. Yet his compositions for the violin, particularly the sonatas for unaccompanied solo violin, are still popular with great performers and are often played on the concert stage.

WHY JOSEPH HAYDN IS CALLED THE FATHER OF THE SYMPHONY

Joseph Haydn (1732–1809) earned the title of Father of the Symphony for he wrote more than a hundred symphonies. His name is associated with the orchestra as is Bach's with the organ, Handel's with the oratorio, and Gluck's with the music-drama. Haydn's first orchestra consisted of six violins, a viola, a violoncello, a double bass, one flute, two oboes, two bassoons and four horns. He eventually enlarged the orchestra to twenty-four instruments, including two trumpets and kettledrums. He was the first to give the kettledrums a very important part. Mozart added two clarinets to the wood-wind section and also used a trombone in his opera music.

When Beethoven began composing, the orchestra consisted of four stringed instruments, two flutes, two oboes, two bassoons, two horns, two trumpets, kettledrums and occasionally, two clarinets. He built on this foundation and it is to him that the symphony orchestra owes its greatest development. In his great Symphony in C Minor (Number 5) three trombones, a piccolo and double bass became regular members of the orchestra. In the Third Symphony (Eroica) we find the first appearance of three horns. In the Ninth Symphony, the last symphony by the last of the great classical composers, even Beethoven could find no better instrument than the human voice to express the exalted joy of the last movement.

Then came the Romantic composers who used valves for the brass instruments, improved the keys for the woodwinds, brought the harp into the orchestra as well as the English horn, the bass clarinet and the bass tuba. Instruments which had been used in pairs and in threes were increased to quartets so that each group could play in full, four-part harmony. Later composers have called for additional instruments until to-day almost every instrument may be a soloist, and any instrument may be called for which will add to the completeness of the tone picture.

GREAT MODERN CONCERT ORCHESTRAS HAVE FROM EIGHTY TO ONE HUNDRED PLAYERS

A symphony is a form of musical composition just as a novel is a form of literature. It is a dignified piece of work, often difficult to understand and to play. Orchestras which play the great symphonies require every type of instrument and skillful players; these orchestras are called symphony orchestras. Such an orchestra, however, may frequently give a concert including musical compositions not properly known as symphonies; or it may even give a complete program and not play a single long symphony. Therefore it is more precise to speak of most of our large orchestras, not as symphony orchestras but as concert orchestras. Modern concert orchestras generally have from eighty to a hundred players; the size of an orchestra may be increased or decreased for special occasions.

Large groups naturally require careful planning and organization. The musicians are seated in groups according to the type of instrument and music they are to play. We find four main groups, or families, of instruments—the strings, the brasses, the wind instruments and the instruments of percussion.

There are no set rules as to where the individual musicians shall be seated. Very often the space and shape of the auditorium or concert hall, as well as the personal preference

INSTRUMENTS OF THE ORCHESTRA

The strings. More than half of the orchestra's instruments belong to this family.
First Violin Second Violin Harp Double Bass Viola Violoncello

The woodwinds, with and without reeds. Some woodwind instruments are now also made of metal.
Contrabassoon Bassoon Bass Clarinet Clarinet English Horn Oboe Flute Piccolo

The brasses are also wind instruments. The player blows into a tube, causing the air to vibrate.
Trumpet French Horn Trombone Bass Trombone Tuba
Courtesy, RCA Victor Co.

of the conductor, will determine the arrangements. However, experience has shown that it is better to have all the instruments playing the same parts seated near one another. The lighter, softer tone-makers are placed toward the front so that their music is not drowned by the heavy brass instruments at the rear.

WHERE THE DIFFERENT PLAYERS IN AN ORCHESTRA USUALLY SIT

As the audience faces the orchestra, we may usually look to the left of the platform, at the conductor's left hand, for the first violins and harp (or harps) and to the right for the second violins. The others are generally grouped behind them to fill in a space like a half circle. Part of the cellos are seated in front of the conductor; the rest, beside the first violins. The double basses are at the left rear. The violas, horns, trombones and cornets are at the right; the woodwinds are in the centre, with the flute and piccolo in the front row. The percussion department is at the right rear. If you will turn to page 7148, you will see a picture of an orchestra.

More than half of the instruments in a concert orchestra belong to the string family, which is, therefore, the main section. It is the most complete group, and to most listeners the most pleasing. It has a range of six and a half octaves and can portray any kind of movement—exceedingly fast or slow; sad or gay, tender or harsh. This makes it useful to the composer who is seeking instruments to imitate certain sounds found in nature. In an orchestra of eighty players, in order to obtain the proper balance, we should have about sixteen first violins, fourteen second violins, eight violas, twelve cellos and eight basses.

THE VIOLIN IS THE BACKBONE OF THE ORCHESTRA

The violin is the most important instrument in the orchestra. It has an old and distinguished family tree, going back several thousand years; but the violin itself was not perfected until the seventeenth century. We have not been able to make better violins than the master craftsmen, such as Stradivarius, made over two hundred years ago. Indeed, a genuine Stradivarius is prized to-day far above the best instrument a modern maker can turn out.

If we wished to make a violin we should need about seventy different pieces, mostly of wood. There are four strings, which for centuries were made from sheep gut, but now metal strings which are cheaper and more durable are much used. The longer a good violin is kept and the more it is played the better it sounds. We tell you more about the violin in the article The Violin and the Piano, which begins on page 1795.

The violins have a most important work to do in the orchestra and usually two parts are written for them—the first and second. While the first violins usually play the melodies, the work of the second violins is harmonic and is used to fill in the chords and emphasize rhythms. Such parts are difficult and at the same time very important; a musician once said: "An orchestra is only as good as its poorest second violinist."

THE CONCERT MASTER IS USUALLY THE BEST PLAYER AMONG THE FIRST VIOLINISTS

In the ordinary concert orchestra, usually the best player among the first violinists is the concert master, who sits on the first outside chair nearest the conductor. He may, in fact, replace the conductor in case of necessity. He usually plays any solos required from the violin section.

The viola looks like the violin, but it is larger in size—longer, with heavier strings. In the symphony orchestra about half as many violas as second violins are employed. The music for the viola is written in two clefs—the alto and the treble. The "timbre" or tonal quality of the instrument is somewhat veiled and nasal. It is often used in strains where a certain sadness prevails.

The Italian word *violone* means double bass, and "cello" means small. Therefore, the small double bass which we know popularly as a "cello" should properly be spelled violoncello, not violincello. The cello is held between the knees and a peg raises the instrument from the floor. The player must always sit. The instrument employs three clefs—the bass clef, the alto clef and the treble clef. Next to the violin the cello is the most important instrument in the orchestra. Some people prefer its warm, vibrant tone to that of the violin. The cello is used as a melody instrument or to provide a tonal background for the higher-pitched instruments.

THE DEEP-VOICED DOUBLE BASS MAY HAVE FOUR OR FIVE STRINGS

Parts for the double bass, which carries the deepest bass parts of the score, are written one octave above their actual sound in order to avoid the constant use of extra lines below the staff—the leger lines, as they are called. The older instruments had only three strings; to-day most double basses have four or five strings to enable the composer to call for extremely low notes.

THE FAMILY OF WOODWINDS WHICH PRODUCE SOUND BY VIBRATION OF AIR IN TUBES

We come now to the second family of instruments—the woodwinds, which consist of wooden tubes through which the performer blows. (Some of these instruments are now also made of metal.) The woodwinds include the oboe, the English horn, the bassoon, the clarinet, the flute and the piccolo.

Some woodwinds are provided with double reeds at the mouthpiece. These reeds are two little slips of cane, fastened by silk thread to the tube of the instrument. The wind forced between these reeds by the breath produces a most unusual sound, which is very colorful in the large orchestra.

The oboe is the most melodious of the double-reed instruments. In quick movements it strikes a light-hearted, jesting note; in slow movements its tone is apt to sound sad and plaintive. The oboe is one of the most difficult of all instruments to play. Unless its tone is perfectly controlled by the performer, this instrument is likely to do queer things—to whine, to sputter or even to howl in an undignified way.

The oboe is used to give the pitch for the whole orchestra by sounding the note A, to which the rest of the orchestra tunes. This practice is said to date from the time of Handel, when the oboe was the principal wind instrument.

HOW THE ENGLISH HORN RECEIVED ITS NAME

The English horn is the tenor or alto oboe; it is pitched a fifth lower than the oboe. This instrument is sometimes called by the French name *cor anglais* (pronounced something like *cawr awngleh*). The mouthpiece containing the double reed is bent at right angles. For this reason the French word for this instrument was originally *cor anglé* or bent horn. Later the word *anglé*, meaning bent, was replaced by the word *anglais*, meaning English. The reason was that people came to mistake the words *cor anglé* for *cor anglais*, since *anglé* and *anglais* are pronounced much the same.

The bassoon is really the bass of the oboe group; it looks something like a bundle of sticks and for that reason the Italians call it the *fagotto*, which means faggot. The tone of the bassoon has a rather comical quality; the instrument is sometimes called the clown of the orchestra. Mendelssohn called for the bassoon to imitate the braying of Bottom in his Midsummer Night's Dream music.

The heckelphone (named for its inventor William Heckel) is a modern reed instrument, first introduced by Richard Strauss. It looks like an enlarged oboe, so long that the bell, or mouth, rests on the floor when the player is seated. In pitch relationship it comes between the English horn and the bassoon, with exceptionally vibrant tones.

THE CLARINETIST USUALLY HAS SEVERAL DIFFERENT INSTRUMENTS

The clarinet has a single reed at the mouthpiece. This instrument has a beautiful tone; the quality is full, rich and organ-like. The tube is made of metal, ebony or cocus, the wood of the granadilla tree. The player uses different clarinets according to the scale variations in the music. They are built to play in the C, B, A and E flat keys. The alto clarinet is a bridging link between the B flat clarinet and the bassoon. The bass clarinet has a turned-up metal bell and looks somewhat like the saxophone.

The flute and the piccolo are the only woodwinds without a reed. The flute is of ancient origin; it was a great favorite with the old Greeks and Romans. A great flutist of antiquity was Cleopatra's father, Ptolemy; he is generally known in history as Ptolemy Auletes or Ptolemy the Flute-player. Indian snake-charmers play flutes.

THE FLUTE, AND THE SHRILL, PIERCING NOTES OF THE PICCOLO

The mouthpiece of the modern flute is a hole set in the side of the instrument; the performer throws the air-stream of his breath against the outer edge of the hole. There are a number of other holes farther down on the instrument; these holes can be stopped up either by the fingers or by keys. The flute is sometimes made of silver. Its tone has been described as suggesting the hollow sound of a dove's cooing. The flute is frequently used to imitate the sound of birds; it imitates the nightingale in Beethoven's Pastoral Symphony. The piccolo (the name means small in Italian) is slightly less than half as large as an ordinary flute, and it sounds an octave higher, making it the highest voice in the orchestra; so high, indeed, that one piccolo is enough for almost any composer. Since it is really a small flute and the player uses a flutist's technique, very often the third flute-player in the orchestra is provided with a piccolo to play for special parts. Its shrill piercing notes (written an octave lower than they sound to avoid the extra or leger lines above the staff) are used for tearing, whistling sounds in music of a stormy or terrifying nature.

THE BRASSES, THE ORCHESTRA'S THIRD FAMILY, ARE ALSO WIND INSTRUMENTS

The brasses make up the third great family of orchestral instruments; they include the French horn, the trumpet, the cornet, the trombone and the tuba. The brasses have mouthpieces but no reeds; the sound is produced by blowing into a tube and causing the air to vibrate. Both woodwinds and brasses belong to the general family of wind instruments.

The French horn consists of a long tube (generally over seven feet long), coiled around until it looks a little like a pretzel. The diameter of the tube at the mouthpiece is only about a quarter of an inch; but at the other end it flares out into a huge bell eleven inches in diameter. Movable pieces called crooks are inserted in the coils to change the pitch; there are crooks for all keys. The right hand of the player is always placed in the bell to prevent harsh sounds and to produce a sweet, veiled tone. The French horn is the most difficult of all the brass instruments to master.

THE TRUMPET IS THE SOPRANO, OR HIGHEST-SOUNDING, BRASS

The trumpet is a long cylindrical tube with a cone-shaped bell; it is the soprano of the brass section. Trumpets are built in C, D, E, F, B flat and A, though A and B flat are most used. The tube is half the length of that of a French horn in the same key, and sounds one octave higher. The modern orchestra trumpet has three valves, which give it a complete chromatic scale within a range of about two and a half octaves.

A cornet, a valve instrument similar to a trumpet, is the leading instrument of a band, though less used in the orchestra. It is easier to play than a trumpet. The tone quality is mellow but not so brilliant as that of the trumpet. Cornets, like trumpets, horns and trombones, may have their notes softened by means of a device set in the bell.

The name trombone comes from the Italian *tromba* and means a large trumpet. The trombone differs from all other brasses in that it has a free-running slide instead of valves. This idea of a tube within tubes is very ancient, having even been attributed to mythical characters. No specimens of ancient trombones have been found, but references are frequent in ancient writings. We now have valve trombones too, but the slide trombone is superior in every respect in tone quality. Trombones are built in varying sizes, but the B flat is most used. They are popular as solo instruments and are used in the orchestra for noble, religious and pompous coloring.

The tuba, the bass of the brass choir, exists in six sizes—soprano, alto, tenor, baritone, bass and contrabass. The small ones are not generally heard in orchestras, but are popular in small bands. The bass tuba, which can give the lower E flat on the piano, acts as a tonal backdrop for the other instruments. The tone quality is full and organ-like, but when played to the limit of its powers takes on a "snap" like that of the trombones. Wagner used the tubas to represent the last snorts and groans of the dragon in "Siegfried" before the monster is finally killed.

THE SAXOPHONE IS A CROSS BETWEEN WOODWINDS AND BRASSES

The saxophone is a sort of cross between the woodwinds and the brasses. The bent tube of metal suggests a brass instrument; but the mouthpiece is provided with a reed mouthpiece like that of a clarinet. The saxophone was invented in the year 1840 by the Belgian instrument maker, Adolph Sax, from whom the instrument takes its name. So you see that it was really invented long before the development of the modern dance orchestra in which it is featured. The tone sometimes suggests the mellow quality of the cello; its upper notes, however, are apt to become shrill. A few of the great composers, including Bizet, have written parts for the saxophone, but it hardly enjoys first-rate standing in the concert orchestras of to-day.

The fourth family of the orchestra, the percussion section (also called the battery or the "kitchen") consists of the instruments which are struck or clanged or beaten. Most of them are played with mallets or clashed together to produce music or noise. The tambourine is an exception. Since the wire strings of the piano are struck by little hammers controlled from the keyboard, it is technically an instrument of percussion. Some of the instruments of this family have pitch, the most important one being the kettledrum. Others, like the cymbal, are used only for one certain tone or effect.

THE KETTLEDRUMS LOOK LIKE COPPER KETTLES WITH DRUMSKIN ON TOP

One can easily see how kettledrums (also called timpani or tympani, with the accent on the first syllable) get their name, for they look like great rounded copper kettles, with a parchment skin stretched over the top. The skin is held in place between two "hoops" which fit into one another—much like embroidery hoops. The inner hoop is of wood. The outer one, of iron, may be tightened or loosened by means of screws, thus changing the pitch of the kettledrum.

The instrument, which rests on a tripod, is played by means of two drumsticks provided with padded ends of felt. A great variety of sounds can be produced on the kettledrum. Single or detached beats may be quired, the tone is damped by quickly bringing the cymbals against the chest. Ordinary cymbals are about twelve inches in diameter.

Chimes are accurately tuned steel tubes, graduated in size and suspended from a wooden framework. Various types of bells are used, including real sleigh bells. From China has come the gong—a round plate of hammered bronze with tambourine-like edges. It is used mostly in connection with

Courtesy RCA Victo

The percussion instruments. The player strikes, beats or clangs them to get his musical effect.
Tympani or Kettledrums — Side or Snare Drum — Tambourine — Triangle — Cymbals — Bass Drum

used to accent the rhythm; sometimes there is a prolonged roll, which adds life to a sustained chord. Thunderous, terrifying sounds can also be produced. Kettledrums are generally used either in pairs or in groups of three.

The bass drum has no definite pitch and is played with one soft-headed drumstick. Struck softly it produces a dark, ominous effect but in loud passages it adds to the general volume of sound and rhythm. A snare-drum has thick strings of gut stretched over its lower head which makes it have a peculiar rattle when played with the two hardwood sticks. The pitch is indefinite. A good roll, close and even, is extremely difficult to produce. The drum is used chiefly for military effects.

Some percussion instruments are simply metallic vibrators. The cymbals are large metal plates, played, not by clashing together, but by striking their edges with a sliding movement. When short notes are required, the tone is damped by quickly bringing the cymbals against the chest.

deep chords sustained by the brass instruments or by the lowest tones of clarinets and bassoons.

As the name suggests, the triangle, made of a bar of steel, is bent in triangular form. Hung by a cord to a music stand or bracket and struck with a small steel rod, it produces a bright tinkling sound.

The celesta looks like a small organ and makes tinkling, bell-like music. The tones, however, are produced by a mechanical action similar to that of a piano. Small hammers strike steel plates which are suspended over wooden resonating boxes which have been accurately tuned. The notes may be sustained by use of a pedal just as with a piano.

Then we have the glockenspiel, the xylophone, castanets, tambourines and wind machines, all at the composer's disposal when needed for some part of a musical picture, just as an artist has extra paints in his box for occasional use.

THE HARP STANDS BY ITSELF AMONG THE FAMILIES OF INSTRUMENTS

The harp stands more or less outside the four great families of instruments in the concert orchestra. Technically, indeed, it is a stringed instrument like the violin or cello, since it has a number of strings tightly stretched so as to produce definite tones. However, these strings are set inside a frame, not over a wooden box (as in the case of the violin or cello). Furthermore the strings are not rubbed with a bow but plucked with the fingers.

The frame of the modern harp is shaped somewhat like a triangle. Two sides of the triangle meet at the pedestal, which is at the player's feet; the side nearest the player is the soundboard and the other is the pillar. They are joined at the top by the curved bracket known as the neck. The strings are stretched between the neck and the soundboard.

The pedestal provides a framework for seven pedals, which look like the pedals of a piano. They are connected with rods passing through the pillar, and the rods in turn are connected with the strings by means of a mechanism in the neck. When a player pushes a pedal halfway down, he raises the note by a semi-tone; when he pushes the pedal down all the way, he raises the note by a whole tone. This means that each one of the strings of the harp can produce three tones. The instrument has a range of six and a half octaves.

The harp is one of the most melodious of all instruments and one of the most difficult to play. The rippling effect of the tones it produces can not be matched by any other instrument. No concert orchestra could be without a harp, for some of the greatest orchestral scores have harp passages.

The history of the harp goes back to ancient times. Harps were used by the Egyptians more than twelve centuries before the birth of Christ; they were known to the ancient Hebrews and Assyrians, the Welsh, the Irish and many other peoples.

THE COMPLICATED MUSICAL TASK OF THE ORCHESTRA DIRECTOR

Each member of the orchestra has a number of problems to work out in learning his part. Players of stringed instruments must study the bowing and intonation (by this we mean the production of different notes by the fingers of the left hand). Trumpeters must analyze the breathing marks in their parts. Flute players must go over difficult runs again and again. When each of the hundred members of the orchestra can play his part correctly, it is the task of the conductor to take a hundred individual performances and to make of them a single, harmonious performance.

THE DIRECTOR, OR CONDUCTOR, MUST BE A SORT OF MUSICAL SUPERMAN

The conductor must be a sort of musical superman. He must have a broad musical background. He must know the problems of counterpoint (see page 6902) and rhythm. He must be able to give an accurate beat to the orchestra; he must know when to quicken or to slacken the beat. He need not be a master performer on any one instrument, but he must understand the uses and the limitations of each. He must be familiar with the musical compositions of the past and of the present. He must also be a leader of men—a leader whom they will respect and obey.

Much of the conductor's work is done before a public performance. First of all, he must select the compositions that are to be played. He must arrange them in such a way that they will make a pleasing, well-rounded program. He must not neglect the well-established classics; on the other hand, it is his duty to introduce to the public unfamiliar works of modern composers—for if he does not present these pieces, how will they ever become known?

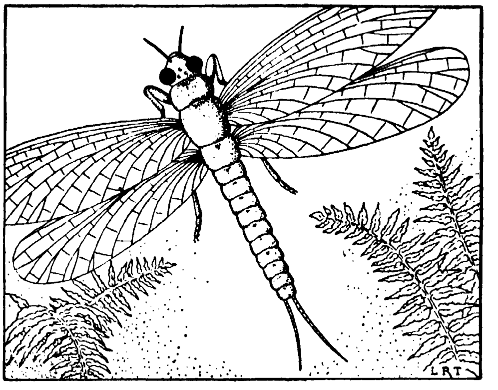
It is not enough for the conductor to know all the notes of the compositions that he has selected. He must also be able to grasp the meaning of each composition and to make his men understand it as well. In rehearsals, the conductor must be able to make the most effective use of the limited time at his disposal; for few conductors will ever admit that they have enough time for rehearsals.

A GREAT ORCHESTRA PLAYING AS ONE MAN IS A MODERN MIRACLE

In these days, when there are many skillful musicians, most professional orchestras can give business-like performances. All the notes will be played correctly; the musicians will play now loudly, now softly, now rapidly, now slowly, according to the markings in their parts. But it takes a great conductor to bring about a musical miracle, when an orchestra ceases to be a group of individual musicians and becomes a single, magnificent instrument. Only an instrument of this sort, played by a master conductor, can set before us in all their splendor the immortal works of a Beethoven, a Brahms or a Tschaikowsky.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 1343.

THE CARBONIFEROUS PERIOD



A giant Carboniferous ancestor of our dragon-fly with a wing-spread of thirty inches.

WITH the Carboniferous period we come to the close of the long Paleozoic era, which included the Cambrian, Ordovician, Silurian and Devonian periods. The name Carboniferous comes from the presence of great veins of coal in the rocks of that system. As you know, coal is largely composed of carbon. By combining the word "carbon" with the word "ferous," which means "bearing," we get Carboniferous. Geologists divide the Carboniferous into an Upper and Lower Carboniferous and a Permian period. This latter period belongs partly to the Paleozoic and partly to the Mesozoic era which followed.

The Upper Carboniferous, also called the Pennsylvanian period, is often referred to as "The Great Coal Age." During this period a large part of the eastern United States, Europe, Asia, and the northern parts of Alaska, Greenland and Siberia were covered by luxuriant swampy forests. It is the remains of these forests that furnish us much of the coal we burn to-day in our homes and factories.

When the plants of these ancient swamp forests died, they became submerged in the water, where they decayed very slowly. The slow rate of decomposition changed the plants into a dark brown substance called peat. Additional accumulation of decaying plant materials increased the pressure on the peat and gradually pressed it into lignite, which is sometimes called brown coal. In time this lignite became either bituminous (soft) coal, or anthracite (hard coal). Most of the coal formed during the Upper Carboniferous is bituminous coal. So, to-day, when we burn coal, we are really burning the plants of these early forests, and setting free the energy of the sunbeams stored in their wood.

Carboniferous rocks are found all over the world, sometimes in small patches and sometimes in huge areas. In England, France and Germany there are small areas of this rock, while in Russia, China and North America there are sheets of such rock spreading over thousands of square miles.

There are two main types of rock in the Carboniferous system: the limestone, built up in the sea by various coral-forming animals; and the sandstone and shale rock, formed in shallow lakes and lagoons. Rocks of both types are found in the Carboniferous of North America. The second type is most important because it includes the valuable coal beds.

The change from the Devonian to the Carboniferous period was, in general, quite gradual, but great upheavals and wearing-away of rock marked the close of the Devonian in Nova Scotia and Maine. The land of New England, Canada and Newfoundland overlooked a Gulf of St. Lawrence that was much greater than at present. Here are sandstones, conglomerates and limestones 6,000 feet in thickness. Southwestward sandstones and shales are 4,000 feet thick, but they become thinner to the west. The Mississippi Valley was once a great inland sea and built up from 1,200 to 1,500 feet of limestones. These reached into Missouri, Arkansas and Texas. There are some limestones, shales and coal in the Lower Carboniferous of Virginia and Nova Scotia.

In the midst of this age came a gentle heaving-up of the eastern ocean floor. Heavy sandstones or millstone grit was laid on the lower rocks, and broad lands of a low, swampy nature came into being along the new shores. This kind of land occupied all Nova Scotia, Pennsylvania, West Virginia, eastern Ohio, parts of Tennessee, Kentucky and Alabama. It was in these swampy lowlands that the coal-producing forests flourished.

Rocks of the Carboniferous period are found westward to California and British Columbia; but west of Nebraska they are usually deep-sea rocks, and they show 13,000 feet of sediments in Utah and Nevada.

CREATURES THAT LIVED IN THE ANCIENT FORESTS

The animal life of the Carboniferous period was various. In the rocks laid down under the sea we find crinoids, corals, foraminifera and brachiopods; and great masses of the limestones are composed of the skeletons of these creatures. Hundreds of kinds of fish have been found in Carboniferous rocks. The fish were mostly sharks, and most of them had flat-crowned teeth adapted for crushing the shells of the creatures on which they lived. In rocks formed in the marshes and lagoons are found numerous types of small fishes, crustaceans and molluscs.

Among land animals are found cockroaches six inches long, crickets, beetles, locusts and dragon-flies with a wing-spread of twenty-nine inches. Since most of these insects are found having fully developed wings, it is thought that they originated long before the Carboniferous period. Scorpions were plentiful, and there were a few crustaceans of the crab and lobster family, and many species of millipedes and spiders.

Amphibians, which began their development in the Devonian period, made great progress during the Carboniferous age. The name amphibian refers to the "double life" lived by these creatures. Like our modern frogs, toads and salamanders, these early amphibians spent the first part of their lives in water, like a tadpole, and only in the adult stage could they venture out upon the land. Most Carboniferous amphibians were small, although a few attained a length of fifteen feet. It was from the amphibians that the great reptiles of the Jurassic and Cretaceous Periods eventually developed.

PLANTS THAT HELPED FORM OUR COAL SUPPLY

As we have already seen, plant life was very abundant in the Carboniferous period, and there were forests extending over a considerable part of the earth; but there were no flowering plants. The vegetation of the age was luxuriant and rank.

These Carboniferous forests and jungles were not at all like the forests and jungles we know to-day. They consisted almost entirely of giant ferns, giant mosses, and giant horsetails, with a few trees here and there. The humble club-mosses which to-day creep upon the ground were represented by lepidodendrons growing fifty or sixty feet high; ferns grew into trees almost equally high; while there were dense thickets of enormous horsetails known as calamites.

THE CLIMATE UNDERGOES A MYSTERIOUS CHANGE

Towards the close of the Carboniferous period the climate throughout the world began to change from a warm, moist one to one that was cold and dry. The mountains became blanketed in snow. Great ice fields, or glaciers, spread down from the north, covering parts of North and South America, South Africa, Madagascar and India. The lowlands were turned into barren deserts. No one really knows what caused these sudden climatic changes, but it is thought that they occurred quite suddenly.

The fossils of the Permian period, the last division of the Carboniferous, show that both plant and animal life also underwent great changes. The thick swamp forests vanished as if by magic and new plants suited to the changed climate took their place. The amphibians began to decline in number, and the earliest reptiles appeared.

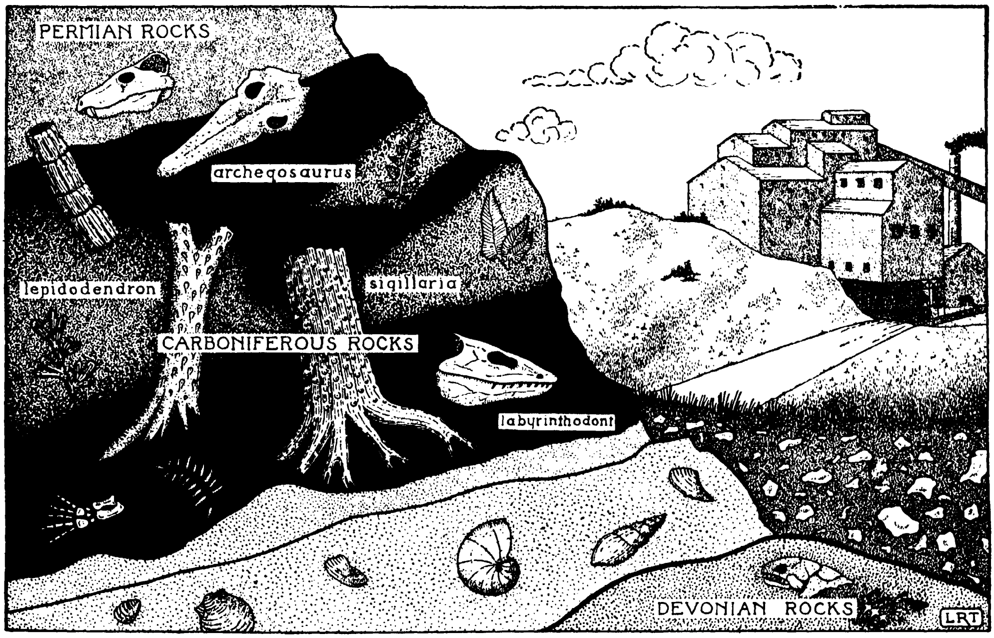
The first reptile of which we know is named Seymouria. It was about two feet long and had a broad stubby tail and short legs. The mouth was equipped with cone-shaped teeth. As time went on, however, reptile life made great strides. Dimetrodon, a later Permian reptile, reached a length of ten feet. His fang-like teeth have earned for him the title of "tiger of the Permian." Upon his back Dimetrodon carried a sail about four feet high. This sail was composed of skin and was held erect by a series of spines that were joined to the creature's back bone. What purpose this sail served is a mystery.

Rocks of the Permian period are found from Nova Scotia to West Virginia, and westward to Nebraska and Texas; where they are thickest. The rocks west from Texas are usually those of inland seas. They consist sometimes of red sandstone and sometimes of limestone and dolomite. The animal life of this period is found chiefly in the limestone rock.

THE NEXT STORY OF THE EARTH IS ON PAGE 1401.

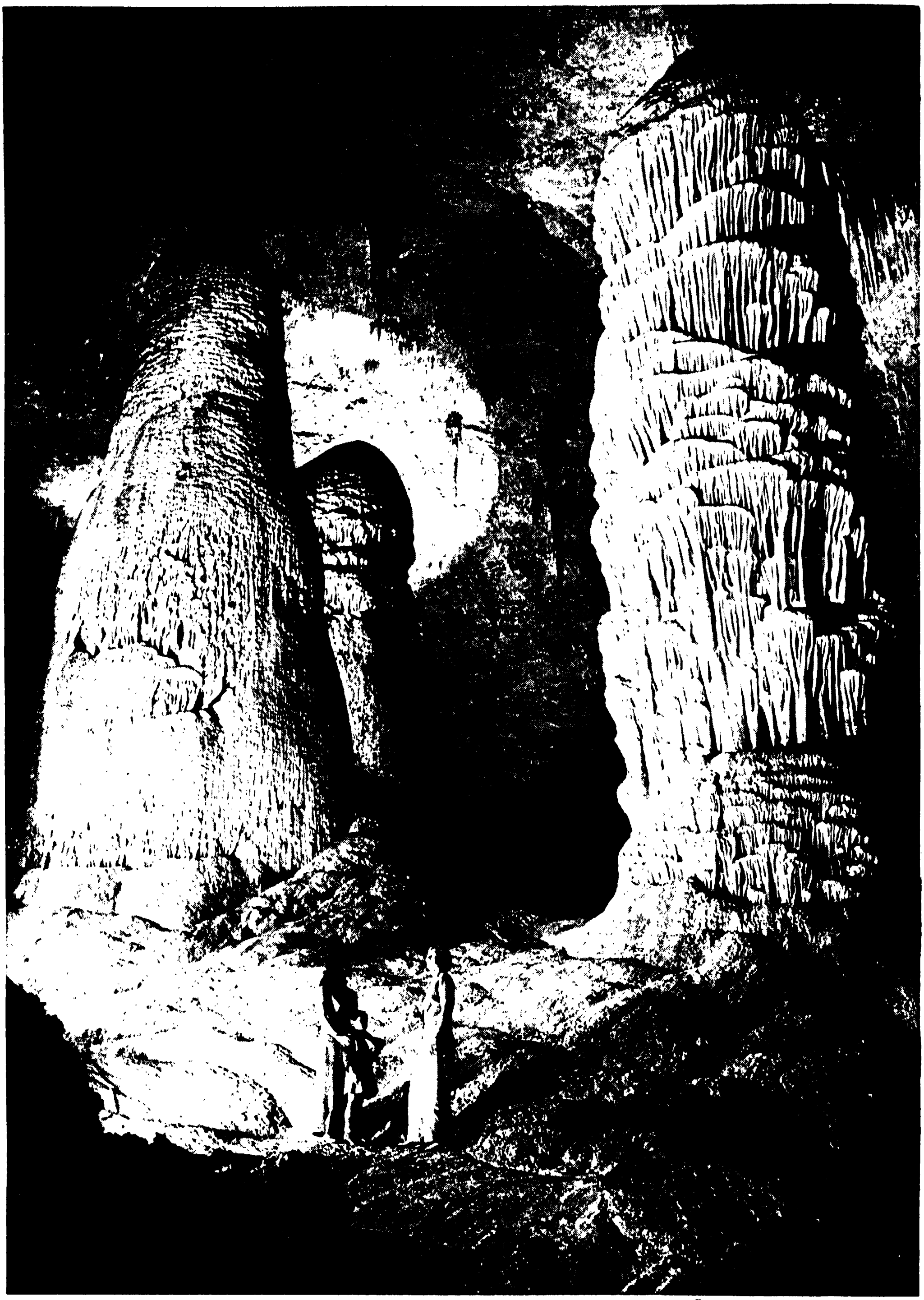
LIFE OF THE CARBONIFEROUS PERIOD

This picture gives us some idea of what a Carboniferous swamp-forest must have looked like. Amphibians, the early relatives of our frogs and salamanders, swam in the warm waters and giant dragon-flies sped through the air. The vegetation looks very different from that with which we are familiar to-day.



Here we see a cross-section through the Carboniferous and Permian rocks. The coal is illustrated in black and contains the fossils of coal-producing vegetation. Between the coal and the earlier Devonian rocks lie the sea-formed limestones bearing the remains of animals that lived in the Carboniferous oceans.

THE BIG ROOM IN CARLSBAD CAVERNS



Santa Fe Railway photograph

The Big Room is more than three-fourths of a mile long; its greatest width is 625 feet, and the ceiling is 300 feet high. Notice how tiny the people look beside the giant stalagmites that have grown up through the ages.

WONDERFUL CAVERNS

THE dictionary says that a cave is just a natural cavity beneath the earth's surface, but we all know it to be much more than that. It is mystery, beauty and adventure, recognized and appreciated the world over.

Caves and caverns (a cavern is simply a large cave) are found wherever water encounters a substance it can eat away. Most caves are hollowed out of limestone which is dissolved by seeping water and bit by bit is carried away. At first only tiny crevices are formed, lacing and interlacing like small veins in the back of your hand. But as more water enters with each rain, over the weeks, months, years, thousands of years and even millions of years, the crevices become great fissures which further enlarge to wonderful systems of interlocking chambers, hundreds of feet high and now and then thousands of feet long. In large caves the seeping water has often been helped in its work by cave-ins or by the hard sand and gravel it carries along to scour a deepening path.

Caves might be large, but they would not be beautiful if the dripping water did not leave something as well as take something away. During its second stage of cave-making, the water evaporates in places, leaving deposits that hang from the roof of the cave or rise from the floor. Those that hang from the roof are called stalactites. Those that rise from the floor are called stalagmites. Occasionally, spiral and branched shapes are formed, known as helictites. All these shapes combine to form carvings more varied and surprising than man could hope to achieve. Nature offers not only beauty of shape but beauty of color as well, since a random trace of some mineral substance, like iron, creates patches and streaks of rose, green and purple

© Caufield & Shook, from Ewing Galloway

Echo River, which flows through Mammoth Cave, three hundred and fifty feet below the surface of the earth.

to contrast with the usual shades of brown in the stone.

Caves are found all over the world. Italy has its famous Blue Grotto, on the beautiful island of Capri. In southern France are those deep caverns where prehistoric man left on the smooth walls remarkable pictures of the animals he knew. The Chalk Cliffs of Devon and Sussex in England were once used as hiding-places by smugglers. The United States has several great caves: Wind Cave, South Dakota; the charming Luray Cavern in Virginia, with its marvelous stalactites; and, above all, Mammoth Cave National Park, in Kentucky, and the Carlsbad Caverns National Park, New Mexico. These two cave-systems are the world's largest.

Wind Cave is famous for the curious wind currents that blow in and out of it. It does not have stalactites, but instead is encrusted with exquisite crystalline honeycombing. Luray Caverns, discovered in 1878, have many rooms and corridors decorated with glittering stalactites, stalagmites and helictites in white and in brilliant colors.

Mammoth Cave is situated in Edmondson County, Kentucky. During the War of 1812 it supplied the country with a considerable quantity of saltpeter, used in making gunpowder. Now it is a point of interest for tourists from all over the world.

At all times of the year the temperature of the air in Mammoth Cave remains the same, about fifty-four degrees. Its cool dampness never varies, although the sun outside may be baking the atmosphere to a fervid heat, or the snow lie knee-deep upon the ground. So majestic and somber is the gloom of the place that it often has an unpleasant effect upon the nerves of visitors.

Courtesy, National Park Service

Mammoth Cave in Kentucky was carved out of soft limestone by the slow, persistent action of water, seeping through cracks, hollowing out great caves, and encrusting their walls, roofs and floors with tiny bits of the shell-like stone. Giant stalactites, like those in the picture, often reach many feet down from a cave's roof to its floor.

It is hard to realize that not so much as a ray of sunlight has ever penetrated these gloomy caverns in all the ages since they were hollowed out of the slowly yielding limestone. In inky pools and cascades there are fish and crayfish that have no eyes. Long ago through underground streams their ancestors wandered into this world of darkness and silence. Gradually, through lack of use, their sense of sight became dulled and finally disappeared altogether. There are about thirty other kinds of life (mostly of the lower orders) to be found in the cave, including crickets that have faded to a pale and sickly hue. Bats are also found in large numbers. In one chamber called the Great Bat Room thousands of these little creatures cling motionless to the walls and ceilings. "They are cold to the touch and when seized between thumb and finger they shrug up their shoulders, move their wings lazily and perhaps utter a feeble cry."

The cricket is a long-legged variety that looks something like a spider. "These are everywhere, and when they die they remain where they happen to be on the wall, while a white fungus covers them with a thick shroud till they look like snowballs with legs. In one of the vaults there are also mineral 'snowballs,' as the ceiling is of gypsum crystals. Farther on, the gypsum takes the form of flowers, chiefly marguerites, sunflowers and regal chrysanthemums, though roses, too, may be found and the graceful forms of celery tops."

The natural entrance of the cavern (there is an artificial entrance at another point) leads into the first great chamber. For a few moments the vastness and the strangeness of what seems a new world stuns the mind. In the dim artificial light great walls of rock rise to the massive roof which rolls into domes and arches overhead. If someone shouts, the sound comes thundering back from the vast, shadowed caverns ahead, and it is a full minute before the echo dies away. This first chamber is known as the Rotunda and is one and a half acres in area. It was the chief workroom of the saltpeter makers, so that its floor is strewn with heaps of nitreous earth and ruins of workmen's vats.

Courtesy, National Park Service

This entrance to Wind Cave, in South Dakota, was dug through the rocks. The only natural entrance is a ten-inch hole through which the wind currents blow in or out, according to the atmospheric pressure outside the cave. When the barometer falls, the wind blows out; when the barometer rises the wind blows into the cave.

Next to the Rotunda is Audubon Avenue, also called Big Bat Room, where the bats we have mentioned take up their quarters for the winter season and cling like swarms of bees. Near by loom the Kentucky Cliffs—so called because of a fancied likeness to the cliffs on the Kentucky River. From them there is a gradual descent to a natural temple known as the Church, which has a sort of Gothic roof formed ages ago from natural stone into hoary, crumbling arches. A rock ledge rising twenty-five feet in the air serves as a pulpit. Here, for the past fifty years or more, the Gospel has been occasionally preached. In the Gothic Arcade more signs of the old mining activities are to be seen on the way to Stalagmite Hall, where huge rock crystals hang like icicles from the lofty dome and stretch up from the floor in peaked cones.

In one portion of Mammoth Cave we come upon a little deserted village of roof-less stone cabins, where many years ago a number of people suffering from tuberculosis took up their home, hoping for benefit from the even temperature. They entered the cave in the month of September, and in January they tottered out, white and bloodless from their long absence from the sun. Most of them died soon after, suggesting how great a life-giver the sun is and how hard it is to maintain health and resistance to disease when we are removed from its rays over any long period of time.

Several rivers, among them the Styx and the Echo, find their gloomy way through the darkness. A flat-bottomed boat carries passengers slowly and quietly down the Echo River. The rock ceiling is little more than two feet above the idle current in some places. As the boat slips along, the guide suddenly raises his voice and runs down the scale of notes. Slowly the tones grow and swell until they come back from the cavern rocks in rich and perfect accord. There is something awesome in that roar of sound, inevitably preceded and followed by silence, unbroken by the glassy stream beneath.

There are many other underground halls of weird beauty and interest that might well be described in detail—such as the Giant's Coffin, the Dead Sea, the Fairy Grotto and Lake Lethe, a broad basin of water enclosed by walls ninety feet high—but we must limit ourselves to an account of Mammoth Dome, where there is a tier of tremendous columns that have won for themselves the name of the Hall of Karnak, from their resemblance to that famous Egyptian temple. The grandeur of this particular place in Mammoth Cave is outstanding. Six mighty columns, eighty feet from top to bottom and twenty-five feet through, support the roof. The gray of the stone is covered with a coating of "yellow stalagmite, rich as jasper," says one observer, "itself covered with tracery as elaborate as Chinese carving. The capitals are projecting slabs of limestone and the bases are garnished by mushroom-shaped stalagmites. In looking up one thinks of great cathedrals, or even of the perpendicular sides of some Western canyon; and

Norfolk & Western Railway photograph

Luray Caverns extend far under a big hill in the Shenandoah Valley in Virginia. A map of the caverns would look something like a spider web, for the galleries and corridors branch out from a central space. There are wonderful stalactites and stalagmites, which flash and glitter in the indirect lighting that has been put in the caves.

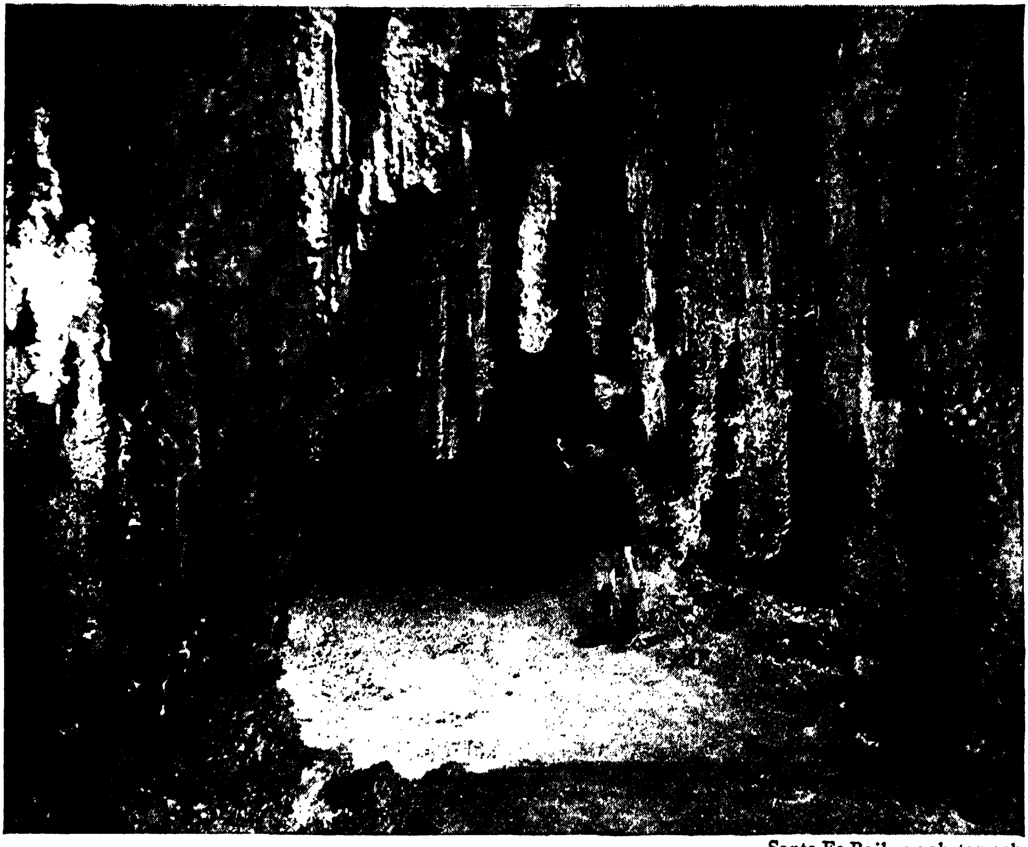
although the dome is only one hundred and fifty feet away, it seems far higher."

The Carlsbad Caverns of southeastern New Mexico, which have been made into a national park, contain enormous rooms with very beautiful stalactite and stalagmite formations. The exact size of the caverns is still not known despite much exploration. Already many miles of passages and chambers have been explored, extending far underground on three levels, one at 750 feet, another at 900 feet and the third at 1,320 feet. The beauty and immensity of this underground world is breath-taking.

The first white man to explore the caverns was Jim White, a cowboy, who entered them in 1901. Because he saw a dark, smoke-like column rising high in the air once each day, he investigated it, only to find that the column was alive, being a great stream of bats on their way to the upper air from the dark recesses of the caves. The natural opening in the earth from which they poured led down he knew not how far into darkness and silence.

With a single companion, Jim White ventured boldly into the cave, marking his trail by smudge spots and strings. Long stretches of string still lie in the less traveled parts of the caverns, reminding the more adventurous visitor that Jim White was there before him.

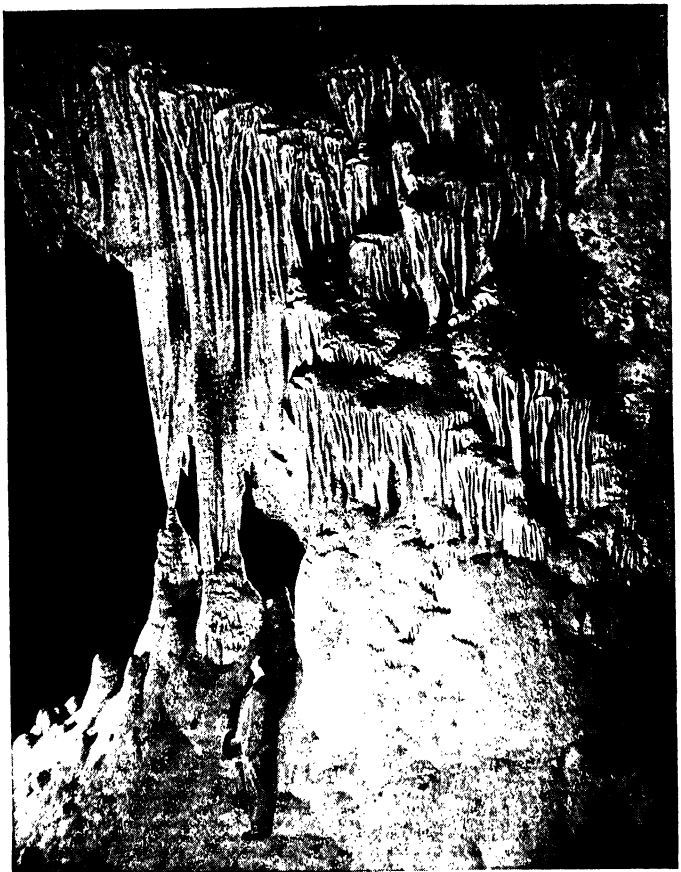
It is said that once he had discovered Carlsbad Caverns, White never missed a chance to show his find to visitors and enthusiastically share with them its many beauties. What these visitors said to their friends about the size and the magnificence of the underground chambers at last resulted in an expert examination of the caverns by Robert Holly, of the Government Land Office, and Dr. Willis T. Lee, of the Geological Survey. Both these men were greatly impressed by what they saw. A short time later Dr. Lee conducted an expedition of the National Geographic Society into the caverns.



Santa Fe Railway photograph

A little girl turns her flashlight on the rich and intricate carvings, made by the slow dripping of water through countless ages, in the King's Palace, one of the most beautiful of the great underground rooms in Carlsbad Caverns.

Seven miles of corridors and chambers are now open to the public. The main corridor just inside the entrance is very large, but it can not compare in beauty with the King's Palace, an almost circular room, shut off from near-by chambers by natural curtains and partitions of gleaming onyx. Next to the King's Palace is the Queen's Chamber, famous for rock formations like elephant ears, some of which hang straight while others are draped or folded back. Some of these ear-shaped formations are so delicate and even transparent that tints of pink and rose are faintly visible when a light is placed behind them. It is in this chamber also that the helictite formations are especially noteworthy, small stick-like shapes lacing and interlacing until they look much like a solid thicket of thorns.



Santa Fe Railway photograph

From any viewpoint the stalactites and stalagmites of Carlsbad Caverns are impressive. The ones shown here make one think of a delicately colored frozen waterfall. Minerals in the water have stained them many colors.

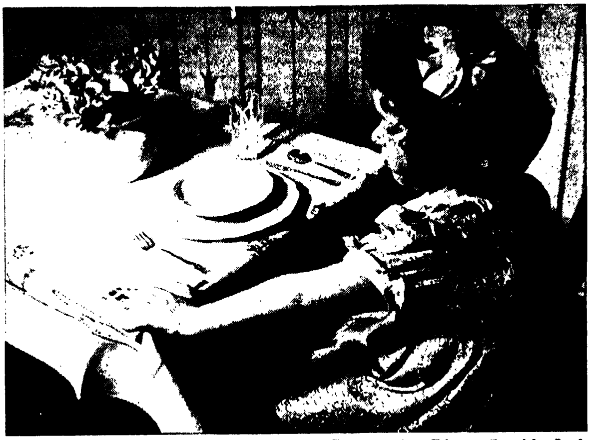
Not far from the Queen's Chamber is the Big Room, probably the greatest cave within a cave in the world. It is nearly 4,000 feet long, 625 feet wide and, at its highest point, rises to the tremendous height of 350 feet above the floor level of the enormous cave.

A public lunchroom is situated at the beginning of the Big Room. Water has been piped down from the surface and is available in sanitary drinking fountains. Tables and benches have been built and rest rooms have been installed.

Some of the wonder of the Carlsbad Caverns would surely be lost were it not for the masterfully effective way in which they are electrically lighted. During the long trip underground the visitor never so much as glimpses a switch, an electric cable or a floodlight. All lights have been cleverly hidden behind rock shields, sending their beams to the ceilings and to the rock formations from which they are reflected back to the trails. The seven miles of trails are divided into twenty-four lighting sections, controlled by switches at the ends of each. As a party enters a section the guide in front pushes a button and the lights flash on for a thousand feet ahead; then, when the party has passed through, a guide in the rear causes the light in his section to fade away, while lights for another thousand feet appear in the distance as if by magic.

The comfort of visitors to the Carlsbad Caverns is assured not only by its system of broad and easy trails, but by its elevator service. The United States Government has installed two high-speed elevators which run between the 750-foot level and the surface. They have an hourly capacity of 500 persons and are the second longest single-lift elevators in the United States, surpassed only by those in the Empire State Building in New York City. These elevators are vital to the many visitors who lack the endurance necessary for a seven-mile trip on foot, despite the fact that cavern air is considered very invigorating.

A TALE OF A KNIFE AND FORK



Courtesy, Community Plate, Oneida Ltd.

A little girl's own knife, fork and spoon of silver.

FOR ages and ages men never dreamed of having knives and forks. The first sort of knife that they used was probably the sharp edge of a shell, gathered on the beach where they caught the shell-fish which formed their food. By and by they improved on this, and made knives and axes and spear-heads of flint stone.

The men of the Stone Age used their flint knives for cutting up the flesh of the animals which they had caught, just as the Indians were doing when the white men came to America. The Stone Age men ate with their fingers, gnawing the meat from the bones of animals, and throwing the bones on the floor of the cave. They did not need forks.

The fork, which grew out of the spear, came a long time afterward. The first forks were used to spear fishes, and were made with three prongs, of which the two outer prongs were barbed. If we want to see what they were like, let us look at a pickle fork, and imagine it to be made, on a much larger scale, of flint or bone, or even of some hard wood. Of course the first ones were crude.

Later on forks were used in cookery, and then centuries passed before anyone thought of using them at the table. It is almost certain that Queen Elizabeth and the ladies of her court ate with their fingers; and it is more than likely that our ancestors of the time never saw a fork smaller than those they used in cooking and serving meat. It is said that the luxurious Venetians used table forks in the eleventh century, and that Charles V of France had a few forks for his own use in the fourteenth century; but probably forks with which to eat food did not become known in Great Britain until the seventeenth century, when they were brought by a traveler from Italy. Until then, in the king's palace and in the noble's mansion only the man who carved the joint would have a fork to help him. For some time after that forks were a luxury and an affectation of the rich. Gradually more and more people came to use them.

The first table forks had only two prongs, or tines. The four-tined fork came into use about 1682. Even to-day the Persians and the Egyptians eat with their fingers and think that Americans and Europeans are very queer people to prefer using forks, and, as we know, most of the Chinese and Japanese still use chop-sticks.

Spoons, of course, came to be used very early. The first ones were doubtless sea-shells. Many different materials were used in ancient times, for eating utensils. In the tombs of the Egyptians spoons of wood, stone and ivory have been found; probably the poorer people among the Greeks and Romans had to be content with wooden spoons, but people of wealth used bronze and silver. In fact, the use of silver for eating utensils goes far back into history. During the Middle Ages possession of a silver spoon was an indication of wealth and social position. People carried their own eating utensils when they traveled, and even when they went to a friend's house on a visit. A silver spoon was put into the mouth of a newborn baby, "to drive out diseases." Only well-to-do people could afford this superstition. The expression "he was born with a silver spoon in his mouth" is used even to-day to indicate a person whose parents were somewhat wealthy. We must remember that silver became scarce in Europe in the

Middle Ages. The discovery of silver in North and South America in the sixteenth century was a great thing for Europe.

As feudal times and feudal ways of life declined, and townspeople began to have more money to spend on beautiful things, and especially after the discovery of rich new deposits in America, tableware of silver and even of gold was made in larger quantity. In the seventeenth and eighteenth centuries very tasteful, lovely ware was turned out by craftsmen who were artists at their work, particularly in England and France, Holland and Germany and also in Spain.

Rules were made to protect the unsuspecting customer from inferior or light metal. Marks sometimes called hallmarks were stamped on pieces that passed inspection by the examining board or hall. Frequently each town would have a mark. The maker's mark, a letter to indicate the year, and other symbols were also stamped on front or back of the piece. Old hallmarked silver is now much sought after. Collectors can read the marks and can tell who made the piece, and when, and where. Nowadays manufacturers are not required by law to stamp their silver with symbols for the name and year, though some of them do still use certain symbols. There is a word, however, that tells us whether or not a piece meets the standard. That word is Sterling, and the story of how it came to be adopted is very interesting.

Towle Mfg. Co.

Paul Revere, Boston silversmith and patriot.

From the time of Richard the First, of England, traders from Eastern Germany had been buying and selling goods in England, using, as money, pieces of silver of high purity. The English called these traders Easterlings, and gradually the name was applied to their silver as a term of confidence; then it was shortened to Sterling.

Absolutely pure silver is too soft to use for forks and spoons. It would bend too easily. Therefore a standard alloy to contribute strength has been adopted; 75 parts of copper are added to every 925 parts of silver. Metal of this quality is known as Sterling. The mark "Sterling" is now protected by law in Great Britain and the United States. Any piece stamped with this word must contain 925 parts of pure silver to every 1,000 parts of metal.

There were silversmiths in America from Colonial days. One of the most famous was John Hull of Boston, who lived from 1624 to 1683. He coined for Massachusetts Colony silver shillings with a pine tree in the centre. He was permitted to keep for himself as pay one shilling out of every twenty that he made, and in time he grew very wealthy and became a banker as well as a silversmith. It is said that when his daughter married he gave as dowry her weight in silver. Designs of Colonial table silver were simple and beautiful. They were, of course, mostly based upon English designs of the period, just as the Colonial furniture was, in these days, largely modeled on English patterns. A man named Apollos Rivoire came to Boston from the island of Guernsey, in the English Channel. He became a silversmith and set up his own shop. He had twelve children; the third was a boy, Paul. The family name was changed to Revere, and Paul Revere, following his father's trade, became a silversmith of renown. He is the same Paul Revere who rode to warn the Colonists of Lexington and Concord, in 1775, that the British red-coats were coming from Boston. Specimens of his silver still exist. There were Dutch silversmiths in New York, and skilled French craftsmen in Quebec, in the seventeenth and eighteenth centuries. Philadelphia and several New England towns also produced work of a high quality.

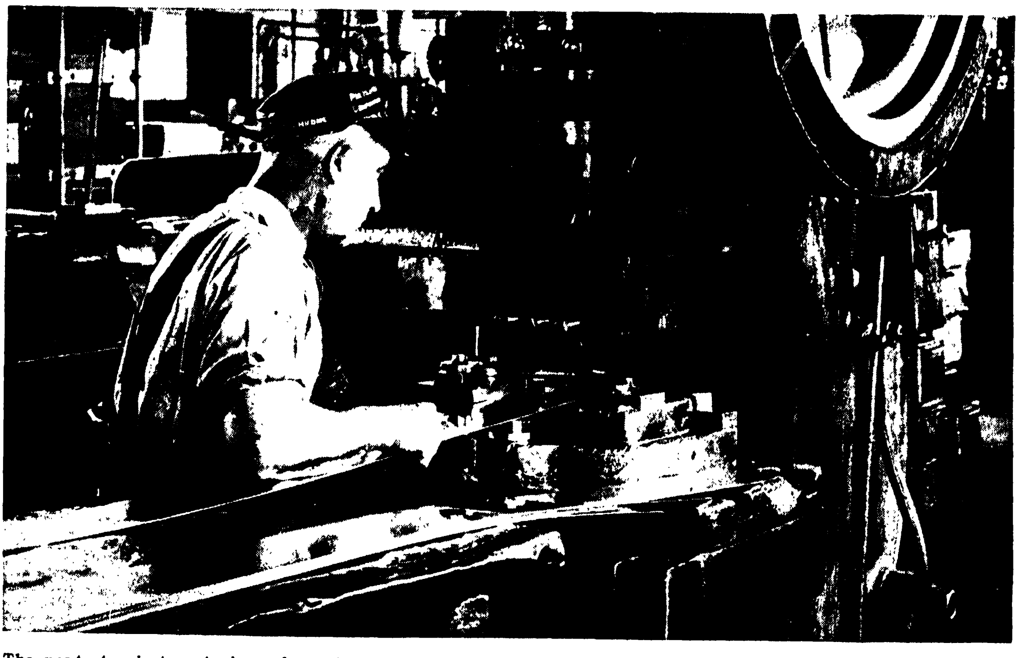
However, silver was costly and not in everyday use. Until about the middle of the nineteenth century, knives and forks of steel were used, in America, except by the wealthy. It was difficult to keep them bright for the steel discolored very quickly; they had to be scrubbed energetically with a kind of sand

polish and this was the task of many a little girl in that day which seems now so far off.

Sheffield, England, has been noted for its fine cutlery since the fourteenth century. In 1742 a cutler, Thomas Boulsover, discovered a way to weld a layer of silver to a copper base. So began a new industry, that of silver-plating. Sheffield plate became famous and pieces of tableware made by the process between 1815 and 1830 are even to-day highly prized. Most old Sheffield ware was in the form of large pieces, coffee pots and teapots, trays and plates and so on. The process was important to the knife and fork and spoon industry because it accustomed people to the use of plated silver, and it started other minds working on the problem of plating base metal with silver for a still wider use.

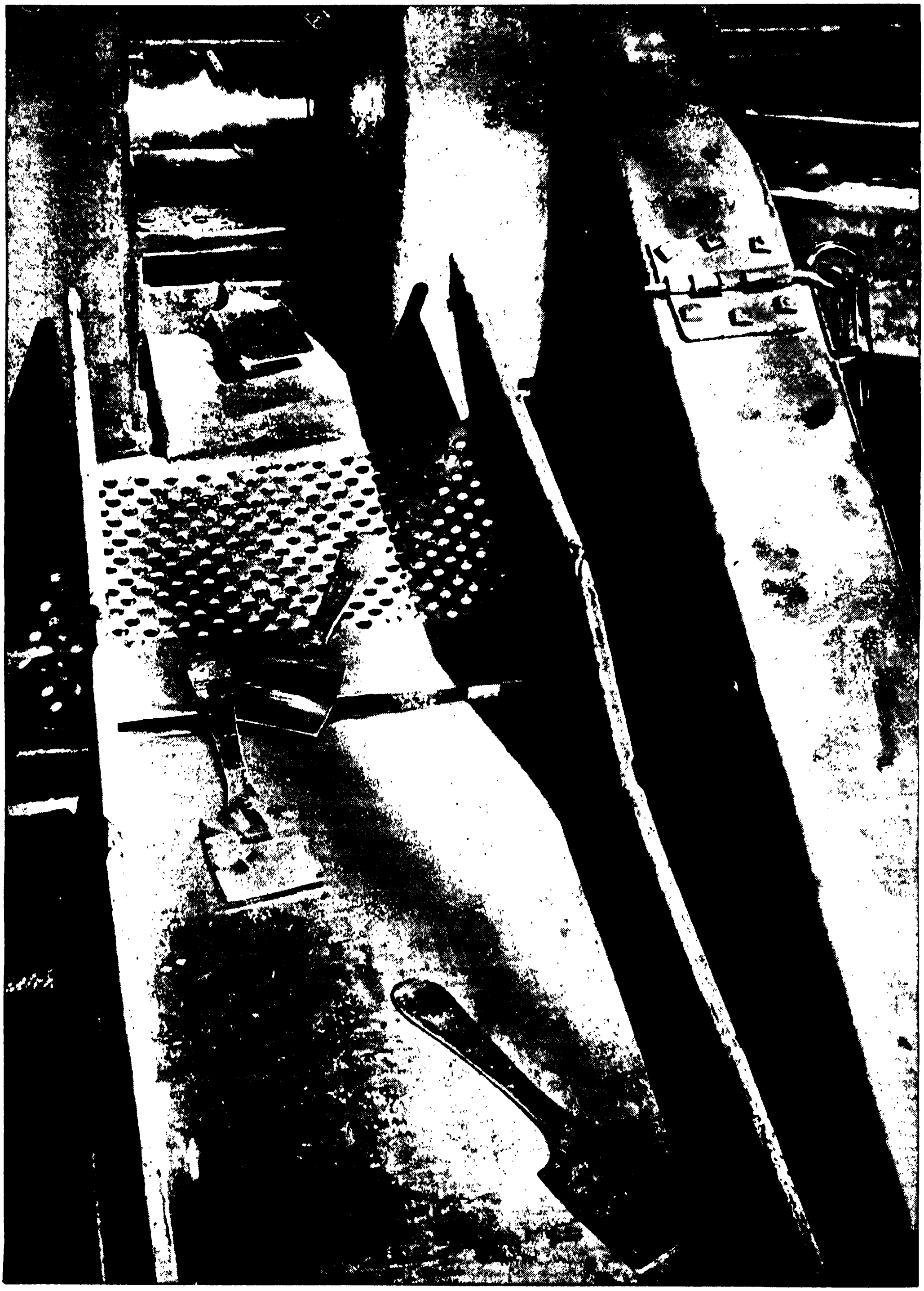
This problem was solved. In 1840 George and Henry Elkington of Birmingham, England, obtained a patent for plating base metal with silver by using an electric current. This is the method in use to-day. It is called electrolysis. A white metal is now generally used as a base, a mixture of tin, antimony and copper in varying proportions. The utensils to be silver-plated are placed on a

A roller presses a bar of silver to the proper thickness for a fork or spoon.

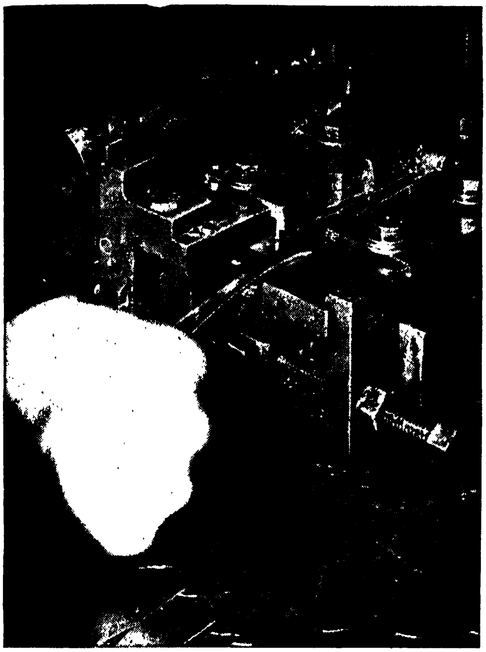


The next step is to cut pieces from the strip, roughly in the shape of forks or spoons. These are called blanks. The cutting is done by great power machines, working much as your mother does when she cuts out cookies.

THE WORK OF THE GRADE ROLLERS



The blanks have been thickened at the shank, where the handle joins the wide part. Now they are sent through the grade rolls, two revolving steel rollers, one of them uneven so that thickness will be given where desired.



Forks are given tines (prongs) by cutting out narrow strips of metal by powerful machines.

rack, like the one pictured on page 1312. The rack is then hung in a bath in which silver has been dissolved by means of chemicals. The rack hangs free in the bath, with the forks and spoons arranged so that they do not touch one another. They must be entirely covered by the solution. Then a current of electricity is turned on, and by its means the silver is made to leave the chemical solution and adhere to the metal of which the spoons or forks are made.

An interesting thing is that the anode, or positive pole, through which the electric current is sent into the bath, is made of silver. The silver of the anode is gradually broken down, or dissolved, by the current and is added to the solution, so that although the silver is constantly leaving it to cling to the spoons or forks, the bath always holds about the same proportion of the precious metal. Unless the metal in the objects to be plated is exquisitely clean the silver will not cling to them; and to make them ready for the coating they are often washed in a solution containing mercury before they are put into the bath. Objects can be plated with a coating of silver that is very thick, or very thin. A well plated knife, or fork or spoon will last for many years before the base metal shows through.

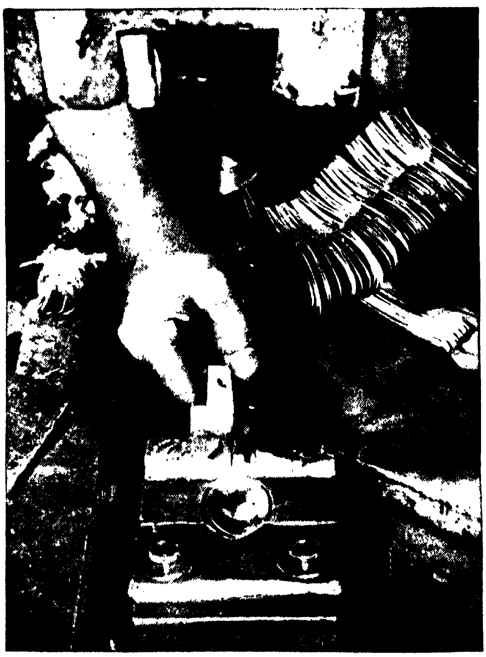
After the silver-plated objects have been taken out of the bath they are put through a number of processes. They may be engraved with your initials as successfully as if they were of solid silver, if the plating is of sufficient depth and when they are finished and packed in tissue paper, they look as if really made of silver.

Many table knives have handles of silver, or silver plate, and blades of steel. An alloy called stainless steel is in common use for knife-blades, as it resists tarnish and staining. Carving knives and forks are made of very fine steel, and great care is taken in their manufacture.

The cutlery industry grew very slowly in America. Even to-day little cutlery is made in Canada and, though the United States has some factories, many of the sharp knives, scissors and instruments used are imported from Europe.

The chief centre for cutlery in England is Sheffield. Solingen, near Dusseldorf, has long been famous for its knives. In bygone days Solingen swords were much respected. France also makes cutlery in normal times. Some knives are made in Massachusetts, New Jersey, New York, New Hampshire, Connecticut, Ohio and other states.

The blades for cheap knives and razors



A blank is placed over a bowl-shaped steel die. A hammer drops down, and the blank becomes a spoon.

MAKING DESIGNS FOR SILVER

Left. Master craftsmen make designs in steel, to decorate the silver. The patterns are made into dies.

The blank is held across the master design, which is on a steel die. A heavy hammer comes sharply down, and the design is impressed upon the metal. You can see the hammer at the upper edge of this picture.

Pictures on pages 1307, 1308, 1309, 1310, and 1311, from International Silver Co., by Ewing Galloway, N. Y.

are stamped out by dies. For the better cutlery, however, the steel is cut into proper lengths and then forged, or beaten out, by heavy machine-driven hammers until it has been made sufficiently thin. After that has been done they are hardened, tempered, ground and fastened to their handles; they are polished until they shine like mirrors, nickel- or silver-plated, sharpened and finished. The cheaper silver-plated knives which are not very sharp or flexible, are forged in one piece, handle and all.

Buffing and polishing, on belts covered with emery.

It may surprise you to learn that many of our shears and scissors are made in two pieces. Very fine scissor-blades are made in one piece of fine steel and are often forged by hand. Only skillful workmen can make these scissors; the making of the "eyes" in the handles is especially difficult. Hand-made scissors are naturally expensive, and a cheaper way of making the large scissors and shears used by tailors and other workmen has been devised. The handles and backs of the blades of these implements are made of soft steel, which is brought to a white heat and forged with heavy hammers. It is then cut with dies into the shape of handles and blades. When this is done, a thin plate of very fine steel is welded to the front to form a cutting edge. Afterward the blades are finished and fitted in pairs, polished, nickel-plated and carefully fastened together, ready for use.

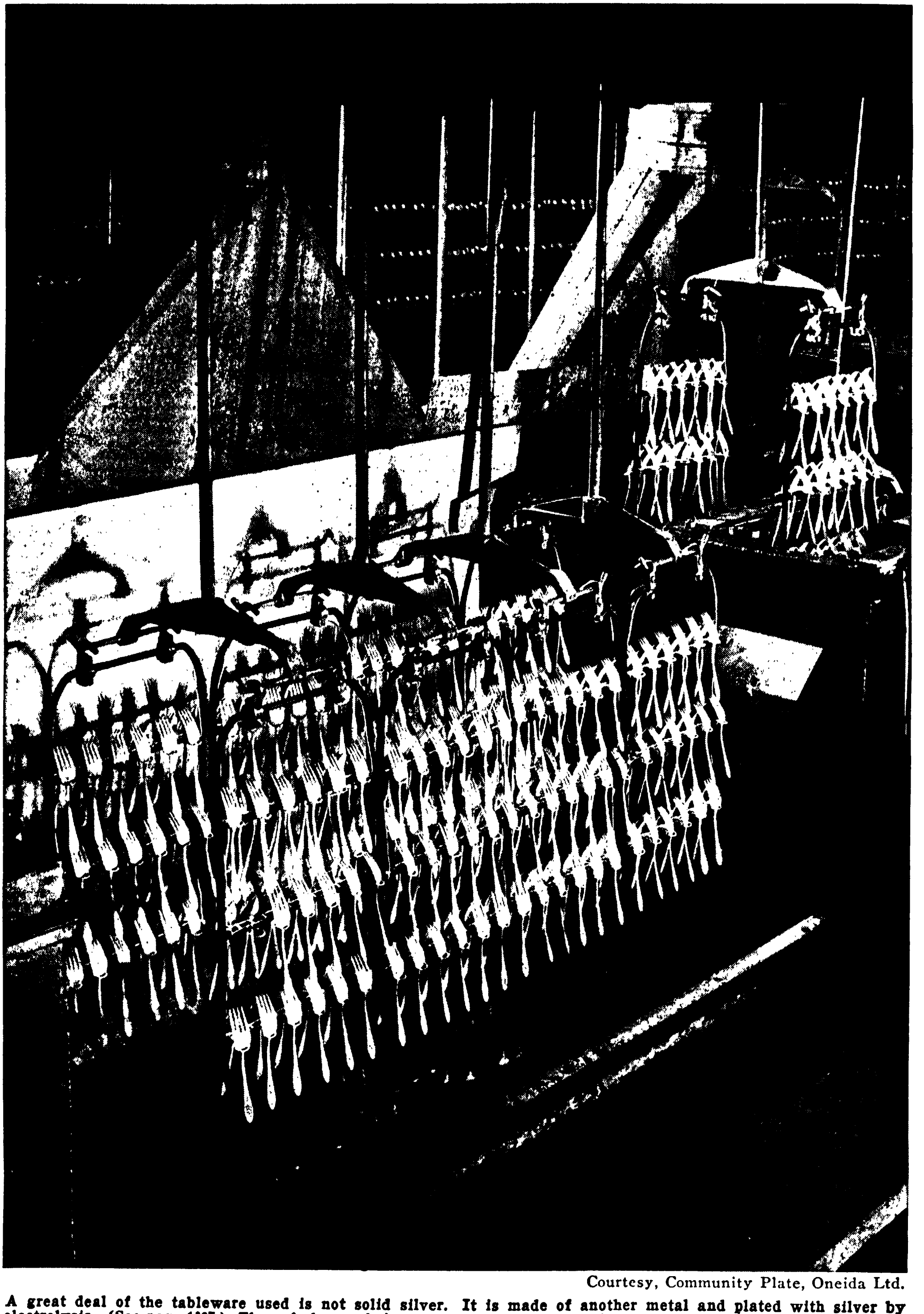
The making of knives and scissors, even when machinery is largely used, is very complicated and includes many processes. The steel, which must be very hard, must be carefully forged. It must be tempered to make it pliable, ground to make it sharp, and after it has been hammered and beaten and ground, it must be polished so that it will keep its brightness.

Knife-handles are made of different substances. Horn, bone, ivory, tortoise-shell, celluloid, wood, silver, and even gold, are all used, and putting the knife into its handle, or hafting the blade, is a special trade. The best knife-blades, like the best scissors, are hand-forged, or beaten out from a thin bar of steel of the thickness of the back of the blade. Scissors must be so carefully put together that the blades will meet and pass each other at exactly the right angle to enable them to shear through the substance that they are to cut. Sharpening is always done by hand, and to give the knife-blade or scissors-blade a proper edge it must be held against the sharpening stone at a particular angle.

The blades of many carving knives, and of other knives, also, are nowadays made of a steel and nickel alloy commonly called "stainless steel." Fruit and other acids that would cause the ordinary steel blade to discolor have very little effect upon the "stainless steel."

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 1404.

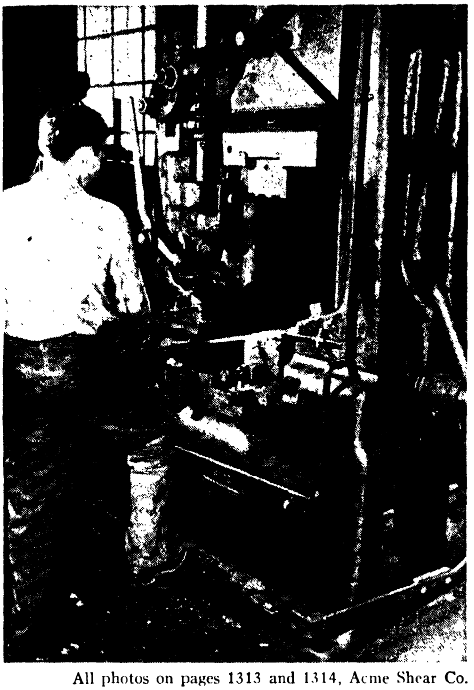
SILVER IS PLATED BY ELECTRICITY

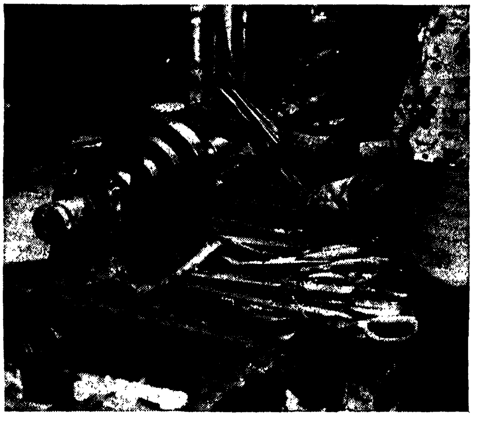


Courtesy, Community Plate, Oneida Ltd.

A great deal of the tableware used is not solid silver. It is made of another metal and plated with silver by electrolysis. (See page 1307.) These forks are being lowered into the silver bath.

FROM FORGE TO GRINDERS





All photos on pages 1313 and 1314, Acme Shear Co.

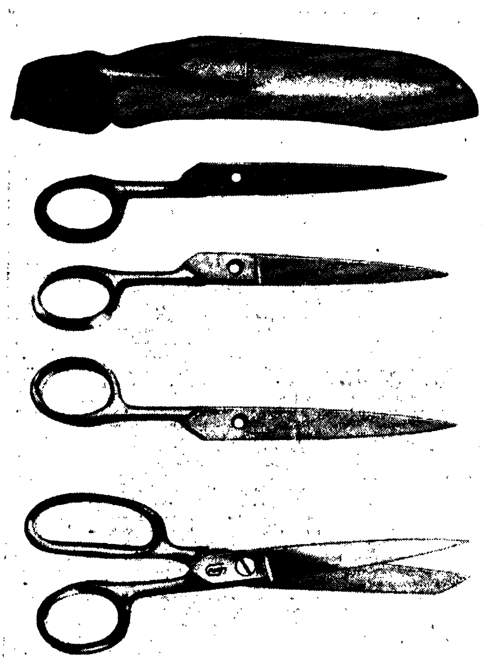
Above, the first step in making hot-forged shears—in a forge, steel rods are heated and shaped into blanks. Top right, the rough trimmed blank is ground to provide a smooth surface for plating. Right center, screw holes are drilled with precision so that the two blades will fit together exactly. Below, another grinding operation which smooths the back and foreside of the blade.

KEEN SHEARS FOR HOME AND SHOP

Above, inspecting blades lifted out of the electroplating bath. The blades remain in the vat until the nickel coating is 4/10,000 of an inch thick.

Above, adjusting the screw for just the right amount of tension for easy cutting. Below, an expert makes sure that every pair of shears cuts properly.

Below, five steps in manufacture: 1. The blank as it comes from the forge, with excess metal. 2. The trimmed forging, with the screw hole drilled in it. 3. A polished thumb blade. 4. The nickel-plated blade. 5. The finished shears.



From a painting by Benjamin Constant

The emperor Justinian in his palace. Justinian was the greatest ruler in the history of the Byzantine Empire.

THE BYZANTINE EMPIRE

AFTER the death of the emperor Theodosius I in 395 A.D., the Roman Empire was divided up between his two sons, Honorius and Arcadius. Arcadius, the older son, took the West, Honorius, the East. The Empire of the West (whose capital was Rome) did not long survive; its last ruler, Romulus Augustulus, was dethroned in 476. The Eastern Empire, however, was destined to continue its career for many centuries.

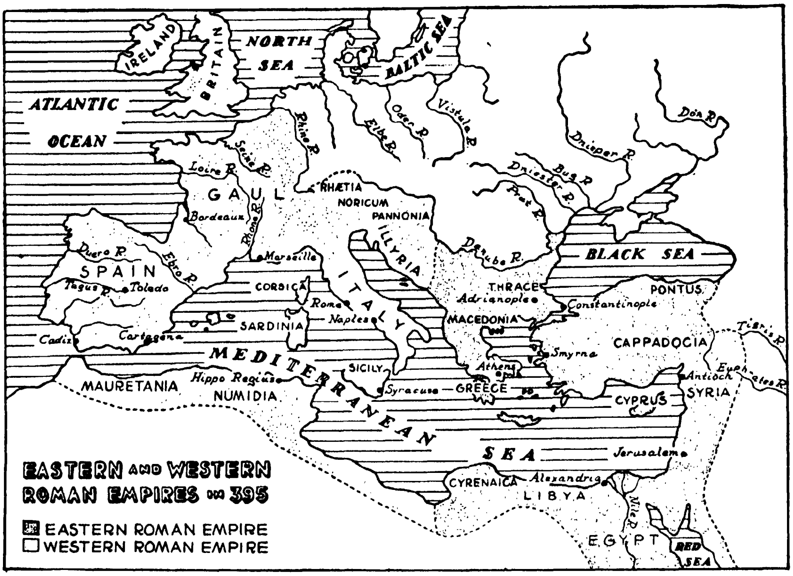
In the course of time it departed widely from the traditions of ancient Rome. Since its capital, Constantinople, had been founded on the site of the ancient city of Byzantium, it came to be known to the men of the Western world as the Byzantine (bi-zan′-tin) Empire. Yet its rulers always considered themselves as the lawful successors of the old Roman emperors—Augustus, Trajan, Hadrian, Marcus Aurelius and the rest.

In the year 395 the Eastern Roman Empire included the European areas south of the Danube and east of the Adriatic; it also took in Asia Minor, Armenia, Mesopotamia, Syria and Egypt. Its capital, Constantinople, was a commercial and industrial centre. It was a mighty fortress, too, with immensely strong walls.

The inhabitants of the Eastern Empire at this time represented a curious mixture of races. There were Romans, Greeks, Armenians, Syrians, Egyptians and many others. Almost all were followers of Christianity, for the old pagan rites were fast disappearing. Many tongues were spoken, but Greek was the chief language, particularly in the lands bordering on the Mediterranean Sea. Latin, the language of the old Roman Empire, continued to be used in official circles for some time to come. But its days were numbered.

At the beginning of the fifth century it seemed that the Eastern Empire, like its sister empire in the west, was doomed to destruction. The Goths, a German people, had invaded its provinces; they had established themselves all over southeastern Europe and Asia Minor. The emperor Arcadius tried to appease them by giving their leader, Gainas, an important military post in the Empire. Soon Gainas was strutting about in Constantinople, lording it over the Emperor and his people alike.

In 401 the people of Constantinople rose against the Gothic soldiers stationed there and slew them almost to a man. Gainas had



L. M. Levin

How the Roman Empire was divided after the death of Theodosius I in the year 395 A.D.

to flee for his life. The emperor Arcadius took heart again; he carried on a vigorous campaign against the Goths and drove every last one of them out of Asia Minor.

The two emperors who followed Arcadius —Theodosius II (408–50) and Marcian (450–57)—managed to hold off the fresh German tribes that attacked the Empire, but in order to do so they had to enlist the services of other Germans. By 457, the year of Marcian's death, one of these barbarian allies, Aspar, had become as powerful as Gainas before him. When Marcian died, Aspar succeeded in having one of his own officers, Leo of Dacia, made emperor.

Aspar thought that the new ruler, who took the title of Leo I, would be content to let him be the real master of the land; but he was badly mistaken. Leo was a man of independent spirit. He had his former commander put to death, and then he reorganized the army from top to bottom. He determined not to seek the help of German soldiers any longer, but to enrol his men from the native subjects of the Empire.

He particularly sought the services of the hardy Isaurians, who dwelt in a mountainous district of Asia. They were a wild and unruly race, but they made wonderful fighting material. Leo married his daughter to the leader of the Isaurians, Tarasicodissa, whose name he changed to Zeno. On Leo's death in 474 Zeno's infant son, Leo II, reigned for a few months. Then he, too, died and Zeno became emperor.

It was during Zeno's reign (474–91) that the Western Empire came to an end. Odoacer, who had dethroned the last of the Western emperors, and who now ruled in Italy, acknowledged Zeno as his master. In exchange for this act of submission, Odoacer received the meaningless title of patrician, or noble, of the Empire.

Not long afterward the Ostrogoths, or East Goths, a German tribe, began a series of violent attacks on the northern provinces of the Eastern Empire. Zeno had great difficulty in defending his realms against these barbarians, who were led by the fierce Theodoric. At last the Emperor got rid of the Ostrogoths by persuading them to turn the force of their arms against Italy. It was agreed that Theodoric was to replace Odoacer as patrician and that in return he was to acknowledge Zeno as his lawful sovereign. Theodoric and his hosts went on to conquer Italy and the Eastern emperor breathed more easily.

Zeno's successor, Anastasius, was a just man and a thrifty one, who put the finances of the Empire on a firm basis. When he died in 518, the state was left without a ruler. Justinus, the commander of the Imperial Guard, took over the throne quietly and met with no opposition. The new emperor, a native of Illyria, on the eastern Adriatic coast, could neither read nor write and knew little of the art of ruling. He came to rely more and more on his clever nephew, Justinian. When Justinus died in 527, his nephew succeeded him upon the throne.

Justinian (527-65) was the greatest ruler in all the history of the Eastern Empire.

He had come to Constantinople as a boy, at the invitation of his uncle, and he had received a careful education. He became highly skilled in statecraft, law, theology, finance, architecture and music. As an emperor he showed amazing industry. He rose early, spent his days in performing his royal duties and the greater part of his nights in reading and writing. His empress, the beautiful Theodora, was as remarkable as the Emperor. A former actress and dancer, she proved to be an ambitious, capable and courageous woman. She became Justinian's partner in the task of ruling the Empire.

Justinian was a very ambitious monarch. He determined to make himself master of the former domains of the old Roman Empire in the West. This territory was almost all in the hands of various German peoples. The Franks held Gaul (modern France); the Visigoths were in Spain; the Vandals held northern Africa. The Ostrogoths, who ruled over Italy, had formerly recognized the Emperor's sovereignty, but had now become practically independent.

The Emperor succeeded in carrying out a considerable part of his program, with the aid of his generals Belisarius and Narses. Italy was captured from the Ostrogoths, and northern Africa from the Vandals; parts of Spain were also conquered. The Mediterranean was now a Roman lake, as in the days of the old Empire. Justinian made no effort to extend the eastern boundaries of his empire. The Persians were a constant threat in this region, and the imperial troops were content to keep them in check.

Justinian was an outstanding administrator; he made the imperial government more efficient than before. He was also a remarkable lawgiver. When he became emperor, he found the existing codes of Roman law in a hopelessly confused state. They were based in large part on five centuries of edicts issued by the emperors of Rome. These edicts often contradicted each other; pagan and Christian ideas were mixed together.

Justinian determined to put an end to all this confusion. His great Code of 533 did away with useless or bad edicts and brought the rest up-to-date. Furthermore, during the rest of his reign he kept adding Novels, or new edicts, to meet the changing conditions of the times. The Code of Justinian had a great influence on the development of our own law system.

Justinian's royal consort, the empress Theodora (third from the left), with lords and ladies of her court.

The Emperor was an industrious builder. Throughout his reign he kept constructing forts, churches, monasteries, hospitals and aqueducts in every part of his domains. His masterpiece was the beautiful church of Santa Sophia, in Constantinople. This edifice is still standing. From the fifteenth century to our own time it was a Mohammedan mosque. Now it is a museum.

At the time of Justinian's death in 565 the Empire occupied more territory than at any time since 395. Yet it was in a greatly weakened condition. The constant wars and the constant building of the Emperor had taken most of the nation's money. The finances were in a bad state; the people were up in arms over the fearfully high taxes. Furthermore, the army had lost so many men in battle that there were not enough soldiers to guard the greatly extended frontiers.

The fifty years that followed the death of Justinian marked a period of decline. Two new barbarian peoples, the Avars and the Slavs, made many raids on the lands south of the Danube. By 600, the Avars had pushed up almost to the walls of Constantinople. In the early years of the seventh century the Persians conquered the eastern province of Mesopotamia and pushed on into Syria and Asia Minor.

In the year 610 a valiant young soldier called Heraclius came to the throne. In the first few years of his reign the sad story of disaster was repeated. The Persians captured Palestine and, later, Egypt. In 622 Heraclius, who had previously left the fighting to his generals, decided to take the field himself against the Persian foe. After six years of bitter fighting, he drove the Persians from every inch of the territory that they had conquered. In 628 he forced them to sue for peace.

Heraclius was hailed as "the new Scipio" by his grateful subjects. (Scipio was a famous general of the old Roman Republic.) But, alas! his reign was to end, as it had begun, in failure and disaster.

A new and formidable enemy had arisen in the desert peninsula of Arabia. An Arabic merchant called Mohammed had founded a new religion. After his death in 632 his followers, who were known as Mohammedans or Saracens, prepared to spread the master's teachings by means of the sword. In 634 they burst into the imperial provinces of Syria and Palestine. In 637 the holy city of Jerusalem fell to the invaders; soon afterward all Syria and Palestine was in their hands. In 640 the Arabs crossed over into Egypt and conquered all of that province except Alexandria, the chief city, which held out until 647.

Culver Service

Belisarius appears before Justinian with Vandal captives.

It was a sorry empire, indeed, that Heraclius left to his successors at his death in 641. It had been reduced to Asia Minor, the Balkan coastline, Sicily, the western part of northern Africa and a few scattered outposts in Italy and other lands. The armies of the Empire had been shattered; its commerce and industries had been crushed.

The successors of Heraclius fought on grimly against the Saracens in the south and against the Avars, the Slavs and another people called the Bulgars in the north. It was a brave fight but, on the whole, an unsuccessful one. North Africa was lost to the Mohammedans; they also captured a good many places in Asia Minor.

The Saracens were turned back at last by a brave general, Leo the Isaurian, who became emperor, as Leo III, in the year 717. At the very beginning of his reign Constantinople was besieged by the Saracens, who had gathered together an army of 100,000 men and a fleet of more than a thousand ships. Leo fired his men with his own unconquerable spirit. After a siege of a year the Saracens had to withdraw. Thereafter the fighting went very much against them. In 738 Leo won a great victory over them in the battle of Acroinon. Never again did the Saracens seriously threaten the safety of the Empire.

Leo perfected the system of government by themes—a system created by a former emperor. The Empire was divided up into a number of large provinces. Each of these was known as a theme, from the name of the army unit stationed there. (A theme was a force of about 4,000 heavily armed cavalry.) The governor of each theme had military as well as civil authority. In case of invasion he was able to lead a trained army against the enemy without delay. This system of themes worked out very well indeed. It accounted in great part for the success of the Empire in holding off powerful foes in the centuries to come.

Constantine V, Leo's son, came to the throne in 740. He, too, was an able ruler. He fought the Saracens with great success; he subdued the quarrelsome Slavic tribes that had settled in Thrace and Macedonia. Commerce and agriculture flourished in his reign. When he died, in 775, he left a full treasury, a loyal and efficient army and a splendid system of administration.

WICKED IRENE BLINDS HER OWN SON AND BECOMES EMPRESS IN THE YEAR 797

A few years after his death the government fell into the hands of a wicked woman, Irene. She first served as regent for her son Constantine VI. So fond of power did she become that when her son came of age at last, she conspired against him. She seized the unfortunate young man, had his eyes put out and shut him up in a monastery. For five years (797–802) she was the sole ruler over the land.

While this unnatural mother was on the throne an all-important event took place in the West. In the year 800 Pope Leo III placed a crown upon the head of Charles, or Charlemagne, King of the Franks, and proclaimed him ruler of the Roman Empire.

The men of Western Europe, including the German conquerors, had continued to have an almost superstitious respect for the old Empire. Up to this time they had also held in reverence the man who reigned at Constantinople—the man whom they considered the successor of the Roman emperors.

By the end of the eighth century, however, there was a general feeling that the Eastern Roman Empire had become quite a different state from the Empire of olden times. By this time Greek had become the official language in the East; Latin was almost forgotten. As for the inhabitants of the Eastern Empire, they included Greeks and Asiatics, but where were the Romans among them?

In the year 800 the Eastern Empire was ruled, as we have seen, by a wicked woman who aroused the horror of all decent people when she blinded her own son in order to seize power. No wonder that men were ready for a change. They hailed the proclamation of Charlemagne as the "great and peaceful Emperor of the Romans." This Charlemagne was a mighty conqueror, a friend and ally of the popes, a lover of learning. He was a man of majestic bearing; he was every inch an emperor.

THE EASTERN EMPIRE LOSES ITS HOLD OVER THE WESTERN PEOPLES OF EUROPE

From this time on, the men of the West no longer thought of the Eastern Empire as carrying on the traditions of ancient Rome. For them it became the Byzantine Empire, a foreign state. The Eastern emperors, or Byzantine emperors, as we shall call them hereafter, did not cut off all relations with the West, but they no longer played an important part in that area.

As a matter of fact, their loss of influence in the West proved to be a blessing in disguise for them. They were not so likely now to use up their resources in costly adventures in Western Europe. Hereafter they devoted almost all their attention to the East, the chief source of their power. The Byzantine Empire was soon to enter upon a period of great prosperity.

THE MACEDONIAN DYNASTY IS FOUNDED IN 867 BY THE EMPEROR BASIL I

In 867 a strong ruler, Basil I, a Macedonian, mounted the throne. His general, Nicephorus Phocas, established Byzantine rule for a time over southern Italy by driving out the Saracens from that region. In the east new territories were conquered and new themes were set up. Syria and Mesopotamia, now in Saracen hands, were raided again and again. Basil founded a new dynasty, or royal family—the Macedonian dynasty—which ruled for almost two hundred years (867–1057).

Under the Macedonian dynasty the Byzantine Empire reached the height of its glory. Its boundaries were not so greatly extended as in Justinian's time, but the Empire rested on a far more solid foundation.

In the main, the Byzantine armies of this

Illustration from old manuscript

Nicephorus (centre), who ruled over the Byzantine Empire from 802 to 811. He is shown with four of his councilors. The two female figures above represent Truth and Justice. Note the richly embroidered costumes.

period were content to fight on the defensive. Their chief strength lay in the heavily armed cavalry of the themes. These sturdy warriors wore steel caps and coats of mail; their arms were a sword, a dagger, a lance, a bow and arrows. They were invincible in their own day. Though often outnumbered in combat, they were more than a match for the Slavs and Bulgars in the north and the Saracens in the south.

Under the Macedonian emperors the navy was very strong. Its ships consisted for the most part of biremes—galleys with two banks of oars. They were often provided with a ram, or beak, extending from the front part of the ship and serving to pierce the hull of enemy vessels. Their chief weapon, however, was Greek fire. This was a highly inflammable substance, made of naphtha, sulphur and nitre. Generally pots filled with the substance were set ablaze and were then hurled against the enemy ships by means of catapults (see Catapult, in the Index).

The commerce of the Byzantine Empire was at its peak at this time. Constantinople was now the trade centre of the Christian world, the one place where East and West could freely exchange their goods. The furs and dried fish of the Russian steppes found their way to the Byzantine capital; so did the amber of the Baltic Sea, the furs and metals of central Europe and the herbs and spices of India.

Silk, formerly imported from China, had been produced within the Empire since the sixth century. (On page 5307 we tell you how the secrets of silk production were revealed by two brave monks.) There was a wonderful silk industry in Constantinople. Byzantine silk fabrics were famous the world over.

Illustration from old manuscript

Heavily armed Byzantine cavalrymen of the ninth century A.D.

The inhabitants of the Empire were still devout Christians, as they had been from the very beginning. Their religious leader was the patriarch (pay′-tri-arc) of Constantinople. He was appointed by the Byzantine emperor and in general served him faithfully. The few patriarchs who tried to act independently of their royal master were not very successful.

By this time the churches of the East and West had drifted apart. The services of the Western or Roman Catholic Church were in Latin; those of the Eastern Church, in Greek. Various differences of doctrine had also developed; sometimes these led to violent quarrels. The two churches kept more or less in touch with each other up to the very last days of the Byzantine Empire; but all attempts to bring them together under a single religious leader failed.

After the Macedonian dynasty came to an end in 1057, a period of decay set in. The Empire faced new enemies. The Normans, a piratical people of Teuton blood, captured southern Italy and, crossing the Adriatic, plundered the Balkan areas. The Seljuk Turks, a Tartar people, advanced upon the Empire from the east. In 1071 they routed the Byzantines in the battle of Manzikert. Soon most of Asia Minor was theirs.

On page 2582 you may read of the Crusades. These were military expeditions made by Christian rulers and their followers against the Mohammedan forces that held the holy city of Jerusalem, formerly part of the Byzantine Empire. The paths of these armed pilgrims took them past or near Constantinople. Hence the Crusades, which lasted from 1096 to 1291, served to keep Western Europe and the Byzantine Empire in touch with each other.

The First Crusade (1096–99) contributed to the decline of Byzantine commerce. As a result of this crusade Syria fell into the hands of certain Western princes. Henceforth goods from the East were carried to the ports of Syria and then by Italian ships to various places in Western Europe. Constantinople had only the northern trade left. Even this came to be carried on, to an ever greater extent, by Italians.

The emperors had begun to neglect their navy. They had adopted the practice of hiring foreign vessels to patrol the waters off their coastal possessions. They yielded valuable commercial privileges to the Venetians, and later also to the Genoese and others, in return for the use of the Italian ships.

The favored Italian merchants paid very low duties on goods brought into the Empire —lower even than those paid by Byzantine

A big caravan bringing in spices from the Far East. Spices were much more important in the Middle Ages than they are now. They helped to keep food from spoiling at a time when refrigeration and canning were unknown.

citizens. Furthermore, they were allowed to set up self-governing communities in Constantinople and in other parts of the Empire. By 1180 there were 60,000 Italians in Constantinople alone. The Byzantine merchants faced ruinous competition.

The emperor Andronicus I, who reigned from 1183 to 1185, was thoroughly alarmed. He decided that the best way to get rid of the foreign merchants was to kill them off, and so he brought about a series of terrible massacres of Italians in Constantinople and other places. Venetians were the chief victims of these massacres, which were never forgotten or forgiven.

In the year 1203 the men of the West organized a Fourth Crusade against the Saracens of the Holy Land. One of the leaders of this crusade was sly old Dandolo, the doge, or chief magistrate, of Venice. He decided to use this crusade as a means of advancing the interests of the Venetians. First he persuaded the crusaders to attack a town in Dalmatia, across the Adriatic Sea from Italy—the town of Zara, which had quarreled with Venice.

While the crusaders were besieging Zara, a party of Byzantines came to them. They told of a revolution that had broken out in Constantinople and they sought aid in behalf of the rebels. Dandolo urged the crusaders to accept the invitation. They proceeded to Constantinople, deposed the reigning emperor, Alexius III, and turned the Empire over to his rivals. The crusaders tarried in the capital city; they never did manage to get to the Holy Land or to fight the Saracens.

As Dandolo had foreseen, the excitable inhabitants of Constantinople resented the presence of the insolent men from the West, and in 1204 they rose against the foreigners. The crusaders easily crushed the rioters and then plundered the city. Some of the treasures of the city, including priceless manuscripts and works of art that had come down through the ages, were destroyed; others were carried off. Then the crusaders proceeded to set up a Latin Empire, with Constantinople as its capital. Dandolo saw to it, you may be sure, that the Venetians were given many special privileges in this new empire.

Much of Asia Minor continued to remain in the hands of the Byzantines. There was one empire-in-exile with its capital at Nicæa (modern Iznik), in the northwestern part of Asia Minor. There was another at Trebizond, on the Black Sea; there was a third in Epirus, in Greece. The Nicæan Empire, which had strong rulers, maintained itself, while the other two fell by the wayside. At last, in 1261, the Nicæan emperor Michael Palæologus captured Constantinople and drove out Baldwin II, the last ruler of the Latin Empire, who had reigned since 1228.

And so the Byzantines again held their capital city. Their empire never recovered its former greatness. In the course of the next two hundred years it became steadily weaker until at last it succumbed to the constant attacks of its enemies. The most ter-

Culver Service

Men of the West, taking part in the First Crusade, are amazed as they see the wealth of the Byzantine Empire.

An incident of the Fourth Crusade. Enrico Dandolo, doge of Venice, shown here standing on the prow of his warship, is defied by the Byzantine emperor.

rible foes of the Empire in this period were the Ottoman Turks. In the late thirteenth century they had taken over the holdings of their kinsmen, the Seljuk Turks, in Asia Minor. In the years that followed the Ottoman Turks advanced steadily, capturing one stronghold of the Empire after the other.

When the emperor Constantine XI came to the throne in 1448, the Byzantine Empire had been reduced to the city of Constantinople and the surrounding territory. The Turks now pressed the attack. The defenses of Constantinople were still very strong and held off the invaders for a time. But at last, in May, 1453, the walls were breached. The Turks came pouring into the city and in the fierce fighting that followed the Emperor was slain. Soon all resistance was at an end. At noon on the 29th of May, 1453, the sultan Mohammed II, leader of the Turks, offered up prayers of thanksgiving in the church of Santa Sophia.

The Byzantine Empire was ended. It had certainly not been an ideal state. Its government had been an Oriental despotism; its court, a hotbed of plots and counter-plots. The people had been superstitious, fickle and sometimes terribly cruel.

Yet, on the whole, the Empire holds an honored place in the history of our civilization. For almost a thousand years after the fall of the Western Roman Empire, the Empire of the East served as a shield to Western Europe by holding off the savage hordes of Persians and Arabs and Turks. It spread the doctrines of Christianity among the inhabitants of the Russian steppes and the wild tribes that had settled in the Balkans. It served as a headquarters for trade and commerce and industry.

For centuries, too, the Empire preserved the great works of Greek literature and philosophy at a time when they were all but forgotten in Western Europe. When Constantinople fell, its scholars fled to the West, bringing with them their priceless manuscripts. Already there had been a revival of learning and of art in Europe—a revival to which we give the name of the Renaissance. The learned Byzantine exiles played a most important part in the final triumph of the Renaissance by opening the eyes of Westerners to the marvels of Greek civilization.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 1428.

WHAT HAPPENS WHEN WE BREATHE

THE LUNGS AND RESPIRATION

THE first important act of our life after birth is to begin to breathe. Breathing then goes on automatically all through life, even while we sleep. If breathing stopped for sixty seconds we would become unconscious, and if it stopped for as long as ten minutes we would surely die. Let us see what breathing is and how it is carried on by the body.

Breathing is often referred to as respiration. That is the technical name for the process of feeding the body with oxygen and disposing of the waste products of breathing. The article on circulation tells you that the oxygen which we breathe into our lungs is picked up by the blood and carried to every part of the body. When this oxygen is used in the cells of the body, something similar to the burning of ordinary fuels takes place. That is, the oxygen combines with the carbon of food material to produce a chemical compound of carbon and oxygen which is called carbon dioxide.

The burning of oxygen and carbon in the cells and the production of carbon dioxide by this burning make up internal respiration. After carbon dioxide has been produced, it has to be carried by the blood from the cells to the lungs, and then to the outside air; while new oxygen must be brought in from the outside air, to the lungs and then to the cells. This whole process is called external respiration.

The body's apparatus for breathing consists of the lungs and other organs associated with them. We might compare this apparatus with an old-style bellows which was used in former times to stir up the flames of an open fire. This bellows had two solid or rigid sides of wood, with two other

Harold M. Lambert from Frederic Lewis

When we exercise our lungs must breathe in more oxygen and breathe out more carbon dioxide than when we rest.

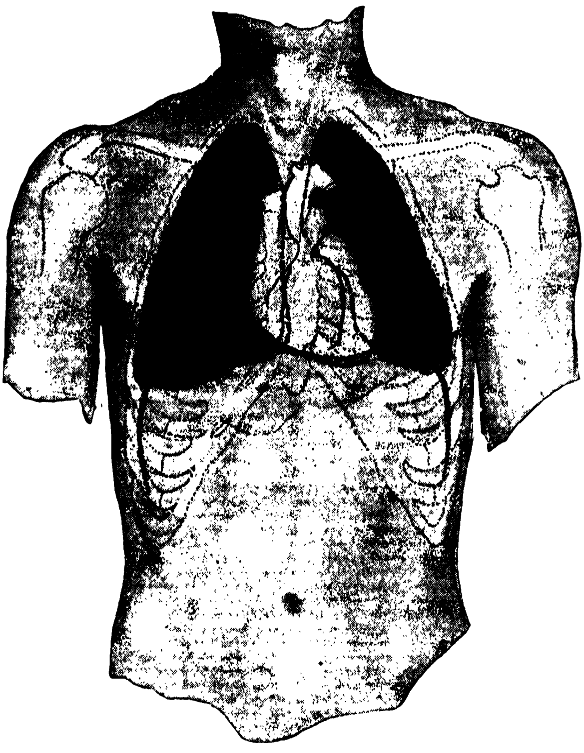
sides and a bottom made of flexible leather or fabric. The rigid, wooden sides could be brought together and thus air was pushed out from the opening at the tip of the bellows. We may think of the lungs as an airtight, rubber bag inside such a bellows, and of the stiff, rigid ribs of the chest as the wooden sides of the bellows.

Another important part of this apparatus is a large, thin muscle called the diaphragm, which stretches across the entire trunk portion of the body at about the level of the lowest ribs. This sheet of muscle is able to move back and forth and to flap around much like the bottom of the bellows. When the diaphragm is pulled downward toward the abdomen (the lower part of the trunk) and when the ribs are pulled upward and outward, air is sucked into the lungs from outside the body. When the diaphragm is pushed up and the ribs are pulled downward and inward, air is forced out of the lungs. This process is repeated by all of us about eighteen times a minute as long as we live.

There are other parts of this apparatus which are important to the process of breathing. As we all know, the air we breathe enters through the nose. In case the nose is blocked up, a safety inlet through the mouth is present so that we always have an additional way of getting air into our lungs. While it may be necessary to breathe through the mouth on some occasions, it is generally better to breathe through the nose because the nose was especially prepared for the intake of the air.

Inside the nose are small shelves of bone, covered with mucous membrane; these quickly warm and moisten the air before it is taken into the lungs. There are numerous hairs in the nose which stop some of the particles of foreign matter which might be breathed in. In addition, the mucous membrane (which lines the passages of the body which communicate with the outside air) is covered, in the regions through which the air must pass, with tiny, hair-like structures. They are so fine that you need a microscope to see them well. These tiny hairs are called cilia. They are found on the mucous-membrane surfaces of the nose, throat and windpipe, and inside the bronchi, within the lungs. They look something like a rippling field of wheat in a mild breeze and are seen to move in waves much as the stems of wheat move in waves when the wind blows them. In this way the tiny cilia are able to whip particles of dust or foreign matter up toward the throat where we can get rid of them by clearing the throat. The mucous membrane is always moist; and it gives off some of its moisture into the air as the air travels over it. Thus the air never reaches the lung without first becoming warmed and moistened.

The air that enters the nose is pulled back and downward through the throat into the windpipe. You can feel your windpipe beneath the voice-box. It is a round tube with little rings in the walls of it. These rings, which are made of firm cartilage, keep the windpipe open so that the air can freely travel through it. At about the center of the chest the windpipe divides into two tubes called the bronchi. These in turn soon divide into smaller and smaller air tubes which pass out into all parts of the lung. The smallest of the air tubes are so tiny that they can be seen only with the microscope. On the tip of each of these small tubes are tiny air sacs called alveoli which are the real breathing parts of the lung. The alveoli have extremely thin walls, composed of one layer of cells, and, like tiny rubber balloons, they can be blown up when air is pulled into their cavities, in the lung. In this way, then, the oxygen from the air breathed into the alveoli is brought into very close contact with the blood which circulates through the lungs.



The lungs lie in the chest cavity, protected by the ribs. In this picture the lungs are in dark gray; bones, in dotted lines.

Look at a piece of beef lung at your butcher's. You will see that it looks very much like a wet sponge. This piece of lung would float if placed on water, just as the sponge floats, because the air sacs in the lungs, like those of the sponge, contain enough air to support the rest of the tissue and keep it afloat.

Sometimes a baby animal is born dead. If it has never taken a breath its lungs will contain no air. If a piece of the lung is put in water it will not float but will sink to the bottom because it has no air in the alveoli.

There has been much discussion as to whether it is better to breathe with the chest or with the abdomen. We do not know of anything wrong with either type of breathing. It seems to be natural for most people to move both the chest and the abdomen. Men, perhaps, breathe more with the abdomen, while women, who may wear tighter clothing, breathe more with the chest. Although no serious trouble comes from wearing tight clothing, it is probably best to wear clothing loose enough to allow motion of both thè chest and the abdomen.

BREATHING CHANGES ACCORDING TO WHETHER WE ARE RESTING OR ACTIVE

Nowadays it is possible to measure the amount of air taken into the lungs with each breath. Doctors usually measure such quantities in cubic centimeters (cc.). You will find this measure used throughout this article. Half a cupful is about 100 cc. We can say generally that a grown person breathes in about one pint of air (500 cc.) with each breath, and breathes out the same amount. If a grown person takes the largest possible breath, then breathes out all the air he can from his lungs, we call this amount of air his vital capacity. It is usually about three and a half quarts of air (3,700 cc.). But after breathing out all the air he can a person has still some air left in his lungs. This is called the residual air, and it amounts to about a quart (1,000 cc.). The amount of air that a person can breathe if he breathes in and out as hard as he can during a certain period of time is called the maximum breathing capacity. In an average-sized person this comes to about 125 to 150 quarts a minute. After running very hard for several blocks, a person would be breathing at his maximum capacity and would draw into and push out of his lungs more than 125 quarts of air each minute. Ordinarily, however, when he is sitting quietly in a chair or lying in bed he breathes into and out of his lungs only about 20 quarts a minute. This shows the ability of the body to provide additional air and oxygen when the need becomes great.

HEALTHY LUNGS HAVE TEN TIMES THE NUMBER OF AIR SACS NECESSARY FOR LIFE

Suppose a person has suffered some damage to the lungs, so that he is able to breathe no more than 50 or 60 quarts a minute. He will approach his maximum breathing capacity after less work or exertion than he would if he were a normal person with a breathing capacity of 125 quarts. As a result he will notice shortness of breath much sooner than the normal person. Ordinarily, a well person has about ten times as much lung tissue and lung air sacs as are necessary to keep him alive, so that a great number of the air sacs can be damaged or destroyed before he is aware of any trouble with the breathing apparatus. If these are gradually destroyed or damaged he will notice that it takes less and less exertion or work to make him become short of breath, and in the worst stages of serious lung conditions he may be short of breath all the time, even while lying quietly in bed. Too, he is apt to have a fever because the blood is working so hard.

BREATHING HELPS TO REGULATE THE TEMPERATURE OF THE BODY

Air, when it is breathed into the lungs, undergoes several changes, some of which we have briefly mentioned. Ordinary outside air is usually cool and dry. The temperature of the body is 98.6 degrees Fahrenheit; and the temperature of the air where most people live is generally very much cooler than that. Suppose it is 60 or 70 degrees. The air that is breathed in is warmed from 60 or 70 degrees to 98.6 degrees, while the body itself grows cooler as it gives off this heat. Human beings have other ways of cooling the body, as by sweat (perspiration); but for certain animals without sweat glands, like dogs, breathing is the most important means of cooling the body. The shallow, rapid breathing of dogs, which we call panting, is a way of speeding up this cooling of their bodies.

WHY YOU CAN SEE YOUR BREATH ON A VERY COLD DAY

Another way in which the bodies of human beings are cooled is by the evaporation of water from the lungs. The air taken into the body generally contains about 40 or 50 per cent of the moisture it could hold; we say its relative humidity is 40 or 50 per cent. But when this air is breathed out again it is fully loaded with moisture, or, as we say, 100 per cent saturated. In this way the body is continually losing moisture through the breath. You can see your breath on a very cold day, because the moisture in the air you breathe out, meeting the cold outside air, condenses in a cloud of tiny drops of water.

The outside air is always about one-fifth oxygen; the rest is almost entirely nitrogen gas, which takes no important part in the body's processes. Air that is breathed out is only about one-sixth oxygen, showing that a certain part of the oxygen was removed by the lungs. Outside air contains only a trace of carbon dioxide; but breathed-out air contains quite a large amount of carbon dioxide. This amount, in fact, is almost equal to the oxygen which was taken out of the air by the lungs. While there has been no significant change in the total amount of gas breathed in and breathed out, part of the oxygen has been replaced by carbon dioxide, showing that certain chemical changes happened inside the body.

PROPER VENTILATION MAKES US THINK BETTER, WORK BETTER AND FEEL BETTER

If several people were kept in a tightly closed room for a long time, they would become ill, have dizziness and headache, be sick at the stomach and less able to do good and careful mental and physical work. Certain bad odors are noticed when the air is breathed over again several times, and often the body odors of people make the air distasteful. As we have said, the air also becomes very warm and moist and so does not feel as good to us when we breathe it as it would if it were cool and dry. There is, however, no scientific evidence of any seriously injurious substances in the air that is breathed out, so that there is little or no danger of actual harm to the person from breathing this air. It is true that the carbon dioxide in the air in the room will increase slightly, but not enough to produce serious effects. Even when windows and doors are closed, the crevices and cracks around them are usually large enough to allow some air to enter, so that the carbon dioxide does not accumulate, and the oxygen does not decrease to a dangerous point. The oxygen contained in the air has to drop from 20.96 per cent to around 10 per cent, and the carbon dioxide must rise from 0.04 per cent to about 4 per cent before definite ill effects can occur. This would seldom happen unless the room were very carefully sealed so as to make it airtight. It should be borne in mind, however, that cool, dry, odorless air is most pleasant to breathe; it increases our efficiency and ability to think and to work and it makes us feel better. For these reasons it is desirable to have good ventilation in homes, schoolhouses and public buildings at all times.

THE EXCHANGE OF GASES WHICH TAKES PLACE IN THE LUNGS

Once the air, or the gases of the air, have reached the small air sacs in the lung which we call alveoli, there occurs a remarkable movement of certain gases in one direction and of other gases in the other direction. The blood in the capillaries of the lung has recently returned from the tissues of the body; it is dark, impure blood, containing much carbon dioxide and much less oxygen than when it left the lungs to start its circle through the body. On the other hand, the air in the alveoli contains little or no carbon dioxide, but it is loaded with oxygen. The body makes brilliant use of this situation. The air in the alveoli and the blood in the lung are separated by a single layer of thin cells. A general mixing of the gases takes place through that thin wall. In the mixing process some of the load of carbon dioxide moves into the lung air sacs and some of the load of oxygen moves in the other direction, into the blood vessels.

OXYGEN IS TAKEN UP BY THE HEMOGLOBIN IN THE BLOOD

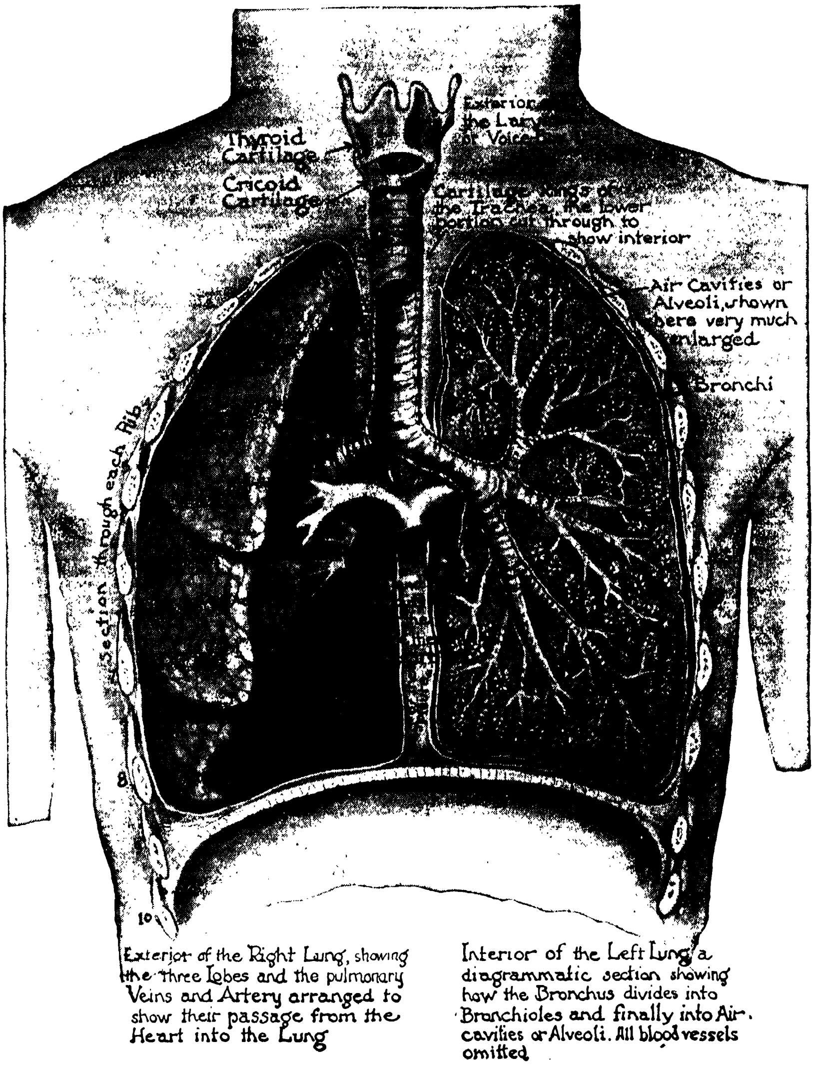
The air is then breathed out, loaded with carbon dioxide. The oxygen is taken up by the hemoglobin of the red blood cells, and the blood which was dark becomes bright red. The heart pumps it through the body, and the oxygen is used in the various cells, and so the continuous story goes on.

The gases in the blood are mainly oxygen, carbon dioxide, and, as we have said before, some nitrogen which takes no part in nourishing the body but is breathed in with the rest of the air and circulates through the body dissolved in the blood. There are also extremely small amounts of methane and hydrogen in the lungs. These are probably carried there from the stomach. The first three—oxygen, carbon dioxide and nitrogen—are the only gases of the blood which are important to us, however.

ARTERIES CARRY MORE OXYGEN, VEINS CARRY MORE CARBON DIOXIDE

These gases may be analyzed by a very simple method. By analyzing the blood in the arteries we find that it contains about 20 cc. of oxygen for each 100 cc. (one-half cupful) of blood. The blood in the veins contains about 16 cc. of oxygen for each 100 cc. of blood. This shows that a certain portion, but not all, of the oxygen is taken out of the blood as it passes through the tissues. On the other hand, the blood of the arteries contains about 38 cc. of carbon dioxide per 100 cc. of blood, while the vein blood contains 45 cc. of carbon dioxide per 100 cc. of blood. By testing the blood, then, it is possible to tell exactly how much oxygen was used up by the tissues. Since nitrogen takes no part in the chemical changes of the body the same amount of nitrogen will be found in the artery blood as in the vein blood. The body needs nitrogen, but can use it only as a product of digestion.

HERE COMES EVERY BREATH YOU BREATHE



In this diagram of the chest cavity, the heart is omitted so that you can see the lungs more clearly. The lower part of the windpipe and the left lung are shown as if cut through, revealing the bronchioles and the little air sacs, or balloons at their tips, called alveoli. The right lung has three parts, or lobes; the left lung has only two.

As the blood, loaded with oxygen, comes from the lungs to the tissues, it flows through the tiny capillary tubes having walls made of a single layer of cells. This blood contains a great deal of oxygen and very little carbon dioxide, while the lymph which bathes the tissue cells by this time contains very little oxygen but a great deal of carbon dioxide. Here, again, as in the alveoli, a mixing of the molecules takes place. Most of the carbon dioxide passes into the blood and most of the oxygen passes into the lymph and then into the tissue cells. This is just the reverse of what happened in the lungs. That is the complete story of the way in which the cells of your body receive oxygen from the outside air and give off carbon dioxide into the outside air.

It still remains to explain how breathing can go on day and night without any stopping. This problem was very beautifully solved by making our breathing a sort of automatic function. What happens if you try to hold your breath? After half a minute, or at most a whole minute, it is impossible for you to keep from breathing any longer. In this way your body very thoroughly protects itself. The reason you are unable to hold your breath longer is that there is a remarkable center of nerve-cells in the back and lower portion of the brain, called the respiratory center, which controls the automatic part of breathing. It is arranged so that you can breathe faster or slower if you wish within certain limits and for a short period of time. If, however, you hold your breath too long the carbon dioxide begins to accumulate throughout the body and also in the respiratory center. Carbon dioxide stimulates the respiratory center to action, so that it overcomes any wish you may have to hold your breath longer. Like an automatic regulator, the respiratory center helps to control breathing at a regular rate while we are awake or asleep, stimulating the muscles of the diaphragm and the muscles that raise the ribs so that they all work smoothly together.

While an increase or decrease in the carbon dioxide in the blood will speed up or slow down the rate of breathing, it is not the only thing which will alter our breathing rate. Breathing is also increased somewhat if the amount of oxygen in the blood is diminished. This may often be noticed when one climbs to the top of a high mountain, where the molecules of oxygen are not so plentiful as they are at or near sea level. On a great height, one feels short of breath even while sitting or lying down, which means that the respiratory center has noticed the scarcity of oxygen molecules in this high altitude and is speeding up breathing in order to take in as many as possible. However, a lack of oxygen is not nearly so important in increasing our breathing as an excess of carbon dioxide in the body.

Paul Parker photo, New York Hospital

An oxygen tent is a comfortable way for a patient to get extra oxygen when it is needed. When the tent is closed, the pure oxygen pumped into it can not escape.

The way in which carbon dioxide acts on the respiratory center is probably as an acid. Carbon dioxide, when dissolved in water produces a very weak acid called carbonic acid (H_2CO_3). With the production of excessive amounts of carbon dioxide larger quantities of carbonic acid are produced which probably stimulate the respiratory center to greater activity. Lactic acid, which

Chicago, Milwaukee, St. Paul and Pacific R. R.

At high altitudes, the air is thin. The molecules of oxygen and other gases are spread apart, and breathing may be difficult. Mountain climbers train themselves to be in fine condition before attempting to scale the highest peaks.

is produced by the muscles during work, may also influence the respiratory center in the same way. This partly explains why we breathe faster and more deeply after muscular exertion.

We have learned how important it is for us to have an abundant supply of oxygen at all times. We can live without food for several months and without water for at least a few days, but we can live without oxygen for only a few minutes. About one-fifth of all the air around us is oxygen. This is true whether we are in a valley or on a high mountain; one-fifth of the air is oxygen, even at great altitudes where aviators fly. But as we go from a lower place to a higher one, the whole atmosphere is thinner. The molecules become more widely separated, so that a breath of air, while it still contains the same *proportion* of oxygen, will contain fewer molecules of oxygen. At 18,000 feet there would be only one-half as many molecules of oxygen in each breath of air as there are at sea level. At 42,000 feet there would be only one-eighth as many molecules of oxygen. Because of this, a person can not live at high altitudes unless extra oxygen is supplied to him. Since airplanes are going ever higher and higher, many new problems have been created for both aviators and doctors.

Pure oxygen can now be breathed easily and comfortably through a mask which fits tightly over the face and which is connected with a tank of oxygen. Aviators sometimes wear this mask and breathe the oxygen which is carried in the airplane when they fly above 10,000 feet. However, some planes which fly at high altitudes are so equipped that all of the air inside the cabin is kept normal for breathing. Many diseases, formerly considered incurable, can now be cured or greatly relieved by giving oxygen through such a mask to the sick person. Every great hospital is prepared to give oxygen in this way if necessary. Many people believe that a sick person receiving oxygen is fatally ill, or about to die. Let us do away with that mistaken idea. Nowadays, oxygen is administered very frequently, and for many conditions. It may be used merely to give a little extra help in getting well. Its administration does not mean that the patient is critically ill.

By ARTELL E. JOHNSON, M.D.

THE NEXT STORY OF OUR OWN LIFE IS ON PAGE 1559.

The Emperor's New Clothes

By HANS CHRISTIAN ANDERSEN

Version by Alice Corbin Henderson. From Children's Literature by Curry and Clippinger. Copyright 1920 by Rand McNally and Co.

MANY years ago there lived an Emperor who thought so much of new clothes that he spent all his money on them. He did not care for his soldiers; he did not care to go to the theatre. He liked to drive out in the park only that he might show off his new clothes. He had a coat for every hour of the day. They usually say of a king, "He is in the council chamber." But of the Emperor they said, "He is in the clothes closet."

It was a gay city in which the Emperor lived, and many strangers came to visit it. Among these, one day, there came two rogues who set themselves up as weavers. They said they knew how to weave the most beautiful clothes imaginable; not only were the colors and patterns used remarkably beautiful, but clothes made from these materials could not be seen by anyone who was unfit for the office he held or was too stupid!

"Those would be fine clothes!" thought the Emperor. "If I wore those I could find out what men in my empire were not fit for the places they held. I could tell the clever men from the dunces! I must have some clothes woven for me at once."

So he gave the two rogues money that they might begin their work.

The rogues immediately put up two looms and pretended to be working. But there was nothing at all on their looms. They called for the finest silks and the brightest gold, but this they put into their pockets. At the empty looms they worked steadily until late into the night.

"I should like to know how the weavers are getting on with my clothes," thought the Emperor.

But he felt a little uneasy when he thought that anyone who was stupid or was not fit

Of this Emperor they said "He is in the clothes closet."

"Mercy!" said the Minister to himself. "Is it possible that I am a dunce? I never thought so! No one must know!"

for his office would be unable to see the cloth. Of course he had no fears for himself; but still he thought he would send someone else first, just to see how matters stood, and to bring him a report.

"I will send my faithful old Minister to the weavers," thought the Emperor. "He can see how the stuff looks, for he is a clever man, and no one is so careful in fulfilling duties as he is."

So the good old Minister went into the room where the two rogues sat working at the empty looms.

"Mercy on us!" thought the old Minister, opening his eyes wide. "I can't see a thing!" But he didn't care to say so.

Both the rascals begged him to be good enough to step a little nearer. They pointed to the empty looms and asked him if he did not think the pattern and the coloring wonderful. The poor old Minister stared and stared as hard as he could, but he could not see anything, for, of course, there was nothing to see!

"Mercy!" he said to himself. "Is it possible that I am a dunce? I never thought so! Certainly no one must know it. Am I unfit for office? It will never do to say that I can not see the cloth!"

"Well, sir, why do you say nothing of it?" asked one of the rogues, while he pretended to weave busily.

"Oh, it is beautiful—charming!" said the old Minister, peering through his spectacles. "What a fine pattern, and what wonderful colors! I shall tell the Emperor that I am very much pleased with it."

"We are glad to hear you say so," answered the two swindlers.

Then they named all the colors of the invisible cloth upon the looms and described the pattern. The old Minister listened intently, so that he could repeat all that was said of it to the Emperor.

The rogues now began to demand more money, more silk, and more gold thread in order to proceed with the weaving. All of this, of course, went into their pockets. Not a single strand was ever put on the empty looms at which they went on working.

The Emperor soon sent another faithful friend to see how soon the new clothes would be ready. But he fared no better than the Minister. He looked and looked and looked, but to his consternation he saw nothing but the empty looms.

"Isn't that a pretty piece of cloth?" asked both rogues, showing and explaining the handsome pattern which the Minister could not see, because it was not there.

"I am not stupid!" thought the man. "It must be that I am not worthy of my good position. That is, indeed, strange. But I must not let it be known!"

So he praised the cloth he did not see, and approved of the color and design that were not there. And to the Emperor he said, "It is charming!"

Soon everybody in town was talking about the wonderful cloth that was being woven for the Emperor. And the Emperor began to think that he would like to see it while it was still on the looms. Accompanied by a number of his friends, among whom were the two faithful officers who had already beheld the imaginary stuff, he went to visit the two men who were weaving, might and main, without any fibre and without any thread.

"Isn't it splendid!" cried the two statesmen who had already been there, and who thought the others would see something upon the empty looms. "Look, Your Majesty! What colors! And what a design!" And they described the cloth that was not there.

"What's this?" thought the Emperor. "I see nothing at all! Am I a dunce? Am I not fit to be Emperor? That would be the worst thing that could happen to me, if it were true." But he did not say it aloud.

"Oh, it is very pretty!" said the Emperor aloud. "It has my highest approval!"

He nodded his head happily, and stared at the empty looms. Never would he say that he could see nothing!

His friends, too, gazed and gazed, but saw no more than had the others. Yet they all cried out: "It is beautiful!" and advised the Emperor to wear a suit made of this material in a great procession that was soon to take place.

"It is magnificent, gorgeous!" was the cry that went from mouth to mouth. The Emperor gave each of the rogues a royal ribbon to wear in his buttonhole, and called them the Imperial Court Weavers.

The rogues were up the whole night before the morning of the procession. They kept more than sixteen candles burning. The people could see them hard at work, completing the new clothes of the Emperor. They took yards of stuff down from the empty looms; they made cuts in the air with big scissors; they sewed with needles without thread; and, at last, they said, "The clothes are ready, Your Majesty!"

The Emperor himself, with his grandest courtiers, went to put on his new suit.

"See!" said the rogues, lifting their arms as if holding something. "Here are the trousers! Here is the coat! Here is the cape! It is as light as a spider's web. One might think one had nothing on. But that is just the beauty of it!"

"Very nice," said the courtiers. But they could see nothing, for there was nothing!

"Will Your Imperial Majesty be graciously pleased to take off your clothes," asked the rogues, "so that we may put on the new ones before this long mirror?"

The Emperor took off all his own clothes, and the two rogues pretended to put on each new garment as it was ready. They wrapped him about, and they tied and they buttoned. The Emperor turned round and round before the mirror.

"How well His Majesty looks in his new clothes!" said the people. "How becoming they are! What a pattern! What colors! It is a beautiful costume!"

"They are waiting outside with the canopy which is to be carried over Your Majesty in the procession," said the master of ceremonies.

"I am ready," said the Emperor. "Don't the clothes fit well?" he asked, giving a last glance into the mirror as though he were looking at all his new finery.

The men who were to carry the train of the Emperor's cloak stooped down to the floor as if picking up the train, and then held it high in the air. They did not dare let it be known that they could see nothing.

So the Emperor marched along under the bright canopy. Everybody in the streets and at the windows cried out: "How beautiful the Emperor's new clothes are! What a fine train! And they fit to perfection."

No one would let it be known that he could see nothing, for that would have proved that he was unfit for office or that he was very, very stupid. None of the Emperor's clothes had ever been as successful as these.

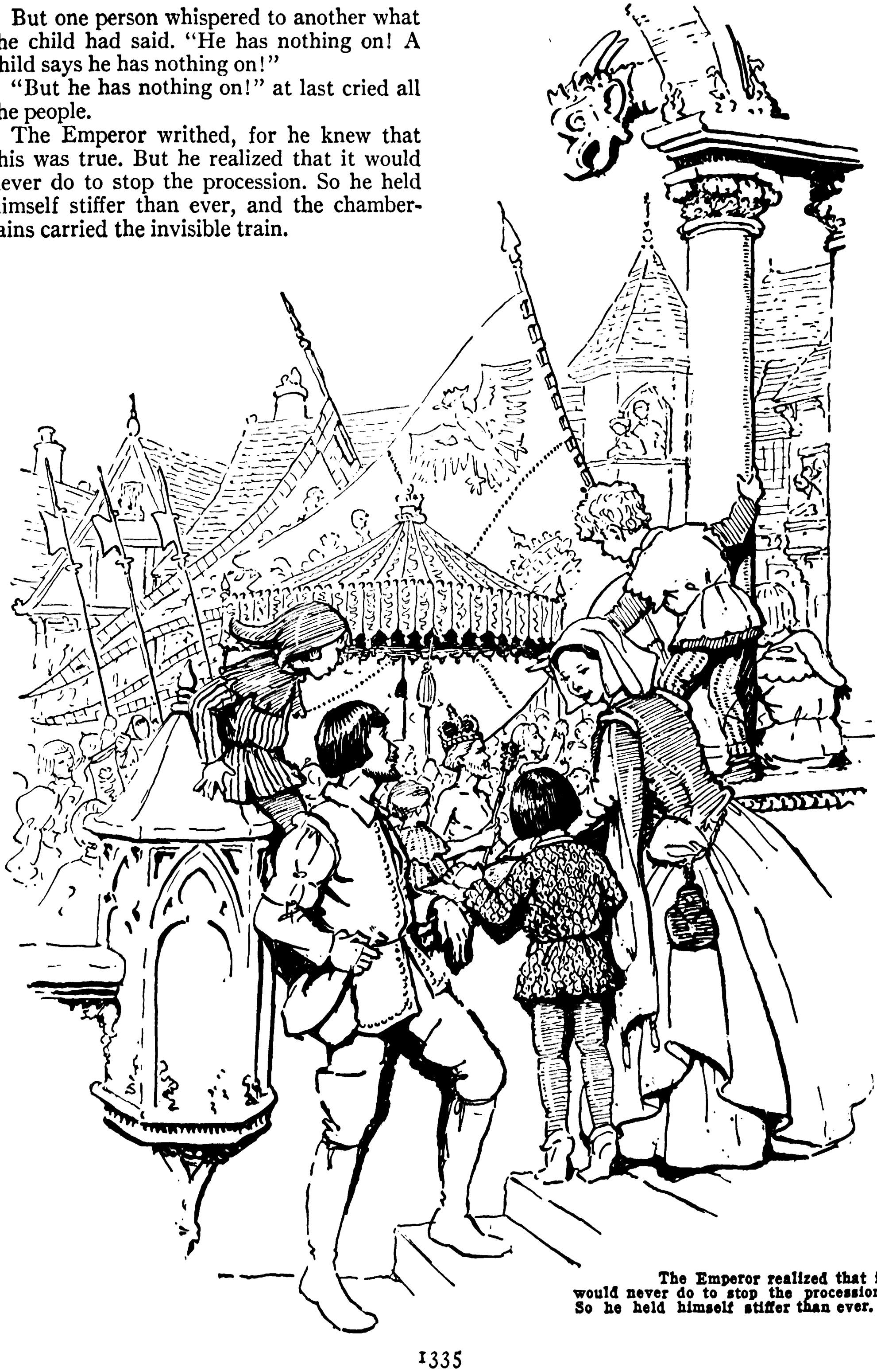
"But he has nothing on!" said a little child.

"Just listen to the innocent!" said its father.

But one person whispered to another what the child had said. "He has nothing on! A child says he has nothing on!"

"But he has nothing on!" at last cried all the people.

The Emperor writhed, for he knew that this was true. But he realized that it would never do to stop the procession. So he held himself stiffer than ever, and the chamberlains carried the invisible train.



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TWELVE DANCING PRINCESSES

THERE was a king who had twelve beautiful daughters. They slept in twelve beds all in one room; and when they went to bed the doors were shut and locked up; but every morning their shoes were found to be worn out, as if they had been danced in all night; and yet nobody could find out how it happened.

Then the king sent a proclamation through all the land, "Hear ye! Hear ye!

"Inasmuch as the twelve Princesses, my beloved daughters, are causing the Royal Brain much distress and puzzlement and

"Inasmuch as it is not fitting for Their Young Highnesses to have secrets from Their Royal Parents and

"Inasmuch as it is time for them to enter the Happy State of Matrimony

"I do therefore proclaim and promise that if any man can find out where Their Young Highnesses go dancing in the night, that man shall be made a Royal Son-in-Law. He shall marry the Princess of his choice.

"And furthermore, upon the Royal Death of the Present King, myself, the Royal Son-in-Law shall become King (may it not happen for many years).

"But beware ye! Beware ye! If any man try for three days and three nights to discover the secret of the Young Highnesses and shall fail, that man shall be declared a Disappointment and he shall be put to death."

Soon a king's son came to try to discover the secret. He was well entertained, and in the evening was taken to the chamber next to the one where the princesses lay in their twelve beds. There he was to sit and watch where they went to dance; and, in order that nothing might pass without his hearing it, the door of his chamber was left open. But this king's son soon fell asleep; and when he awoke in the morning he found that the princesses had all been dancing, for the soles of their shoes were full of holes. The same thing happened the second and third nights, so the king ordered this prince's head to be cut off. After him came several others; but they all had the same fate, and all lost their heads in the same manner.

Now it happened that an old soldier, who had been wounded in battle and could fight no longer, passed through the country where this king reigned. As he was traveling through a wood, he met an old woman who asked him where he was going.

"I want to find out where it is that the princesses dance, and then in time I might be a king."

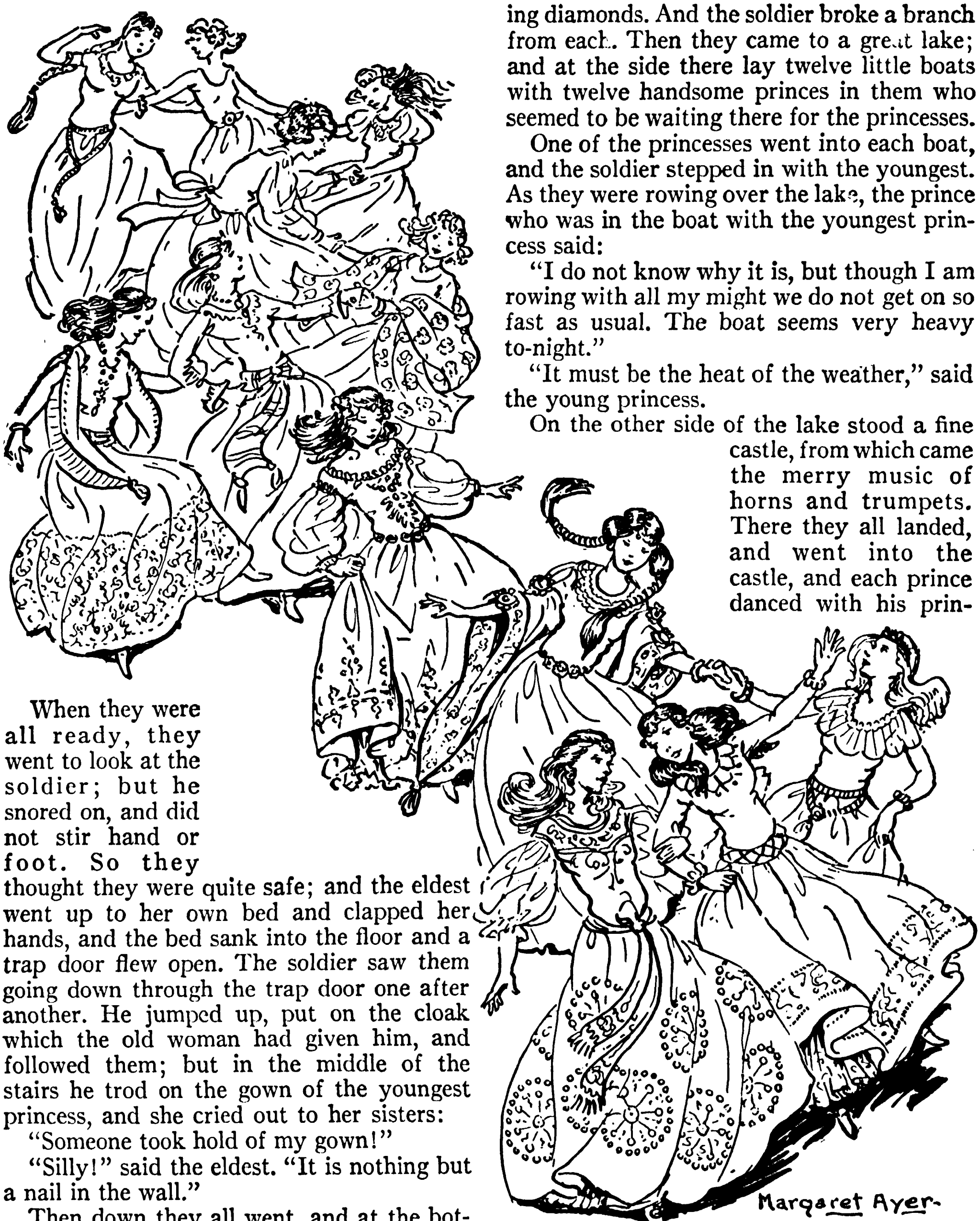
"Well," said the old dame, "that is no very hard task. Only take care not to drink any of the wine which one of the princesses will bring to you in the evening; and as soon as she leaves you pretend to be fast asleep."

Then she gave him a cloak, and said: "As soon as you put that on you will become invisible, and you will then be able to follow the princesses wherever they go."

When the soldier heard all this good counsel, he went to the king, who ordered fine royal robes to be given him; and when the evening came the old soldier was led to the outer chamber. Just as he was going to lie down, the eldest of the princesses brought him a cup of wine; but the soldier threw it all away secretly. Then he lay down on his bed, and in a little while began to snore as if he were fast asleep. When the twelve princesses heard this they laughed heartily, and rose up and opened their boxes, and took out all their fine clothes, and dressed themselves and skipped about as if they were eager to begin dancing. But the youngest of them said anxiously:

"I feel very uneasy to-night. Do you think we had better go?"

"Do not be silly!" answered the eldest princess. "If kings' sons watched us in vain, this old soldier will not succeed. Besides, I gave him the sleeping-draft myself; and now listen to his snores."



When they were all ready, they went to look at the soldier; but he snored on, and did not stir hand or foot. So they thought they were quite safe; and the eldest went up to her own bed and clapped her hands, and the bed sank into the floor and a trap door flew open. The soldier saw them going down through the trap door one after another. He jumped up, put on the cloak which the old woman had given him, and followed them; but in the middle of the stairs he trod on the gown of the youngest princess, and she cried out to her sisters:

"Someone took hold of my gown!"

"Silly!" said the eldest. "It is nothing but a nail in the wall."

Then down they all went, and at the bottom they found themselves in a most delightful grove of trees. The leaves were all of silver, and glittered and sparkled beautifully. The soldier wished to take away some token of the place, so he broke off a little branch.

Then they came to another grove of trees, where all the leaves were of gold; and afterward to a third, where the leaves were glittering diamonds. And the soldier broke a branch from each. Then they came to a great lake; and at the side there lay twelve little boats with twelve handsome princes in them who seemed to be waiting there for the princesses.

One of the princesses went into each boat, and the soldier stepped in with the youngest. As they were rowing over the lake, the prince who was in the boat with the youngest princess said:

"I do not know why it is, but though I am rowing with all my might we do not get on so fast as usual. The boat seems very heavy to-night."

"It must be the heat of the weather," said the young princess.

On the other side of the lake stood a fine castle, from which came the merry music of horns and trumpets. There they all landed, and went into the castle, and each prince danced with his princess; and the soldier, who was all the time invisible, danced with them too; and when any of the princesses had a cup of wine set by her, he drank it all up, so that when she put the cup to her mouth it was empty. At this the youngest sister was terribly frightened, but the eldest always silenced her.

They danced on till three o'clock in the morning, and then all their shoes were worn out, so that they were obliged to leave off. The princes rowed them back again over the lake—but this time the soldier placed himself in the boat with the eldest princess—and on the opposite shore they took leave of each other, the princesses promising to come again the next night.

When they came to the stairs, the soldier ran on before the princesses, and lay down; and as the twelve sisters slowly came up, very tired, they heard him snoring in his bed, so they said: "Now all is quite safe." Then they undressed, put away their fine clothes, pulled off their shoes, and went to bed. In the morning the soldier said nothing about what had happened, but determined to see more of this strange adventure, and went again the second and third nights. On the third night the soldier carried away one of the golden cups as a token of where he had been.

As soon as the time came to declare the secret, he was taken before the king. He had with him the three branches and the golden cup; and the twelve princesses stood listening behind the door to hear what he would say. And when the king asked him: "Where do my twelve daughters dance at night?" he answered: "With twelve princes in a castle underground."

He told the king all that happened, and showed him the three branches and the golden cup.

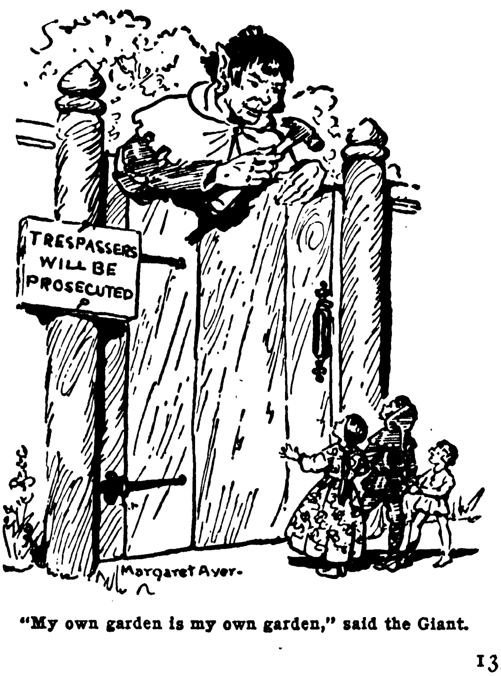
Then the king called for the princesses, and asked them whether the soldier's tale was true; and they confessed it all. And the king asked the soldier which of them he would choose for his wife.

"I am not very young," he answered, "so I will have the eldest."

And they were married that very day, and the soldier was declared the Royal Son-in-Law and after many years he became king.

THE SELFISH GIANT

By OSCAR WILDE



"My own garden is my own garden," said the Giant.

EVERY afternoon, as they were coming from school, the children used to go and play in the Giant's garden.

It was a large lovely garden, with soft green grass. Here and there over the grass stood beautiful flowers like stars, and there were twelve peach-trees that in the Springtime broke out into delicate blossoms of pink and pearl, and in the Autumn bore rich fruit. The birds sat on the trees and sang so sweetly that the children used to stop their games in order to listen to them. "How happy we are here!" they cried to each other.

One day the Giant came back. He had been to visit his friend the Cornish ogre, and had stayed with him for seven years. After the seven years were over he had said all that he had to say, for his conversation was limited, and he determined to return to his own castle. When he arrived he saw the children playing in the garden.

"What are you doing here?" he cried in a very gruff voice, and the children ran away.

"My own garden is my own garden," said

the Giant; "anyone can understand that, and I will allow nobody to play in it but myself." So he built a high wall around it, and put up a noticeboard:

TRESPASSERS
WILL BE
PROSECUTED

He was a very selfish Giant.

The poor children had now nowhere to play. They tried to play on the road, but the road was very dusty and full of hard stones, and they did not like it. They used to wander round the high wall when their lessons were over, and talk about the beautiful garden inside. "How happy we were there," they said to each other.

Spring came to the outside world, but in the garden of the selfish Giant it was still Winter.

Then the Spring came, and all over the country there were little blossoms and little birds. Only in the garden of the Selfish Giant it was still Winter. The birds did not care to sing in it as there were no children, and the trees forgot to blossom. Once a beautiful flower put its head out from the grass, but when it saw the noticeboard it was so sorry for the children that it slipped back into the ground again, and went off to sleep.

The only people who were pleased were the Snow and the Frost. "Spring has forgotten this garden," they cried, "so we will live here the year round." The Snow covered up the grass with her great white cloak, and the Frost painted all the trees silver. Then they invited the North Wind to stay with them, and he came. He was wrapped in furs, and he roared all day about the garden, and blew the chimney-pots down.

"This is a delightful spot," he said; "we must ask the Hail on a visit."

So the Hail came. Every day for three hours he rattled on the roof of the castle till he broke most of the slates, and then he ran round and round the garden as fast as he could go. He was dressed in grey, and his breath was like ice.

"I cannot understand why the Spring is so late in coming," said the selfish Giant, as he sat at the window and looked out at his cold white garden; "I hope there will be a change in the weather."

But the Spring never came, nor the Summer. The Autumn gave golden fruit to every garden, but to the Giant's garden she gave none.

"He is too selfish," she said. So it was always Winter there, and the North Wind, and the Hail, and the Frost, and the Snow danced about through the trees.

One morning the Giant was lying awake in bed when he heard some lovely music. It sounded so sweet to his ears that he thought it must be the king's musicians passing by. It was really only a little linnet singing outside his window, but it was so long since he had heard a bird sing in his garden that it seemed to him to be the most beautiful music in the world.

Then the Hail stopped dancing over his head, and the North Wind ceased roaring, and a delicious perfume came to him through the open casement.

"I believe the Spring has come at last," said the Giant; and he jumped out of bed and looked out.

What did he see?

He saw a most wonderful sight. Through a little hole in the wall the children had crept in, and they were sitting in the branches of the trees. In every tree that he could see there was a little child. And the trees were so glad to have the children back again that they had covered themselves with blossoms, and were waving their arms gently above the children's heads. The birds were flying about and twittering with delight, and the flowers were looking up through the green grass and laughing. It was a lovely scene, only in one corner it was still Winter. It was the farthest corner of the garden, and in it was standing a little boy. He was so small that he could not reach up to the branches of the tree, and he was wandering all round it, crying bitterly. The poor tree was still quite covered with frost and snow, and the North Wind was blowing and roaring above it. "Climb up! little boy," said the Tree, and it bent its branches down as low as it could; but the boy was too tiny.

And the Giant's heart melted as he looked out. "How selfish I have been!" he said; "now I know why the Spring would not come here. I will put that poor little boy on the top of the tree, and then I will knock down the wall, and my garden shall be the children's playground for ever and ever." He was really very sorry for what he had done.

So he crept downstairs and opened the front door quite softly, and went out into the garden. But when the children saw him they were so frightened that they all ran away, and the garden became Winter again. Only the little boy did not run for his eyes were so full of tears that he did not see the Giant coming. And the Giant stole up behind him and took him gently in his hand, and put him up into the tree. And the tree broke at once into blossom, and the birds came and sang on it, and the little boy stretched out his two arms and flung them round the Giant's neck, and kissed him. And the other children, when they saw that the Giant was not wicked any longer, came running back, and with them came the Spring.

"It is your garden now, little children," said the Giant, and he took a great axe and knocked down the wall. And when the people were going to market at twelve o'clock they found the Giant playing with the children in the most beautiful garden they had ever seen.

All day long they played, and in the evening they came to the Giant to bid him good-bye.

"But where is your little companion," he said: "the boy I put into the tree?" The Giant loved him the best because he had kissed him.

"We don't know," answered the children; "he has gone away."

"You must tell him to be sure and come here to-morrow," said the Giant. But the children said they did not know where he lived, and had never seen him before; and the Giant felt very sad.

Every afternoon, when school was over, the children came and played with the Giant. But the little boy whom the Giant loved was never seen again. The Giant was very kind to all the children, yet he longed for his first little friend, and often spoke of him. "How I would like to see him!" he used to say.

Years went over, and the Giant grew very old and feeble. He could not play about any more, so he sat in a huge armchair, and watched the children at their games, and admired his garden. "I have many beautiful flowers," he said, "but the children are the most beautiful flowers of all."

One winter morning he looked out of his window as he was dressing. He did not hate the Winter now, for he knew that it was merely the Spring asleep, and that the flowers were resting.

Suddenly he rubbed his eyes in wonder, and looked and looked. It certainly was a marvelous sight. In the farthest corner of the garden was a tree quite covered with lovely white blossoms. Its branches were all golden, and silver fruit hung down from them, and underneath it stood the little boy he had loved.

Downstairs ran the Giant in great joy, and out into the garden. He hastened across the grass, and came near to the child. And when he came quite close his face grew red with anger, and he said: "Who hath dared to wound thee?" For on the palms of the child's hands were the prints of two nails, and the prints of two nails were on the little feet.

"Who hath dared to wound Thee?" cried the Giant; "tell me, that I may take my big sword and slay him."

"Nay!" answered the child; "but these are the wounds of Love."

"Who art Thou?" said the Giant, and a strange awe fell on him, and he knelt before the little child.

And the child smiled on the Giant, and said to him: "You let me play once in your garden; to-day you shall come with Me to My garden, which is Paradise."

And when the children ran in that afternoon, they found the Giant lying dead under the tree, all covered with beautiful white blossoms.

THE LILY MAID OF ASTOLAT

THERE lived in Astolat, in the days of King Arthur, a brave old lord with his two sons and a daughter so fair that she was called the Lily Maid.

So rare was this Elaine that she filled the eye with the whiteness of a lily, and the soul with fragrant thoughts of goodness and of love. She was but a child, a tender maid, and yet she kept the house for the old lord, her father. To her two brothers, just beginning to dream of knighthood, the Lily Maid was like a mother. Over all in that castle she exercised the sway of a pure heart and a most lovely soul.

Happily passed the long summer days. What could ever break the spell of that greenwood peace, that hearthside happiness? The little mother of the castle had ever a song on her lips. The two brothers loved to have her watching their sword-play, and her old father found his age sit lightly upon his shoulders because in the maid he saw again the loveliness and sweetness of the wife who awaited him in heaven.

One day there sounded in the courtyard the clatter of a horse's hoofs, and presently there strode toward the door a mighty armed figure, with shield and spear, the blazoned shield dented by many strokes, the sunburned cheek of the warrior scarred by a sword-cut. He revealed not his name, but asked of the Lord of Astolat a favor.

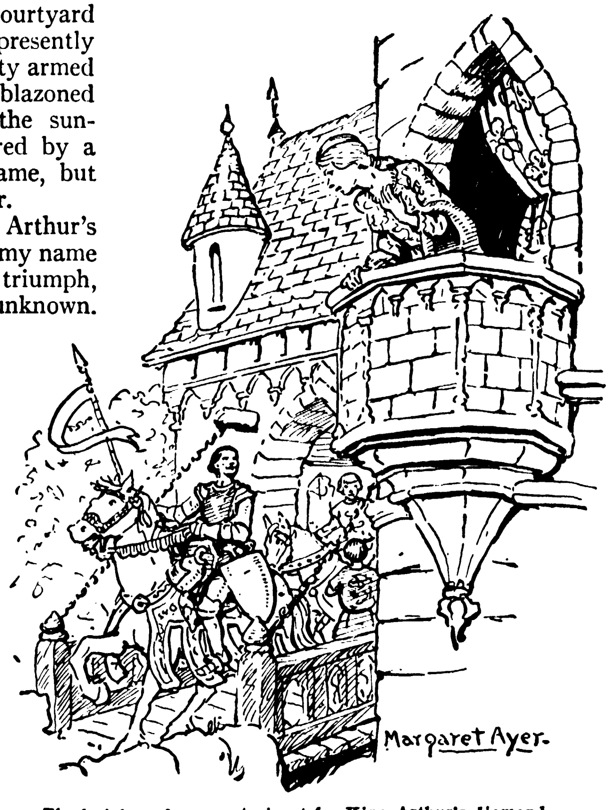
"I go to joust," said he, "for King Arthur's diamond; but because men say it is my name rather than my spear that gets me triumph, I will go this time secretly and unknown. Therefore, good lord, let me, I pray you, leave here my blazoned shield, well known at Arthur's Table, and take with me one that is innocent of all device, that no man may know me."

The little maid looked at the knight, and her heart leaped up in her bosom. The Lily Maid looked upon Lancelot—the brave, noble, but world-stained Lancelot, though she knew not his name—and loved him for the carriage of his head, the aspect of his eye, the steady music of his voice. To the simple maid the war-scarred soldier thrice her age was as a god from heaven.

While he stayed at the castle she looked upon him much and loved him more; and when he left his shield with her she gave him a broidered sleeve to wear in the tournament, "for my sake." The great Lancelot laughed lightly, for never had he worn lady's favor, his heart being given in secret to Queen Guinevere; but as one humors a child, so he took the pretty sleeve and bound it round his helmet, and rode away with one of Elaine's brothers as his squire.

Then Elaine watched over the shield Lancelot had left behind, and learned to know every mark and wound upon it, and the more she dwelt upon the scars, the more she loved the great, stern knight who had outlasted such deadly conflict. His eyes came to her in her dreams. His voice was always in her ears. Poor maid, poor Lily Maid of Astolat!

The days passed, and at last there came a knight of Arthur's Table to Astolat, bearing with him the diamond. He said that he had thought to find there Lancelot, who had been wounded and would no doubt presently return to claim his shield. When that occasion came, said he, let the diamond be given to



The knight rode away to joust for King Arthur's diamond.

him, for now King Arthur knew his name. So spake the knight, and rode away.

Elaine watched over the shield Lancelot had left.

Then Elaine, knowing at last the name of her hero, cried to her father that she might go and seek him with the diamond, and he suffered her. So with her brother she set out, and came at last where Lancelot lay sick unto death in the cave of a holy and pious hermit.

The Lily Maid approached the bed whereon the pale knight lay, and, her heart swelling with love, laid the diamond in his hand.

Her face was near, and as we kiss the child
That does the task assigned, he kissed her face.
At once she slipt like water to the floor.
"Alas," he said, "your ride hath wearied you!"

He did not know how she loved him; his man's heart could not guess the depth of this pure maid's worship. He treated her like a child. And when he grew well, and she saw that he did not know, and that he might ride away without a word to her, she told him of her love.

But Lancelot smiled upon it as a mere fancy that would pass, called her "child," bade her love one more worthy of her, and in his heart sighed for the love of Guinevere.

Then Elaine cried that she could not live without him; that if she might not be his wife, he would let her at least go with him through the world. All this the great knight treated as the fancy of a child, for such indeed he thought her.

"It will pass," he told her. "I have known such flashes in my own youth."

And then, because her nursing had given him back his life, he declared to her that when she came to marry one of her own age he would bestow upon her half of his territory, and that he would be always her knight, with sword and spear held ready at her service.

"In all your quarrels will I be your knight.
This will I do, dear damsel, for your sake,
And more than this I cannot."
While he spoke
She neither blushed nor shook, but deathly pale
Stood grasping what was nearest, then replied:
"Of all this will I nothing"; and so fell,
And thus they bore her swooning to her tower.

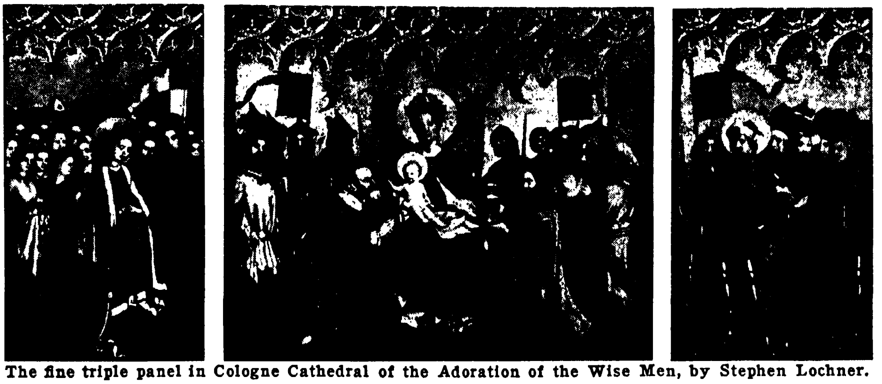
Then the old Lord of Astolat came to Lancelot, saying: "Use some roughness to her; peradventure, then the love she bears thee will return to her bosom." But Lancelot could not speak harsh words to the Lily Maid; yet when he rode away he took no leave of her, and she, who had never guessed that her so great love could be despised and cast aside, looking down from her window, saw him depart without a word. Her heart broke within her. She had given all her love to him, given all herself; there was nothing now—nothing. The old lord and his sons, watching the maid, saw her fade swiftly to her death.

Lancelot at Arthur's court forgot the Lily Maid and gave himself up to the delights of converse with the beautiful Queen. His wound was healed, his health returned: he began to take pleasure in life. Far away in his memory dwelt the kindness and sweetness of the simple little maid who had so innocently offered him her love.

One day, as he sat with Queen Guinevere, they looked from the window and saw a great barge, solemnly draped, floating toward the castle; and the barge carried a maiden's bed, and on the bed lay the Lily Maid of Astolat in royal robes, with her golden hair spread upon the pillow, a lily in one hand and a letter in the other. And this was the letter, which King Arthur read aloud when the lovely maid had been solemnly borne into the hall, and while Lancelot mused upon the childlike innocence of her face:

"Most noble lord, Sir Lancelot of the Lake,
I, sometimes called the Maid of Astolat,
Come, for you left me taking no farewell,
Hither, to take my last farewell of you.
I loved you, and my love had no return,
And therefore my true love has been my death.
And therefore to our Lady Guinevere,
And to all other ladies, I make moan:
Pray for my soul, and yield me burial.
Pray for my soul thou, too, Sir Lancelot,
As thou art a knight peerless." Thus he read,
And, ever in the reading, lords and dames
Wept, looking often from his face who read
To hers which lay so sweet, and at times,
So touch'd were they, half-thinking that her lips
Who had devised the letter moved again.

THE NEXT STORIES ARE ON PAGE 1525.



The fine triple panel in Cologne Cathedral of the Adoration of the Wise Men, by Stephen Lochner.

THE GERMAN PAINTERS

IN Germany the art of painting had a slow and rather curious development. No leaping imagination, like that of Italian art, was here; nor do we find such clear vision as belonged to the Flemish artists. Germany produced two artists who stand in the first rank of genius, and a few other gifted men. But aside from these her expression in the arts of color and form was rather small and limited. Literature and music are the realms in which her greatest masters found their places.

Woodcarving was a form of art by which many Germans were able to express themselves most freely and naturally. Some of the painters were happier with a knife than with a brush; and we can see from their very pictures that this was so. The heavy draperies on the figures have a sort of wooden look, with none of the light and buoyant appearance that we remember as belonging to Gothic and Renaissance art.

To understand why German painting lagged behind and showed less progress than art in the neighboring countries, we must know that life there was different because the people themselves were different—more crude and awkward. In Germany at this time there was less culture, less learning, less feeling for beauty than in France and Italy. Among the rulers, those who might have been patrons of the arts, there were few who were alive to the interest and value of beautiful things. So there was little to encourage painters. Those who did paint gave their thought mostly to presenting in their pictures the character and life of their own people, whose interests were chiefly material.

Yet in the fourteenth, fifteenth and sixteenth centuries, in spite of all discouraging conditions, schools of painting came into existence in various parts of Germany, at Prague and Cologne; in Swabia, Bavaria, Saxony and Alsace. Many of the paintings mentioned in terms of praise by chroniclers of the various periods have been lost; a great number are anonymous—for these reasons we have the titles given to unknown artists, such as The Master of the Altar of St. Bartholomew, The Master of the Life of the Virgin.

The first great known artist was "Master Stephan," or Stephen Lochner, who painted, about 1435, a famous picture in three panels called The Adoration of the Magi. This beautiful work is in Cologne Cathedral, and stands out as Germany's one glorious contribution to medieval art. Lochner was a happy painter of saints whose lives did not seem to be marked by "prayer and fasting plenty." He had truly religious feeling, however, and he painted in colors brilliant and soft. He was skillful in composing groups, but his drawing was not always successful.

After the lonely greatness of Lochner there arose in Cologne a host of mediocre painters who imitated certain of the Flemish artists, notably Thierry Bouts and Roger van der Weyden. Some few were gifted men, such as the unknown painter of The Descent from the Cross, now in the Louvre. The qualities of the Cologne school were the same as those found in the whole art of Germany in the fifteenth and sixteenth centuries. The pictures produced were sturdy, realistic studies of men and women in whom culture and grace had no part. The greatest lack in all this work is the lack of good taste.

A FEW FINE FLOWERS IN A DESERT OF WOODEN ART

The spaces are overcrowded, the color is gaudy; a great many artists continued to use the gold backgrounds of Byzantine and early Christian art and never really learned perspective; thus the greatness achieved by men like Van der Goes and Brueghel, who, as we have seen, brought time and space into their backgrounds, was not even remotely imitated by their German neighbors.

Engraving on wood and metal was a favorite practice in many of the art centres of this time. Martin Schongauer of Colmar (the Swabian school), a follower of Van der Weyden, produced some very fine engravings as well as a number of paintings. The Virgin in the Rose Garden, now in Colmar Cathedral, is his best painting, but he got a quality into his engraved line that he could never equal in his brushwork. A pupil of Schongauer's, Burgkmair, was working about the same time in Augsburg, and there also Holbein the elder was busy.

Then there was Lucas Cranach, who lived from 1472 to 1553 and founded the Saxon school, and later Mathias Grünewald of Alsace.

Cranach, whose art is rustic with an attempt at elegance, succeeded, among the host of pictures and engravings he made, in painting one or two fine realistic portraits such as the Old Man, in the Brussels Museum. Cranach knew Martin Luther and painted his portrait. Unfortunately the artist was very fond of taking subjects from Greek mythology, and in his hands the women whom the Greeks portrayed as gracious and beautiful became comical-looking creatures with large foreheads and narrow, slanting eyes.

TWO GIANTS WHO STALKED INTO THE WORKSHOP OF GERMAN ART

Grünewald was an artist who, so to speak, traded in horrors. His Crucifixion is so realistic as to make one's flesh creep. But Grünewald had the distinction of being a fearless colorist. He put into his pictures color used as a painter should use it. Others of his time used color in the way of an illuminator. But Grünewald was too melodramatic, too lacking in taste, to be great.

Toward the end of the fifteenth century, into this workshop and playground of little, busy men, there stalked two giants, Albrecht Dürer and Hans Holbein, who were destined to swing German art to new and unapproachable heights. Dürer, who lived from 1471 to 1528, is of an unrivaled greatness. He ranks with Leonardo da Vinci and Michelangelo, but stands apart from them in his vision, his style, in that which makes a man.

Dürer was the son of a goldsmith of Nuremberg. It was his father's wish that the boy should adopt his own trade, but when genius began to show itself this plan was discarded. Albrecht was apprenticed at the age of fifteen to Michel Wohlgemuth of the same town, an artist of but indifferent merit who is remembered chiefly for the connection with his famous pupil.

ALBRECHT DÜRER—PAINTER, VISIONARY, SEER, SCHOLAR AND POET

Four years later, Dürer started off on seven years of wandering and study, going to Colmar and Basle, across the Alps into Italy. He stayed at Venice for a time, where, of all the artists, Mantegna and Giovanni Bellini pleased him and informed him the most. In 1497 he was back at Nuremberg and set up a studio of his own. After a few years' work he went to Venice again and then returned to new activities in Nuremberg.

From 1507 onward he lived a life of constant work, literary study and creative thought; 1521 saw him visiting the Netherlands and "soaking in" the qualities of the great Van Eyck. During his last few years Dürer worked under the great handicap of ill-health. He was not sixty when he died.

Dürer was not only a painter; he was a visionary, a seer, a great scholar, and he had the instinct of the true poet. In spirit he truly belonged to the Middle Ages and the Renaissance—a world that was hungry for knowledge, with skies always getting higher, and horizons rolling farther away. If we look at his work—having first learned how to look, that is to say, studying the pictures from Dürer's point of view—we can see something of this wonderful quality which the world has never since quite recaptured. We can see the artist thinking, learning, experimenting, working in one medium and another, and succeeding in imprinting with his pencil the life and adventures of the soul—adventures upon which he seems often to have gone forth.

He seems to have spent some time each day in the far land of the spirit. Hence we get the genius that created his noble pictures—The Knight and Death, Melancholy, The Repose in Egypt, The Mills, The Adoration of the Magi, and The Four Evangelists—this last the greatest contribution Germany has made to the world's art.

And this man, whose thoughts and imaginations carry him to such a height, is at the same time a very faithful portrait-painter. We can see this in such portraits as the famous Jerome Holzschuher, in the Berlin Museum, and The Young Girl in the same collection; in the portraits of Oswolt Krell, The Artist, and A Man, all three in Munich.

Dürer's most beautiful painting is The Adoration of the Magi, now in the Uffizi, Florence. There is something very delightful in the delicate gradation of tone; the composition, as in all Dürer's work, is faultless. His great masterpiece, The Four Evangelists, in Munich, has a simple grandeur that is almost unrivaled in painting.

DÜRER'S LINES AS FLEXIBLE AS THE STRANDS OF A SPIDER'S WEB

Nuremberg was famous for its woodcarving, and perhaps that is why the art of engraving and woodcutting is Dürer's greatest expression of genius. He might be challenged by painters of other countries, but in his engravings he stands alone. He was a master of line; his heaviest lines are flexible as the strands of a spider's web. His engravings are filled with a wealth of minute detail, yet all the parts fit so harmoniously into place that the picture gives an impression of largeness, of grandeur. Not a buckle, a link of a chain or a nail, not one fold in a garment or one leaf on a branch escaped him. Dürer's fine pictures are the best answer to those artists who argue that they can gain largeness by "scamping" in drawing.

When we look at these engravings and woodcuts we see Dürer working in this way because of his intense love for this medium of expressing himself. Outside influences may have caused him to excel in painting, but he was at home by himself in his engraving. And always behind the work we can see the thinker, engrossed in the eternal Why? of human questioning.

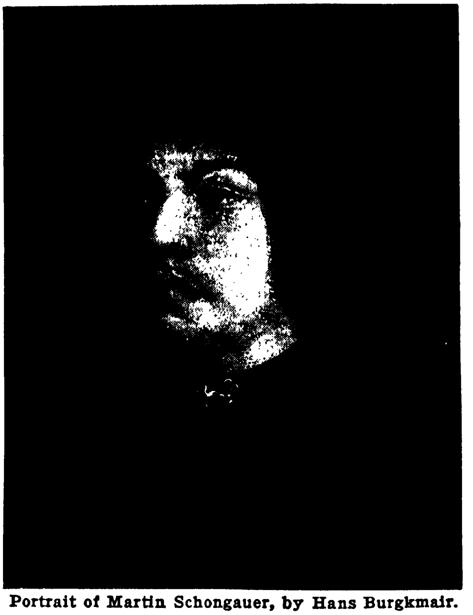
HANS HOLBEIN THE ELDER AND HANS HOLBEIN THE GREAT

Hans Holbein, who lived from 1497 to 1543, was Dürer's companion in greatness, but a man of a very different stamp. He had not the rock-ruggedness of Dürer, and he had a grace which was lacking in the older artist. While Dürer was forever searching and analyzing, probing human destiny with his finger, so to speak, Holbein was a very accomplished looker-on at life and fate.

Holbein began painting at Augsburg under his father, who is remembered only because of his son. Hans the younger early went away, to travel and work in various towns of Europe. He employed himself in many ways, from working at illuminated manuscripts to painting house-fronts. Before he was twenty years old he had painted and drawn a great deal, and some of this early work shows remarkable ability for so young an artist. Living at Basle, in Switzerland, for some time, Holbein made a number of portraits and other paintings there. Later, in England, he had the friendship of Sir Thomas More, and at one time was in the service of German merchants at the Steelyard in London. Later he became artist to Henry VIII and some of his nobles.

His well-known portrait of Sir Thomas More is in a private collection. In the National Gallery, London, is a masterpiece Holbein painted a year or so before he became attached to the English

Katharine von Borg, by Lucas Cranach the Elder.

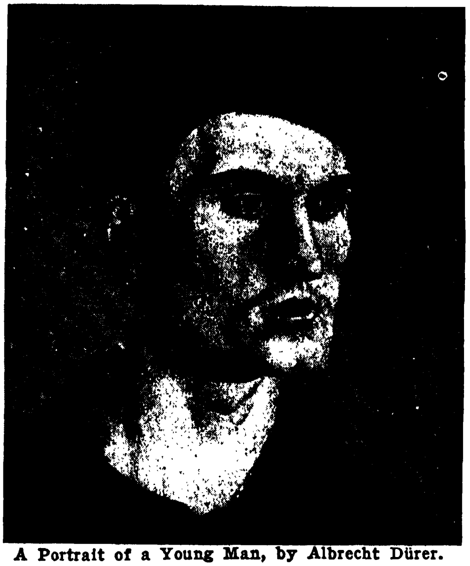


Portrait of Martin Schongauer, by Hans Burgkmair.

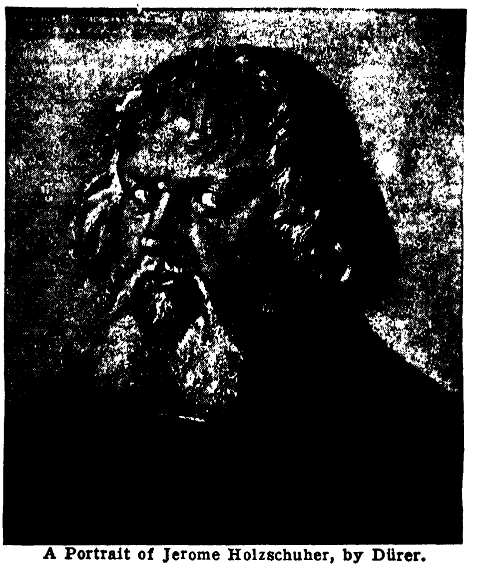
Albrecht Dürer's fine picture of The Adoration of the Magi.

Photographs of paintings on these pages by D. Anderson, F. Hanfstaengl, F. Bruckmann and E. Alinari.

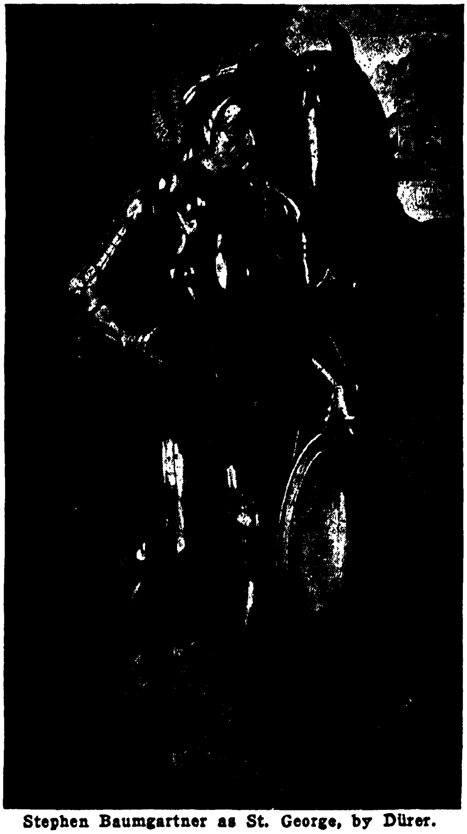
PICTURES BY DÜRER AND HOLBEIN THE ELDER



A Portrait of a Young Man, by Albrecht Dürer.



A Portrait of Jerome Holzschuher, by Dürer.



Stephen Baumgartner as St. George, by Dürer.

The Death of Mary, by Hans Holbein the Elder.

court. It is a portrait group of two French gentlemen and is known as The Ambassadors. The portrait of the Duchess of Milan is in the same collection.

THE ONLY GREAT IDEALIST GERMAN ART HAS EVER KNOWN

All Holbein's portraits have his peculiar personal quality. He is very German in the thoroughness of his attention to detail, as we can see from the number of objects shown in a portrait like that of the Merchant George Gisze, in the Berlin Museum. He is distinctly un-German—a little French, perhaps—in his restraint and elegance.

The details never took his attention from the qualities of the persons he was painting. He showed in his canvases their coarseness and greed and meanness, their virtues and their lovableness. Over all he laid a curious dignity and nobility that was his own rather than the sitter's. In this way he was an idealist, the only great idealist that German art has ever known.

Holbein shows his strength by putting emphasis on the essential things in his work. All the details of his portrait groups are chosen not to fill up spaces, but to cast a light on the surroundings, the nationality or the character of the persons painted. This artist, who was such a gifted observer, had seen a great deal of Flemish and Italian art; but he was not an imitator. It was part of his genius to be able to take the best of what he saw and make it his own. In this he was like Raphael.

St. George and the Dragon, and a Knight and a Lady—two drawings by Albrecht Dürer.

A number of Holbein's pictures other than portraits are in existence—notably his famous group in Darmstadt Castle, the Meyer Madonna, where the Virgin and Child are painted as guests in the Burgomaster's family. This painting is familiar through the copy which is in the Dresden Museum. A drawing of the wife of this burgomaster, in the Basle Museum, helps us to understand people who say that, great as Holbein was with his brush, he was greater with his pencil. In another person's hands the drawing would be a sketch; in Holbein's it is a finished study. There is another of these lovely drawings, done in red chalk, in Windsor Castle.

Holbein's genius was really divided between his portraits and his engravings. In engraving he shares his fame with Dürer; as portrait-painter he stands alone in his country's story.

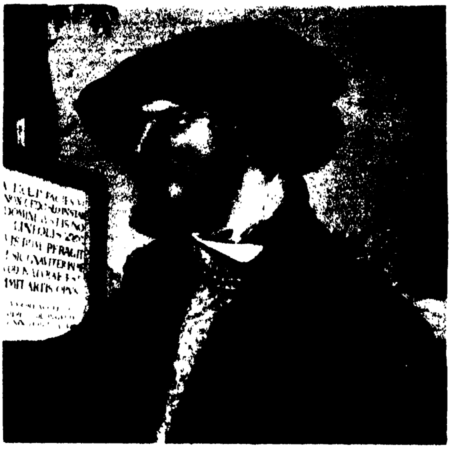
THE NEXT STORY OF THE FINE ARTS IS ON PAGE 1454.

SOME OF THE MANY MASTERPIECES OF HANS HOLBEIN

Photo, Courtesy of the Metropolitan Museum of Art.

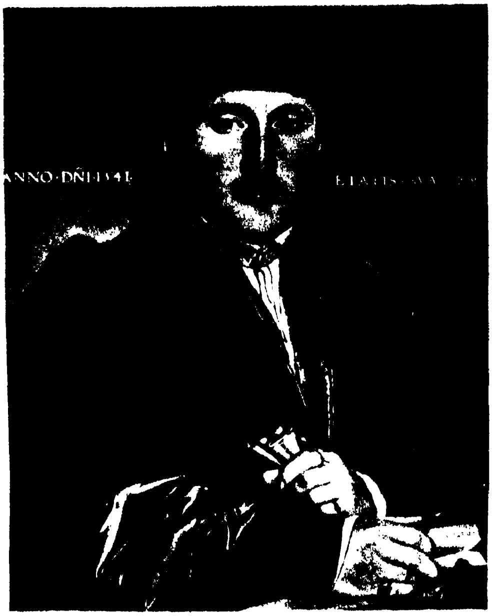
PORTRAIT OF MARGARET WYATT, LADY LEE

GEORGE GISZE, IN THE BERLIN MUSEUM

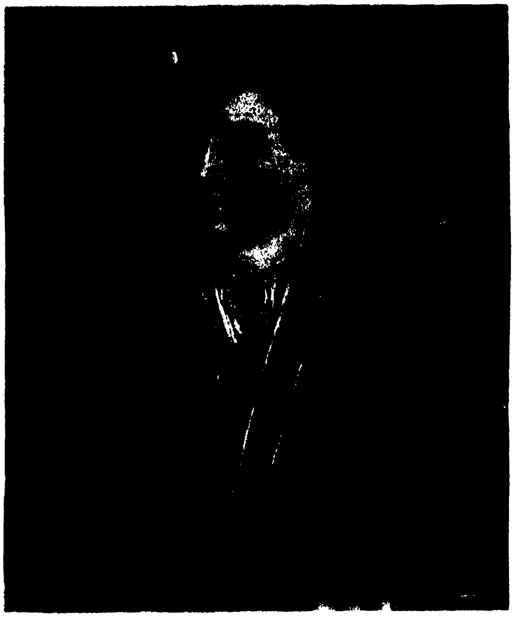


BONIFACE AUERBACH, IN THE BASLE MUSEUM

SIR THOMAS GODSALVE AND HIS SON JOHN, IN THE DRESDEN GALLERY



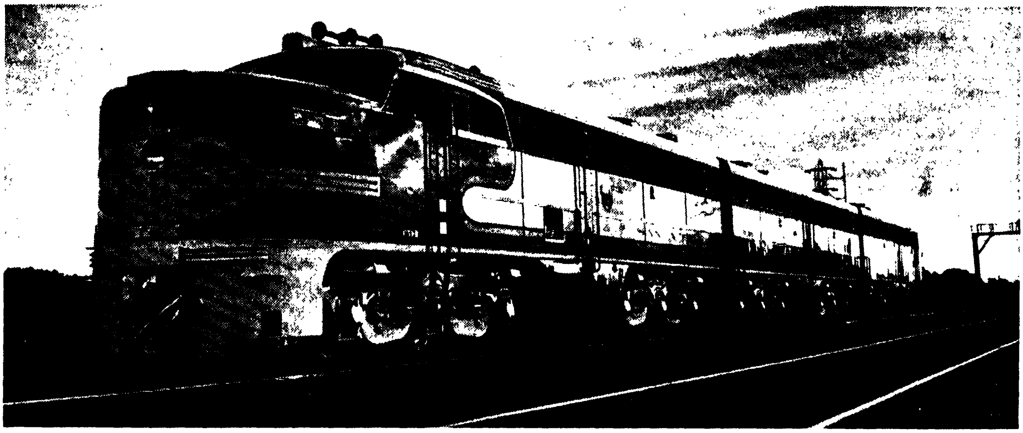
PORTRAIT OF A YOUNG MAN, IN THE VIENNA GALLERY



HOLBEIN'S PORTRAIT OF HIMSELF, IN THE BASLE MUSEUM

PORTRAIT OF ROBERT CHESEMAN, FALCONER TO KING HENRY VIII, IN THE HAGUE GALLERY

THE MADONNA OF THE BURGOMASTER MEYER, IN THE DRESDEN GALLERY



American Locomotive Co.
Huge Diesel engines of this type now haul many passenger and freight trains in the United States and Canada.

HOW DOES A DIESEL ENGINE WORK?

ONE of the things you learn in physics is that air—or any gas—can be tightly compressed. If it is compressed enough, it becomes very hot.

Try this experiment with your bicycle pump. First, hold your finger over the end of the tube; then push down the plunger. You are compressing the air inside the pump, because you are pushing it into a smaller space from which it has no chance of escaping.

Now if you could compress this air to one-sixteenth of its original volume, it would be hot enough to melt tin or set fire to any liquid fuel. Going a step further, if you could squirt a drop of fuel oil into this very hot air, there would be an explosion. The force of the explosion would make the plunger fly out—and you would have demonstrated the principle of the Diesel engine.

If you wanted to make your bicycle-pump Diesel do some work for you, you would hook the handle of the plunger to a crankshaft. The up-and-down motion of the plunger would make the crankshaft revolve. By attaching some valves to the pump—to let out the burned gas and draw in new air and fuel—you could get a series of explosions that would keep the plunger moving and the shaft turning.

A real Diesel engine is, of course, much larger than your bicycle-pump engine, but the principle is the same. Let's start one and see how it works.

There are various ways of starting the engine. In a large one, for example, compressed air from a tank may be forced into the cylinders. This causes the pistons to move downward and so rotate the crankshaft. After a few revolutions, the air becomes hot enough to ignite a fine spray of fuel oil, and keep it going. Or the engine may be started electrically.

And now let's see what happens inside the cylinders. As the pistons start their first downward stroke, or movement, they pump in a charge of air. The fresh-air valves automatically close as the pistons reach the bottom of their stroke and start upward again. Coming up, the pistons increase the pressure of the air to more than 800 pounds per square inch and raise its temperature to about 1,000 degrees Fahrenheit. At the same time, a pump forces a fine spray of fuel oil into the cylinder. The oil immediately starts to burn, and as it burns creates hot gases which expand in all directions.

The expanding gases force the pistons downward again in a third stroke. This is called the power stroke, because the chemical energy of the fuel has been turned into mechanical energy which turns the wheels. A fourth, and upward, stroke completes the cycle of movement. It is called the exhaust stroke because the pistons, in their upward movement, force out the burned gases through another valve. This makes room for a new charge of air, and the pistons start the same procedure all over again with another air intake stroke and spray of fuel oil.

The operation which we have just explained takes place in a four-stroke cycle engine. A more compact type of Diesel is the two-stroke cycle engine. Its mechanical operation is the same, with one exception: As the piston nears the end of its power stroke, the exhaust valve automatically opens and lets out the burned gases. At the same time, air holes at the bottom of the cylinder wall let in fresh air. You can see that this two-in-one action cuts out two up-and-down movements of the pistons. Therefore, the two-stroke cycle engine needs less size and weight to produce a given amount of power because it gives twice as many power strokes for a given number of piston movements.

Some people believe that Diesels use cheap crude oil for fuel. That is not true. Engineers have found that the best fuel for this type of internal-combustion engine is clean, high-grade oil, very much like that used in an oil furnace for home heating. The real reason for the lower cost of operation is that a Diesel makes more efficient use of its fuel and gets more work out of it than a gasoline engine.

In a gasoline engine, the fuel must be vaporized and mixed with air in the carburetor *outside* the cylinder. The mixture is then forced into the cylinder and is exploded by a spark from the spark plug. In the Diesel engine, the oil fuel and hot, compressed air are mixed *inside* the cylinder. There is no need of a spark plug to ignite it.

The first Diesel engine was patented by Dr. Rudolf Diesel of Munich, Germany, in 1892. The first American-built engine was finished in 1898. In the beginning these new engines were big, slow and heavy. As late as 1933 some of the more powerful ones weighed 100 pounds per horse-power. A 100-horse-power engine would have weighed about 10,000 pounds.

In 1933, Charles Franklin Kettering produced a high-speed, heavy-duty engine that weighed only twenty pounds per horse-power. It was small enough to fit inside a railroad car. Later, smaller sizes of this engine were developed. Finally one weighing only six pounds per horse-power was made for trucks, marine and stationary uses.

During World War II these engines were put to good use. A special high horse-power Diesel engine, known as the "pancake," that weighed only four pounds per horse-power, was made for submarine-chasers. Diesels also were used for tanks, landing-boats, submarines and their mother-ships, destroyers, and towboats.

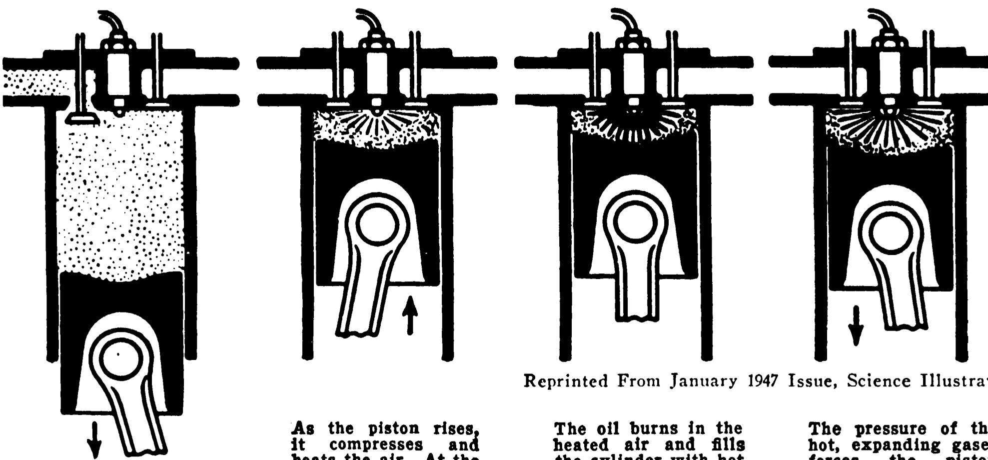
Today Diesels are used in ships, trucks, busses, excavators, bulldozers, railroad locomotives, and in fixed machinery such as farm-irrigation pumps and power plants for small factories.

The Diesel engine has not yet appeared in passenger automobiles because so far it has proved a more expensive engine to build than the gasoline engine. It has not made headway in airplanes because the gasoline engine can still be made lighter than the Diesel.

By VOLNEY B. FOWLER.

THE NEXT WONDER QUESTIONS ARE ON PAGE 1449.

HOW THE OIL BURNS IN A CYLINDER OF A DIESEL ENGINE



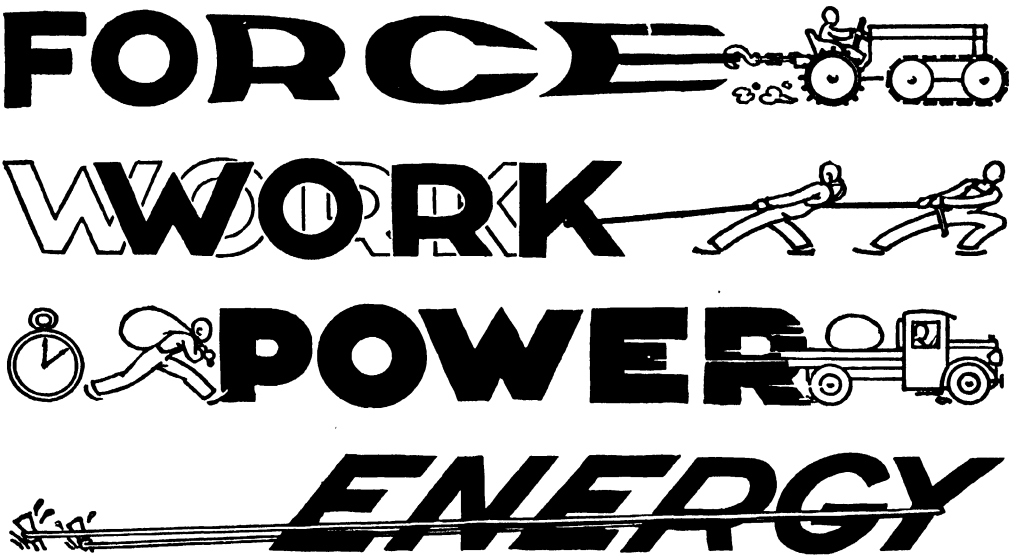
Reprinted From January 1947 Issue, Science Illustrated

Air enters at the top of the cylinder.

As the piston rises, it compresses and heats the air. At the same time, a fine spray of oil is pumped into the cylinder.

The oil burns in the heated air and fills the cylinder with hot gases that spread and exert pressure in all directions.

The pressure of the hot, expanding gases forces the piston downward again in what is called the power stroke.



HAVE you ever heard your friend strike a wrong note on the piano when playing a very familiar piece? Either you laughed or became annoyed. Good musicians do not make such mistakes.

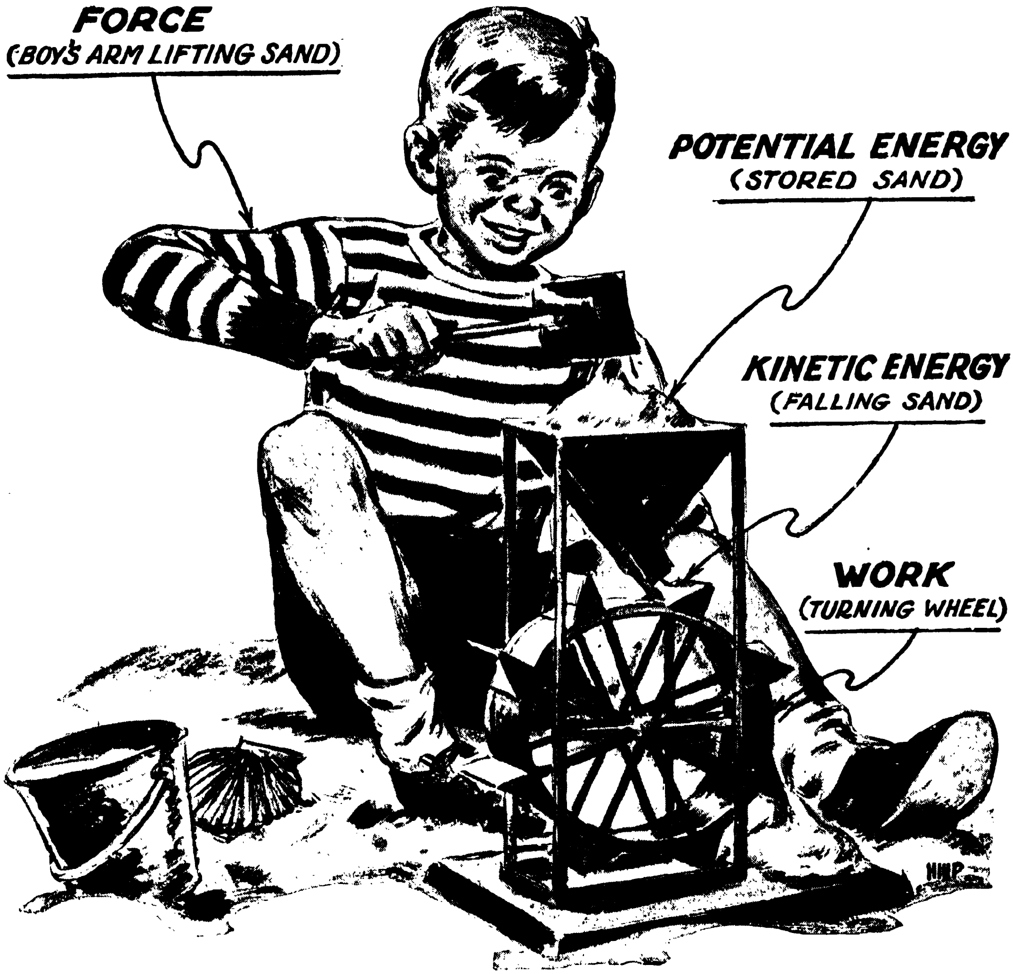
Have you ever heard people use words that do not belong? Surely you noticed that too! Once more either you laughed or became annoyed. Your English teacher insists that you use words correctly. Scientists are more, much more, exacting in their use of words. For instance, the words force, work, power and energy are often misused by ordinary people because their meaning is not really understood. In science each of these words has a separate and distinct meaning and can not be interchanged with the others.

The word "force" appears very often in the study of physics. There are many kinds of forces. The gravitational pull between the earth and your body when you are standing on a scale is a force. We drop a ball and it falls by the force of gravity. A mountain stream rushes to the sea by the same force of gravity. Our own muscular pulls and pushes are forces. The force created by an explosion of powder in a cartridge causes a lead bullet to move at high speed; when the bullet strikes a steel plate, a force is produced which not only stops the motion but also changes the shape of the bullet. *Force is anything that produces motion or changes of motion in solid bodies.*

When a brick is attached to a spring scale, you will notice that the spring scale stretches a certain amount. When two bricks are attached the spring will stretch twice the amount, and three bricks will stretch the spring three times as much. Thus we can see that the gravitational attraction of the earth for the brick, which is a force, can be measured by measuring the amount of stretching which the force produces in a coiled spring. Suppose that each of the bricks mentioned before weighs two pounds. Attach a string to one of them. What would be the tension, or the pull, in the string? The answer is obviously two pounds. To prove this, insert a spring scale any place between the brick and the string; the spring scale will read two pounds. Thus we see that the gravitational pull on the brick is a force that can be measured by means of a spring scale.

From this little experiment we also learn the fact that tension is a force, too. We have mentioned before that our muscular pushes are also forces. If you take a coiled spring between your hands and compress it, you will note that its size decreases. To do this requires a force just as in the case before, when we stretched the string. The two-pound brick will compress the spring when placed on top of it just as much as it will elongate (lengthen) the spring when suspended from it. In other words, a force has changed the shape of the spring by compressing it. Therefore compression is also a force. When a tow-car pulls a disabled automobile along, the tow-car applies a force to the automobile which results in motion. We mentioned before that when we drop a ball it falls by the force of gravity, and that a mountain stream rushes downward by reason of the same mysterious force. Force produces motion, or as a scientist would say, *force is a push or pull which tends to change a body's motion or its shape.*

The word "work" in physics has a meaning which is quite different from its everyday use. Suppose you were trying to push a car that was stalled. You pushed with all your might; you sweated; became very tired, but did not budge that car one inch. In that case you have done no work whatsoever, though you pushed very hard and were tired; you have done no work because according to physics work is done when a force *moves* an object. When a force is successfully applied to overcome resistance, work is accomplished. *The amount of work done is the product of the force and the distance through which the force is exerted.*



The boy exerts a force against gravity as he lifts sand from the beach. In the funnel this sand possesses potential energy, or the ability to do future work. The falling sand has kinetic energy, or energy because of its motion. When the sand hits the buckets, the force turns the wheel, thus performing work.

No work is done unless (1) a force is exerted and (2) a body is moved. When you climb a hill you do work because you lift your weight against the pull of gravity; a locomotive does work because it hauls a train against frictional resistance. The columns in a modern steel building do no work although they sustain great weight; if they did work there would have to be motion, and if the building were moved it would probably collapse. If you hold a chair in your hand, you may get tired but you will do no work in the sense in which this word is used in physics. All that counts in physics is the result and not the effort made. The important thing to remember is that a force must move through a certain distance in order to produce work.

THE TERM "POWER" TAKES THE ELEMENT OF TIME INTO CONSIDERATION

Suppose a man can carry a ton of bricks to the roof of a building in ten hours, and that a steam shovel can accomplish the same work in one hour. In each case the same amount of work is done. *Time* does not enter into the calculation of the *amount* of work done. Power is a term which takes into account the time element, or the rate at which work is done. The less time it takes to do a certain amount of work the more power is exerted. If it takes the steam shovel less time to lift the bricks to the top of the building, it is because the steam engine has more power. Time is an important element in comparing the work of a man and the work of an engine. Such a comparison is made by dividing the work by the time. In our example the steam engine is ten times as powerful as the man because it does the same amount of work in one-tenth of the time. *Power is work divided by time.*

THE ABILITY, OR CAPACITY, FOR DOING WORK IS WHAT WE KNOW AS ENERGY

From our everyday experiences we know that under certain conditions bodies possess the capacity for doing work. Thus a coiled-up spring, a body of water at a high level and steam confined in a steam boiler are all able to do work if we connect them to the proper motors. The mechanical energy stored in the mainspring of a clock does work on the gears of the clock. When the body of water at high level is allowed to fall, it can turn the water-wheel of a flour mill. This water-wheel in turn is connected to the proper grinders to grind the flour, and when the flour has been ground work has been done. A steam boiler may be used to drive a steam engine, such as we have mentioned before, in lifting the bricks to the top floor of the building. Surely work was done in that case. From the examples we have just mentioned we can conclude that *energy is the capacity for doing work.*

A body may be capable of doing work immediately due to the fact that it is in motion (a torpedo heading for a ship), or it may be capable of doing work at some future time (the wound-up mainspring of a clock). The energy that has been stored in the clock spring is called *potential energy.* The body of water at high level and the steam in a boiler are also examples of potential energy. Every body which is in motion possesses *kinetic energy.* (Kinetic comes from the Greek word for motion.) The swiftly moving torpedo which demolishes a ship, the descending hammer which forces a nail into wood, the rapidly moving rivers which carry bridges away are only a few examples to show that kinetic energy can do work.

POTENTIAL ENERGY IS STORED ENERGY; IT IS A CAPACITY FOR FUTURE WORK

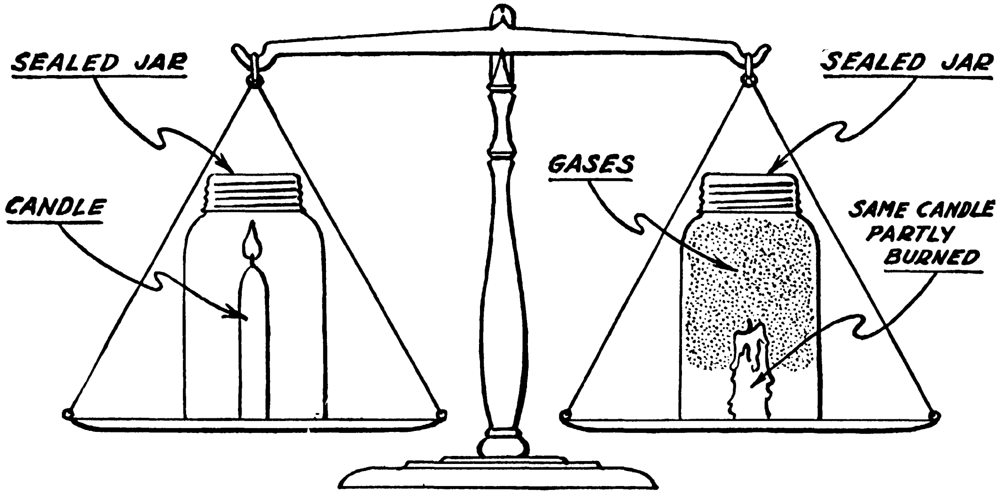
You may know that some clocks are operated by falling weights. When these weights are lifted potential energy is stored in them. Since the force of gravity acts on them all the time, they descend slowly and operate the clock. Here we see an example of how potential energy of the lifted weight is slowly being converted into kinetic energy of the falling weight. Another example may make this clearer. You know what a pile driver is—a huge weight that is lifted by machinery some feet above the ground and then allowed to fall upon a pile (a post) that is to be driven into the earth. When the pile driver is lifted, work is done on it. Potential energy is stored in it. From our discussion before we know that this pile driver is now capable of doing work. This is precisely what we mean by energy—ability to do work. When the pile driver is released and allowed to descend it can do work by driving a post into the ground. Thus we see that the potential energy of the pile driver when it is in the air is converted into kinetic energy when it moves, and so it does work.

WE SHOULD LEARN TO USE THESE TERMS OF SCIENCE IN THEIR EXACT MEANINGS

In closing, let us review what we have learned. Force is a push or pull which tends to change the motion or shape of a body. Work is done when a force moves an object through a distance. Power is the rate of doing work, that is, the work done divided by the time it takes to do it. Energy is the capacity for doing work.

By SIMON WEISSMAN.

CONSERVATION OF MATTER AND OF ENERGY



If you burn a candle in an airtight jar, there is no weight lost in the process. Only half a candle is left, but the weight lost in wax is made up by an increase in the amount of gases within the jar.

WEIGH a loaf of bread. Now slice it and weigh the slices. The solid loaf and the slices weigh the same. Mix the bread with water, salt and herbs to make a turkey stuffing. The stuffing has the combined weight of the separate materials. Stuff the bird and roast it. The cooked stuffing will weigh the same as the uncooked, minus the weight of water that has gone off in steam.

Let us take another example. When coal is burned in a furnace it leaves only a small amount of ashes. What has happened to the coal? This question can be answered by remembering that coal needs air in order to burn. The oxygen from the air has combined with the coal to form gases which go up the chimney. Now, we know that a gas is matter and therefore it has weight. If we weighed together the gases which escaped through the chimney and the ashes, we would find a sum greater than the weight of the coal, because oxygen was added in the burning.

Here is an experiment which you may try at home. Place a candle in a large glass jar and light it. After making the jar airtight, suspend it by a long rubber band and note the length of the band. The candle will continue to burn in the jar until all the oxygen is used up; and then the light will die out. The length of the rubber band will remain the same, showing that the weight being suspended has remained the same. The candle is a little shorter and the oxygen has been used up—yet no weight has been lost. Part of the candle changed to gas in combination with the oxygen. The contents of the jar after the experiment equal exactly the contents before the experiment. This proves a very important law in science, namely, that *matter can not be destroyed but only changed in form.*

Suppose the coal was not burned directly in a furnace, but combined with air and limestone to make nylon and the nylon was woven into hose. The weight of the hose, and the waste materials in manufacture should exactly equal the weight of the original tree plus the weight of the limestone and the air.

That is what scientists used to mean when they spoke of the conservation of matter. They meant that no matter on earth or in the universe could ever be gained or lost; and in a sense they were right. Matter may change its form—a solid may become a liquid or a gas. Matter may float off into the atmosphere, as smoke or steam, and be seen no more, yet it will still exist in the atmosphere; it has not gone into nothingness. Neither can matter arise from nothingness. A plant grows big from a tiny seed by building plant matter out of other materials—minerals and water which its roots take from the soil, and carbon dioxide which its leaves take from the air. If we could add together the weight of the seed, and the weight of all these materials that were taken in, and subtract the weight of water sweated out and gases breathed out, we would come very close to the weight of the full-grown plant. This is according to the law of the conservation of matter.

There is a sister-law—the conservation of energy. This law tells us that energy is never destroyed, and never created out of nothing; it can only be changed to another form. Energy—the capacity for doing work—is of several kinds, as we tell you in the chapter beginning on page 1355. There is kinetic energy (energy of motion) and potential energy (stored-up energy). Or you may list the forms in another way—as mechanical energy, heat energy, electrical energy, chemical energy, light energy.

Mechanical energy may be obtained from heat energy, as in the steam locomotive. You may get it from electrical energy, as in the electric trolley; from chemical energy, as in the automobile; or from light energy. This last occurs as follows: sunlight helps green plants grow, we eat these plants as vegetables and so obtain strength for human effort.

Changing mechanical energy back into one of the other forms can be done, too. That is what happens when a dynamo (or even a windmill) generates electricity or when rubbing two sticks together gives us a spark (heat and light).

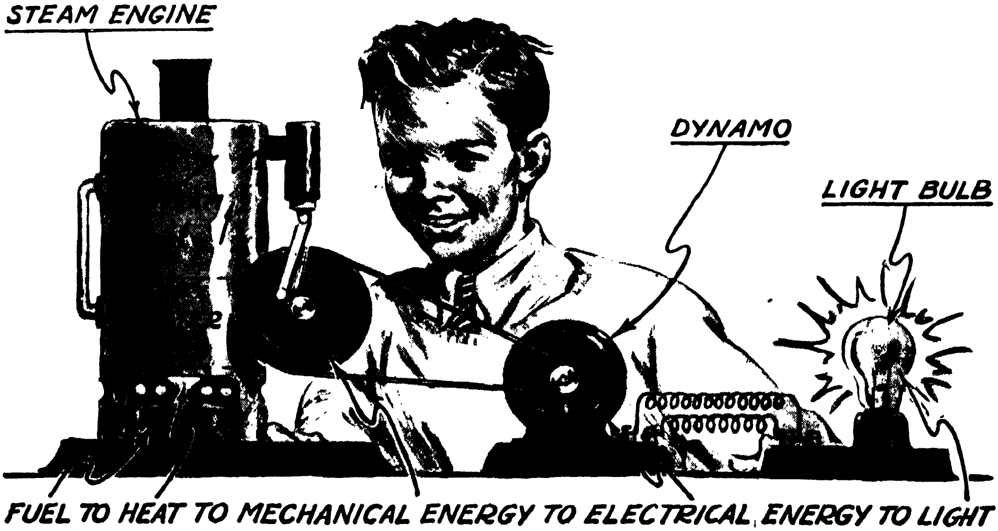
We have not created energy; we have merely transformed one type into another. And each form can be changed into every other form.

It is easy to understand that we can not make any given amount of energy disappear into nothingness. It will go into another form of energy, but it will still exist in the universe. That is what scientists used to mean, when they talked about the conservation of energy.

However, modern science asks us to take a wider view of the great law of conservation. Scientists have recently shown us that there is a definite relationship between the amount of work (friction) and heat. If a certain amount of matter is made to disappear, an equivalent amount of energy must appear elsewhere. Our sun and the stars in the heavens are slowly dissolving into light. The total energy radiated in one second by our sun is enormous. If we convert this energy into its matter-equivalent, it gives the enormous figure of four million tons. Our sun, therefore, should weigh less by four million tons every second. It would seem that we should be able to detect this loss, but in comparison to the whole weight of the sun it is like a drop being taken out of the ocean. At this rate of losing matter the sun will last about ten million years.

You may ask—if matter is converted into energy, can we reverse the process? Can energy be changed into matter? The answer appears to be yes. Recently scientists have performed experiments which seem to prove just that.

THE NEXT STORY OF SCIENCE IS ON PAGE 1415.



It is possible to change one form of energy into another as illustrated above. The total amount of energy put into the engine as fuel will be greater than the light energy of the bulb, due to friction losses in each device.

Culver Service
Scipio Africanus the Elder surprises a group of citizens planning to overthrow the Roman republic.

FAMOUS MEN OF ANCIENT ROME—I

WE have told you elsewhere the story of ancient Rome, that proud city-state that ruled over much of the civilized world in the days of old. In this chapter we shall tell you about some of the famous Romans who lived in those days.

SCIPIO (sip′-ee-oh) AFRICANUS THE ELDER

IN the last years of the third century B.C. Rome fought a great war against Carthage—the Second Punic War (218-01). Never were the Romans closer to utter destruction, for fighting against them was Hannibal of Carthage, one of the greatest generals of all time. He invaded Italy, won many victories and advanced to the very gates of Rome. But if Carthage had her Hannibal, Rome had her Scipio. He, too, was a mighty general, and it was his military skill and bravery that finally saved the day for his native land.

Publius Cornelius Scipio (237?-183 B.C.) belonged to a noble Roman family. He was a youth of nineteen when the Second Punic War broke out; yet he was in the thick of the fighting from the very beginning. He saved his father's life in the battle of the Trebbia River (218); he was one of the few Roman officers who survived the overwhelming defeat of Cannæ in 216.

Scipio first won fame as a military leader in 210. In that year, though he was but twenty-seven years old, he was given command over all the Roman forces in Spain, where the Carthaginians were very strong. He won a number of brilliant victories and by 206 the Carthaginians had been driven out of the land. The natives of Spain, who had been inclined to favor Carthage at first, were won over by Scipio's soldierly qualities and his fair dealing. They even asked him to become their king; but the young Roman general had other plans.

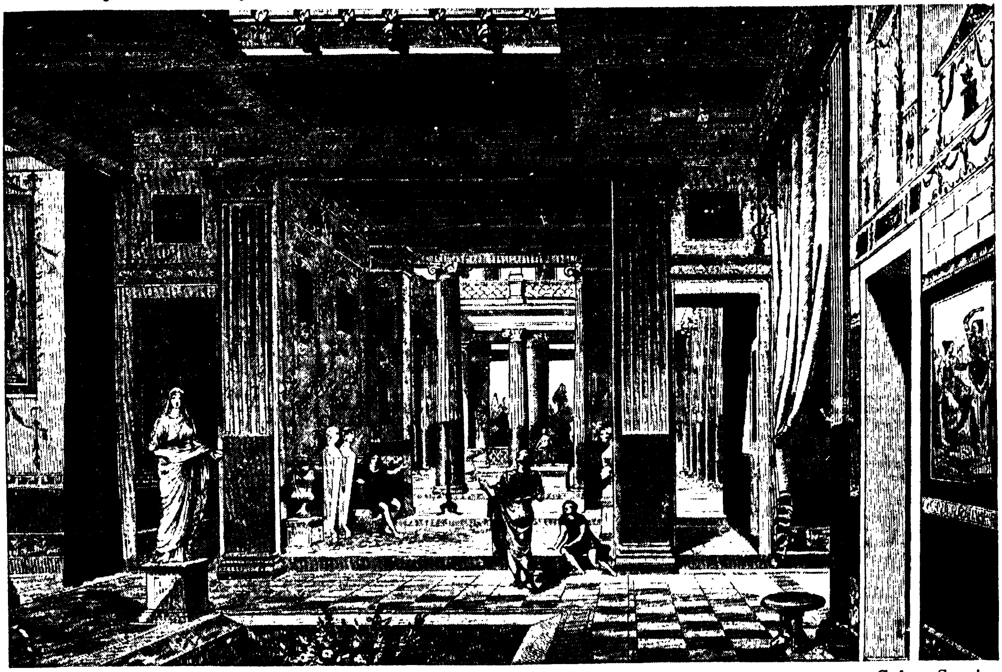
Scipio was elected consul in Rome for the year 205 B.C. He wanted to carry the war to Carthage, in northern Africa, but most of the senators were opposed to his plans. At last they reluctantly agreed to let him make his headquarters in Sicily, which was across the Mediterranean from Carthage. They even gave him permission to cross over into Africa if he thought it advisable. But they gave him no army with which to fight!

Scipio was not discouraged. He asked for volunteers, and they flocked to his banners from all parts of Italy. At last he had not only a large army but a large fleet as well, and in 204 he set sail for Africa. Upon landing there, he got the help of King Masinissa of Numidia, and he defeated the Carthaginians again and again.

Hannibal had remained in Italy all this time. He was now recalled to defend his native city. The armies of Scipio and Hannibal met near Zama in 202, and the Carthaginians suffered a terrible defeat. In the following year the Carthaginians had to make peace. Hannibal went into exile.

Scipio returned to Rome in triumph and was greeted with great enthusiasm by his fellow-citizens. They gave him the surname, or additional name, of Africanus (man of Africa). They wanted to make him consul and dictator for life; but he refused and retired from public life for a time.

In 194 he was sent as an ambassador to the court of King Antiochus III of Syria. Here he met his old enemy Hannibal. The two famous generals greeted each other warmly and chatted pleasantly. Scipio asked Hannibal: "Who was the greatest general who ever lived?" "Alexander," was the reply. "Who was the second greatest?" "Pyrrhus." "Who was the third greatest?" "Myself." "What would you have said, then," asked Scipio, "if you had conquered me?" "Why, in that case," Hannibal answered, "I would have placed myself above all the rest."



Culver Service

The home of a wealthy Roman. In the foreground was the atrium, or entrance hall, with rooms on either side (alae). Behind the atrium was the small tablinum where family statues were kept, and beyond that the peristyle or court.

The last years of Scipio's life were embittered by persecution at home. In 185 the public officers called tribunes of the people brought a charge against him of having accepted bribes from Antiochus III of Syria. On the first day of his trial Scipio did not deign to defend himself. Instead, he spoke only of the great services that he had rendered to the Roman people.

The next day Scipio pointed out that this was the anniversary of the victory of Zama. "Follow me to the Capitol," said he, "and give thanks to the immortal gods. Pray that they may grant the Romans other citizens like myself." (The Capitol was the temple of Jupiter on the Capitoline Hill of Rome.)

The people of Rome were so touched by Scipio's words that they made the tribunes drop the trial. But Scipio's heart was not softened. He left at once for his country estate at Liternum and never did he return to Rome. When he died, he was buried in Liternum and not in the ungrateful city which owed so much to him.

This great man is generally known as Scipio Africanus Major (the Elder). Another Scipio won great fame in Africa and received the title of Africanus Minor (the Younger).

CATO (kay′-toh) THE CENSOR

AFTER the extensive conquests of the Romans in the third and second centuries B.C. great wealth poured into Rome and a spirit of luxury began to prevail. Men became more self-seeking; there was increasing dishonesty in public office. It was then that a man of the old school made a determined effort to bring back the old-fashioned Roman virtues of simplicity, patriotism and honesty. This man was Marcus Porcius Cato (234-149 B.C.), generally called Cato the Censor.

While he was still a boy, Cato's father died and left him a farm in the Sabine hills, not far from Rome. Cato spent the years of his youth in this place. He hardened his body by constant exercise; he shared in all the work of the farm; he learned to manage his own property. It was here that he acquired the habits of thrift and simplicity that never left him.

Cato led a very full life as a soldier and statesman. He served with great bravery in the Second Punic War against Carthage; he also won distinction in the fighting against King Antiochus III of Syria. As a statesman he won the highest honors that the Roman Republic could bestow. He was consul in 192 and censor in 184. Yet he was happiest when he could return to his Sabine estate and lead the life of a farmer.

He had his first opportunity to deal a crushing blow against luxury when he was consul. At that time it was proposed to abolish the Oppian Law, which forbade Roman women to wear more than half an ounce of gold on their clothing and to dress in garments of various colors. This measure had been passed in the midst of the Second Punic War, in order that the money spent on personal adornment might be used to carry on the fight against the Carthaginians.

By the time of Cato's consulship, many people felt that there was no longer any necessity for the measure, since the emergency had long passed. Cato claimed that there was more need for the Oppian Law than ever before, since the love of luxury had become a national vice. If Cato could have prevented the abolishment of the Oppian Law, he would have scored a great triumph for his ideas. But he met his match in the women of Rome. They demanded the right to wear whatever ornaments they pleased, and in the end they had their way.

It was while he was censor that Cato was able to carry on most effectively his campaign to bring back the good old days. The censors of Rome were very powerful officials. They had charge of the voting lists; they could deprive citizens who behaved badly of the right to vote and of other political rights. They were thus the guardians of public morals; they controlled fashions and even speech. They also administered the finances of the state.

No man was ever more zealous than Cato in carrying out the duties of the censorship. He insisted that those who handled the state money should be perfectly honest; he punished severely those who accepted bribes. He set very heavy duties on luxuries. Above all, he sought to make the Romans improve their behavior. He drove from the senate a man whose conduct had become a public scandal. He went so far, indeed, that he punished a certain Manilius for kissing his wife in broad daylight in the presence of their daughter!

The Romans acknowledged that Cato had fulfilled his duties as censor honestly and conscientiously; they voted to erect a statue in his honor. Yet Cato was unable to bring about a permanent change in their way of living. He found, as many statesmen have found since his day, that one can not make a people honest and simple and patriotic merely by passing laws.

TIBERIUS AND GAIUS GRACCHUS (grak′-us)

THE greatest reformers of ancient Rome were two brothers, Tiberius and Gaius Gracchus. They belonged to the aristocratic class of Rome; yet they unselfishly tried to better the lot of the poor. Tiberius Gracchus was born in 169 B.C.; his brother Gaius was nine years younger.

Their father, who was a renowned statesman and soldier, died when the boys were very young. Their mother, Cornelia, took charge of their education, and they became the most promising lads in all Rome. One day a haughty Roman lady, richly adorned, asked Cornelia why she wore no jewels. Cornelia sent for her two fine sons. "These," said she, proudly, "are my jewels!"

Tiberius Gracchus served in the Roman army in the Third Punic War against Carthage—the war in which Carthage was destroyed. He was the first Roman to scale the walls of that city in the final attack. Later, he won fame as an officer in Spain. He was a great favorite with the Roman people. A great career as a military leader and a statesman seemed to be in store for him. But his star was soon to set.

Culver Service
Cornelia, mother of the Gracchi, and her two young sons.

Yet he gave up his career for the sake of the poor people of Rome. It seemed to him unjust that the wealthy should own vast estates, while the poor farmers hardly produced enough from their few acres to keep body and soul together. He determined to do all in his power to bring about a fairer division of the land. He began by seeking election as one of the tribunes of the people—officers whose duty it was to protect the interests of the poor. With the people's support, he was elected for the year 133 B.C.

One of his first acts as tribune was to introduce a law which would divide the land more fairly. This measure became known as the agrarian law of Tiberius. (Agrarian comes from the Latin word *ager,* meaning field or land.) In former times a law had been passed forbidding any Roman to own more than 500 *jugera* (about 300 acres) of land; but this law had not been enforced for many years. In his agrarian measure Tiberius proposed to restore this old law, with some changes. The large estates of the wealthy were to be broken up into small farms, and these were to be distributed among the poor citizens.

The agrarian law of Tiberius was passed. It met with violent hostility from the senate and the aristocracy, many of whose members were now in danger of losing their great estates. They put one obstacle after another in the path of Tiberius, and the law could not be enforced.

When his year of office was drawing to its close, Tiberius announced that he would seek re-election as a tribune. This was contrary to custom; but Tiberius feared that his law would be abolished unless he remained in office. The senators were furious. On election day they armed themselves with clubs and attacked Tiberius and his followers. The poor people of Rome were too dazed to defend their champion. Tiberius was struck on the head with a club and instantly killed. More than 300 of his supporters were also slain, their bodies cast into the Tiber River.

At the time of his brother's murder, Gaius Gracchus was serving in the Roman army in Spain. At first he made no effort to avenge his brother's death. For some years he continued his career in the army, where, like his brother, he won great distinction. But one night, while he was serving in the island of Sardinia, the ghost of his dead brother appeared to him in a dream, saying: "Gaius, why do you linger? There is no escape; you must die, like myself, defending the rights of the people."

Gaius now determined to carry on his brother's program. He had himself elected as one of the tribunes for the year 123, and his first move was to have the agrarian act of Tiberius renewed and enforced. He helped the people in other ways. He provided that corn should be collected in public storehouses and that it should be sold to the poor for a low price. He made the state pay for the equipment of common soldiers. He also did all he could to curb the power of the upper classes of Rome.

Gaius was re-elected as tribune for 122. His enemies now decided to bring about his downfall by shaking the confidence of the people in him. They persuaded a tribune named Drusus to propose measures far more revolutionary than those of Gracchus himself. Drusus made wild promises, which could not be carried out, and Gracchus made no effort to match these promises. As a result he lost the support of the people, who did not understand that Drusus was only a tool in the hands of the aristocracy.

When Gaius sought to be tribune for a third time, he was defeated. Now, indeed, he was exposed to the attacks of his enemies. He sought to flee from the gangs of hired assassins who pursued him, but he found enemies on every side. At last, in despair, he had his slave run him through with a sword (121 B.C.). The faithful slave then slew himself with the same blade.

In after years the people of Rome were filled with remorse for their failure to support the brothers who had done so much for them. They erected many statues to the Gracchi. The places where they had fallen were declared holy ground; and here sacrifices were offered to Tiberius and Gaius Gracchus as in the temples of the gods.

MARIUS (may′-ri-us)

GAIUS Marius (156?-86 B.C.) was a man of the people. While still quite young, he served as a soldier in Spain and won the favor of an eminent Roman general, Scipio Africanus the Younger. Marius became one of the foremost military leaders of Rome. He was beloved by the soldiers, for he shared their toils and ate the same food they did. He was also beloved by the people, whose interests he always served.

In 107 B.C. he became consul. While consul, Marius continued to work for the com-

Culver Service

"Tell the Governor," said Marius, "that you have seen Marius a fugitive sitting on the ruins of Carthage."

Culver Service
The Roman senate chamber. In the foreground, two attendants.

mon people, in spite of the bitter opposition of the aristocracy. He also added to his military fame. He crossed over to northern Africa with an army and brought to an end the war against King Jugurtha of Numidia, who had defied the Romans for years.

A great danger now threatened Rome. Two barbarian tribes, the Teutones and the Cimbri, began to spread destruction north of the Alps in areas that belonged to Rome. The barbarians defeated several Roman armies and there was wild panic in Rome. It was felt that only Marius could save the state. In 105 B.C. he was elected consul for a second time by the unanimous vote of all parties. In the years that followed he was re-elected again and again.

Marius spent several years in preparing the Roman armies for the hard fighting that lay ahead. At last, in 102, he took his post at a fortified camp on the Rhone River. The Teutones attacked the camp, but they were driven off. They then marched away in the direction of Italy. So great were their numbers that it took them six days to pass by the Roman camp. Marius followed the barbarians and caught up with them at last at Aix. In the fierce battle that followed the Teutones were cut to pieces.

Marius now marched in pursuit of the Cimbri, who had gone on to Italy. In 101 he met them in the battle of Vercelli, west of Milan, and he crushed them also. Marius had a great triumph at Rome. He was hailed by all as the savior of the city; his name was coupled with those of the gods.

A great historian once said that it would have been fortunate for Marius if he could have died on the day of his triumph. In the years that followed he seemed determined to make the Romans forget all the good things that he had accomplished. Soon after his triumph he was guilty of a treacherous act. He got the help of two politicians, Saturninus and Glaucia, and as a result was re-elected as consul; then he turned against them and had them put to death.

In 88 he had a violent quarrel with the consul Sulla, who was the leader of the aristocratic party. Civil war broke out and Sulla was the victor. Marius fled, closely pursued by Sulla's men. He was caught by the town authorities of Minturnæ, and they decided to put him to death. A Cimbrian soldier, with drawn sword, entered the room where Marius was kept imprisoned. "Man," said the old general sternly, "do you dare to murder Gaius Marius?" The barbarian, in a panic, threw down his sword and fled. The people of Minturnæ now repented and let Marius escape.

He made his way to Carthage, which was now in Roman hands; this famous city, once the rival of Rome, was but a mass of ruins. The Roman governor, Sextilius, bade the fugitive leave at once. Marius turned to the soldiers who had brought the message of Sextilius and said: "Tell the Governor that you have seen Marius a fugitive, sitting on the ruins of Carthage."

Events at Rome soon encouraged the return of Marius. Sulla had left Italy and while he was gone civil war had broken out again between his supporters and those of Marius. Marius joined forces with the consul Cinna, who was friendly to him. The two men carried all before them and at last they entered the city of Rome itself.

Marius took a fearful revenge for the sufferings he had endured while in exile. The leading supporters of the aristocratic party were hunted down and mercilessly slain, while their property was confiscated. There were fresh victims every day and it seemed that the slaughter would never cease. Marius and Cinna had themselves named consuls for the year 86. But Marius did not live long to enjoy his triumph. In the eighteenth day of his consulship he died of an attack of pleurisy.

SULLA (sull′-ah)

LUCIUS Cornelius Sulla (138-78 B.C.) was an aristocrat to his finger tips. As a youth he studied Latin and Greek literature with great zeal, and he continued his literary studies to the end of his days. He combined with his love of literature a love of pleasure of a vulgar sort.

In those days almost all Romans served in the army at some time or other. Sulla found himself under the orders of the great general Marius in the campaign against King Jugurtha of Numidia, in northern Africa (107 B.C.). Marius, a man of the people, at first despised this pleasure-loving young nobleman. But Sulla proved to be an active and courageous officer. He became a great favorite with Marius and with the soldiers.

After a time Marius intrusted Sulla with a dangerous mission. Jugurtha had gone to the court of King Bocchus of Mauretania (modern Morocco) to beseech his aid. Marius sent Sulla to Bocchus to persuade him to give the Numidian king up to the Romans. Bocchus could not make up his mind at first whether to give Jugurtha up to Sulla or to give Sulla up to Jugurtha. But in the end he was won over by Sulla's charm. And so the Roman went back proudly to his camp with King Jugurtha in chains. Sulla had a seal ring engraved with a design showing the surrender of Jugurtha; and he wore this ring to the day of his death.

In the years that followed, Sulla won great renown as a skillful general. He became the leader of the aristocratic party and a bitter enemy of Marius, who was the foremost representative of the people. In 88 B.C. the quarrel between the two men came to a head. Sulla was consul in that year and was eager to lead the Roman armies against King Mithridates of Pontus, a dangerous foe of the Romans. But Marius wanted this command himself, and he won it by means of unworthy intrigues.

Sulla had been stationed with an army at Nola, in western Italy. In a fury he now marched on Rome, where Marius was gloating over his newly won honors. It was the

Sulla entering Rome at the head of his troops in 88 B.C., driving out his enemy, the consul Marius.

The Bettmann Archive

The right to wear the toga virilis (manly toga) was conferred with solemn ceremony upon the sons of Roman citizens when they reached the age of fourteen.

first time that a Roman general, at the head of Roman troops, had ever marched against the city; but, alas! it was not the last time. Sulla entered Rome with his troops and Marius fled. Sulla used his victory with moderation; only Marius and eleven followers were condemned.

In 87 B.C. Sulla left Italy to carry on the war against Mithridates. He first went to Greece and plundered Athens, which had been an ally of Mithridates. Then, crossing over to Asia Minor, he defeated the forces of the king of Pontus in one battle after another and at last made him sue for peace, in the year 84.

While the campaign against Mithridates was in full swing, Marius and his friends seized the government of Rome and slew many of Sulla's friends. Sulla waited until his campaign against Mithridates was over; then he sailed for Italy with his devoted troops. Marius had died some time before; but his followers were still strong and their forces greatly outnumbered those of Sulla. Sulla's men, however, were tried and true veterans, who had great confidence in their leaders. They were victorious everywhere, and soon Sulla was master of Rome.

It was now his turn to seek revenge. He drew up a list of all the prominent members of the popular party and posted it in the Forum, or public square, of Rome. The people on the list were to be killed at sight; their property was to be confiscated. Fresh lists were continually drawn up. No one felt safe. Sulla let his followers put their personal enemies on the lists—even those who had belonged to no political party. Many thousand Roman citizens were slain.

He had himself made dictator in 81 for as long a time as he thought advisable. He then proceeded to make over the government so as to put all the power in the hands of the senate and the aristocracy. By 79 B.C. his reforms had been completed and, to the great astonishment of all, he resigned his office. He retired to his estate at Puteoli; here he became the pleasure-seeking nobleman of former years. He died in 78. Sulla's friends were still powerful; they prevailed upon the people of Rome to give him a magnificent state funeral.

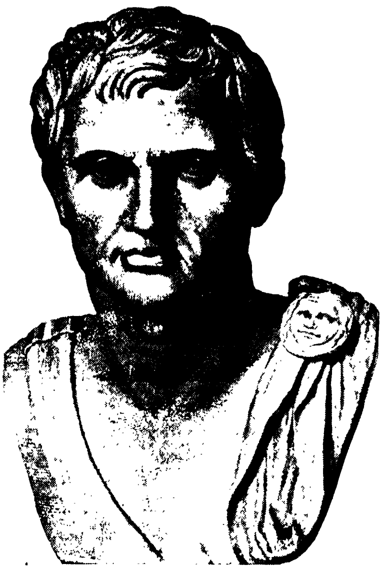
Sulla has often been represented as a cruel monster, who rejoiced in human suffering. This reputation was not altogether deserved. He did many cruel things, it is true, but only because he had suffered great provocation. His character is best summed up in a famous saying of his: "None of my friends has ever done me a kindness and none of my enemies has ever done me a wrong that was not fully repaid."

POMPEY (pom′-pee)

POMPEY is the name that English-speaking people give to Gnæus Pompeius (106-48 B.C.), the only Roman of the Republic to be called Magnus, or the Great, in his own lifetime. He was of noble birth and first belonged to the aristocratic party. He won a reputation as a skillful soldier in the Social War of 90-88, in which Rome fought against her Italian allies.

When Marius, the head of the popular party, came into power in 87, many aristocrats were slain and their property was confiscated. Even after Marius died in 86, his party was all-powerful. Pompey, therefore, prudently remained in the background for the time being. But when he heard that Sulla, the enemy of Marius, was coming to Italy, Pompey raised a big army to help him.

There was much bitter fighting before Sulla finally triumphed, in 82; and in this fighting Pompey played an important part. The young general won many victories over the party of Marius in Italy and in Sicily and it was then that he was given the surname, or additional name, of Magnus.


A bust of Pompey the Great, the friend and later the rival of Julius Cæsar.

Pompey went to Spain in 76 B.C. to fight the armies of Sertorius, a general of the Marian party. Pompey was never able to defeat Sertorius decisively. But after that leader was slain by one of his own men, Pompey had no difficulty in crushing his opponents. On returning from Spain, he helped to bring to an end a revolt led by the gladiator Spartacus, who had incited the slaves of Rome to rebel.

Pompey was elected consul for the year 70 B.C.; his fellow consul was Crassus, the wealthiest man in Rome. Pompey continued to do great things. At this time the Mediterranean Sea swarmed with pirates. They possessed fleets in every part of that sea; they plundered the coastal cities of Greece and even of Italy. Pompey obtained extraordinary powers in order to carry on a campaign against them; he was made dictator over all the Mediterranean and its coasts. He conducted the fight against the pirates with great skill; in three months he had swept them from the seas (67 B.C.).

In 66 B.C. Pompey was given command of the war against Mithridates of Pontus, a cruel foe of Rome. Pompey defeated the king, who became an exile far from his native land. Pompey then carried the might of Roman arms to Syria and Palestine. He captured Jerusalem, the holy city of the Jews, after a siege of three months. The Jews of Palestine were allowed to keep their independence, but they agreed to send an annual tribute to Rome.

Pompey returned to Rome in 62 B.C. and received a mighty triumph. (A triumph was a grand parade given in honor of a man, usually a general, returning home victorious after a war.) With this triumph the first and most glorious part of Pompey's life was ended. He had won undying fame as a general and was the most popular man in all Rome. He now decided to take an active part in political affairs. Unfortunately for him, he was not nearly so good a statesman as he was a soldier. He was wanting in tact.

He quarreled with the senate, which had refused to grant lands to his veterans. He decided, therefore, to join forces with Julius Cæsar, leader of the popular party. In the year 60 he formed with Cæsar and Crassus an alliance called a triumvirate, or government by three men. Pompey's marriage with Julia, Cæsar's daughter, tightened the bonds between them.

In the years that followed Cæsar scored a series of brilliant successes in his campaigns against the barbarians of Gaul. Soon his praises were on everybody's lips and Pompey became jealous. The relations between the two men became strained; the last bond between them was broken when Julia, whom Pompey dearly loved, died in 54 B.C. Pompey now became reconciled with the senate and the aristocratic party.

By 49 Pompey and Cæsar were openly at war. Cæsar soon became the master of Italy. Pompey fled to Greece, where he raised a large army and awaited Cæsar's attack. The first clash between the two former friends at Dyrrachium resulted in a victory for Pompey. Flushed with success, he pursued Cæsar's troops to the plains of Pharsalia, in Greece. In the great battle that took place here (48 B.C.) Pompey's army was routed and he had to flee.

He made his way to Egypt with a number of his soldiers and sought the protection of the Egyptian king, who was a boy of thirteen. The men who governed Egypt in his name—Pothinus, Theodotus and Achillas—feared that Cæsar would be angry if they gave shelter to his rival. And so they had Pompey put to death as he was about to land.

THE NEXT STORY OF MEN AND WOMEN IS ON PAGE 1858.

National Film Board photograph

THE SHEEP AND GOATS

THE sheep and goats belong to the order of even-toed ungulates (animals with divided hoofs), the same order to which cattle belong. They are also, like cattle, members of the group known as ruminants, or animals that chew the cud. They eat grass and leaves and they have a special stomach to digest this food. You will find a description of the ruminants on page 1264.

For thousands of years sheep and goats have been among the most useful of man's possessions. It would be difficult to count all of the comforts and necessities for which we are indebted to these two small animals. There is meat, and wool for clothing and carpets and felt hats; leather for shoes and gloves and bookbindings. The skin is also used to make parchment, and in some regions goat's milk and the cheese that is made from it are important articles of food.

Wool is probably the most important product of the sheep. This fleecy covering consists of multitudes of tiny fibres which are furnished with scales that make the fibres curl and cling to one another. It is this tendency to stick together that makes it possible to spin the wool fibres into thread which can be woven into cloth. Some of the finest fibres come from certain kinds of goats, such as the cashmere and the angora. From some kinds of sheep, notably those of western Asia, we get the furs known as Persian lamb, astrakhan, krimmer, caracul and broadtail.

Australia has more than one hundred million sheep. Russia, the United States, Argentina and South Africa each have about half as many. Australia clips over nine hundred million pounds of wool every year, and the United States has produced as high as 425,700,000 pounds in a year.

Sheep raising in the United States has been on the increase for a number of years. The most rapid advance took place between 1925 and 1930, when the number of sheep was almost doubled. In the western states from Montana to Texas sheep raising is done on a very large scale, especially for the wool, but in the midland states of Iowa, Ohio, Minnesota, Michigan, Kentucky and Missouri, much attention is devoted to raising fine breeds in smaller flocks. Canada is not an important sheep-raising country, but the industry is spread fairly evenly throughout the Dominion. Ontario, Quebec and Alberta have the largest numbers.

Many people gain by the raising of sheep. The breeders earn money by sale of them; the shepherds, by taking care of them. If they are properly managed they fertilize the land over which they feed, but when they are grazed on dry, hilly country they may completely destroy the vegetation and leave it a desert. The extra income from a small flock helps the farmer to pay his bills. Some farmers make money by renting grazing rights to sheep owners.

The wool reaches the factories and builds up such wealth that some of these manufacturing towns are said to be, for their size, the richest in the world. The cloth passes to the tailors and other traders, and finally to those who wear the clothes. Great Britain is the greatest manufacturer of woolen goods and sells a great deal to other nations.

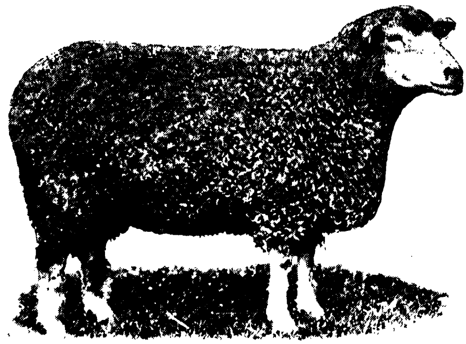
It is impossible to discover who first tamed sheep. But it must have been in the Mediterranean region, probably in western Asia, for that is where the wild sheep live from which the tame ones came. Since wild sheep are hairy, they were probably tamed for mutton and for the shaggy clothes their skins would make. After a while someone saw that their wool could be used, perhaps first for making felt cloth. Each year sheep shed their coats and grow new ones. The mixed wool and hair sticks together when wet to make a crude felt. The more woolly

Pictures, U. S. Dept. of Agriculture
Rambouillet ram. This is a French merino breed.

sheep were kept for breeding when this was discovered, and many years later shearing was invented and the wool was spun into threads for weaving. The people who first kept records had been shearing, spinning and weaving wool for generations, so we will never know who learned these arts, or when.

Although for centuries men have been breeding sheep that grow good fleeces, unless the flocks are cared for and only the better ones allowed to breed, sheep go back to coarse wool and hair. Even the food sheep eat affects the quality of their fleece; flocks that have the lush grass and moisture of the lowlands do not grow the best wool. Those that live on the colder hills, where food is less abundant, have the finest fleeces.

Sheep are not very intelligent animals, especially the lowland breeds which can not look out for themselves, and they have some deep-seated instincts. Whatever the leader of a flock does, the others will do. In slaughterhouses a goat is sometimes kept to lead the sheep in to their death. The goat knows the way that is strange to the sheep, and the trusting sheep follow without questioning or fear. Once at Grenoble, France, two thousand sheep were being brought down from their mountain pasture in the autumn. A dog frightened the leading ram, which jumped down a precipice. The whole



Lincoln ewe. The Lincoln is a fine English sheep.

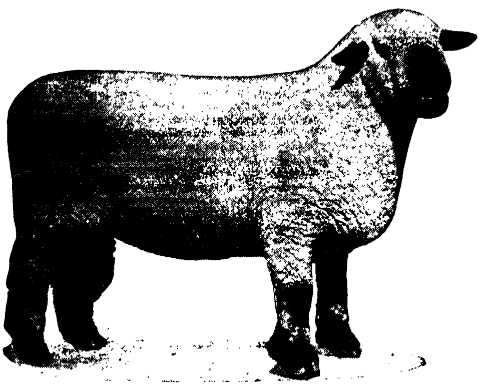
flock followed and plunged down to death, carrying their shepherd with them.

Another interesting point is the ability of the hardier breeds of sheep to endure privation. After a bad storm flocks have been buried in the snow for days and even weeks and yet have been found still alive. This does not mean that it is not important to feed sheep. These sheep were fat, they could not move head or foot and so did not exert themselves and use up their strength. Their thick wool coats kept the heat in their bodies, and the snow actually helped in this —snow is a fine insulating material, you know. Some of the Eskimos build their winter houses of snow.

Just as man has been able by careful selection for generations to develop many different breeds of dogs and cattle, so we find many distinct breeds of sheep which differ more or less. All have one or more qualities, such as hardiness, flesh, or type of wool, which are valuable in a particular market.

So many breeds have been developed that it is hard to group them all. Great Britain has the most varieties, but Spain and France have some famous breeds. Most of our sheep came originally from one of these countries. Sheep may be divided in several different ways. There are mutton breeds, wool breeds, mountain breeds, lowland breeds, long-wools, medium-wools, short-wools, and so on.

Sheep have both coarse hair and fine, curly wool. In the wild sheep and in some domestic breeds, especially in warm countries,



Pictures, U. S. Dept. of Agriculture
Hampshire ram. An outstanding short-wool breed.

the hair covers the entire body and mixed with it is the shorter wool. But most domestic sheep have lost the coarse hair, except on the face and legs, and have grown a thick, long fleece of wool. The wool fibres are really very fine hairs, so fine that you can barely see the separate fibres; in the best merino wool they are only 1/2000 of an inch thick, but in ordinary wools they are three or four times as thick as that. Viewed under a microscope the wool fibres look rough and scaly. It is this quality that causes them to stick together to form thread for making cloth. When clipped the whole fleece hangs together and falls in a single piece. The wool may be as much as a foot and a half long and the fleece may weigh thirty pounds before it is thoroughly washed.

The merino is the most widely distributed sheep. It was brought to North America more than one hundred years ago, and soon made itself at home. American merino wool is not surpassed anywhere. The merino developed in Spain and from there has been taken all over the world. The wool is fine, and the sheep thrives in poor pasture, but it makes poor mutton. So in many countries the merino is crossed with one of the larger breeds, such as the Lincoln. The weight and quality of the flesh is improved, and the fineness of the wool is not much injured. The Rambouillet has been developed in France from merino stock, and many merinos have been taken to other countries.

A prize Dorset ram. A sturdy short-wool specimen.

Of the many British breeds, the best known long-wools are the Leicester, Border Leicester, Lincoln and Cotswold.

The Leicester is one of the most important and shows the progress of all. In little more than a century and a half it has been improved from a gaunt, coarse sheep of heavy, inferior wool into a good quality of flesh and fleece. It is often crossed with other breeds.

The Border Leicester has Leicester characteristics combined with the hardihood of sheep that thrive in the North. Great size is attained by the ancient Cotswolds and their rivals, the Lincolns. The Romneys are ancient and famous for their resistance to foot-rot and for an independence of spirit which causes them to keep apart and so avoid overcrowding of pasture. Ireland has only one native sheep, the Roscommon, which turns sparse hillside herbage into good mutton and wool. These various traits are the result of centuries of domestication.

The short-wools give us nearly a dozen classes. The most important are: Southdown, Shropshire, Suffolk, Hampshire Down and Oxford Down. The Southdowns are famous, not for size but for their mutton and the excellent quality of their wool. They began their career as a breed of fame at the same time as the Leicesters, and have relations in many of our distinguished breeds.

It is said that the peculiar excellence of Southdown mutton comes from the multitude of very, very tiny snails they eat. Snails teem on the herbage of the Downs, and snails and grass together satisfy a South-

American Museum of Natural History

White or Dall sheep, inhabitants of the lofty Alaskan highlands. They are sure of foot and very swift.

down's appetite. The Shropshire Down and Dorset Horned flocks give the earliest lambs; the Shropshires put on flesh and wool at express speed. They are very popular, and many are shipped to other countries. Most of the British breeds may be found in America; some of them we have changed to suit our special needs.

The hardy mountain breeds do wonders in surroundings which would be impossible for cattle, not only because of the rough country, but also because of the scarcity and poor quality of food. Yet their flesh is esteemed, and their wool, though of less value than other breeds, is abundant and admirable for coarser manufactures.

Nature is mindful of their conditions, and not so many lambs are born to mountain sheep as to breeds in more favored pastures. If attempts at improvement are made by the introduction of other sheep into mountain flocks, stern winters soon destroy them, and the mountaineers remain unchallenged owners of their hills.

There is a fascinating story about the Herdwicks—that they are descended from forty sheep which swam to land from a Spanish Armada ship cast ashore on the coast of England. The facts, however, are even more romantic. If historians of the breed have told their story aright, the Herdwicks are Vikings, descendants of sheep carried by the hardy Norsemen to the Isle of Man, and taken thence to England.

Passing to other breeds, we note the hairy long-legged sheep of Guinea; the gnu-like Hausa sheep with their curious spiral horns; a black and white hairy Zulu sheep which produces wool in England; the fierce Hunia sheep of India, of which the rams are kept for fighting, as bulls are in Spain; and also the unicorn sheep of Nepal.

You know there never was such an animal as a unicorn. But as the two horns of the unicorn sheep grow together into one stout back-curving horn we call it the unicorn sheep. The growth of this horn is often so great that it has to be cut at the tip to prevent it from growing into the back of the ram. For a contrast we have the Wallachian sheep, whose long horns, twisted like corkscrews, branch out to right and left.

Another freakish growth is the tail of the fat-tailed sheep, many pounds in weight. Often men brace it, by a board, with sometimes even a little wheeled trolley attached, to prevent injury.

The wild sheep from which our flocks have descended are not known with any certainty. Our sheep may have come from one or from several wild species or races; perhaps the ancestor was the moufflon of Mediterranean

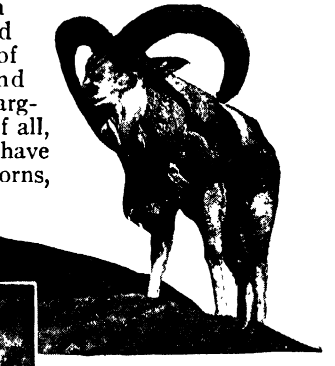
Europe (now found only in Corsica and Sardinia), or the red sheep of Cyprus, Asia Minor and Persia. These are about the size of tame sheep; the rams are a little less than thirty inches high. These sheep look much like some of our domestic sheep—the horns of moufflon are much like those of the Soay variety and the red sheep are much like the tame sheep of ancient Greece and the Swiss lake-dwellers.

The urial is a sheep found in northern Persia and the lower outlying ranges of the Himalayas to the Salt Range of India. The horns of this species are usually triangular in cross-section, and the rams have a ruff of long hair on the throat. Urials are grayish brown in color (the Indian variety is more reddish than others) and the underparts are white. The ruff is usually blackish on the outer side, but may be blackish all over.

In the mountains of Mongolia and southern Siberia the wild sheep are about as large as donkeys, and the rams have splendid horns. The white of the underside extends up on the neck, and the nose, rump and lower parts of the legs are white. The Marco Polo argali, found in the high Pamirs, has the largest horns of any sheep. They are seventy-five inches long, and twist spirally.

White sheep live in Alaska. They are white in summer as well as in winter, and during much of the year they live near the snow banks. Their horns are in spirals, but are not so handsome as those of the argali. However, few wild animals are as handsome and graceful as the Alaskan sheep. In the mountains south of Alaska the sheep are almost black; and gray sheep are found in between. These are all considered to be varieties of the same species. Another variety is found in Kamchatka, across the Bering Sea from the white sheep; it is brownish gray, but has the same type of horns.

Our Rocky Mountain bighorns are not restricted to the Rocky Mountains, but are also found to the south, in the snow-clad mountains of Arizona and Mexico. The largest bighorns of all, and those that have the heaviest horns, are found in the Rockies. There the rams are dark brown, almost black, with a large white area on the rump. In the spring and summer the rams form bands by themselves, leaving the ewes and lambs lower on the mountain slopes. The lambs are born in the spring, about May, and are able to follow



The top picture shows a Punjab wild sheep, an inhabitant of the hilly northeastern regions of the Punjab, in India. To the left is shown a ewe and two lambs of the same species.

Pictures, New York Zoological Society

The aoudad, a goat-like wild sheep, which inhabits the Atlas Mountains of northern Africa. This interesting animal is often seen in zoos; it breeds readily in captivity.

FOUR ODD MEMBERS OF THE SHEEP FAMILY

New York Zoological Society

Rocky Mountain bighorn sheep. This animal is a wonderful climber; it is also remarkable for its speed and endurance.

New York Zoological Society

The moufflon, a wild sheep of Corsica and Sardinia, where it wanders about the summits of the mountain ranges in small flocks.

The homely but useful fat-tailed sheep, found in various parts of Africa and Asia. It is remarkable for the fat that it stores in its tail; this fat is often used instead of butter. The flesh of this sheep is considered a delicacy.

U. S. Dept. of Agriculture

Karakul ewe and lamb. The karakul is an Asiatic sheep. The long, straight wool of the adult is not particularly valuable. The newborn karakul lamb, however, has an extremely fine wool that is tightly twisted in curls, as in the case of the little lamb that is shown in this picture. This wool is in great demand for fur coats.

their mothers shortly after birth. Before the breeding season, the rams often battle among themselves. They stand shoulder to shoulder and strike each other with the front feet, as if in challenge. Then they back off a few yards apart, rush towards each other and hit head on with terrific force.

The blue and the Barbary sheep illustrate the difficulty in distinguishing the sheep from the goats. The blue sheep, or bharal, is found in Asia, from eastern and northern Tibet to Szechwan. It is really brownish gray, becoming almost slate-color in winter. The color of the sides is margined with black and the front legs are largely black in the males. The horns of the rams are large and rounded, and they sweep outward and backward in an S-curve. The males do not have a beard nor do they have a strong odor, but in other respects these sheep are goatlike.

The Barbary sheep of North Africa is the only member of this group in Africa. Its horns are somewhat like those of the bharal, but the throat, chest and forelegs of the rams are covered with long hair. The tail is long, too, for a sheep, reaching almost to the hocks, or heels. In European and American zoos the Barbary sheep are called aoudads, but the people of their homelands call them arui. In color they are yellowish brown, blending with the country in which they live.

Goats, close relatives of the sheep, usually live in rougher and higher country than the sheep. Few places are too inhospitable for these hardy animals. The males have beards and an unpleasant odor.

Goat-keeping is probably as ancient as sheep-keeping. In Asia, Africa and southern Europe, millions are kept for their flesh, their skins and their milk. In English-speaking countries they are not so popular, though leather from kids or goats is much used for gloves and shoes.

Our domestic goats were brought from abroad, but until recently farmers have paid little attention to them. There were a few on many farms, but more were kept as pets. Nowadays many Angora goats are being kept for their fleeces in some parts of the United States and Canada. There are great goat ranches in Texas, New Mexico and other states. These animals originated in Asia Minor and their long curly coats are known as mohair. They like rough land, where they feed on the shrubs, and the flesh of the kids is much liked. Their skins also make leather.

U. S. D. A. photograph by Peter Killian

Young goats at a research centre operated by the United States Department of Agriculture in Maryland.

American Museum of Natural History

Rocky Mountain goats. These animals, which inhabit the heights of the Rockies and the Cascade range, are about the size of a common goat. Their food is the short moss growing on the rocks among which they climb.

though it is not so good as that of the common goat. The long silky hair of the Angora goat weighs about three pounds.

The Kashmir breed has a thick coat of wool mixed with its hair. The *pashm,* as this is called, can be combed out in summer and it is used to make the fine Kashmir shawls and a very soft cloth. Flocks are kept in northern India and Tibet.

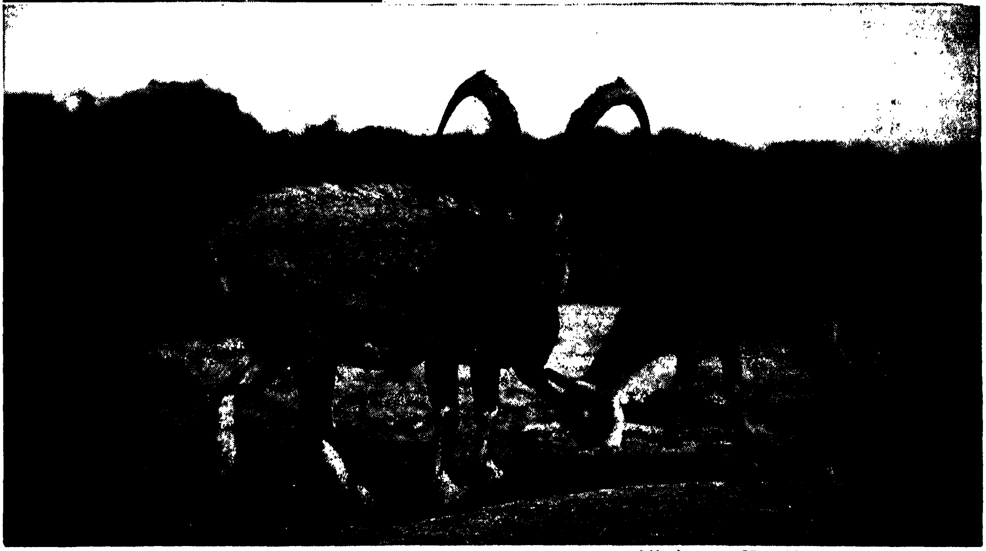
Many goats are kept nowadays to furnish milk for children and invalids. The Toggenburg and the Saanen, both from Switzerland, are best liked, and some give more than a gallon of milk at a time.

Domestic goats have gone wild on the Canary Isles and also on Guadalupe, St. Helena, Juan Fernández, this last one lying off the coast of Chile, and elsewhere. On islands such as Guadalupe, which are small, dry and uninhabited, the vegetation may be almost completely destroyed by the goats. On other islands they do less harm. Hunting these goats is a fine sport. Even experienced sportsmen find that bagging an old billy goat is difficult and thrilling.

Tur are the closest goat allies of the sheep. Their home is in the Caucasus. The Spanish wild goats of the Pyrenees are their near-

The top picture shows the Patna goat, an inhabitant of India.

Left: the markhor, a mountain goat of Afghanistan and India.



All pictures, New York Zoological Society

The Spanish ibex, a wonderful mountain climber, found among the crags of the lofty Pyrenees Mountains.

The chamois, shown here, is a wonderful jumper.

est kindred in the goat family, but the common wild goat, over a yard high and with wonderful horns curving in a noble sweep over fifty inches long, ranges from Europe into Asia. They are superb climbers, making dizzy leaps with perfect accuracy. Wild goats are grayish brown, with a dark brown stripe down the back and on the face.

The ibexes are closely related to domestic goats. They have long, sharply curved horns, with strong cross-ridges on their front sides. In Europe these animals are almost extinct, but other ibexes are found in the Ethiopian mountains, the Himalayas and their outer ranges, and in Arabia. No animal can excel the ibex as mountain climber.

The markhor, with long, spirally twisted horns, lives in the higher mountains of Northern India and Afghanistan.

The goat antelopes are less goat-like than the animals mentioned above. Tahr have short curving horns and a shaggy coat of dull brown; they live in the Himalayas. The serow and goral of China and southern Asia live in rough country, often not far from the steaming jungle; the serow is found in Japan and Sumatra as well as on the Asiatic mainland. The Rocky Mountain goat of North America is a goat antelope, nearer to the serow than to the true goats. It is about the size of a common goat, but is stouter. It has slender, sharp-pointed horns, which curve backwards. The Rocky Mountain goat is white in color, shaggy of coat and clumsy of build, but is a rival of the ibex as a mountaineer. It lives high above timber line from Mount Rainier to Alaska, where it may come down to a few feet above sea level. The chamois of the Alps, Pyrenees and other European and Near-Eastern mountains belongs in this group. Chamois make astonishing leaps and slides through treacherous snow. This is called glissading, and it is one of the most thrilling sights in nature.

Chamois, along with many other game animals, have been taken to New Zealand, where there were no large mammals before white settlement. There, in the Southern Alps, they have done splendidly. Long may these daring and agile creatures live on.

Another group of these relatives of the goats and sheep consists of the takin and the musk-ox. The musk-ox lives as far north as man, almost to the northernmost point of land. During the great Ice Age, musk-oxen roamed over Europe and central United States, but now they live on the treeless tundra of the North, in Greenland and northern Canada. There were some in Alaska, but they were killed off. Recently some were imported from Greenland and they are doing well. The takin is found in the high mountains of western China and Tibet, and northern India. Most varieties are dull gray in color, but the takin of West China is almost the color of gold. It may have been a skin of this animal which, passed from trader to trader, reached the Black Sea and gave rise to the legend of the Golden Fleece.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 1440.

Both pictures, New York Zoological Society

The quaint musk-ox, found only in the Arctic areas of North America. Its flesh has been used for food on expeditions to the Far North.

POETRY

How Horatius Kept The Bridge

A TALE OF ANCIENT ROME

By THOMAS BABINGTON MACAULAY (1800-1859)

Illustrated by Dan Sweeney

LARS PORSENA of Clusium
  By the Nine Gods he swore
That the great house of Tarquin
  Should suffer wrong no more.
By the Nine Gods he swore it,
  And named a trysting day,
And bade his messengers ride forth
East and west and south and north,
  To summon his array.

East and west and south and north
  The messengers ride fast,
And tower and town and cottage
  Have heard the trumpet's blast.
Shame on the false Etruscan
  Who lingers in his home,
When Porsena of Clusium
  Is on the march for Rome.

And now hath every city
  Sent up her tale of men;
The foot are fourscore thousand,
  The horse are thousands ten.
Before the gates of Sutrium
  Is met the great array;
A proud man was Lars Porsena
  Upon the trysting-day.

But by the yellow Tiber
  Was tumult and affright:
From all the spacious champaign
  To Rome men took their flight.
A mile around the city,
  The throng stopped up the ways;
A fearful sight it was to see
  Through two long nights and days.

For agèd folk on crutches,
  And women great with child,
And mothers, sobbing over babes
  That clung to them and smiled,
And sick men borne in litters
  High on the necks of slaves,
And troops of sunburned husbandmen
  With reaping-hooks and staves,

And droves of mules and asses
  Laden with skins of wine,
And endless flocks of goats and sheep,
  And endless herds of kine,
And endless trains of wagons,
  That creaked beneath the weight
Of corn-sacks and of household goods,
  Choked every roaring gate.

Now, from the rock Tarpeian,
  Could the wan burghers spy
The line of blazing villages
  Red in the midnight sky.
The Fathers of the City,
  They sat all night and day,
For every hour some horseman came
  With tidings of dismay.

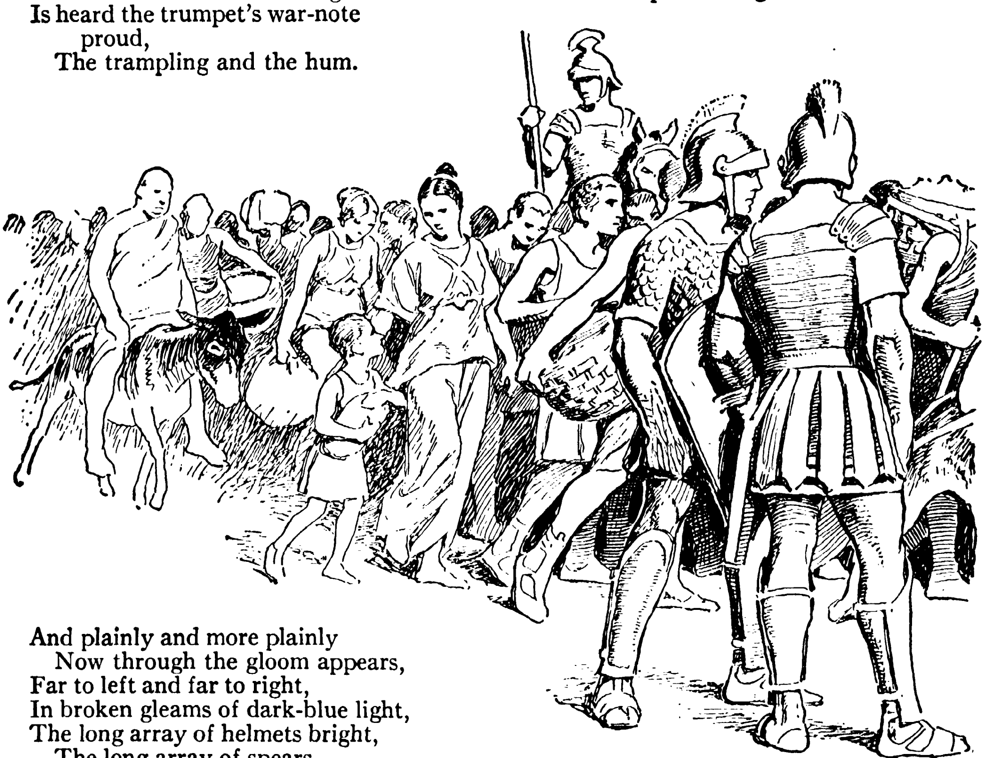
To eastward and to westward
  Have spread the Tuscan bands,
Nor house, nor fence, nor dovecote
  In Crustumerium stands.
Verbenna down to Ostia
  Hath wasted all the plain;
Astur hath stormed Janiculum,
  And the stout guards are slain.

I wis, in all the Senate,
  There was no heart so bold,
But sore it ached and fast it beat,
  When that ill news was told.
Forthwith up rose the Consul,
  Up rose the Fathers all;
In haste they girded up their gowns,
  And hied them to the wall.

They held a council, standing
  Before the River Gate;
Short time was there, ye well may
    guess.
  For musing or debate.
Out spake the Consul roundly:
  "The bridge must straight go down;
For, since Janiculum is lost,
  Nought else can save the town."

Just then a scout came flying,
  All wild with haste and fear:
"To arms! to arms! Sir Consul,—
  Lars Porsena is here."
On the low hills to westward
  The Consul fixed his eye,
And saw the swarthy storm of dust
  Rise fast along the sky.

And nearer fast and nearer
  Doth the red whirlwind come;
And louder still, and still more loud,
From underneath that rolling cloud
Is heard the trumpet's war-note
    proud,
  The trampling and the hum.



And plainly and more plainly
  Now through the gloom appears,
Far to left and far to right,
In broken gleams of dark-blue light,
The long array of helmets bright,
  The long array of spears.

But the Consul's brow was sad,
  And the Consul's speech was low,
And darkly looked he at the wall,
  And darkly at the foe.
"Their van will be upon us
  Before the bridge goes down;
And if they once may win the bridge,
  What hope to save the town?"

Then out spake brave Horatius,
  The Captain of the Gate:
"To every man upon this earth
  Death cometh soon or late.
And how can man die better
  Than facing fearful odds,
For the ashes of his fathers,
  And the temples of his Gods?

"Hew down the bridge, Sir Consul,
  With all the speed ye may;
I, with two more to help me,
  Will hold the foe in play.
In yon strait path a thousand
  May well be stopped by three.
Now who will stand on either hand,
  And keep the bridge with me?"

Then out spake Spurius Lartius;
  A Ramnian proud was he:
"Lo, I will stand at thy right hand,
  And keep the bridge with thee."
And out spake strong Herminius,
  Of Titian blood was he:
"I will abide on thy left side,
  And keep the bridge with thee."

"Horatius," quoth the Consul,
  "As thou sayest, so let it be."
And straight against that great array
  Forth went the dauntless Three.

For Romans in Rome's quarrel
  Spared neither land nor gold,
Nor son nor wife, nor limb nor life,
  In the brave days of old.

Then none was for a party,
  Then all were for the State;
Then the great man helped the poor,
  And the poor man loved the great:
Then lands were fairly portioned;
  Then spoils were fairly sold:
The Romans were like brothers
  In the brave days of old.

Meanwhile the Tuscan army,
  Right glorious to behold,
Came flashing back the noonday light,
Rank behind rank, like surges bright
  Of a broad sea of gold.
Four hundred trumpets sounded
  A peal of warlike glee,
As that great host, with measured tread,
And spears advanced, and ensigns spread,
Rolled slowly towards the bridge's head,
  Where stood the dauntless Three.

Now Roman is to Roman
  More hateful than a foe,
And the Tribunes beard the high,
  And the Fathers grind the low.
As we wax hot in faction,
  In battle we wax cold:
Wherefore men fight not as they fought
  In the brave days of old.

Now while the Three were tightening
  Their harness on their backs,
The Consul was the foremost man
  To take in hand an axe:
And Fathers, mixed with Commons,
  Seized hatchet, bar, and crow,
And smote upon the planks above,
  And loosed the props below.

The Three stood calm and silent,
  And looked upon the foes,
And a great shout of laughter
  From all the vanguard rose:
And forth three chiefs came spurring
  Before that deep array;
To earth they sprang, their swords they
    drew,
And lifted high their shields and flew
  To win the narrow way:

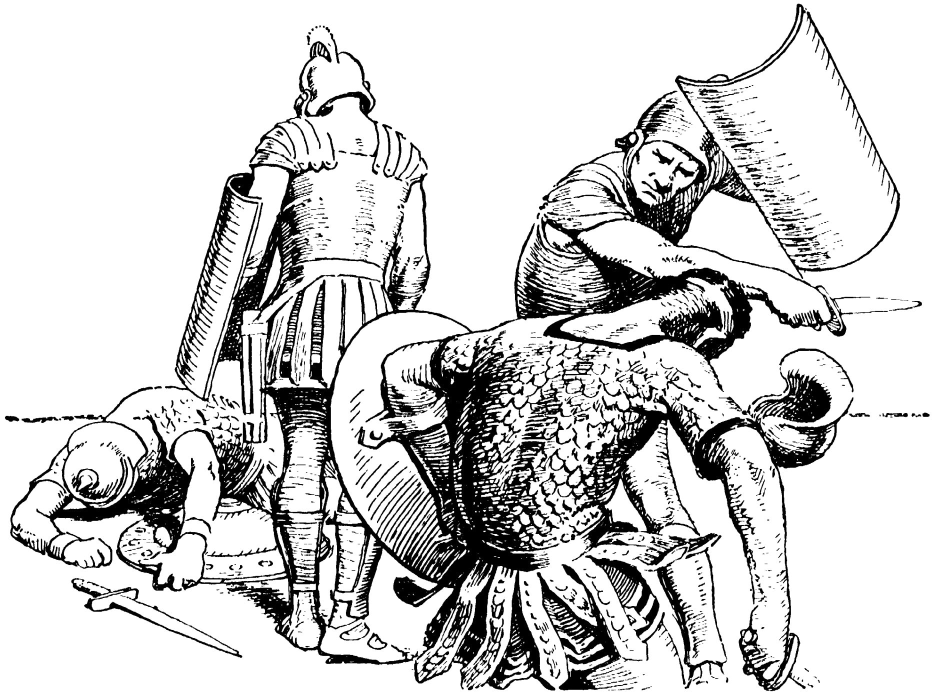
Aunus, from green Tifernum,
  Lord of the Hill of Vines;
And Seius, whose eight hundred slaves
  Sicken in Ilva's mines;
And Picus, long to Clusium
  Vassal in peace and war,

Who led to fight his Umbrian powers
From that grey crag where, girt with towers,
The fortress of Nequinum lowers
O'er the pale waves of Nar.

Stout Lartius hurled down Aunus
Into the stream beneath;
Herminius struck at Seius,
And clove him to the teeth;
At Picus brave Horatius
Darted one fiery thrust;
And the proud Umbrian's gilded arms
Clashed in the bloody dust.

"Lie there," he cried, "fell pirate!
No more, aghast and pale,
From Ostia's walls the crowd shall mark
The track of thy destroying bark.
No more Campania's hinds shall fly
To woods and caverns when they spy
Thy thrice accursèd sail!"

But now no sound of laughter
Was heard among the foes.
A wild and wrathful clamor
From all the vanguard rose.



Then Ocnus of Falerii
Rushed on the Roman Three;
And Lausulus of Urgo,
The rover of the sea;
And Aruns of Volsinium,
Who slew the great wild boar,—
The great wild boar that had his den
Amidst the reeds of Cosa's fen,
And wasted fields, and slaughtered men,
Along Albinia's shore.

Herminius smote down Aruns;
Lartius laid Ocnus low;
Right to the heart of Lausulus
Horatius sent a blow.

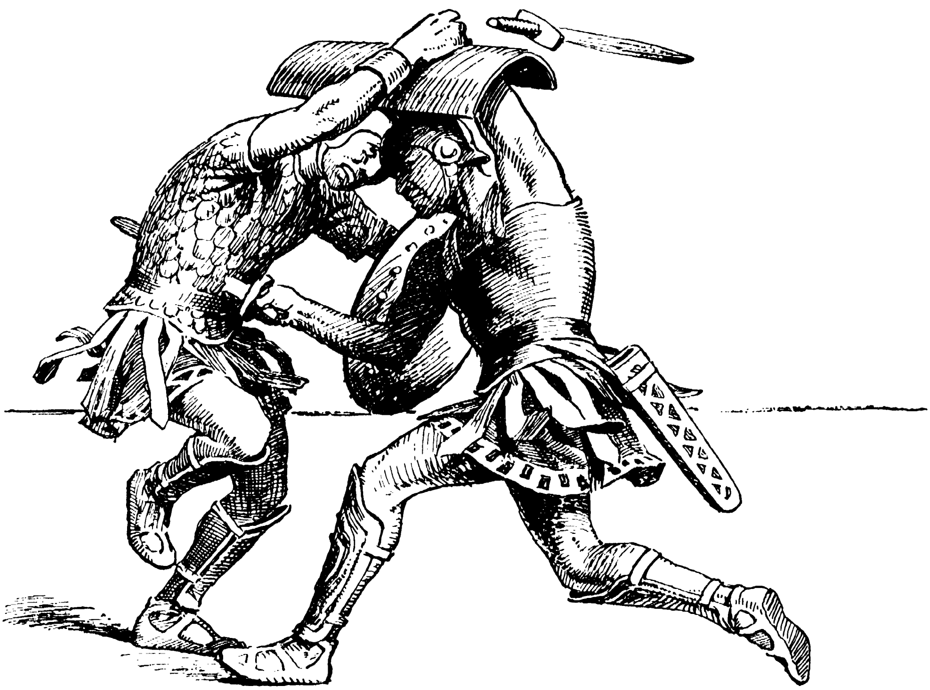
Six spears' lengths from the entrance
Halted that deep array,
And for the space no man came forth
To win the narrow way.

But hark! the cry is Astur:
And lo! the ranks divide;
And the great Lord of Luna
Comes with his stately stride.
Upon his ample shoulders
Clangs loud the fourfold shield,
And in his hand he shakes the brand
Which none but he can wield.

He smiled on those bold Romans
A smile serene and high;

He eyed the flinching Tuscans,
  And scorn was in his eye.
Quoth he, "The she-wolf's litter
  Stand savagely at bay;
But will ye dare to follow,
  If Astur clears the way?"

Then, whirling up his broadsword
  With both hands to the height,
He rushed against Horatius,
  And smote with all his might.
With shield and blade Horatius
  Right deftly turned the blow.



The blow, though turned, came yet too nigh;
It missed his helm, but gashed his thigh.
The Tuscans raised a joyful cry
  To see the red blood flow.

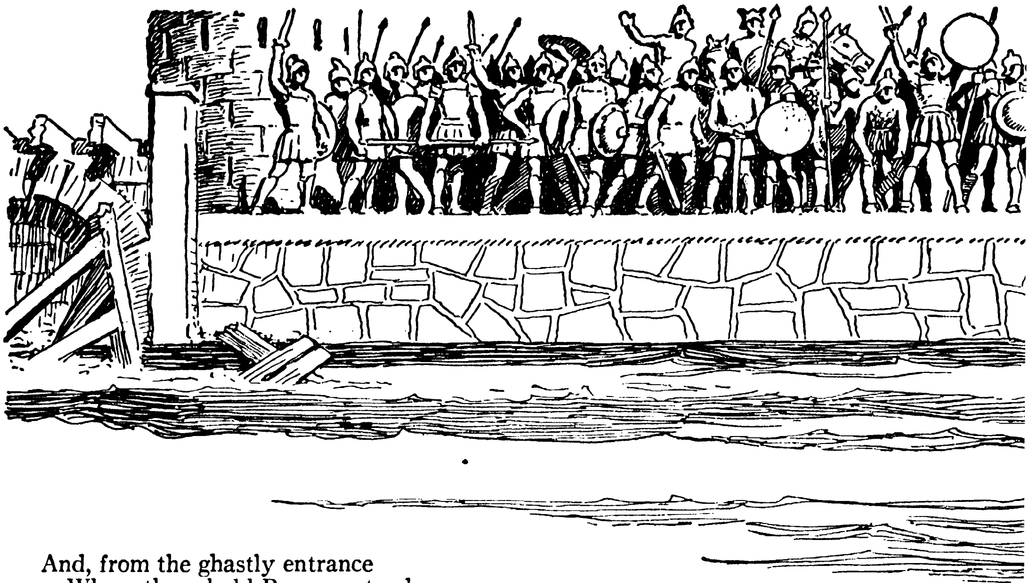
He reeled, and on Herminius
  He leaned one breathing-space;
Then, like a wild cat mad with wounds,
  Sprang right at Astur's face.
Through teeth, and skull, and helmet
  So fierce a thrust he sped,
The good sword stood a hand-breadth out
  Behind the Tuscan's head.

And the great Lord of Luna
  Fell at that deadly stroke,
As falls on Mount Avernus
  A thunder-smitten oak.
Far o'er the crashing forest
  The giant arms lie spread;
And the pale augurs, muttering low,
  Gaze on the blasted head.

On Astur's throat Horatius
  Right firmly pressed his heel,
And thrice and four times tugged amain,
  Ere he wrenched out the steel.
"And see," he cried, "the welcome
  Fair guests, that waits you here!
What noble Lucumo comes next
  To taste our Roman cheer?"

But at his haughty challenge
  A sullen murmur ran,
Mingled of wrath, and shame, and dread,
  Along that glittering van.
There lacked not men of prowess,
  Nor men of lordly race;
For all Etruria's noblest
  Were round the fatal place.

But all Etruria's noblest
  Felt their hearts sink to see
On the earth the bloody corpses,
  In the path the dauntless Three:



And, from the ghastly entrance
  Where those bold Romans stood,
All shrank, like boys who unaware,
Ranging the woods to start a hare,
Come to the mouth of the dark lair
Where, growling low, a fierce old bear
  Lies amidst bones and blood.

Was none who would be foremost
  To lead such dire attack:
But those behind cried "Forward!"
  And those before cried "Back!"
And backward now and forward
  Wavers the deep array;
And on the tossing sea of steel,
To and fro the standards reel;
And the victorious trumpet-peal
  Dies fitfully away.

Yet one man for one moment
  Stood out before the crowd;
Well known was he to all the Three,
  And they gave him greeting loud:
"Now welcome, welcome, Sextus!
  Now welcome to thy home!
Why dost thou stay, and turn away?
  Here lies the road to Rome."

Thrice looked he at the city,
  Thrice looked he at the dead;
And thrice came on in fury,
  And thrice turned back in dread;
And, white with fear and hatred,
  Scowled at the narrow way,
Where, wallowing in a pool of blood,
  The bravest Tuscans lay.

But meanwhile axe and lever
  Have manfully been plied;
And now the bridge hangs tottering
  Above the boiling tide.
"Come back, come back, Horatius!"
  Loud cried the Fathers all.—
"Back, Lartius! back, Herminius!
  Back, ere the ruin fall!"

Back darted Spurius Lartius;—
  Herminius darted back:
And, as they passed, beneath their feet
  They felt the timbers crack.
But when they turned their faces,
  And on the farther shore
Saw brave Horatius stand alone,
  They would have crossed once more.

But with a crash like thunder
  Fell every loosened beam,
And, like a dam, the mighty wreck
  Lay right athwart the stream.
And a long shout of triumph
  Rose from the walls of Rome,
As to the highest turret-tops
  Was splashed the yellow foam.

And, like a horse unbroken
  When first he feels the rein,
The furious river struggled hard,
  And tossed his tawny mane,

And burst the curb and bounded,
  Rejoicing to be free,
And whirling down, in fierce career,
Battlement, and plank, and pier,
  Rushed headlong to the sea.

Alone stood brave Horatius,
  But constant still in mind,—
Thrice thirty thousand foes before,
  And the broad flood behind.
"Down with him!" cried false Sextus,
  With a smile on his pale face.
"Now yield thee," cried Lars Porsena,
  "Now yield thee to our grace."

Round turned he, as not deigning
  Those craven ranks to see;
Nought spake he to Lars Porsena,
  To Sextus nought spake he;
But he saw on Palatinus
  The white porch of his home;
And he spake to the noble river
  That rolls by the towers of Rome:

"Oh, Tiber! Father Tiber!
  To whom the Romans pray,
A Roman's life, a Roman's arms,
  Take thou in charge this day!"
So he spake, and, speaking, sheathed
  The good sword by his side,
And with his harness on his back
  Plunged headlong in the tide.

No sound of joy or sorrow
  Was heard from either bank;
But friends and foes in dumb surprise,
With parted lips and straining eyes,
  Stood gazing where he sank;
And when above the surges
  They saw his crest appear,
All Rome sent forth a rapturous cry,
And even the ranks of Tuscany
  Could scarce forbear to cheer.

But fiercely ran the current,
  Swollen high by months of rain:
And fast his blood was flowing;
  And he was sore in pain,
And heavy with his armor,
  And spent with changing blows:
And oft they thought him sinking,
  But still again he rose.

Never, I ween, did swimmer,
  In such an evil case,
Struggle through such a raging flood
  Safe to the landing-place;
But his limbs were borne up bravely
  By the brave heart within,
And our good Father Tiber
  Bore bravely up his chin.

"Curse on him!" quoth false Sextus;
  "Will not the villain drown?
But for this stay, ere close of day
  We should have sacked the town!"

"Heaven help him!" quoth Lars Porsena,
"And bring him safe to shore;
For such a gallant feat of arms
Was never seen before."

And now he feels the bottom,
Now on dry earth he stands;
Now round him throng the Fathers
To press his gory hands;
And now, with shouts and clapping,
And noise of weeping loud,
He enters through the River Gate,
Borne by the joyous crowd.

They gave him of the corn-land,
That was of public right,
As much as two strong oxen
Could plough from morn till night;
And they made a molten image,
And set it up on high,
And there it stands unto this day
To witness if I lie.

It stands in the Comitium,
Plain for all folk to see,—
Horatius in his harness,
Halting upon one knee:
And underneath is written,
In letters all of gold,
How valiantly he kept the bridge
In the brave days of old.

And in the nights of winter
When the cold north-winds blow,
And the long howling of the wolves
Is heard amidst the snow;
When round the lonely cottage
Roars loud the tempest's din,
And the good logs of Algidus
Roar louder yet within;

When the oldest cask is opened,
And the largest lamp is lit;
When the chestnuts glow in the embers,
And the kid turns on the spit;
When young and old in circle
Around the firebrands close;
When the girls are weaving baskets,
And the lads are shaping bows;

When the goodman mends his armor,
And trims his helmet's plume;
When the goodwife's shuttle merrily
Goes flashing through the loom;
With weeping and with laughter
Still is the story told,
How well Horatius kept the bridge
In the brave days of old.

THE NEXT POEMS ARE ON PAGE 1513.

The crabapple and what it has become.

HOW PLANTS CAME TO BE

WE look out on the world around us, with its myriads of flowering plants; its pine forests and groves of coco-palms; its club-mosses, ferns and horsetails; its mosses and liverworts; its toad-stools, molds and microbes; its sea-weeds and simple single-celled diatoms; and its quaint double-plants, the lichens; and we are bound to ask how the world of things has come to be as it is.

The first part of the answer we have already had. Most botanists think that the first plants were free-swimmers in a universal, or almost universal, sea.

According to this theory, fixed sea-weeds arose in shallow water; and from the seaweeds, more or less directly, as the dry land rose out of the water, there emerged land plants. From simple forms there also arose the ancient ferns, with mosses on a side-track; and from the great fern alliance came conifers and cycads, and eventually the ordinary flowering plants which gladden our eyes to-day.

There has been a gradual ascent. The simpler plants gave rise to the more complex. This is what is meant by saying that the plant world of to-day has *evolved* from a simpler plant world of the day before yesterday, so to speak; that, again, from a simpler vegetation of a million years ago; and so on backward and backward, till we come to the mist of life's beginnings, of which we know almost nothing.

But on the top of the first question comes a second. If the present-day flora developed from an older and simpler flora, how did it do it? Everyone knows the crab-apple, with its very beautiful flowers and its very sour fruit. Now, it seems that this wild apple is the ancestor of all the cultivated apples of the orchard, just as the wild rock-dove is the ancestor of all the domesticated pigeons in the dovecote. It is not that good soil and comfortable shelter directly changed the crabapple into a golden pippin; it is rather that the crabapple, under cultivation, has produced promising new departures, or novelties, that man has fostered and established as races of cultivated apples. Man did not change a wolf into a domestic dog in some magical way by taming and teaching; it is probable that he took advantage of docile and kindly wolf cubs to which more or less captive wolves had given birth.

But, to be honest, we must confess that we do not know how our ancestors were able to domesticate so many useful animals, or to cultivate so many useful plants. The gleam of light we have on these achievements is just this—that living creatures are very changeful, not so much in themselves as in their offspring. These new departures, or novelties, or freaks, or sports, or variations—what a lot of names they have!—are the raw material out of which have been sifted new races. In wild nature the sifting is what we call the *natural selection,* because nature does the selecting, or sifting; but when man came upon the stage, he became the maker and holder of the sieve.

THE BIG FAMILY OF THE WILD CABBAGE OF THE SEASHORE

The wild cabbage of the seashore varied, and he gave food and shelter to those sports that seemed to him promising. More sports followed, and he sifted again. So we have cabbages and cauliflowers, Brussels sprouts and curly greens, and more besides—all developed from the wild cabbage, through variation and selection.

In some cases, like the apple, the cabbage and the wheat, we are reasonably certain of the wild ancestors of our cultivated plants; but in most cases the origin and history of our garden flowers, fruits and vegetables are not clear. We may know in a general way where they came from, but we cannot tell the precise story. It was not till lately that the wild wheat was discovered. Most of the important cultivations began very long ago, and the clue has been lost.

But this does not matter very much as far as concerns the general question of how things came to be as they are. For the process of change continues briskly still, and we have only to visit a flower show to see how many novelties are always being produced.

THE RACE OF ORANGE TREES WITH SEEDLESS FRUITS

The orange-growers and marmalade-makers decide that it would be a good thing to have a seedless orange, and after a few years of patient care they have what they want. How is it done? Those orange trees which showed a tendency to produce fruit with few seeds were selected; cuttings were taken which grew into trees, and again there was a sifting out of those which showed fewest seeds in their fruit. The process was then continued until there arose a race of orange trees with delicious seedless fruits. In wild nature this race would immediately perish just because there are no seeds; but man propagates the orange trees by cuttings, and under his shield the race prospers. In other cases, like wheat, man separates the seed of individual good plants and cultivates these till he has large numbers; or, again, he may dust the pollen from one good plant on to the pistil of another which is equally promising in another direction.

One of the best-known plant-breeders of modern times was Luther Burbank, of California. He would never allow the word magician to be used about him, for what he always did, like other practical evolutionists, was simply to take advantage of promising novelties that nature put into his hand.

Of course, there must be a keen eye to detect their first appearance. The novelty of promise is bred from, and sheltered from the possibility of being crossed by commonplace relatives; similar forms are paired together, so that the new race becomes *inbred,* as we say; "rogues" and "throw-backs" and other undesirables are promptly got rid of, and so a new race is started.

THE FREAK OF NATURE THAT GAVE US THE STONELESS PLUM

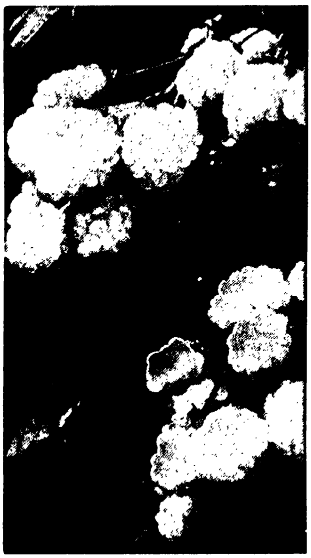
One of Mr. Burbank's successes has been the rearing of a stoneless plum. In the centre of the juicy fruit there is, as usual, a kernel, or seed, but it is naked. By some freak, which naturalists call a *mutation,* trees showed fruits in which the hard stone was suppressed, just as sometimes cats may have kittens without tails, or cows may have calves without horns; and Mr. Burbank encouraged this new departure. *He fixed a freak.*

Another success was a cross between the bramble and the raspberry, which yielded the Phenomenal berry. This is so fixed and stable that it breeds true from seed, whereas some of the bramble-crosses can be propagated only by cuttings and layers. Another good thing was the Primus berry, a cross between the Californian dewberry and the Siberian raspberry; it is a good new creation.

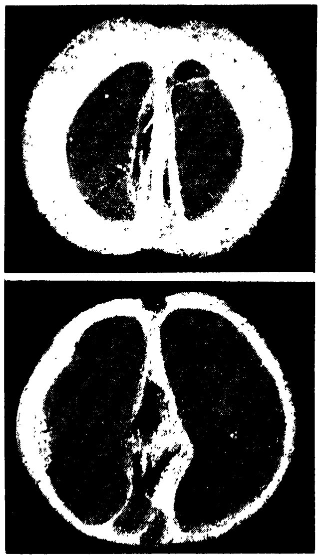
The work of Mr. Burbank, like that of many other successful plant-breeders, consisted in setting apart and fostering promising novelties which appeared in nature's fountain of change, or else in crossing one promising plant with another and then sifting the results of the crossing. It sounds simple, but Professor de Vries, the Dutch botanist who has particularly studied these changes, calls attention to the amount of work that was

TRANSFORMATIONS OF THE PLANT WORLD

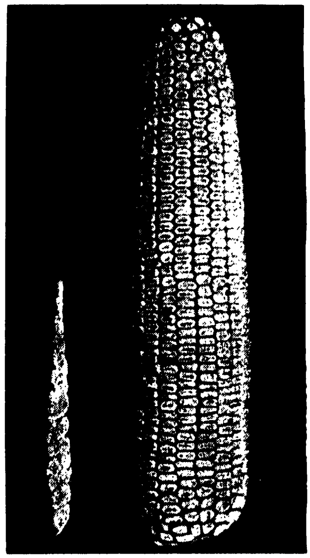
Lamarck's Evening Primrose and three of the new species Professor Hugo de Vries obtained from it.



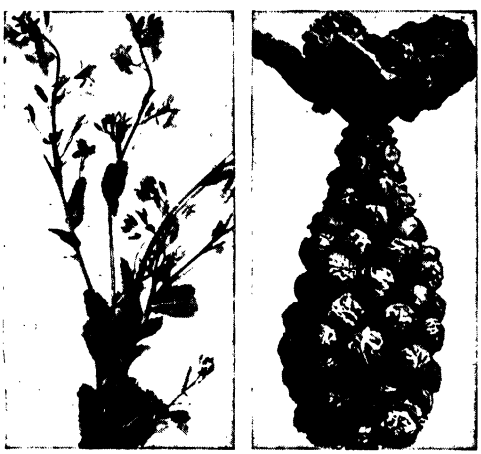
The white blackberries.



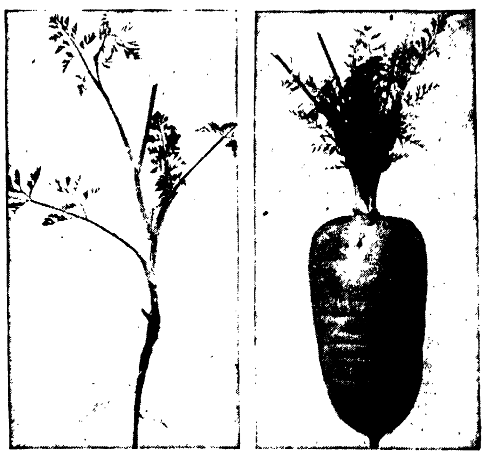
The changed orange peel.



Wild and cultivated corn.



Wild cabbage and the Brussels sprout developed from it.



The wild carrot and the cultivated carrot developed from it.

often necessary to produce a new race. Forty thousand blackberry and raspberry hybrids were produced and grown until the fruit matured, and then from all these a single variety was chosen as best. It is now known under the name of Paradox.

Professor de Vries tells us what happened to the others; it is very interesting:

All the others were uprooted with their crop of ripening berries, heaped up into a pile twelve feet wide, fourteen feet high, and twenty-two feet long, and burned. Nothing remains of that expensive and lengthy experiment, except the one parent-plant of the new variety.

Similar selections have produced the famous plums, the brambles and the blackberries, the Shasta daisy, the peach-almond, the improved blueberries, the hybrid lilies, and the many other valuable fruits and garden flowers that have made the fame of Burbank.

Of course, it must be understood that Luther Burbank was only one of the many experimenting breeders who have worked hand in hand with nature in establishing *new creations*. The experimenter must have eyes that are quick to catch the slightest differences and a nose that is sensitive in distinguishing odors. He needs, too, unfailing patience and courage to meet disappointment and try again.

THE EVENING-PRIMROSE AND ITS WONDERFUL OFFSPRING

What is true of plants under cultivation is true also of plants in natural conditions. However, it must be admitted that some plants are very stable, as if they had attained to a finely balanced constitution. It is very likely that Professor de Vries is right in his suggestion that in the history of plants as a whole, and in the history of particular kinds of plants, there are periods of changefulness which alternate with periods of stability. It is very probable, for instance, that a marked change of climate might, in many plants at once, "pull the trigger" of the changefulness which is part of the secret of every living creature.

In a potato-field near Amsterdam Professor de Vries found an escaped stock of Lamarck's Evening-primrose. The escaped stock was remarkably variable. Almost all its parts varied as if swayed by a restless internal tide.

From this stock De Vries obtained half a dozen or more distinct varieties—*new species in the making*. What was striking about many of the novelties was their separateness from the parent forms—as if they had leaped from one kind to another suddenly; and a second striking feature was that the new departures bred true; that is to say, they produced offspring like themselves. So De Vries was led to the very important conclusion that "new varieties are produced from existing forms by sudden leaps."

PLANTS THAT CHANGED FROM THE LIKENESS OF THEIR PARENTS

Darwin thought that the most important changes from generation to generation in living creatures were small changes —a little more of this and a little less of that. From a continuous crop of these little changes, which might be called *fluctuations*, a big change may be brought about in a long time, if the little changes continue from generation to generation and if the sifting process continues.

But the conclusion of De Vries is rather that changes of a striking kind sometimes come about all at once. Some of the new evening-primroses which the Dutch botanist reared from his changeful stock were very different from their parents. Some had few branches instead of many; some had small flowers instead of large; some had quite different leaves. It is certain that considerable changes may suddenly crop up from generation to generation, and it is likely that many of our cultivated plants arose in this sudden way. They may *leap* as well as creep, for there is no longer any doubt that novel characters may suddenly appear in great perfection and not be linked to their parents by halfway stages.

THE CURIOUS THING THAT HAPPENED IN THE APOTHECARY'S GARDEN

Another striking feature is that when a novelty of this sort comes, it usually comes to stay. It takes grip and reappears generation after generation. In other words, it is hereditary. Thus, the oak-leaved variety of the Greater Celandine seems to have appeared suddenly in 1590 in an apothecary's garden in Heidelberg, and it has been breeding true ever since. Its main peculiarity is in having much-cut-up leaves, and this peculiarity is constant, whether the plant is multiplied by cuttings or by seeds. Weeping willows and copper beeches illustrate the same kind of sudden change, and the abrupt origin of the new is occasionally seen in the simplest plants of all—the bacteria.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 1469.

From All the Children.
A young artist at work engraving a linoleum block.

LINOLEUM BLOCK PRINTING

THE process of linoleum block printing may be mastered in a short time, and it does not require elaborate equipment. Yet the worker in linoleum blocks can produce many original effects.

You too may become proficient in this fascinating art. First of all, you must provide yourself with a smooth plain-color linoleum block, at least ⅛ inch thick. Armstrong's ¼ inch Battleship Linoleum is excellent for the purpose. If you use a printing press in making prints, you must make your block type-high, that is, .918 inches thick, so that it will fit into the bed of the press. This may be done by mounting the linoleum on a wooden block by means of glue or cement. Some printing houses supply type-high linoleum blocks all ready for cutting and printing.

To get the best results you will find it advisable to use the following cutting kit:

1) *Carver's tools.* Four woodcarver's gouges of various sizes are often used. These tools generally have 4-inch handles which may be cut down so that they may be handled more easily. A standard outfit (Speedball cutters), intended especially for preparing linoleum blocks, is also available. This consists of a handle and five or more blades, which can be inserted in the handle as required.

2) *Knife.* You may use any knife (such as a stencil knife) with a very thin blade that can be ground down to a fine point.

3) *Sharpening tools.* It will be necessary for you to keep your tools sharp at all times. Provide yourself with a good oilstone or carborundum stone. You will also find it advisable to have some small slipstones to slip inside the gouges and to sharpen the inner edges of these tools.

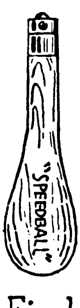


Fig. 1

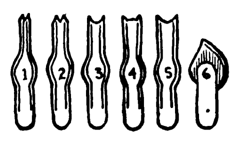


Fig. 2

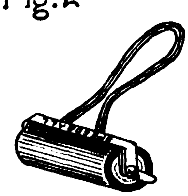


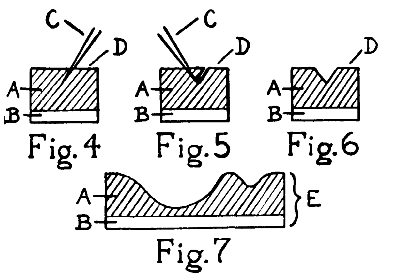
Fig. 3

Courtesy, Hunt Pen Co.

Some useful linoleum block printing tools. Fig. 1. Speedball cutter handle, without blade. Fig. 2. Speedball cutter blades to be inserted in the handle. Fig. 3. Brayer, used to spread ink on the block.

With the above equipment you will be ready to cut out your linoleum block. First of all, bear in mind that what is cut out of the block will not show on the print; also that the design which you cut on the linoleum block will be the reverse of the one that will appear on the print. It is best for the beginner to make the design on ordinary paper and then to transfer it to the block. This design should be as simple as possible. It should have large areas of flat masses, with very little detail.

When you have finished your design, you must transfer it to the block in the following manner. First make a tracing of the design on thin tracing paper with a hard pencil. Now place a sheet of carbon paper over the block and put the tracing on the carbon paper with the *reverse* side of the original design facing you. The tracing paper should be attached securely to the linoleum block by fastening



Figs. 4-7. Engraving details. A. Linoleum. B. Burlap backing. C. Knife blade. D. Printing area. E. Cross-section of engraved block.

the edges of the sheet to the block with small gummed stickers. Next, trace the entire design on the block with a hard pencil, leaving a sharp outline on the linoleum. It would be advisable to mark with black ink the parts of the block that are not to be cut out.

You are now ready to engrave the block. The first cut will be a shallow one with your knife all around the outline of your design. The knife should be held at a slight angle so as to cut away from the part of the design that is to register (figure 4). Now make a second cut slightly outside the first, holding your knife at the opposite angle (figure 5). Pry out the linoleum from between the two cuts. A groove will be left all around the sections that are to be printed (figure 6).

The next step is to clear away the parts of the linoleum block that are not to be printed. To remove large areas the linoleum should be cut away almost or altogether to the burlap foundation. Use one of the larger gouges. Smaller areas to be cleared away are not cut so deeply and the smaller gouges should be used. Always work away from the edges of the area that is to be left, and cut away the material in a slight curve toward the deepest part of your cut. In this way you will give the printing areas of your block a firm base that will resist the heavy pressure of printing (figure 7). When you have engraved a design, cut away the outer border. Using a steel square as a guide, cut straight through the linoleum and the burlap back with a knife.

You are now ready to print your design. You will find Japanese paper best for this purpose. However, any soft, rough-finish, somewhat absorbent paper will do.

To ink your block, if it is very small, you may use a stamping pad. Otherwise you must apply printer's ink to the block by means of a roller, or brayer (figure 3), as it is sometimes called. You may obtain a tube of printer's ink at any printer's supply store. Put a small quantity of this ink on a marble or glass slab, and spread it over the slab with a palette knife. If the ink is too thick, it may be thinned by means of linseed oil or reducing varnish. Now pass the roller over the slab until the ink has been completely distributed over the surface of the roller. Then roll the ink over the linoleum block, first in one direction, then in the other.

You are now to transfer the design to your printing paper. For this purpose you may use almost any device that will exercise enough pressure upon the linoleum block. Very small blocks may be applied directly to the paper, like a rubber stamp. In the case of larger blocks, you may get some excellent prints by using a spoon. Place the inked block upon a table, face up, and lay

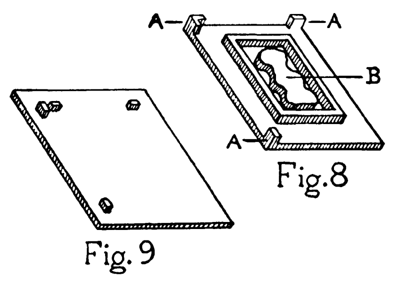


Fig. 8. Engraved linoleum block with register blocks. A-A-A. Register marks. B. Printing area. Fig. 9. Register sheet.

the paper upon it. Then rub the paper with the back of the spoon until the paper has taken the impression of the block. A regulation letterpress may also be used for printing. After being inked, the block is placed in the centre of the press. A sheet of printing paper is placed over the face of the block, and upon the printing paper is placed padding, consisting of soft papers. Then the press is screwed down until a firm impression has been made upon the paper. Etching presses or clothes wringers are sometimes used. Job presses are particularly effective. If the print is to be made by a job press, the block must be mounted type-high, as we explained before. After you have taken as many prints as you wish, you should clean the face of your linoleum block with a cloth moistened with benzine.

Courtesy, Hunt Pen Co.
Fine linoleum block print.

If your first prints are imperfect, do not despair, but try to discover what errors you have made. You may not have put enough ink on the block; the ink may not have been thin enough to flow freely; you may not have used enough pressure or pressure may not have been applied evenly. Experience will soon teach you what is wrong, and how mistakes may be corrected.

If you wish to print a design in more than one color, you must engrave each color in the design upon a separate block, and you must print each block separately. On each one of the blocks leave only that portion of the design that is to be printed in one particular color.

It is very important that each block shall print in its proper place on the paper. This is to be accomplished by making *register marks*. Reverse the tracing that you made of the original design; then with your steel square draw a right angle, the two sides of which will meet near the upper right-hand corner. When you have transferred your tracing to the block, cut away all the portions of the block outside the sides of the angle. The edges of the block that form the right angle are to be cut away with the exceptions of three little islands, as we might call them, of linoleum. One of these islands will be formed by two short lines meeting at the right angle; the other two will be continuations of the first two lines, but at the further ends of the block. These little islands are the register marks (figure 8). As they are left on the engraved block, they will show in each print. Therefore they should be placed far enough away from the edge of the design so that there will be ample margin space after the printed register marks are trimmed off.

If your design is to have four colors, you will have to prepare four blocks of linoleum. As before, make a careful tracing of the original design, establishing the position of the register marks. Trace in carbon paper upon the first block the portion of the design that is to print, say, in yellow. Next, transfer to another block the parts of the design to be printed in blue; and so on. Then engrave the various blocks, cutting register marks for each block. As the different colors generally join each other, you will have to cut the printing surfaces accurately. If you make any cuts within the lines of the printing area, there will be a streak of white between the various colors of the print. It is better to cut a little outside of the line of the printing area and to let the colors merge on the print. You may easily trim these lines if the print shows a heavy line where the two colors join.

Even experienced workers in linoleum block printing sometimes find it advisable to trim their blocks after studying the prints that have been made from them. This is also true of other artists whose finished work (woodcuts, etchings and the like) is in the form of prints taken from blocks or plates.

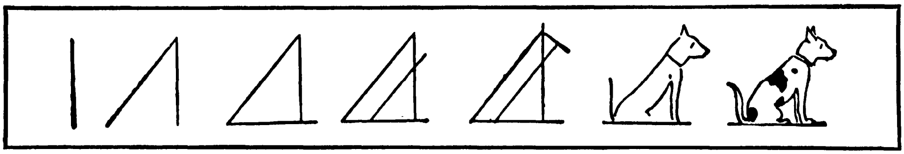
To print blocks in two or more colors, you will have to have a *register sheet*. With a steel square, draw a right angle near the edges of a piece of stiff cardboard, larger than your block. Along the sides of the right angle, glue down little pieces of cardboard of about the same size and in about the same relative positions as the register marks on your block (figure 9). Now ink the first block with the appropriate color (use colored printer's inks). Place the block, design side up, on the register sheet so that the angle formed by the register marks on the block will slip into the angle formed by the pieces of cardboard on the register sheet. Place a sheet of printing paper over the block, attaching it to the upper edge of the register sheet by means of clips. Apply the proper pressure on the paper. Remove the first block, keeping the paper in position by means of the clips. Place the second block in position. Put the paper upon it, being sure that the register marks on the print correspond to those on the linoleum blocks; then print as before. Repeat the process with the rest of the blocks.

The type of register sheet that we described above is to be used with a hand press or a letterpress. If you use an etching press or a clothes wringer, the sides and tops of the register sheet should be built up with strips of cardboard, thus forming what printers call a *bed*. This bed will move between the rollers of the press in the process of printing.

You will find that linoleum block printing in color offers more difficulties than printing in a single color. However, the results obtained will more than justify the added effort that is required. A fine colored linoleum block print is always startlingly effective. It is no wonder that prints of this sort are often used to illustrate expensive books.

Not only is linoleum block printing a fascinating pastime, but you will be amazed at the number of ways in which you will be able to put the art to practical use. You will be able to print letter-heads, individual Christmas cards, greeting cards of all sorts, posters, bookplates and a number of other things. When you have become thoroughly skilled in engraving and printing, you may be able to find a profitable market for your articles carrying linoleum prints.

A SIMPLE WAY TO DRAW A DOG



IF you want to draw a dog and you are not skilled in drawing, this shows you how to make a fine little dog by the aid of three straight lines drawn faintly in pencil in the form of a triangle. When you have filled in the outline, the pencil lines that you first drew should be rubbed out, and finishing touches added.

ANSWERS TO PROBLEMS ON PAGES 1285-86

1. The profit of three handkerchiefs sold at 8 cents each is the same as the profit of one handkerchief sold at 9 cents. Therefore the profit of one handkerchief at 9 cents must have been three times the profit of one at 8 cents, and the difference between 8 cents and 9 cents must have been equal to the profit of two at 8 cents. From the above it is clear that the profit of one handkerchief at 8 cents must have been ½ cent; also that the handkerchiefs in question must have cost 7½ cents each.

2. The boatman in this problem got 40 cents from the two extra passengers. As his total profit, however, was only 10 cents more by having the two extra passengers, the reduction of 5 cents each to the other passengers must have amounted to 30 cents altogether. From this it follows that there must have been six passengers in the original number or eight in all.

3. If Brown had taken all the baggage, he would have paid $1.20 more excess than he actually paid. Therefore $1.20 would have been the excess charge on 120 pounds, which amount is equivalent to 1 cent per pound. As Smith paid 20 cents excess on a total weight of 120 pounds, his excess weight at the rate of 1 cent per pound must have been 20 pounds, so that 100 pounds was the weight allowed free. As Brown paid 30 cents excess for the share that he took himself, that share must have amounted to 100 pounds plus the number of cents in 30 cents, or 130 pounds. It may be seen, therefore, that the total weight of the baggage was 250 pounds.

4. Since the whole piece of bacon and 10 eggs cost as much as half the bacon and 25 eggs, it is clear that half the bacon equals 15 eggs and the whole piece of bacon equals 30 eggs. Now, as 50 eggs were offered together with the bacon for $1.60, the same sum would buy 80 eggs (that is, $30 + 50$). Thus the eggs in the problem cost 2 cents each, so that the 50 eggs offered with the bacon represented the sum of $1. The price of the bacon may be obtained by deducting $1 from $1.60, and 60 cents is the answer to our little problem.

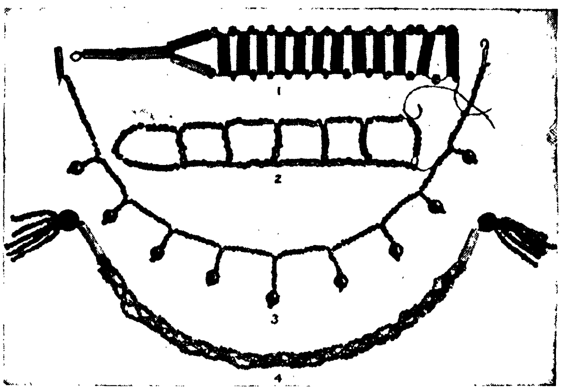
5. This problem is so difficult because the answer is so simple! The question that George had in mind, and that must have puzzled you quite as much as it did George's friend, was merely this: "What does y-e-s spell?"

6. The difference between 5 per cent and 20 per cent is 15 per cent. The difference with respect to the article purchased was $3, so that we must find of what sum $3 is 15 per cent. Three dollars is 15 per cent of $20, so that the marked price was $20. This price would have been reduced to $16 during the sale, but only to $19 after the sale was over.

WHAT TO DO WITH A BOX OF BEADS

EVERY girl knows how to thread beads, and many little girls can make a ring of beads for their finger; but here we are going to see how to make something more interesting than plain chains and rings.

You will need two little bundles, or "hanks," as they are called, of glass beads, one pink and one blue, and a few bugle beads, the long round ones like little tubes. The hanks contain twelve rows of beads.



Bead bracelets and necklaces for dolls.

In picture 4 we see a plaited necklace with tasseled ends just fit for a big doll. To make this necklace, separate three rows of beads from the hank, and without letting any slide off the thread, carefully knot the threads together at one end. Then plait the three rows of beads—in the same way as you would plait your hair. Then knot the other ends of the threads close up to the finish of the plait.

Now, with a needle and thread begin the tassels. You will notice that a bugle comes next to the plait. To fix this on, tie the end of a thread (attached to the needle) to the end of the plait with a small knot, and then thread on the bugle in the usual way. Next thread on a big round bead of some pretty color (a pearl bead will look good if you can find one), and then take *one* of the glass beads from the hank and thread that on. Hold it close up to the big bead and put the needle through it *again,* drawing the thread tightly round the bead. This bead will now be firmly fixed; it keeps the big bead and the bugle in position while you make the tassel.

Still with the same thread take up twelve glass beads, push them up close to the fixed bead, and "fix" the last one—the twelfth bead—in the same way, by passing the thread through again and drawing it tightly. Now pass your needle through the eleven beads again, bringing it out at the other end. Each piece of the tassel is made in this way. So you see there are *two* threads in each piece and a fixed bead at the end. Make five pieces and your tassel is complete. When you have made a tassel at the other end of the plait, the necklace will be finished.

Now look at picture 3. This is a plain chain necklace with little "bobs," or pendants, hanging from it all the way round.

You begin by attaching one end of an ordinary fastener, or catch, to your thread. If you cannot find one of these from an old necklace, a piece of baby ribbon from a chocolate-box will make quite a pretty fastening.

Thread on about 20 pink beads, then 1 blue one, then 4 pink ones, 1 pearl (a good deal bigger to form the bob), and then 1 blue one again. This last blue one has to be *fixed* in the way we have already learned.

When the last blue bead is fixed, return the needle *through* the pearl bead and also through the 4 pink glass ones; then thread on 1 more blue bead and 10 more pink ones. You see now that you have made a piece of the chain with one little pendant hanging from it.

After the 10 pink beads you must thread 1 more blue one, and make another pendant in the same way, then 10 more pink beads, and so on, to the end of the necklace.

You can, of course, make it as long as you like—but you must decide how long it is to be before you start, because it is very annoying to find that you have not enough thread on the needle. It makes the necklace look nicer if you add one more pink bead to the pendant each time, until you get to the middle; then leave one off each time in order to make the other side match.

If you look carefully at the picture you will see why this has been done—it makes the centre bob the longest, and gives a better appearance to the necklace.

Picture 1 shows a ladder bracelet made of bugles and blue beads. For these ladders you must work with *two* threads instead of one.

Take about a yard for each needleful, and tie the ends of the two threads together with a good big knot. Now thread on one bugle and pass both needles and threads through it, then put on two bugles, one on each thread; then a blue bead on each thread—that makes the start. The next bugle that comes is the first step on the ladder and goes "across."

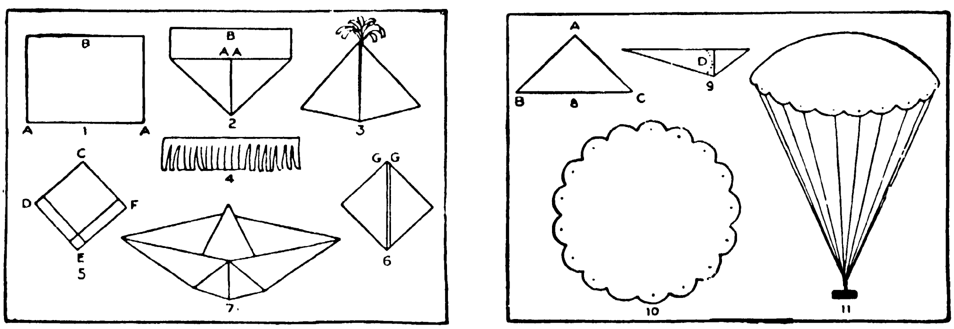
To get this you put both needles through the bugle, one in at one end and one in at the other, so making the threads cross to the other side of the ladder. Next put on two blue beads, one each side, and then another crossway bugle in the same way as the last. Continue this until your chain is long enough for a bracelet. Then finish it off with three beads in the same position as the three you started with.

It will make it easier to manage if you fix the end, after you have made a start, to the table-cover or a pincushion. To do this, put a safety-pin through the knot at the beginning.

Picture 2 shows a ladder chain made of small beads only. It is made in just the same way as the bugle ladder, with two threads.

You start out with 12 beads on each thread, and then put 8 across, then 8 each side, and 8 more across. If you find that it is a little difficult to prevent it from slipping out of place when you begin, "fix" the last side bead of each 8 before threading on the 8 across. But you ought not to find this at all hard to manage. The result will be a very pretty ladder chain.

A HAT, BOAT AND PARACHUTE OF PAPER



How to fold the paper to make the hat in picture 3, the boat in picture 7, and parachute in picture 11.

HAVE you ever tried to find out how many toys can be made out of a sheet of paper? With a little practice and skill we can convert a plain sheet of paper into any one of quite a number of delightful little toys. Shall we begin with the simplest of all, and learn to make a paper hat like that which you see in picture 3?

Take a sheet of paper—either plain or colored, or even newspaper will do—about 19 inches long and 14 inches wide; fold it in half to look like picture 1; turn up the corners *AA* until they meet below *B* as in picture 2; turn down the top pieces marked *B*, one on the one side of the triangle and the other on the other side. Arrange the corners that stick out neatly by tucking one inside the other, and the hat is complete.

To make a cockade for our hat, cut a strip of paper as shown in picture 4, fold it in three, and push it in between the folds as in picture 3.

A paper boat is built up from a paper hat.

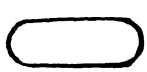
When the hat is complete, we hold each side of the triangle in the middle with the thumb and first finger of each hand, and carefully pull out until the figure becomes square (double, of course) as in picture 5. Turn up the corners *E*, one on one side and the other on the other side, to meet point *C*, so that we again form a triangle. Once more hold the sides of the triangle and pull out to form a square as in picture 6. Finally, hold corners *GG* with thumb and first finger of each hand and gently pull out right and left until the boat is complete, as in picture 7.

Another very simple toy to make is a paper parachute. Take a smooth square piece of tissue-paper and fold it from corner to corner, making a triangle as in picture 8. Fold corner *C* to *B;* again fold in the same way from corner to corner and fold in half as in picture 9. Take a pencil and mark a curved line as shown by the dotted line in picture 9; then, with a pair of sharp scissors cut through all thicknesses of the paper round this line. Bore a hole at *D* with a stiletto; open out the paper, when it will look like picture 10.

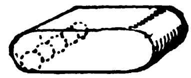
We must now get sixteen threads of cotton of equal length; fasten one through each hole in the paper, bringing the loose ends together below. Fasten these together and attach a small piece of cardboard or stiff folded paper as ballast. Our parachute is now complete, and if taken out of doors on a windy day it will sail up a considerable height and then gracefully descend.

THE MYSTERIOUS TUMBLING TABLET

THIS is an amusing little toy that is easily made. We cut two pieces of thick cardboard, 1½ or 2 inches long and ½ inch wide. Both of these we cut at each end to the shape of a semicircle. Now we get a strip of paper — writing-paper will do — 1 inch wide, and gum it or glue it around the edges of the two pieces of cardboard in the position shown in picture 2. That gives us a tiny oblong box, as seen in the picture. But before fixing on the paper as we have already described, we place inside the box a few round lead bullets or large shot, but not more than will lie across the box in one row. Our "tumbling tablet" is now ready to commence its performances. All that is left for us to do now is to place it on any surface with a gentle slope and give it a little start. Of course, we place the tumbling tablet up at the highest part of the sloping surface. Perhaps it will need a start to go off, and



1. Shape of side.



2. Complete tablet.

if so, we need only roll it over once. Then it will roll over and over, down the slope, looking almost as if it were alive. If we are really clever, we can easily understand why it behaves so. The balls or shots roll down the inside of the tablet until they reach the lower end, against which they bump, thereby causing the tablet to turn over. This movement lands the balls at what has become the higher end of the tiny box, and again they roll down and they will repeat the operation time after time, until they come to a stop because the bottom is reached. An ironing board and some books will make a nice long slope.

HOW TO MAKE A MAGIC KNOT

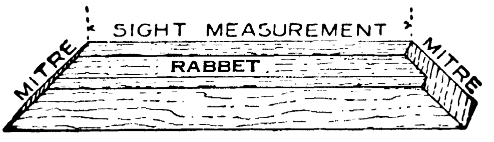
WE ask one of our friends to take hold of a handkerchief by two of its opposite corners, and to tie a knot on it without losing hold of the corners.

This trick is not as difficult as it may seem to be. All that is required is that the person taking hold of the ends of the handkerchief should fold his arms before doing so. Then, by simply unfolding the arms, the knot comes on the handkerchief as a matter of course. A piece of string will serve as well as a handkerchief, but it should be not less than 18 inches long. If the string is too short, you will find it much more difficult, if not indeed impossible, to perform the trick.

PICTURE-FRAMES THAT BOYS CAN MAKE

IT is not a difficult matter to frame pictures, but the work requires care and accuracy. The wood of a picture-frame is called the picture-frame molding. This molding is sold in lengths of 6 feet or longer.

If you look at the end of a piece of picture-frame molding, you will find that, whatever may be the shape of the ornamental surface which will be visible when the picture is framed, there is at the back of it what is called a rabbet, but what is actually a groove cut in the edge all along one side. When the picture is framed this groove is put on the inside next to the picture, so that it forms a regular depression all round in which the picture and the glass lie. Picture 1 shows a piece of molding cut at the ends to the shape required for making a frame, and illustrates the rabbet.



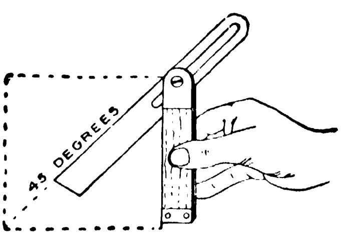
1. Picture-frame molding cut to shape.

In an ordinary picture-frame the molding is in four pieces, the top and bottom pieces being exactly alike in length, and the two sides being exactly alike in length. The ends of the different pieces are not cut square across, but are cut to an angle of 45 degrees. Although most people know what an angle of 45 degrees means, it may be well to explain it. The corner of a square is a right angle. If from one corner of a square to the opposite corner of the same square we draw a straight line, we divide the right angle into two equal parts, and each half is an angle of 45 degrees. By following the instructions given here, it will be easy to draw an angle of 45 degrees when you wish to cut the picture molding into the necessary lengths. The carpenter who wishes to mark wood to an angle uses a bevel, such as is seen in picture 2.

A neat picture-frame depends upon the neatness of the mitres, or corners, and the ends must be sawed very accurately and put together very exactly. If the molding is a plain one, with a surface that is flat or nearly flat, it may be quite possible to cut the corners to the proper angles; but if the molding has an irregular or ornamental surface, then this may not be possible without using an instrument which is called a mitre-block, such as is shown in picture 3.

A plain mitre-block consists of two pieces of wood nailed together, both of the same length, but the lower one a little wider than the upper one. The sizes are unimportant. Through the narrowest piece saw-cuts are made to guide the saw, as shown in the picture. Two of these are at an angle of 45 degrees, sloping opposite ways. The middle one is square across, for square cutting. The molding rests on the lower part of the block, and is pressed against the edge of the upper narrower piece while it is being sawed. A mitre-block may be purchased at a tool-shop, or one may be made. It should be made of hard wood, such as beech, oak, or the like.

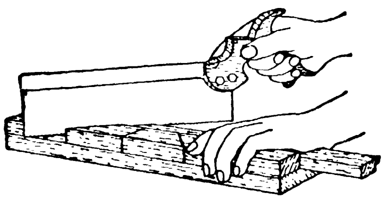
The sizes for the four pieces of molding are, of course, taken from the picture itself. The inside, or rabbet, edge of the molding is about ¼ inch shorter than the side of the picture where it is to touch. This allows the extreme edge of the picture to go into the rabbet. This length of the inside edge of a piece of molding is called the sight measurement because upon this depends the size of the picture that will show within the frame.



2. Using the bevel.

The mitres when sawed are not accurate enough to fit each other as perfectly as is necessary for neat appearance, and therefore a plane should be used after a saw. To do this properly, another special appliance, called a mitre-shoot, is required. Picture 4 shows how it is used. The plane is slid on its side, and the molding bears against a piece of wood put on at an angle of 45 degrees. This insures the mitred ends being planed to the correct angle, and if the plane-iron is set carefully, it will cut square in the vertical direction. Without a mitre-shoot it is quite possible to plane or pare the mitres accurately, but it is not easy, and there is risk of injury to the edges of the molding. Plain molding that can be turned over on its face on the mitre-shoot may have both its ends planed in the position shown in picture 4 in the next column, but generally it is necessary to turn the shoot round and work the plane with the left hand for one end. Mitre-cutting machines are very useful, but are regarded as too expensive for anyone who is not constantly framing pictures.

Frames are held together by glue and nails at their corners, and also by paper, which is generally glued to the frame. After the mitres are cut, the four pieces should be placed in position, to be sure that all the corners fit properly. There are then two different ways in which the gluing and nailing may be done. Of course, if corner-clamps or an entire frame-clamp is to be used, that will simplify the work; but we will suppose the frame is to be put together without these appliances. The simplest, quickest and roughest way is shown in picture 5. One piece of molding is gripped in a vise tightly enough to resist the force of hammering the nails into its end, and then the glue is applied and the next piece of

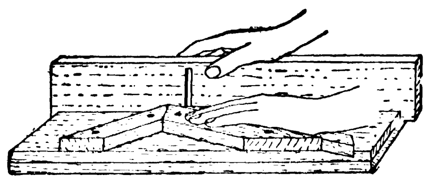


3. Using the mitre-block.

molding held in position and nailed to it. The best vise for the purpose is an iron one but a piece of wood or cardboard should always be put between the iron jaw and the outer edge of the molding in order not to injure the latter. On the inner edge the vise-jaw grips in the rabbet where marks of the vise on the wood will not matter. Fine wire nails should be used, and holes bored for them with a bradawl through the first mitred piece, and slightly into the end grain of the second. As the hammering is likely to cause the first mitred piece to slip inward a little at the joint, the nailing should begin with the first piece too far out. A side and end of the frame are joined in this way, and then the other side and end similarly. After this the two remaining corners may be done without the vise, if preferred, but to avoid risk of injury to the joints already secured it is safest to continue with the vise.

The other way of putting a frame together is first to glue the parts and then clamp them together, leaving them for a few hours until the glue has set before putting in the nails. This is slow, and some means of clamping is necessary, but a neat result is more certain, for by the other method the parts are liable to shift out of exact position while the nails are being driven.

Without special clamps the simplest way to bind the frame together while the glue



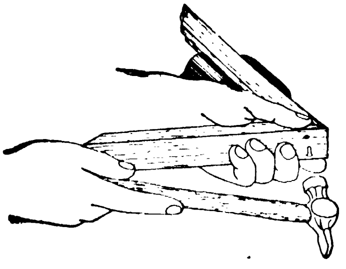
4. Using the mitre-shoot.

is setting is to make four blocks to fit the corners, and to tie string round the outside as shown in picture 6. A flat surface is cleared to lay the frame on, glue is applied to all the mitres; they are quickly placed together with the blocks outside, and then the string is tied round as tightly as possible. Sometimes it is not tied very tightly at first. The method of tightening shown in picture 6, however, is easy and satisfactory for ordinary work of moderate size. A loop is formed at one end of the string, and the other end is pulled through this, so that it can be strained tightly simply by pulling. It is then necessary to secure the end of the string to prevent it from loosening again. This can be done by winding it a few times around nails in one of the corner-blocks as shown.

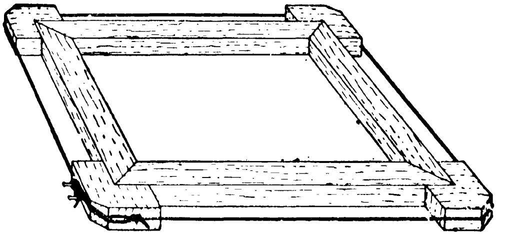
If glass is used it must fit easily into the rabbet. The picture is placed face down on the glass, and generally a sheet of clean brown paper is placed on the back of the picture. Then the backboard, which is a thin piece of wood of the same size as the glass, is put in and secured by driving fine wire nails horizontally into the molding, leaving their heads standing out a little way, so that they keep the backboard pressed against the picture-back. Brown paper is generally pasted either over the joints only, or over the entire backboard and frame.

Unmounted pictures—that is, pictures on thin paper not mounted on cardboard—are liable to become wrinkled, and will not lie evenly against the glass if they are put in dry. Therefore, the backs of such are always damped, and allowed a few minutes in which to stretch before the backboard is put in. This should press firmly on the picture, and as the latter dries it becomes strained and always remains quite flat. The result is better and the added work is slight.

It is much easier to make a frame if metal corner-clamps are used. These hold the corners more securely than the wood blocks in picture 6 and the nails can be driven without waiting for the glue to dry. By the method shown in picture 5 there is no waiting, but it is not easy to nail the frame together accurately in that way. A very useful appliance is a combined mitre-block and corner-clamp. With this, and a fine saw, the corners can be fitted without the use of a plane or chisel.



5. Joining the corners.



6. Binding the picture-frame.

A BOX THAT MAKES A WHIRLWIND

IT is to be hoped that none of us may ever be at any place where a really bad whirlwind is formed; but we may each of us make a miniature whirlwind in a very simple way. We take a box with a lid that swings backward and forward quite easily upon its hinges—a box such as the ordinary kind of cigar box that holds a hundred cigars—and knock out the bottom of it. Then we stand it up on its end, and swing the door violently. The door pushes the air in front of it, and when it is closed there is for a moment no air left in its track. But instantly air rushes in from all directions to fill up the vacant place, and the result is a miniature whirlwind. That the air is whirling round may be seen by putting down in front of the box some tiny fragments of tissue-paper, which are carried round and round by the cyclone. Of course, the larger the box the greater will be the whirlwind. A soap-box is a very good size to use for this experiment. A large packing box would give even better results.

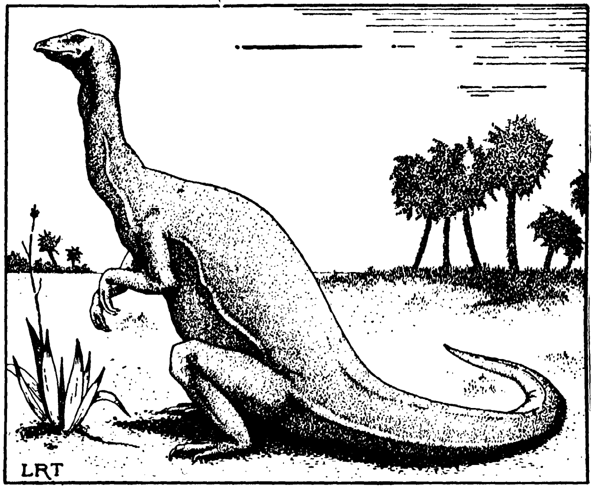
HOW TO TELL THE WEATHER

IF at sunset the sky appears red, fine weather may be looked for on the coming day; but if the sky is red in the morning there will probably be wind or rain. A yellow sky in the evening generally means a wet day to follow, and if the sun sets in a dense bank of clouds, rain may also be looked for. If the morning is hazy, and the sun is seen through a mist while the sky appears blue, the day will most likely be warm.

If the early morning is cloudy, but as time goes on the clouds begin to disperse, a fine day is to be anticipated. When the stars seem particularly bright at night, and twinkle more plainly than usual, a wet day usually follows. We may often get a good idea of the weather that is likely to be experienced by watching animals. Cats often rub themselves behind the ears a great deal when bad weather is coming, and before rain cats are restless and lie with their backs to the fire.

THE NEXT THINGS TO MAKE AND TO DO ARE ON PAGE 1655.

THE TRIASSIC PERIOD



Anchisaurus, a flesh-eating dinosaur of the Triassic period.

SO far we have been dealing with the rocks belonging to the oldest era of life on earth—the era that is known as the Primary or Paleozoic, the era of ancient life. Now we are about to enter on a newer chapter of life, known as the Secondary or Mesozoic, the era of intermediate life. The Mesozoic is divided into the Triassic, Jurassic and Cretaceous periods.

One of the most striking facts about the Triassic period in North America was the lessening of the area covered by the seas and the gradual increase in dry land area. The climate of the period was desert-like. Movements of the earth at this time resulted in the formation of mighty ranges of mountains. The eastern border of North America was raised and the original Appalachian Mountains came into being. These ranges, higher than to-day, ran from Newfoundland to Alabama; the Ouachitas of Arkansas were also formed then.

About this time there seems to have been a marked and noticeable change both in the general character of the rock and in the general nature of life. From this point the crust of the earth appears to have been more steady than before and the rocks somewhat different in their structure and arrangement. In the Paleozoic era the crust of the earth seems to have been subject to violent movements, and its rocks are much more broken, twisted and crumpled than in the Mesozoic era. In the Paleozoic era, the volcanoes were numerous and enormous, and were in a state of continual activity, pouring forth floods of lava which covered hundreds of square miles thousands of feet deep. In the Mesozoic era volcanoes were smaller and fewer, and were rarely in violent eruption. However, in British Columbia and extending into Alaska there were many volcanoes, and there is much volcanic rock. In the East through great cracks the igneous rock forced its way to the surface. The Palisades of the Hudson broke through at this time.

The Mesozoic era seems to have also been a new starting-point for plant and animal life. The trilobites passed away; the crinoids became more numerous; the giant ferns and horsetails and mosses dwindled and were replaced by pine trees and cycads; and the dicotyledons began to dominate the plant world. In all, fossils of about 400 different plants have been found in Triassic rocks, about 150 of which grew in North America.

The Triassic rocks, which are taken as the rocky boundary line of this new period of the earth's geological and biological history, are to be found at or near the surface all over the world. Like the Carboniferous rocks, they are of two kinds—one kind formed in lagoons and lakes and another in deep seas.

The lagoon type consists of red sandstone and clays, with bands and layers here and there of salt and limestone. It is found in western and central Europe and in the eastern states of North America. These rocks were formed of the mud of slowly evaporating briny water, and are often marked with suncracks, ripples, raindrops and the footprints of animals of ancient days. There is also some coal formed by Triassic plants.

The deep-sea type consists of great masses of limestone and dolomite sometimes thousands of feet thick, and is much more extensive. It is found in the Mediterranean basin, and stretches thence through the Carpathian Mountains and southern Russia right into Asia and India. It is also found in Spitzbergen, Japan, North and South America, New Zealand and South Africa. It contains sea creatures of a great many kinds.

The United States shows all of these types of Triassic rocks. Sandstones and shales were formed where lagoons and bays once existed. The red sandstones and shales of the Connecticut valley, north-western New Jersey, central Maryland and elsewhere are among these. They have been greatly broken and also invaded by volcanic rocks since they were deposited. Even peat bogs and swamps formed, giving good coal beds to the area occupied by the states of Virginia and North Carolina.

LAND PLANTS CHANGED AND BECAME FEWER

The plant life of the Triassic period does not seem to have been nearly so rank and luxuriant as it was in the Carboniferous period, when the great coal forests of fern trees and club-mosses flourished; but in New Zealand and Australia, and in some other parts of the world, there is coal made from the decayed material of Triassic forests. There were still ferns, cypresses and other cone-bearing trees, but the most abundant and characteristic trees of the period were cycads—plants like great ferns in appearance, but with tufty tops, and not related to ferns but to pines.

THE REPTILES, NEW RULERS OF THE EARLY WORLD

The animal life of the Triassic period was quite different from anything we have seen so far in our study of the earth's history. The amphibians, who made such progress in the Carboniferous period, still existed, but they were no longer a dominant form of life. Their place was taken by the reptiles, especially the dinosaurs, who were very numerous and of a great many varieties. In Triassic rocks have been found the scant and rare remains of the earliest mammals of which we have knowledge. In many ways these first mammals resembled the reptiles, and they did not give promise of becoming as important an order as they are to-day.

The seas of the Triassic period contained great reptiles like the fish-lizard ichthyosaurus and the long-necked plesiosaurus. Ichthyosaurus sometimes reached a length of thirty feet and had a long snout and jaws armed with many small, sharp teeth. Plesiosaurus grew as long as fifty feet. About a half of this length was neck. In all of these sea-living reptiles the legs had changed to swimming paddles or flippers.

THE GREATEST CREATURES EVER TO WALK THE EARTH

The dinosaurs are particularly interesting creatures. Some were quite small, and others were the largest beasts the world has ever seen, reaching a length of from sixty to eighty feet and weighing about forty tons. Some walked on all four legs; some stalked about on their hind legs, holding their much shorter fore legs in front of them like the modern kangaroo. Their footprints show impressions sometimes of three, four or five toes and vary in length from an inch to nearly two feet.

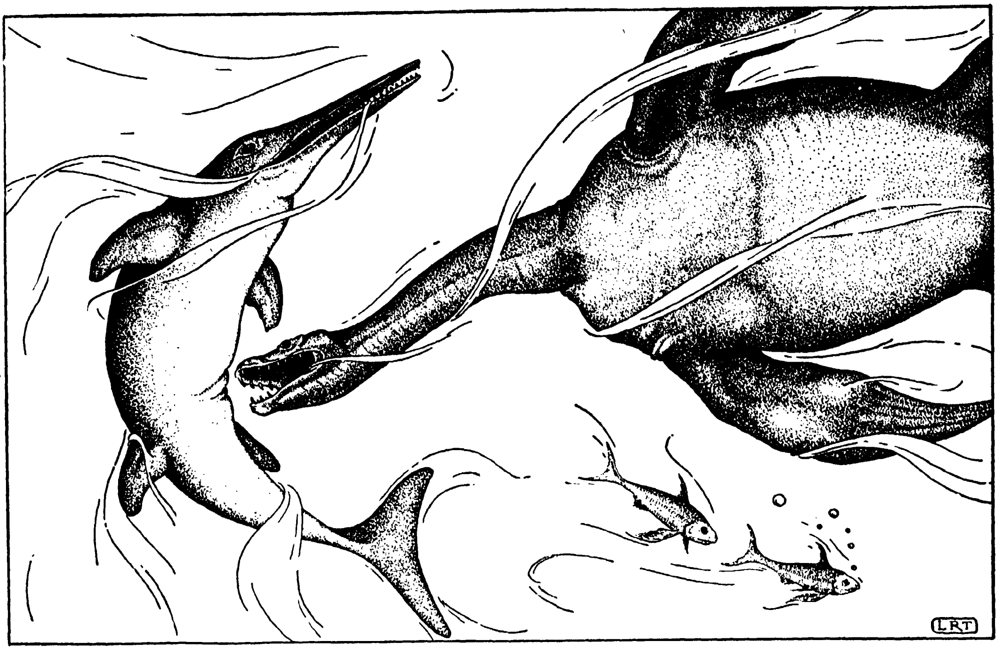
Not all of these great dinosaurs were as terrible as they sound. Many of the largest ones were herbivorous, or plant-eaters. Others, however, were extremely ferocious. The carnivorous, or flesh-eating, dinosaurs were equipped with long, muscular hind legs that enabled them to run very fast. Their shorter fore legs were armed with sharp claws to aid in holding and rending their prey. The jaws were filled with rows of cruel teeth.

AMMONITES AS BIG AROUND AS CARTWHEELS

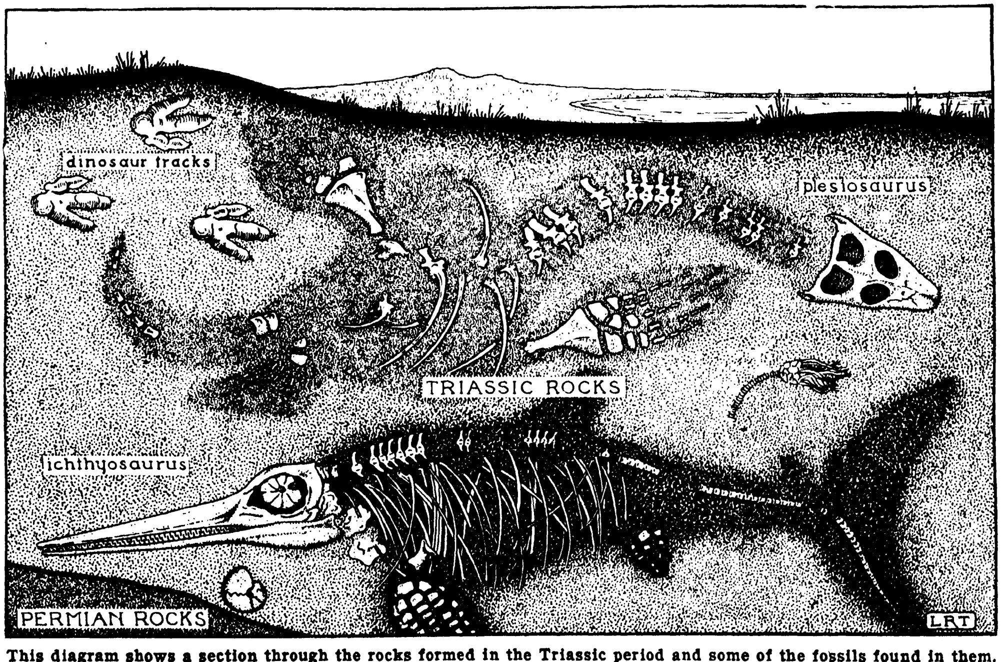
In addition to the monster reptiles of the land, the Triassic waters swarmed with lesser life. Corals, foraminifera, sponges, crinoids, and creatures like shrimps and prawns flourished. The molluscs were particularly numerous. No less than 2,600 species of cephalopods, including the ammonites and belemnites, inhabited the seas. The ammonites were the most beautiful and the most characteristic animals of the Mesozoic oceans. Triassic ammonites were much more active creatures and better swimmers than the cephalopods of the Paleozoic era, about which we have already read. In size they ranged from a diameter of three or four inches to the diameter of a good-sized cartwheel. If the coiled tube which formed the shell of some of the largest ammonites were straightened out, the length would be from twenty-five to thirty feet. The belemnites were ancestors of the modern squid. The name belemnite comes from the Greek word meaning "dart," the fossils of these creatures being at one time looked upon as the thunderbolts of Thor, the Scandinavian god of thunder.

THE NEXT STORY OF THE EARTH IS ON PAGE 1545.

LIFE AND REMAINS OF THE TRIASSIC



In this picture we see a battle between the fish-lizard, ichthyosaurus, and the long-necked plesiosaurus. Carnivorous, or flesh-eating, reptiles such as these swarmed in the Triassic seas, battling one another or preying upon smaller forms of marine life. Notice that flippers have taken the place of legs in these reptiles.



This diagram shows a section through the rocks formed in the Triassic period and some of the fossils found in them. In addition to the giant reptiles who ruled the ancient waters, we find ammonites and crinoids. Sometimes the tracks of land reptiles, the dinosaurs, are preserved in Triassic rocks.

Courtesy, United States Rubber Company Courtesy, Firestone Tire and Rubber Company

Tapping for rubber in Sumatra (left) and Liberia (right). Latex from the cuts drips into little cups set below.

THE STORY OF RUBBER

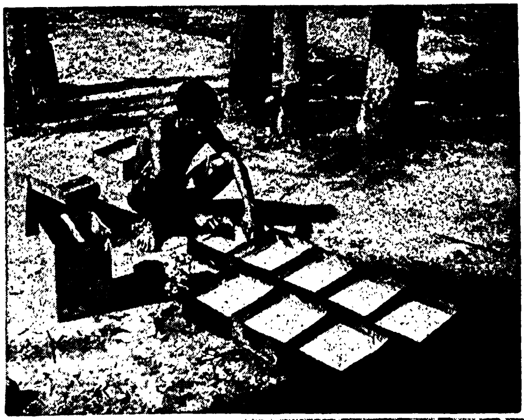
THE world in which we live today would be very different, and not nearly so comfortable, without certain raw materials that play an important part in our ordinary daily life. Among these basic raw materials are iron, cotton, wood, coal and rubber. Some of these materials, such as iron and wood, have been known and used from early times. Rubber is one of the newer materials; it was discovered about the time that Columbus discovered America and was actually one of the gifts that the New World brought to mankind.

Natural rubber, which is also sometimes called India rubber, or caoutchouc, can be obtained from a large number of different trees, vines, shrubs and other plants. Nearly all of the rubber of commerce, however, comes from the rubber trees of tropical countries. The Brazilian hevea tree is the chief source and its product is of the highest quality. Nowadays hevea trees are grown in a number of different countries, but for a long time most of the rubber was exported from the seaport of Para, in Brazil, and even today the product of the hevea tree is known as Para rubber.

C. I. A. A. photo

Collecting the latex that has dripped into cups, Honduras.

The rubber, or caoutchouc, is the gummy part of a thick juice called latex which is found in a spongy layer between the



The pictures show three steps in the preparation of rubber. Above, the latex in pans is exposed to the sun. Part of the liquid evaporates.

bark and the wood of the tree trunk. We may think of this layer as a sort of inner bark. The latex is a thick, milky fluid, quite separate and different from the sap that flows through the wooden trunk of the tree. The latex is obtained by making cuts through the bark into this layer, but not deep enough to touch the wood. Cups are then fastened below the cuts, and the latex oozes out and drips into them.

Latex is an emulsion, like milk: that is, the tiny gummy particles of rubber are mixed with a watery fluid, and if allowed to stand these particles tend to rise to the top, as cream rises to the top of milk. The amount of rubber in latex varies from about 20 to 40 per cent. Heating, or mixing with acids, hastens the rising and thickening of the gummy substance. When it has thickened into a spongy mass it is treated to get rid of the water; then it undergoes further treatment and is combined with sulphur. It has now become the raw rubber of commerce and is quite different from the original gum, or caoutchouc.

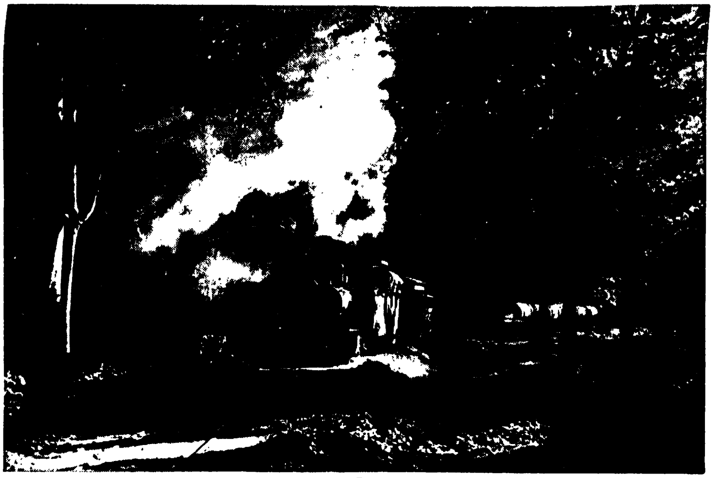
In recent years a great deal of the natural rubber has been grown in Malaya and the East Indies. While the Japanese held these districts in World War II, we were deprived of our supply of natural rubber. Then we vastly increased the manufacture of certain plastics from petroleum, coal, grains and other substances to take the place of natural rubber. These plastics have become known as synthetic rubber, and we tell you more about them in another chapter. None of these plastics is exactly like natural rubber, but they can take the place of natural rubber in many uses.

Rubber has become one of the necessities of modern civilization because it has so many and varied qualities. For example, its frictional quality makes it tend to cling to any surface on which it is pressed or rubbed. It is this quality that caused it to be called

After the latex has been exposed to the sun for a time, it becomes a sticky, spongy mass. It is now passed through wringers.

Pictures on this page, Screen Traveler, from Gendreau

Finally the sheets are hung up to dry, as shown above. These pictures were taken on a big rubber plantation in Sumatra.



Courtesy, United States Rubber Company
This picture, taken in Sumatra, shows latex being transported to the coast.

rubber in the first place. All boys and girls know that if you rub it lightly over paper it will cling closely enough to the surface to rub off pencil marks and soiled places. This same quality is what makes non-skid tires stick to the road; gives us non-slip rubber heels and soles for shoes; and makes rubber floor coverings and mats safer.

Its wonderful elasticity gives it two of its most valuable qualities: it can be stretched almost to the breaking point, and when let go will snap back to its normal shape and size; and when it is compressed it will absorb vibrations and bumps and shocks. It is a non-conductor of electricity; it is waterproof; and it is not affected by most acids and alkalis, except very strong ones. Alcohol will not dissolve it. It is soluble in turpentine and vegetable oils, and in naphtha, benzine, carbon bisulphide and other volatile liquids which evaporate quickly and leave the rubber as it was.

When rubber is used as a cement or glue or is applied in liquid form to cloth or other materials, it dries, sticking very tightly to the material it is applied to. It is a poor conductor of heat and does not burn easily. In a plastic state it can be formed or molded to any shape and then hardened. By treating it with sulphur in a special way it can be made into a hard, tough substance called vulcanite, or ebonite. In this state it has no elasticity and can be machined or carved and polished, and is much like ivory or horn.

Another valuable property of rubber is that it does not lose its elasticity in cold (except extreme cold, when it grows brittle); and it stays elastic under moderate heat, up to about 160 degrees F. It is durable if protected from the air. When it is exposed to the air for a long time it gradually loses elasticity and begins to get crumbly.

These qualities have made rubber useful to us in the most astounding number of ways, both big and little. The motor-car industry is the largest user of rubber for tires and inner tubes, and also for smaller things such as windshield wipers, insulation for electric wiring, floor mats and a number of little gadgets. The electrical industry uses an enormous amount of rubber, of course, because it is a non-conductor and can be used for insulation, to direct the electrical current in its proper way and for safety's sake. Indeed, it can be said that wherever electricity is used, rubber is used.

We use it to waterproof clothing, shoes and boots, and special sheets or blankets for hospitals or for soldiers and campers. One of the most important uses is for hose to carry water and other liquids. Fire hose is as necessary as water to protect our towns and factories and everything else that may be destroyed by fire. Every house that has plumbing fixtures and pipes for water has rubber washers or gaskets to make watertight joints in the pipes.

If you were to notice and count everything that you see or touch in one day that has rubber in it, you would wonder what our way of living would be like if all the rubber were suddenly to vanish. Some of the small but important uses will give you an idea of its widespread use. For example, there are the many kinds of rubber stamps used by the post office to cancel postage stamps; stamps used by banks and stores and other businesses to mark papers; the rubber in balls for all kinds of games and sports; the rubber in toys and playthings, elastic bands and erasers on pencils. It is said that rubbing out pencil marks on paper was one of the first uses to which rubber was put after it was brought to Europe.

There are floors, floor coverings and mats made with rubber; also carpeting which is

Both pictures, C. I. A. A. Photos

In Brazil the crude rubber is stirred into a ball.

made of wool fibers set in rubber-covered burlap. In fire hose, tires and other articles where great strength is required, cords or stout fabrics are embedded in the rubber. For many purposes pure rubber is not necessary. For instance, in floor mats or molded articles fillers are used to give more bulk, and the rubber serves as a plastic binder. Worn-out rubber articles are not a total loss, as the rubber can be dissolved and used over again. This is known as reclaimed rubber, and it is used chiefly for goods of inferior strength. Reclaimed rubber is also used to mix with pure rubber for articles, such as tires. The recovery of scrap (old) rubber makes an important saving in the use of natural rubber.

One valuable quality in natural rubber is that it will mix, or combine, with some of the synthetic rubbers and give them certain qualities which they lack. As we know, it stands up well under heat: it has been found that some types of synthetic rubber used for automobile tires tend to heat up and lose strength, especially tires on heavy trucks. The addition of about 30 per cent of natural rubber overcomes this loss of strength. For inner tubes nothing has been found or made quite so good as natural rubber.

The ball of raw rubber, cut in two.

There are many hundreds of different trees, plants, shrubs, vines and even vegetables that have latex containing a gummy substance of the nature of rubber, or caoutchouc. Of all these, however, less than a dozen have been used to any extent as a source of commercial rubber. Until about the beginning of the twentieth century rubber came from trees and plants found growing wild in tropical and semi-tropical regions of South America, Africa, India, the East Indies, Central America and Mexico. This is known as wild rubber.

Our century has seen the development of large plantations in which the trees are carefully cultivated. Millions of acres were under cultivation when war started in the Pacific in 1941, and these formed the chief source of natural rubber. It has taken immense sums of money to establish these plantations, as the land must be cleared and seedlings set out in rows like vast orchards. It then takes seven or eight years before the trees can be tapped for the latex, and the quality and amount obtained increase as the trees grow older. This "plantation" rubber is of highest quality, as only the best varieties of trees are planted, and the rubber is free from dirt, bark and other impurities. The best rubber is obtained from the older and larger trees. The more important sources of natural rubber which are in cultivation today are as follows:

The Brazilian hevea rubber tree is most important, growing wild throughout the valleys of the Amazon and its tributaries and in the adjoining countries of Peru, Colombia, Venezuela and the Guianas. This is, as we have said, the original source of Para rubber which ranks highest on the market. It is also the species of rubber tree that has been most used to form the great plantations of cultivated trees in Ceylon, Malaya, Africa and the East Indies, and more recently in Brazil.

The manihot tree from which Ceara rubber is obtained is also a native of Brazil. The latex of this tree does not flow so freely as that of the hevea tree, and the rubber obtained from the wild trees is not so well prepared and has more dirt and bark in it. The trees of this variety that have been planted in plantations in Ceylon and East Africa yield a better quality, but it does not have the market value of Para rubber.

Courtesy, Firestone Tire and Rubber Co.
Crude rubber stored in a manufacturer's warehouse.

The castilloa tree of Central America and Mexico is the source of Ule rubber. It is usually of a darker color and has impurities in the latex that cause it to have less strength than the Para rubber. This tree has also been cultivated to some extent.

The tree which is commonly known as the rubber tree, or India rubber tree, and cultivated in America and England as an ornamental plant, is a native of Assam and India where it grows to a large size. It has furnished most of the wild rubber of India, Sumatra and Java; but because of the careless methods of collecting the latex, it has much impurity. Where improved methods are used the rubber is of good quality.

The native African rubber tree, commonly called the silk rubber tree, produces what is known as Lagos rubber. This is of good quality, but like other wild rubbers has impurities that lower its value. There are a number of other trees which have been planted experimentally and have in some cases shown very good results.

Besides trees, there are vines and climbing plants in tropical Africa and Asia which produce a latex from which a good quality of rubber is obtained. The difficulty with these is that the vines are liable to be injured or killed by careless tapping. Then, too, the vines are so widely scattered in the forest that tapping and gathering the latex is slow and laborious. The most important of these vines is the landolphia vine of Africa. Other species of rubber-producing vines are found in South America. In Borneo much of the wild rubber exported has come from other species of these vines. In the Congo and the South Sudan, in Africa, the natives prepare a root rubber from the roots of the landolphia and other vines. The roots are crushed in hot water and the rubber then separated from the fibers. The ecanda plant of Portuguese West Africa (Angola) has tuberous roots from which the rubber is extracted in a similar way by the natives.

THE RUSSIAN DANDELION, OR KOK-SAGHYZ, IS A PROMISING SOURCE OF RUBBER

The Russian dandelion, or kok-saghyz, is a non-tropical source of rubber. The roots are treated in a similar way to other root plants, but modern machinery is used to crush the roots and carry on the preparation. This plant has been used in Russia with considerable success, and during World War II the American and Canadian governments financed the planting of experimental fields from Quebec and Vermont to British Columbia and Oregon.

The guayule plant is a shrub native to northern Mexico, and its wild growth extends across the Rio Grande into the Big Bend area of Texas. In 1910, when rubber production was much less than it has since become, the guayule shrub produced about 10 per cent of the world's rubber. The rubber is obtained by breaking the stems of the plant and then crushing by machinery in order to extract the rubber. This rubber has about 16 to 20 per cent of resins, which are easily separated. The United States Government fostered the planting and cultivation of 30,000 acres in California and other southwestern states. The cultivated guayule produces more than twice the amount of rubber per acre that the wild variety does.

Other sources of natural rubber which have been sponsored by the United States Government include a species of golden rod with which Thomas A. Edison made some experiments on a 600-acre farm in Georgia. Edison was able to produce 100 pounds per acre on poor land. The desert milkweed, the wild rabbit bush and the one-year castilla are also being experimented with, and in Haiti the cryptostegia has been put under cultivation.

The world production of rubber in long tons (2,240 pounds) is given in the following table from a report of the United States Department of Commerce.

YEAR	ASIA and EAST INDIES	AMAZON VALLEY	MEXICAN GUAYULE	AFRICA	TOTAL
1910	10,979	37,938	9,542	20,143	94,013
1920	305,106	23,216	982	6,402	341,994
1930	802,082	14,260	1,095	3,961	821,914
1940	1,353,052	17,661	3,634	16,314	1,390,661

Shoveling sulphur into the mill rolls, where it is to be mixed with crude rubber. A number of other substances are also mixed with the crude rubber.

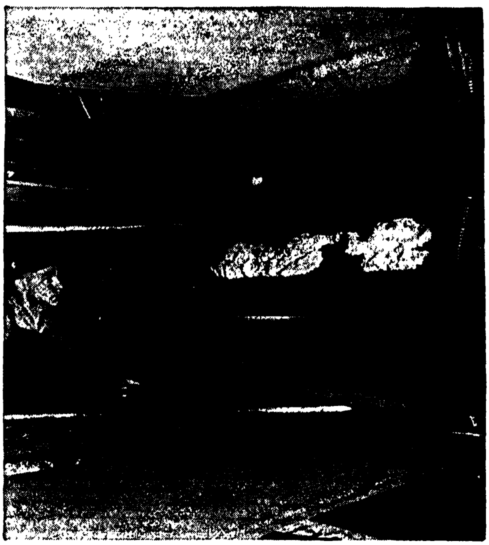
In 1910 the rubber produced was nearly all wild rubber. Since then the great increase has been almost entirely in Asia and the East Indies, where large rubber plantations have come into bearing during the years. This table shows the rapid falling off in wild-rubber production until the outbreak of the war in the Pacific. Since 1940 some plantation rubber has come into the market in South America and Africa and probably these areas will never again be neglected.

The production and preparation of rubber varies very much, depending upon the kind of tree or other source the rubber comes from. From the shrubs and vines the rubber is obtained by crushing the stems or the roots and mixing with hot water to separate the rubber from the fiber. This, of course, destroys the plant. From the rubber trees the latex which contains the rubber is tapped periodically, and in that way the tree will produce for many years, provided the tapping is done carefully.

Originally the natives gathering rubber from the wild trees in the forests used small axes to cut through the bark into the latex-bearing layer beneath, but they often cut too deep into the wood of the trunk. This permitted fungus or rot to attack the wood, and eventually the tree died.

On plantations where most of the rubber is now produced, special tapping knives are used to keep from cutting too deep. Several methods of tapping have been in use. One is to make V-shaped cuts on four sides of the tree and place small cups at the point of the V to catch the latex. Another method is to make a series of V-cuts in a vertical line, up and down the trunk, all of them connected by a vertical cut which leads like a trough down to the base of the tree, where the cup is placed. This is called the herringbone system. More approved methods are the later spiral methods of tapping.

The latex is gathered into buckets, or carried in tanks to a central station where the rubber, or caoutchouc, is separated from the watery fluid. The rubber from some varieties of trees can be separated by a machine; but with latex from the hevea tree acid liquids are added to make the rubber coagulate, that is, come together in a spongy mass. The rubber is then washed and dried and cut



Both photos, courtesy, United States Rubber Company

The important process of calendering. In this process the rubber is pressed between several rolls, called calenders, and is made into smooth sheets.

up and passed through grooved rollers in a washing machine, coming out in sheets or crinkly ribbons. These are dried and are compressed into blocks or other shapes.

The original native way of preparing the rubber for shipment was to use a stick, or paddle, which was dipped into the latex and then held and turned in thick smoke from a small fire. The thin layer of rubber would dry and would also absorb some of the smoke. The paddle would be dipped and dried in the smoke again and again, till a large ball of dry, smoked rubber was built up on the paddle. The creosote in the smoke acted as a preservative as it does in smoked meats, fish and the like. The rubber prepared in this crude way was of a high quality.

NOWADAYS LATEX IS OFTEN SHIPPED LONG DISTANCES IN TANKS

Modern methods now enable the latex to be kept liquid by the addition of ammonia, and then it is shipped long distances, in tanks on ships or in tank cars, to factories where the rubber is separated. Then it goes through machines which wash, dry and further treat it. This rubber, or caoutchouc, is not yet the rubber we know. It is still gummy, and if warmed it gets sticky. It must be combined with sulphur to give it toughness and solidity and the elasticity which is its chief quality. This process is called vulcanizing. When it is combined while heated with 2.5 to 10 per cent of sulphur, we get the ordinary rubber of different degrees of elasticity. If it is brought to a greater heat and combined with about 30 per cent of sulphur, the rubber becomes the hard, tough material known as vulcanite or ebonite. This can be molded while it is still soft, or when hard it can be carved or machined. The production of plantation rubber brought with it an era of scientific research and invention, in which crude hand methods were largely done away with.

Rubber plantations today are the result of more than sixty years of experimenting and of scientific plant-breeding. Seeds for planting have been continuously selected from trees that showed the highest yield of latex of the best quality. To avoid insect pests and diseases that attack the roots of high-yield trees, plants are selected from hardy varieties that are immune to such pests and diseases; and when these plants are well established, buds from the high-yield trees are grafted on to the hardy plant, near the ground, so as to form the trunk of the full-grown tree from which the latex is obtained.

In some regions which have the right soil and climate, there are, unfortunately, pests which attack the leaves. To meet this threat, as soon as the young tree is big enough another variety is bud-grafted at the top of the plant. This gives a healthy leaf structure which is immune to the pests. This method of grafting of rubber trees to secure a high yield and have trees which are immune to leaf and root diseases was started in the early 1920's; and records show that while the average yield of trees grown from seed was 300 pounds per acre, the average yield of trees that had been bud-grafted was 1,000 to 1,700 pounds per acre.

Some of the rubber plantations include several million acres, not all planted in rubber but with large areas of the most suitable land cleared and the trees planted in rows. The trees are about 15 feet apart in the rows, and the rows are 13 feet apart, which makes about 220 trees to the acre. As the seeds spring up the seedlings in each seed-bed are thinned out, leaving at the end of the year only two of the strongest plants to each bed. These are bud-grafted, and the one that is most successful is left standing.

PLANTATION RUBBER—THE REWARD OF LABOR, SKILL AND PATIENCE

About five years after bud-grafting, the tree is tall enough for a test tapping to be made. This is continued from time to time during the following three years, or until the tree has reached the size for regular tapping. During this time the trees which do not come up to the required standard of yield and quality of latex are removed. This reduces the number of trees per acre to about 100, though the growth of the trees varies in different regions. It is greatest where the rainfall is most regular. This, in outline, gives some idea of the long process to be gone through before any rubber is produced at all. As the trees grow older and larger the yield of latex becomes greater. The planting and raising of the trees is only a part of what must be done to bring a modern plantation into production and to maintain this production.

The largest, most numerous and oldest plantations are in the East Indies and southeast Asia. British companies have plantations in Ceylon, India, Malaya and Borneo, and some in Africa. French companies have plantations in French Indo-China; and Dutch companies, in Sumatra and Java. Plantations have also been established in Brazil, Haiti and several other countries of the Western Hemisphere.

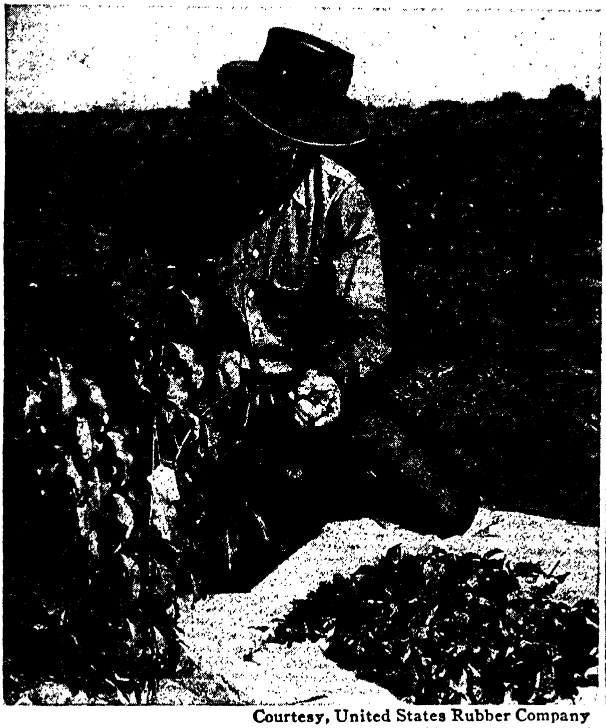
THREE PLANTS THAT YIELD RUBBER

U. S. Forest Service Photo

A field of five-year-old guayule in the Salinas Valley of California. The guayule plant is a shrub native to northern Mexico and southern Texas; it has also been cultivated in California and other southwestern states. It yields a good grade of rubber.

U. S. Forest Service Photo

Close-up of a guayule plant. The rubber is obtained by breaking the stems of the plant and then crushing by machinery.



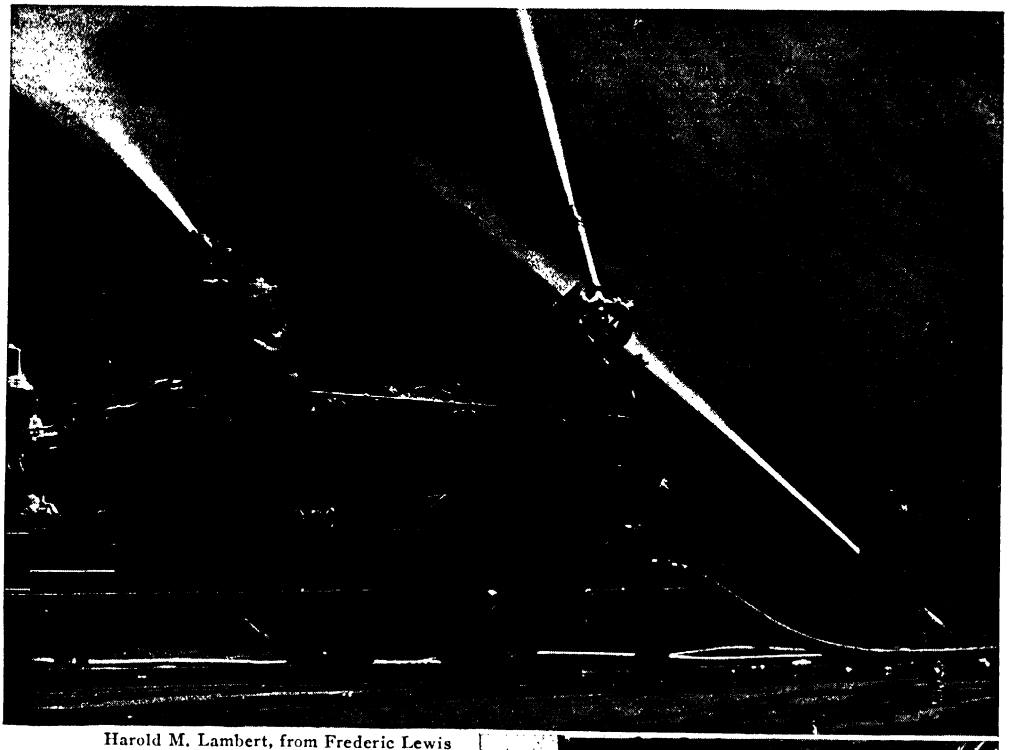
Courtesy, United States Rubber Company

The cryptostegia, cultivated in Haiti for its rubber. When a leaf is broken or a stem is cut, the latex forms in wee drops.

Courtesy, U. S. D. A.

Russian dandelion, or kok-saghyz. This plant is a non-tropical source of rubber.

SOME MODERN USES OF RUBBER



Harold M. Lambert, from Frederic Lewis

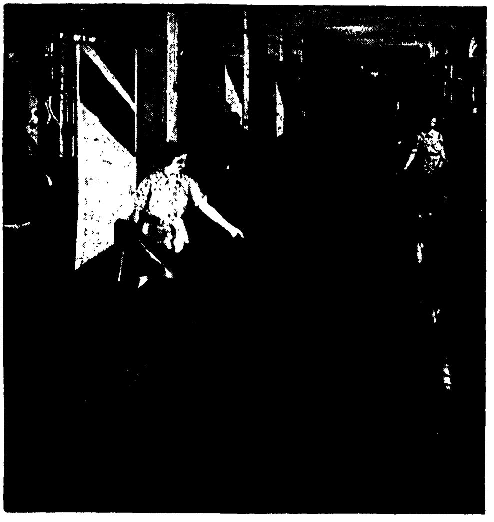
Articles of rubber form an important part of the fire-fighter's equipment. Helmet, coat, boots, hose line, truck tires—all are made of rubber.

Courtesy, United States Rubber Company

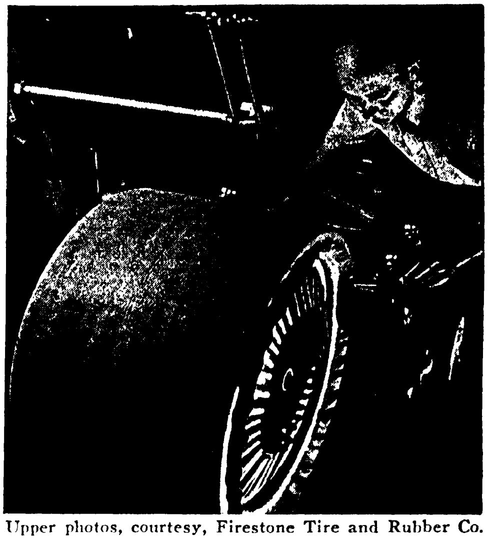
Rubber conveyor belt used in loading coal. Conveyor belts are widely used in modern industry.

Courtesy, Firestone Tire and Rubber Company

Building up tire beads. The beads, which fit on the wheel rims, are made of tough steel wire set in rubber.



Cord fabric for the body of tires passing on a conveyor between rows of tire-building machines. The women are feeding this fabric into the machines.



Upper photos, courtesy, Firestone Tire and Rubber Co.
This picture shows the "flat band" method of tire construction. The different plies (that is, layers) are built up on a drum one on top of the other.

Only in recent years have American rubber companies established plantations to supply their needs. In 1925 the Firestone Rubber Company leased about a million acres in Liberia, in Africa. By 1941 there were nearly 100,000 acres under cultivation, and the acreage has increased each year since. In 1928 the Ford Company secured a concession of about 2,500,000 acres in the Amazon Valley in Brazil, and by the time war broke out had begun limited production.

In 1940 the United States took 811,000 tons of the world's production of 1,390,000 tons of rubber, and of this, 777,000 tons came from the East Indies and Asia. This was nearly all plantation rubber, and the supply was cut off by the Japanese. To replace this supply a great program for making synthetic rubber was adopted, and encouragement was given to the development of plantations of guayule, Russian dandelion and other quick-growing plants. By these means

Goodyear News Service
A battery of individual vulcanizers in a modern tire factory. We explain the process of vulcanization in this article. This process has made possible the use of rubber for a great many different purposes.

it was hoped that a permanent home supply of rubber might be established. This supply might not entirely take the place of the Asiatic rubber, but once established, it would give a certain independence and could be expanded in any future emergency. The plants we have mentioned will give a much greater yield of rubber after some years of careful selection of seed and cultivation.

THE STORY OF RUBBER GOES BACK TO THE DAYS OF CHRISTOPHER COLUMBUS

The story of rubber goes back, as we have said, to the time of the discovery of America. The historian Herrera, who wrote the account of Columbus's second voyage, tells of the elastic balls made from the gum of a tree and used by the natives of Haiti in their games. The Spaniard Juan Torquemada, writing in 1615, tells of the rubber tree in Mexico and of the native method of getting the gum to coat shoes. The Spaniards themselves were soon using the gum to waterproof cloaks. About 1735 the French government sent De la Condamine on a scientific expedition to South America. While there he investigated this elastic gum and wrote a complete account of his findings. He called the gum caoutchouc, which is the French way of spelling an Indian name for it.

In 1770, Joseph Priestley, the English chemist, found that this gum made an excellent rubber to rub out pencil marks. In telling about it Priestley mentioned that a small cube of about one-half inch dimensions could be bought for three shillings. That would be about seventy-five cents today but the amount had much greater purchasing power then. Artists and a few other people began to use the gum for erasing marks, but that was the only use for it known. Since the French name caoutchouc was difficult to pronounce and to spell, the English came to call it by the simple name "rubber."

The fact that the gum was waterproof led Samuel Peel, about 1791, to invent a way of waterproofing clothes by dissolving the gum in turpentine and spreading it on cloth. In 1823 Charles Macintosh thought of a better way of waterproofing. He used the gum to cement two pieces of cloth together, thus doing away with the sticky outside surface. That is why, to this very day, raincoats are often called mackintoshes in Britain.

The great trouble about all such uses of rubber, or caoutchouc, was that in damp, warm weather it became soft and sticky and in cold weather it became stiff. Many inventors tried to think of ways to overcome this drawback, and among them were Charles Goodyear of the United States and Thomas Hancock of England.

After much labor and experiment, Goodyear, about 1843, discovered that the gum, if moderately heated, would absorb sulphur, and that even in small amounts the sulphur would make a remarkable change in the nature of the rubber. The rubber would lose its stickiness and become far more elastic, and it would keep its elasticity even in very hot or very cold weather. Hancock, the Englishman, working independently, added to this discovery and did much to make the new product a commercial success. This process is called vulcanizing.

The discovery of vulcanizing marks the beginning of the use of rubber on a wider scale. New uses were found for it, and the production gradually increased. In the last part of the nineteenth century electric light and power systems began to spread over many countries, and this greatly increased the demand for rubber. Rubber tires began to be used for vehicles, especially bicycles: first solid tires and then hollow tires filled with air—or pneumatic tires. Then came the growth of the automobile industry in the twentieth century, and the need for rubber tires became enormous.

HOW THE HEVEA TREE WAS BROUGHT TO THE PLANTATIONS OF THE EAST INDIES

It usually happens that when there is a strong need for improvement in any article, people get busy to bring about the improvement. The demand for a better quality of rubber in the last part of the nineteenth century brought about the establishment of plantations for the planting and cultivation of superior trees. The rubber of Asia and the East Indies was not so good as that of Brazil, so an Englishman, H. A. Wickham, went to Brazil and collected seeds of the hevea tree. He had to smuggle them out of the country, as the Brazilians had a monopoly of good rubber and it was forbidden to export seeds or plants. The seeds that Wickham took were planted in greenhouses at Kew Gardens, in England. When the seedlings grew they were carefully packed and shipped to India, Ceylon and Singapore and set out on specially prepared land. From these seedlings grew the huge system of rubber plantations of the East Indies that produced, at the time of the Japanese invasions, more than 95 per cent of the world's rubber supply.

THE NEXT STORY OF FAMILIAR THINGS IS ON PAGE 1549.

United States Navy photograph

The farther down a diver goes in the water, the greater is the pressure on his body.

THE PRESSURE OF LIQUIDS AND GASES

THE molecules of liquids are always in motion. Although scientists have never watched these tiny particles in action, they believe that if it were possible to see them in a glass of water, we would find them colliding furiously with one another and bumping against the walls of the glass. These millions and billions and trillions of little bumps cause pressure against the glass. That is part of what we mean when we say that liquids, such as water, milk, oil and so on, exert a pressure on the walls of the vessel in which they are kept. This pressure is exerted equally in all directions.

But that is only half the story. All matter on earth is attracted downward, toward the center of the earth, by the force of gravity. When one object is on top of another, the one farther from the center of the earth exerts pressure on the one beneath. You exert pressure on the floor when you stand on it. The milk exerts pressure on the bottom of the bottle; the water of the ocean exerts pressure on the bottom, and upon the fish—less pressure on fish that live near the top of the sea, more pressure on fish living in the deeps.

The rule is that the pressure exerted by a liquid on an object is equal to the weight of the column of liquid above the object. For example, the pressure on the hull of a submarine 600 feet below sea level is 260 pounds per square inch, that is, for each square inch of area the water exerts a force of 260 pounds. As the submarine rises, the pressure becomes less; as the submarine goes deeper, the pressure increases.

As you may know, few submarines can go as deep as 600 feet; few are built so that they can stand so much pressure. One of the wonderful things about whales is that these great animals can dive hundreds of feet down, which means they can bear monstrous pressures on every square inch of their bodies. They are able to do this, because they can develop tremendous pressure inside their bodies also, to withstand the outside pressures.

Just so, William Beebe in his bathysphere has descended more than 3,000 feet beneath the surface. The bathysphere (the word means deep-sphere) is a hollow steel ball in which air is kept at proper pressure by the use of oxygen stored in tanks. The diver is also supplied with air pressure; otherwise he could not go down very far.

The pressure on any area depends on the height of the column of liquid upon or against that area, and has nothing to do with the quantity of surrounding liquid there may be. A pebble at the bottom of your aquarium (which has, say, two feet of water) has the same pressure on top of it that it had when resting at the bottom of a pond with two feet of water, though the pond might be quite large. This is part of a law of physics known as Pascal's Principle.

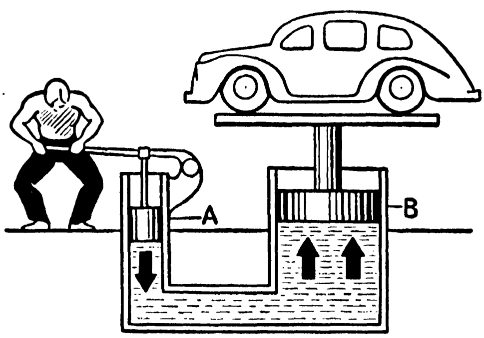


Fig. 1.
The man lifts the automobile by pushing down on the lever attached to plunger A. This forces the A column of water down and the B column up; in this way a large weight may be lifted with a small force.

Let us see how we use Pascal's Principle. For one thing, we use it in making the hydraulic elevator and the hydraulic press. Hydraulic comes from the Greek words for water and pipe. Look at Figure 1. The man wishes to lift the automobile, so he drives it upon the platform of a big plunger B whose stem rests on a column of water. The height of the B column can be raised or lowered by the man as he works the small plunger A. If he raises the B column, B plunger must rise, for the water pressure will push it up. In other words, a small force on a small area will cause a large force over a large area, and so large weights may be lifted.

We spoke of the great pressure a whale must bear on its body when it dives. We also bear pressure, for gases as well as liquids exert pressure, and the rule includes the air above and around us. We call the air's pressure atmospheric pressure, and it is very considerable—nearly 15 pounds on every square inch of our bodies, at sea level. As we go higher, up a mountain or up in a plane, the atmospheric pressure becomes less. As you know, air thins out above the earth, so in higher regions there is less of it to press upon us. (See Figures 2 and 3.)

Even in any one spot on earth the pressure frequently changes, for the earth's blanket of atmosphere is always moving and its composition is changing. The article on Winds and Ocean Currents tells you about this. We have an instrument, called a barometer, to measure the pressure of the atmosphere. One type is the mercury barometer. This is a glass tube sealed at the top. The open end is inserted in a vessel of mercury. There is no air in the tube. As the atmosphere presses down upon the mercury in the vessel, some mercury goes up the tube—the heavier the air pressure, the higher the mercury will climb in the tube. The outside of the tube is marked off as a measuring-stick, and so we can measure the atmospheric pressure by noting how high the mercury has climbed in the tube.

There is a limit to the distance up the tube the mercury will climb—29.92 inches, or 760 millimeters. It can not climb higher because the air pressing down upon the mercury in the vessel is never heavy enough to send it higher.

Another form of barometer is called the aneroid barometer (from the Greek word meaning non-liquid). Most airplanes use a kind of aneroid barometer as an altimeter, or altitude measurer. This barometer, in its simplest form, is a box with very thin flexible walls. The air is drawn from the box, so that there is almost no pressure against the walls from the inside. (You can not get a perfect vacuum, as you know.) The thin walls of the box are pushed in as the air presses against them from the outside; they begin returning to their former shape as the pressure decreases. All this is registered on a scale. Less pressure is registered as the airplane ascends; more pressure, as the plane loses altitude.

We have said that the air is never heavy enough to send a column of mercury higher than 29.92 inches. Water is much lighter than mercury and so air pressing on water can push this liquid up a tube or pipe much farther than it can push mercury. Yet there is a limit to the height it can send water, and that limit is 34 feet.

MEASURING A MOUNTAIN'S HEIGHT WITH AIR

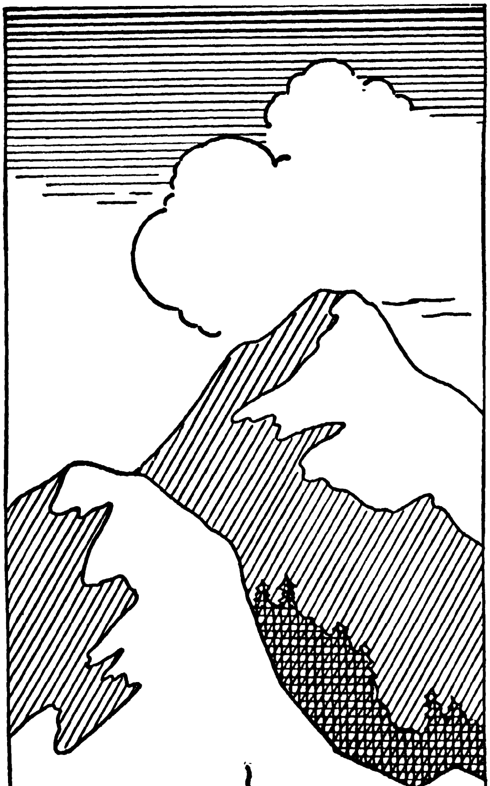


Fig. 2.

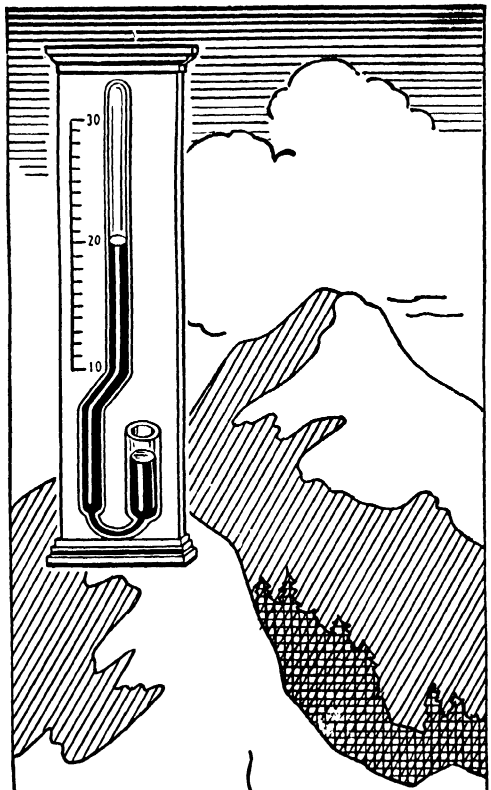


Fig. 3.

In Fig. *2* we see a barometer at the foot of a mountain. The weight of the air on the mercury in the open-end tube forces the column to rise a certain height in the closed-end tube. At the top of the mountain, Fig. 3, the air is thinner in the open tube; there is less of it to press on the mercury. Therefore, the column rises less in the closed-end tube. The difference in the two readings measures the mountain's elevation.

This explains why a water pump (of the kind we call a suction pump) is not useful if the water is too deep underground. Figures 4, 5 and 6 show how the pump works. On the upward stroke the piston valve is closed and the foot valve is open; the air pressure outside forces water into space A. On the downward stroke the piston valve is open and the foot valve is closed. This forces water into B. On the next upward stroke the foot valve is open and the piston valve is closed; this forces water out of the spout and into the bucket. The water is pushed upward again into A by the air pressure outside. The height to which this water goes depends on the air pressure. For normal pressure it is 34 feet, as we have said. If you dig a well and find water below 34 feet (or better, 28 feet) a pump there will be useless.

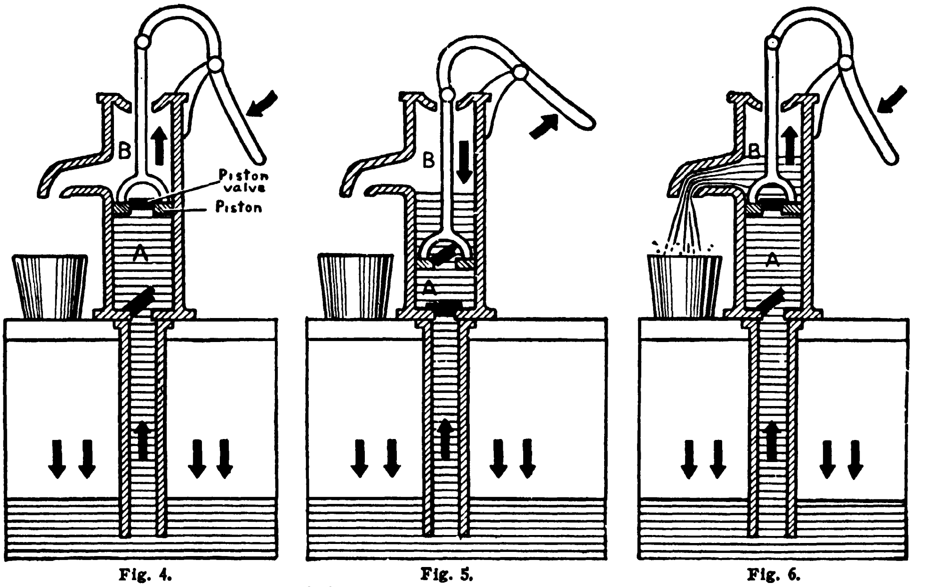


Fig. 4. Fig. 5. Fig. 6.

A common water pump makes use of air pressure. In Fig. 4 the piston valve is closed and the foot valve is open; air pressure forces water into A. In Fig. 5 the piston valve is open and the foot valve is closed; water is forced into B. In Fig. 6 the foot valve is open and the piston valve is closed; water is forced out into the bucket.

In the chapter on Density we explain how it is that some objects float on the top of a liquid, while others sink to the bottom. Whether an object floats on top or settles partway in the liquid and floats (as swimming) we say the object is "buoyed up" by the liquid. Buoyancy means lightness. Objects with less density than water float on top. An object will settle partway down and float, when its weight is equal to the weight of the water it displaces, that is, whose place it takes. Ships are built to have so many tons displacement—1,000 or 10,000 or perhaps 50,000. A ship built to carry a total weight of 10,000 tons would sink if it were loaded with 25,000 tons.

When an object is fully immersed in a liquid, something very astonishing happens. The object loses weight! Figures 7 and 8 show what happens. Suppose you want to change the balanced condition of Figure 7 to that shown in Figure 8. We shall not touch the weight on the pan. In order to make the pan go down and the block go up, as in Figure 8, we can do either of two things: cut a piece off the block, or push up on the block from underneath. The latter is what happens when the block is immersed in water. The water supports the wood just as it does a floating rowboat.

When the block is immersed, a volume of water overflows, equal to the volume of the block. The weight of the water equals the upward, or buoyant, force. In other words, if the block weighs eleven pounds in air, and ten pounds when immersed in water, the weight of overflow water is one pound. The buoyant force of the water is one pound. The principle is called Archimedes' Principle, after the man who developed it. It applies to gases as well as to liquids.

Up to now we have talked only about the pressure of liquids at rest. Whenever a gas or a liquid is flowing, the pressure that it exerts (against any container) becomes less as its velocity increases. This is known as Bernoulli's Principle. When you work an insect spray, the plunger forces a stream of air across the top of a small vertical tube which extends down into the liquid. The high velocity air-flow creates a low pressure. Atmospheric pressure is higher than this low pressure, and it forces the liquid up the tube and into position for spraying.

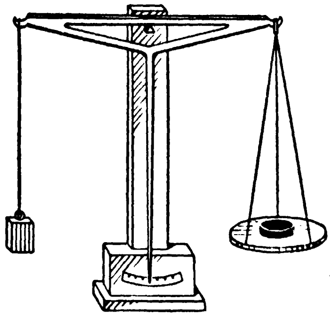


Fig. 7.

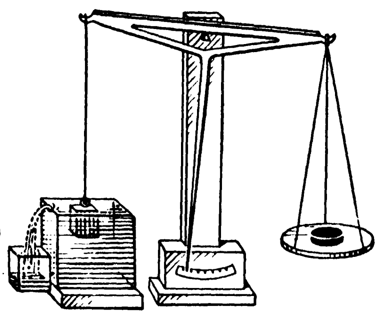


Fig. 8.

An object loses weight when it is fully immersed in a liquid. In Fig. 7 the scale is balanced. In Fig. 8, however, the tray is lower than the block of wood. This is true because the water exerts an upward, or buoyant, force on the wood, proportional to the volume of overflow water.

In shooting galleries one can see celluloid balls riding on jets of water. The speed of the stream is greater at the center than at the sides. Therefore the pressure is greater at the sides than in the middle. If the ball begins to fall to one side it is pushed back by the greater pressure and will stay in the center until some good marksman shoots it off.

You can demonstrate Bernoulli's Principle for yourself and astonish your friends. Stick a pin through a cardboard disc about two inches in diameter. Then insert the pointed end of the pin into the hole of a spool. Hold the cardboard against the hole for a moment, and then blow into the other end of the spool. Instead of blowing the card away, the stream of air only makes it stick tight against the spool. The pressure of the air between the spool and card is made smaller by blowing, and the pressure of the air outside pushes the card against the spool.

The special construction of an airplane wing allows the air to move faster over the top than under the bottom of the wing. Therefore the pressure at the lower end of the wing is greater than at the top. The difference between the pressures tends to lift the wing up.

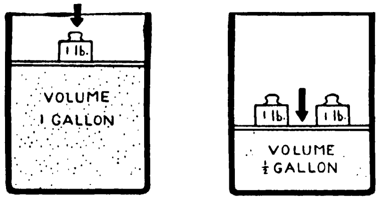
One more illustration. When the air is moving fast, as during a storm, or just before a storm, the barometer (the pressure-measurer) falls, showing that the moving air has less pressure. When fine, tranquil weather is at hand, the barometer rises, showing increasing pressure of the stiller atmosphere.

A pint of milk represents a definite quantity of milk to us; and nothing we do to it by ordinary means (except drinking) makes it less than a pint. Not so with gases. Unless we know the pressure exerted on it, the volume of a gas is not known. The greater the pressure, the smaller the volume of the gas. If the volume of a gas under a pressure of 1 pound is 1 gallon, the volume will be $\frac{1}{2}$ gallon if the pressure is 2 pounds, $\frac{1}{3}$ gallon if the pressure is 3 pounds, etc. This is known as Boyle's Law. Every time we inflate an automobile tire we show that air may be compressed to one-half, one-fifth or one-tenth its normal volume. Furthermore, the expansibility of air, that is, its tendency to spring back to a larger volume as soon as the pressure is decreased, is proved every time a hollow rubber ball or a football bounces, or the air rushes out from a punctured tire.

An insect spray demonstrates Bernoulli's Principle, as does your mother's perfume atomizer. It is explained in the text.

This shows also why the walls of hollow bodies are not crushed in by the enormous forces which the weight of the atmosphere exerts against them. The air inside such bodies presses their walls out with as much force as the air outside presses them in. Once the air is removed the walls are pushed in. That is why a toy balloon collapses when it is pricked with a pin.

It is not quite correct to say that the volume of a gas depends only on the pressure. When we raise the temperature of a gas or liquid the volume will become larger, or if this is not possible (because of the obstructing vessel) the pressure will increase. Take an empty bottle and close it not too tightly with a cork. Then heat the bottle. After a short time the cork will be thrown into the air. The air in the bottle expanded, that is, increased its volume, and the pressure increased until the force was large enough to throw the cork out of the bottle into the air.

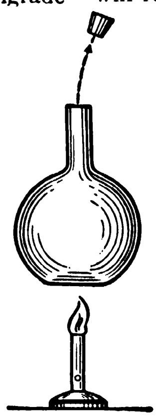


The volume of a gas depends on the pressure exerted upon it. The greater the pressure, the less the volume.

When James Watt saw how the top of his mother's teakettle was lifted by the escaping steam, he conceived the idea of the steam engine. We explain how a steam engine works on pages 406 and 407.

We have shown that the volume of a gas depends on the pressure and on the temperature. If we know both pressure and temperature we can figure the weight of any volume of any gas. The weight of a gas at greatest atmospheric pressure—which will raise a column of mercury 760 millimeters, or 29.92 inches—and at 0 degree Centigrade is known as the weight at N.T.P. (Normal Temperature and Pressure).

This is the way the study of physics marches forward. To explain the experimental facts and laws so far discovered we formulate a theory which is to account for all known facts and laws in that field; the theory may also predict some new ones. If we find things which are contradictory to our theory, or not fully explained by it, we have to discard the theory altogether or change it to suit the newly discovered facts. (For example, Newton's Law of Gravitation had to be changed somewhat after Einstein's studies and experiments.) Being up-to-date with the explanations and theories keeps work in physics always fascinating.


When we heat a gas in a closed bottle, its volume is increased. The expanding gas will push the cork out.

Therefore, when we tell you of molecules, and their actions, we tell what scientists believe to be true; but no molecule has ever been seen in motion. Yet the Molecular Theory seems to explain many things that happen in physics and chemistry. The number of molecules in a cubic centimeter of air at normal temperature and pressure is 27 billion billion (that is 27 with eighteen zeros). It has been estimated that this is the number of grains of sand necessary to fill a box one mile long, one mile wide and ¼ mile deep.

The molecules of a gas are moving in all directions at a high rate of speed, a higher rate than the speed of molecules in a liquid. They collide with one another and with solid surfaces, bouncing off like perfectly elastic balls. It is the continuous stream of millions upon millions of molecules pounding against a surface that causes the gas pressure. This is what we believe to be true, according to the Kinetic Theory of Gases. Kinetic comes from a Greek word meaning to move.

If the available space, that is, the volume in which the molecules move, is reduced, more molecules will hit the walls, and so will increase the pressure. Thus the Kinetic Theory of Gases gives a simple explanation of Boyle's Law (that less volume means more pressure).

If the temperature is raised, the molecules will receive more energy and therefore move with a greater speed. As a consequence, there will be more hits in the same time, and therefore the pressure will be increased. This explains why the pressure of a gas increases with temperature rise.

In conclusion it may be well to remind you that there is no fundamental difference between solids, liquids and gases. They are not three kinds of matter, but three states of matter. In solids, the molecules are so closely packed that they have almost no freedom of motion; in liquids, the attractive forces between the molecules keep them together, while in gases, the molecules are so far apart that the attractive forces between them do not play any appreciable part.

By GERALD E. TAUBER.

THE NEXT STORY OF SCIENCE IS ON PAGE 1519.

ADVENTURES OF BARON MUNCHAUSEN

THIS amusing book appeared in England in the year 1785 and was a satire, that is, a book which made fun of the tales of men who had written extravagantly of their travels in distant parts of the world. Travelers had come home from journeys to almost unknown lands and had told stories of marvelous things they had seen and done. Listeners and readers were startled by these strange tales which they thought could not be true. Rudolf Raspe, a German scholar who was clever but not very honest, had taken refuge in England to escape punishment for some wrongdoing in Germany. He was very poor, and to make some money he wrote his little book. It became popular at once because the adventures of Baron Munchausen were so ridiculous that they made people laugh. As the years went by, other unknown authors added to the book, until it became a volume of some size. It has been translated into almost every language and has given enjoyment to millions of people. And the word Munchausen has been adopted into everyday speech to mean a person who "draws a long bow," that is, one who stretches the truth. Here we give, word for word as they were written, some of the tales supposed to have been told by Baron Munchausen.

THE LION AND THE CROCODILE

SOME years before my beard announced approaching manhood, or, in other words, when I was neither man nor boy, but between both, I expressed in repeated conversations a strong desire of seeing the world, from which I was discouraged by my parents, though my father had been no inconsiderable traveller himself, as will appear before I have reached the end of my singular and, I may add, interesting adventures. A cousin, by my mother's side, took a liking to me, often said I was a fine forward youth, and was much inclined to gratify my curiosity. His eloquence had more effect than mine, for my father consented to my accompanying him in a voyage to the island of Ceylon, where his uncle had resided as governor many years.

We sailed from Amsterdam with despatches from their High Mightinesses the States of Holland. The only circumstance which happened on our voyage worth relating was the wonderful effects of a storm, which had torn up by the roots a great number of trees of enormous bulk and height, in an island where we lay at anchor to take in wood and water; some of these trees weighed many tons, yet they were carried by the wind so amazingly high, that they appeared like the feathers of small birds floating in the air, for they were at least five miles above the earth: however, as soon as the storm subsided they all fell perpendicularly into their respective places, and took root again, except the largest, which happened, when it was blown into the air, to have a man and his wife, a very honest old couple, upon its branches, gathering cucumbers (in this part of the globe that useful vegetable grows upon trees): the weight of this couple, as the tree descended, overbalanced the trunk, and brought it down in a horizontal position: it fell upon the chief man of the island, and killed him on the spot; he had quitted his house in the storm, under an apprehension of its falling upon him, and was returning through his own garden when this fortunate accident happened. The word fortunate, here, requires some explanation. This chief was a man of a very avaricious and oppressive disposition, and though he had no family, the natives of the island were half-starved by his oppressive and infamous impositions.

The very goods which he had thus taken from them were spoiling in his stores, while the poor wretches from whom they were plundered were pining in poverty. Though the destruction of this tyrant was accidental, the people chose the cucumber-gatherers for their governors, as a mark of their gratitude for destroying, though accidentally, their late tyrant.

After we had repaired the damages we sustained in this remarkable storm, and taken leave of the new governor and his lady, we sailed with a fair wind for the object of our voyage.

In about six weeks we arrived at Ceylon, where we were received with great marks of friendship and true politeness. The following singular adventures may not prove unentertaining.

After we had resided at Ceylon about a fortnight I accompanied one of the governor's brothers upon a shooting party. He was a strong, athletic man, and being used to that climate (for he had resided there some years), he bore the violent heat of the sun much better than I could; in our excursion he had made a considerable progress through a thick wood when I was only at the entrance.

Near the banks of a large piece of water, which had engaged my attention, I thought I heard a rustling noise behind; on turning about I was almost petrified (as who would not be?) at the sight of a lion, which was evidently approaching with the intention of satisfying his appetite with my poor carcase, and that without asking my consent. What was to be done in this horrible dilemma? I had not even a moment for reflection; my piece was only charged with swan-shot, and I had no other about me; however, though I could have no idea of killing such an animal with that weak kind of ammunition, yet I had some hopes of frightening him by the report, and perhaps of wounding him also. I immediately let fly, without waiting till he was within reach, and the report did but enrage him, for he now quickened his pace, and seemed to approach me full speed: I attempted to escape, but that only added (if an addition could be made) to my distress; for the moment I turned about I found a large crocodile, with his mouth extended almost ready to receive me. On my right hand was the piece of water before mentioned, and on my left a deep precipice, said to have, as I have since learned, a receptacle at the bottom for venomous creatures; in short, I gave myself up as lost, for the lion was now upon his hind legs, just in the act of seizing me; I fell involuntarily to the ground with fear, and, as it afterwards appeared, he sprang over me. I lay some time in a situation which no language can describe, expecting to feel his teeth or talons in some part of me every moment: after waiting in this prostrate situation a few seconds I heard a violent but unusual noise, different from any sound that had ever before assailed my ears; nor is it at all to be wondered at, when I inform you from whence it proceeded: after listening for some time, I ventured to raise my head and look round, when, to my unspeakable joy, I perceived the lion had, by the eagerness with which he sprung at me, jumped forward as I fell, into the crocodile's mouth! which, as before observed, was wide open; the head of the one stuck in the throat of the other! and they were struggling to extricate themselves! I fortunately recollected my *couteau de chasse*, which was by my side; with this instrument I severed the lion's head at one blow, and the body fell at my feet! I then, with the butt-end of my fowling piece, rammed the head farther into the throat of the crocodile, and destroyed him by suffocation, for he could neither gorge nor eject it.

Soon after I had thus gained a complete victory over my two powerful adversaries my companion arrived in search of me; for finding I did not follow him into the wood, he returned, apprehending I had lost my way, or met with some accident.

After mutual congratulations, we measured the crocodile, which was just forty feet in length. The skin was stuffed and sent to the Amsterdam museum.

THE BARON RESCUES HIS HORSE

I SET off from Rome on a journey to Russia, in the midst of winter, from a just notion that frost and snow must of course mend the roads, which every traveller had described as uncommonly bad through the northern parts of Germany, Poland, Courland and Livonia. I went on horseback, as the most convenient manner of travelling; I was but lightly clothed, and of this I felt the inconvenience the more I advanced north-east. What must not a poor old man have suffered in that severe weather and climate, whom I saw on a bleak common in Poland, lying on the road, helpless, shivering and hardly having wherewithal to cover his nakedness? I pitied the poor soul: though I felt the severity of the air myself, I threw my mantle over him, and immediately I heard a voice from the heavens, blessing me for that piece of charity, saying,

"You will be rewarded, my son, for this in time."

I went on: night and darkness overtook me. No village was to be seen. The country was covered with snow, and I was unacquainted with the road.

Tired, I alighted, and fastened my horse to something like a pointed stump of a tree, which appeared above the snow; for the sake of safety I placed my pistols under my arm, and laid down on the snow, where I slept so soundly that I did not open my eyes till full daylight. It is not easy to conceive my astonishment to find myself in the midst of a village, lying in a churchyard; nor was my horse to be seen, but I heard him soon after neigh somewhere above me. On looking upwards I beheld him hanging by his bridle to the weather-cock of the steeple. Matters were now very plain to me: the village had been covered with snow overnight; a sudden change of weather had taken place; I had sunk down to the churchyard whilst asleep, gently, and in the same proportion as the snow had melted away; and what in the dark I had taken to be a stump of a little tree appearing above the snow, to which I had tied my horse, proved to have been the cross or weather-cock of the steeple!

Without long consideration I took one of my pistols, shot the bridle in two, brought down the horse, and proceeded on my journey. My horse felt absolutely no ill-effects from his experience.

A STAG WITH A CHERRY TREE

I DARE say you have heard of the hunter and sportsman's saint and protector, St. Hubert, and of the noble stag, which appeared to him in the forest, with the holy cross between his antlers. I have paid my homage to that saint every year in good fellowship, and seen this stag a thousand times either painted in churches, or embroidered in the stars of his knights; so that, upon the honor and conscience of a good sportsman, I hardly know whether there may not have been formerly, or whether there are not such crossed stags even at this present day. But let me rather tell what I have seen myself. Having one day spent all my shot, I found myself unexpectedly in presence of a stately stag, looking at me as unconcernedly as if he had known of my empty pouches. I charged immediately with powder, and upon it a good handful of cherry-stones, for I had sucked the fruit as far as the hurry would permit. Thus I let fly at him, and hit him just on the middle of the forehead, between his antlers; it stunned him—he staggered—yet he made off. A year or two after, being with a party in the same forest, I beheld a noble stag with a fine full-grown cherry-tree above ten feet high between his antlers. I immediately recollected my former adventure, looked upon him as my property, and brought him to the ground by one shot, which at once gave me the haunch and cherry-sauce; for the tree was covered with the richest fruit, the like I had never tasted before.

THE WONDERFUL HUNTING DOG

IN a voyage which I made to the East Indies with Captain Hamilton, I took a favorite pointer with me; he was, to use a common phrase, worth his weight in gold, for he never deceived me. One day when we were, by the best observations we could make, at least three hundred leagues from land, my dog pointed; I observed him for near an hour with astonishment, and mentioned the circumstance to the captain and every officer on board, asserting that we must be near land, for my dog smelt game. This occasioned a general laugh; but that did not alter in the least the good opinion I had of my dog. After much conversation pro and con, I boldly told the captain I placed more confidence in Tray's nose than I did in the eyes of every seaman on board, and therefore proposed laying the sum I had agreed to pay for my passage (viz., one hundred guineas) that we should find game within half an hour. The captain (a good, hearty fellow) laughed again, desired Mr. Crowford, the surgeon, who was prepared, to feel my pulse; he did so, and reported me in perfect health. The following dialogue between them took place; I overheard it, though spoken low, and at some distance.

Captain.—His brain is turned; I cannot with honor accept his wager.

Surgeon.—I am of a different opinion; he is quite sane, and depends more upon the scent of his dog than he will upon the judgment of all the officers on board; he will certainly lose, and he richly merits it.

Captain.—Such a wager cannot be fair on my side; however, I'll take him up, if I return his money afterwards.

During the above conversation Tray continued in the same situation, and confirmed me still more in my former opinion. I proposed the wager a second time, it was then accepted.

Done! and done! were scarcely said on both sides, when some sailors who were fishing in the long-boat, which was made fast to the stern of the ship, harpooned an exceeding large shark, which they brought on board and began to cut up for the purpose of barrelling the oil, when, behold, they found no less than *six brace of live partridges* in this animal's stomach!

They had been so long in that situation, that one of the hens was sitting upon four eggs, and a fifth was hatching when the shark was opened! ! ! This young bird we brought up by placing it with a litter of kittens that came into the world a few minutes before! The old cat was as fond of it as of any of her own four-legged progeny, and made herself very unhappy, when it flew out of her reach, till it returned again. As to the other partridges, there were four hens amongst them; one or more were, during the voyage, constantly sitting, and consequently we had plenty of game at the captain's table; and in gratitude to poor Tray (for being a means of winning one hundred guineas) I ordered him the bones daily, and sometimes a whole bird. And, indeed, he well deserved such a reward.

A WORLD TOUR BY EAGLE

ABOUT the beginning of his present Majesty's reign I had some business with a distant relation who then lived on the Isle of Thanet; it was a family dispute, and not likely to be finished soon. I made it a practice during my residence there, the weather being fine, to walk out every morning. After a few of these excursions I observed an object upon a great eminence about three miles distant: I extended my walk to it, and found the ruins of an ancient temple: I approached it with admiration and astonishment; the traces of grandeur and magnificence which yet remained were evident proofs of its former splendor: here I could not help lamenting the ravages and devastations of time, of which that once noble structure exhibited such a melancholy proof. I walked round it several times, meditating on the fleeting and transitory nature of all terrestrial things; on the eastern end were the remains of a lofty tower, near forty feet high, overgrown with ivy, the top apparently flat; I surveyed it on every side very minutely, thinking that if I could gain its summit I should enjoy the most delightful prospect of the circumjacent country. Animated with this hope, I resolved, if possible, to gain the summit, which I at length effected by means of the ivy, though not without great difficulty and danger; the top I found covered with this evergreen, except a large chasm in the middle. After I had surveyed with pleasing wonder the beauties of art and nature that conspired to enrich the scene, curiosity prompted me to sound the opening in the middle, in order to ascertain its depth, as I entertained a suspicion that it might probably communicate with some unexplored subterranean cavern in the hill; but having no line I was at a loss how to proceed. After revolving the matter in my thoughts for some time, I resolved to drop a stone down and listen to the echo; having found one that answered my purpose, I placed myself over the hole, with one foot on each side, and stooping down to listen, I dropped the stone, which I had no sooner done than I heard a rustling below, and suddenly a monstrous eagle put up its head right opposite my face, and rising up with irresistible force, carried me away seated on its shoulders: I instantly grasped it around the neck, which was large enough to fill my arms, and its wings, when extended, were ten yards from one extremity to the other. As it rose with a regular ascent, my seat was perfectly easy, and I enjoyed the prospect below with inexpressible pleasure. It hovered over Margate for some time, was seen by several people, and many shots were fired at it; one ball hit the heel of my shoe, but did me no injury. It then directed its course to Dover cliff, where it alighted, and I thought of dismounting, but was prevented by a sudden discharge of musketry from a party of marines that were exercising on the beach; the balls flew about my head, and rattled on the feathers of the eagle like hailstones, yet I could not perceive it had received any injury. It instantly reascended and flew over the sea towards Calais, but so very high that the Channel seemed to be no broader than the Thames at London Bridge. In a quarter of an hour I found myself over a thick wood in France, where the eagle descended very rapidly, which caused me to slip down to the back part of its head; but alighting on a large tree, and raising its head, I recovered my seat as before, but saw no possibility of disengaging myself without the danger of being killed by the fall; so I determined to sit fast, thinking it would carry me to the Alps, or some other high mountain, where I could dismount without any danger. After resting a few minutes it took wing, flew several times round the wood, and screamed loud enough to be heard across the English Channel. In a few minutes one of the same species arose out of the wood, and flew directly towards us; it surveyed me with evident marks of displeasure, and came very near me. After flying several times round, they both directed their course to the south-west. I soon observed that the one I rode upon could not keep pace with the other, but inclined towards the earth, on account of my weight; its companion perceiving this, turned round and placed itself in such a position that the other could rest its head on its rump; in this manner they proceeded till noon, when I saw the rock of Gibraltar very distinctly. The day being clear, notwithstanding my degree of elevation, the earth's surface appeared just like a map, where land, sea, lakes, rivers, mountains, and the like were perfectly distinguishable; and having some knowledge of geography, I was at no loss to determine what part of the globe I was in.

Whilst I was contemplating this wonderful prospect a dreadful howling suddenly began all around me, and in a moment I was invested by thousands of small black, deformed, frightful-looking creatures, who pressed me on all sides in such a manner that I could neither move hand nor foot: but I had not been in their possession more than ten minutes when I heard the most delightful music that can possibly be imagined, which was suddenly changed into a noise the most awful and tremendous, to which the report of cannon, or the loudest claps of thunder could bear no more proportion than the gentle zephyrs of the evening to the most dreadful hurricane; but the shortness of its duration prevented all those fatal effects which a prolongation of it would certainly have been attended with.

The music commenced, and I saw a great number of the most beautiful little creatures seize the other party, and throw them with great violence into something like a snuff-box, which they shut down, and one threw it away with incredible velocity; then turning to me, he said they whom he had secured were a party of devils, who had wandered from their proper habitation; and that the vehicle in which they were enclosed would fly with unabating rapidity for ten thousand years, when it would burst of its own accord, and the devils would recover their liberty and faculties, as at the present moment. He had no sooner finished his relation than the music ceased, and they all disappeared, leaving me in a state of mind bordering on the confines of despair.

When I had recomposed myself a little, and looking before me with inexpressible pleasure, I observed that the eagles were preparing to light on the peak of Teneriffe: they descended to the top of a rock, but seeing no possible means of escape if I dismounted determined me to remain where I was. The eagles sat down seemingly fatigued, when the heat of the sun soon caused them both to fall asleep, nor did I long resist its fascinating power. In the cool of the evening, when the sun had retired below the horizon, I was roused from sleep by the eagle moving under me; and having stretched myself along its back, I sat up, and reassumed my travelling position, when they both took wing, and having placed themselves as before, directed their course to South America. The moon shining bright during the whole night, I had a fine view of all the islands in those seas.

About the break of day we reached the great continent of America, that part called Terra Firma, and descended on the top of a very high mountain. At this time the moon, far distant in the west, and obscured by dark clouds, but just afforded light sufficient for me to discover a kind of shrubbery all around, bearing fruit something like cabbages, which the eagles began to feed on very eagerly. I endeavored to discover my situation, but fogs and passing clouds involved me in the thickest darkness, and what rendered the scene still more shocking was the tremendous howling of wild beasts, some of which appeared to be very near: however, I determined to keep my seat, imagining that the eagle would carry me away if any of them should make a hostile attempt. When daylight began to appear I thought of examining the fruit which I had seen the eagles eat, and as some was hanging which I could easily come at, I took out my knife and cut a slice; but how great was my surprise to see that it had all the appearance of roast beef regularly mixed, both fat and lean! I tasted it, and found it well flavored and delicious, then cut several large slices and put in my pocket, where I found a crust of bread which I had brought from Margate; took it out, and found three musket-balls that had been lodged in it on Dover cliff. I extracted them, and cutting a few slices more, made a hearty meal of bread and cold beef fruit. I then cut down two of the largest that grew near me, and tying them together with one of my garters, hung them over the eagle's neck for another occasion, filling my pockets at the same time. While I was settling these affairs I observed a large fruit like an inflated bladder, which I wished to try an experiment upon: and striking my knife into one of them, a fine pure liquor like Hollands gin rushed out, which the eagles observing, eagerly drank up from the ground. I cut down the bladder as fast as I could, and saved about half a pint in the bottom of it, which I tasted, and could not distinguish it from the best mountain wine. I drank it all, and found myself greatly refreshed. By this time the eagles began to stagger against the shrubs. I endeavored to keep my seat, but was soon thrown to some distance among the bushes. In attempting to rise I put my hand upon a large hedgehog, which happened to lie among the grass upon its back: it instantly closed round my hand, so that I found it impossible to shake it off. I struck it several times against the ground without effect; but while I was thus employed I heard a rustling among the shrubbery, and looking up, I saw a huge animal within three yards of me; I could make no defence, but held out both my hands, when it rushed upon me, and seized that on which the hedgehog was fixed. My hand being soon relieved, I ran to some distance, where I saw the creature suddenly drop down and expire with the hedgehog in its throat. When the danger was past I went to view the eagles, and found them lying on the grass fast asleep, being intoxicated with the liquor they had drank. Indeed, I found myself considerably elevated by it, and seeing everything quiet, I began to search for some more, which I soon found; and having cut down two large bladders, about a gallon each, I tied them together, and hung them over the neck of the other eagle, and the two smaller ones I tied with a cord round my own waist. Having secured a good stock of provisions, and perceiving the eagles begin to recover, I again took my seat. In half an hour they arose majestically from the place, without taking the least notice of their encumbrance. Each reassumed its former station; and directing their course to the northward, they crossed the Gulf of Mexico, entered North America, and steered directly for the Polar regions, which gave me the finest opportunity of viewing this vast continent that can possibly be imagined.

Before we entered the frigid zone the cold began to affect me; but piercing one of my bladders, I took a draught, and found that it could make no impression on me afterwards. Passing over Hudson's Bay, I saw several of the company's ships lying at anchor, and many tribes of Indians marching with their furs to market.

By this time I was so reconciled to my seat, and become such an expert rider, that I could sit up and look around me; but in general I lay along the eagle's neck, grasping it in my arms, with my hands immersed in its feathers, in order to keep them warm.

In these cold climates I observed that the eagles flew with greater rapidity, in order, I suppose, to keep their blood in circulation. In passing Baffin's Bay I saw several large Greenland-men to the eastward, and many surprising mountains of ice in those seas.

While I was surveying these wonders of nature it occurred to me that this was a good opportunity. to discover the north-west passage, if any such thing existed, and not only obtain the reward offered by government, but the honor of a discovery pregnant with so many advantages to every European nation. But while my thoughts were absorbed in this pleasing reverie I was alarmed by the first eagle striking its head against a solid transparent substance, and in a moment that which I rode experienced the same fate, and both fell down seemingly dead.

Here our lives must inevitably have terminated, had not a sense of danger and the singularity of my situation, inspired me with a degree of skill and dexterity which enabled us to fall near two miles perpendicular with as little inconveniency as if we had been let down with a rope; for no sooner did I perceive the eagles strike against a frozen cloud, which is very common near the poles, than (they being close together) I laid myself along the back of the foremost and took hold of its wings to keep them extended, at the same time stretching out my legs behind to support the wings of the other. This had the desired effect, and we descended very safe on a mountain of ice, which I supposed to be about three miles above the level of the sea.

I dismounted, unloaded the eagles, opened one of the bladders and administered some of the liquor to each of them, without once considering that the horrors of destruction seemed to have conspired against me.

But suddenly a monstrous bear began to roar behind me, with a voice like thunder. I turned round, and seeing the creature just ready to devour me, having the bladder of liquor in my hands, through fear I squeezed it so hard, that it burst, and the liquor flying in the eyes of the animal, totally deprived it of sight. It instantly turned from me, ran away in a state of distraction and soon fell over a precipice of ice into the sea, where I saw it no more.

The danger being over, I again turned my attention to the eagles, whom I found in a fair way of recovery, and suspecting that they were faint for want of victuals, I took one of the beef fruit, cut it into small slices and presented them with it, which they devoured with avidity.

Having given them plenty to eat and drink, and disposed of the remainder of my provision, I took possession of my seat as before. After composing myself, and adjusting everything in the best manner, I began to eat and drink very heartily; and through the effects of the mountain, as I called it, was very cheerful, and began to sing a few verses of a song which I had learned when I was a boy: but the noise soon alarmed the eagles, who had been asleep, through the quantity of liquor which they had drank, and they arose seemingly much terrified. Happily for me, however, when I was feeding them I had accidentally turned their heads towards the south-east, which course they pursued with a rapid motion. In a few hours I saw the Western Isles, and soon after had the inexpressible pleasure of seeing Old England. I took no notice of the seas or islands over which I passed.

The eagles descended gradually as they drew near the shore, intending, as I supposed, to alight on one of the Welsh mountains; but when they came to the distance of about sixty yards two guns were fired at them, loaded with balls, one of which penetrated a bladder of liquor that hung to my waist; the other entered the breast of the foremost eagle, who fell to the ground, while that which I rode, having received no injury, flew away with amazing swiftness.

This circumstance alarmed me exceedingly, and I began to think it was impossible for me to escape with my life; but recovering a little, I once more looked down upon the earth, when, to my inexpressible joy, I saw Margate at a little distance, and the eagle descending on the old tower whence it had carried me on the morning of the day before. It no sooner came down than I threw myself off, happy to find that I was once more restored to the world. The eagle flew away in a few minutes, and I sat down to compose my fluttering spirits.

I soon paid a visit to my friends, and related these adventures. Amazement stood in every countenance; their congratulations on my returning in safety were repeated with an unaffected degree of pleasure, and we passed the evening as we are doing now, every person present paying the highest compliments to my courage and veracity.

THE NEXT STORY OF FAMOUS BOOKS IS ON PAGE 1898.

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Sons of Clovis, at target practice. This was a branch of education in the Early Middle Ages.

THE EARLY MIDDLE AGES

WE give the name of antiquity, or ancient times, to a long period of human history. It extends from the earliest times of which there is any record to the fall of the Western Roman Empire in the year 476 A.D. Since our modern era dates from about 1500, you can see that there is an interval of a thousand years or so between ancient and modern times. To this in-between or middle period we give the name of the Middle Ages.

There was a time when most people scorned the Middle Ages. They thought of this period as a time when there was no progress; when all was ignorance and superstition and cruelty. We now realize that the Middle Ages made valuable contributions to our civilization. This era produced great statesmen, lawgivers, writers, religious thinkers, architects and painters. Then too, many things in our modern civilization had their beginnings in medieval times. (Medieval, pronounced mee-di-ee'-val, means "of or belonging to the Middle Ages.")

The Middle Ages fall into three more or less distinct periods. In the Early Middle Ages (476–900) the wonderful civilization of the old Romans fell to pieces and a new way of life—feudalism—was built up on the ruins of the old. The Feudal Ages (900–1300) mark the flowering of this new way of life. In the Late Middle Ages (1300–1500) feudalism came to an end. There was then a great revival, called the Renaissance, or Rebirth. With the triumph of Renaissance ideals, the modern era begins.

In this article we shall tell you about the Early Middle Ages. People sometimes refer to them as the Dark Ages, because of the widespread disorder that followed the downfall of the Western Roman Empire. Most historians, however, consider this name quite misleading. They point out that there have been other dark ages in the world's history; besides, not all was darkness in this period.

To understand how things were at the beginning of the Middle Ages, we must go back a number of years. The last emperor to rule over all the Roman Empire was Theodosius the Great, who died in 395 A.D. He left the eastern regions of the Empire, south of the Danube and east of the Adriatic, to his older son, Arcadius; the younger son, Honorius, became master of the West. The Eastern Empire continued its career for more than a thousand years. We tell you its fascinating story in our article on the Byzantine Empire.

The Western Empire knew only disaster after the partition (division) of 395. Long before this time the German barbarians had begun to pour into the Empire from the north and northeast. In the fifth century these invasions multiplied. The Germans occupied one imperial province after another. The end came in 476, when the last emperor, Romulus Augustulus, was deposed by a German military leader, Odoacer.

What was the situation, then, in the year 476? Almost all the territory that had once made up the Roman Empire of the West was now in the hands of German barbarians. Odoacer ruled over Italy. Northern Africa was occupied by the cruel Vandals. Most of Spain was under the control of the Visigoths, or West Goths, who also held southwestern France. The Burgundians were established in the valleys of the Rhone and Saône rivers. Farther to the north, along the Meuse, the Moselle and the lower Rhine, were the warlike Franks. The Anglo-Saxons had already begun the conquest of England, which had been left to the old Celtic inhabitants (the Britons) when the Roman garrisons withdrew.

The descendants of the old Romans had by no means disappeared from the areas of Europe once occupied by the Empire. They had fallen on evil days, indeed. Once the masters of the world, they were now the helpless subjects of German invaders. Yet they found that they could get along quite well with these new masters. As time went on, they inter-married freely with them.

The German dialects of the conquerors had not replaced Latin, the language of the old Roman Empire. The Germans let the Romans use their own tongue. They even used Latin themselves for the business of government, since they found it more useful for this purpose than their own languages, which were comparatively primitive. And so, in 476, Latin and the various German dialects existed side by side.

The Latin used by learned men was still pretty good at this time. However, the Latin spoken by the people had become hopelessly corrupt. This Vulgar Latin, or people's

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Clovis, hard-pressed in battle, calling upon Christ to give him victory. The King became a Christian in 496 A.D.

Latin (*vulgus* is the Latin word for people), disregarded most of the rules of grammar; it introduced a number of new words. It varied from province to province, and sometimes from town to town. In the course of time it developed into a number of different languages—French, Spanish, Portuguese and Italian, among others.

In 476 Christianity was supreme in most of the areas formerly occupied by the Western Roman Empire. Practically all the descendants of the old Romans belonged to the Christian group known as Catholics. The most powerful religious leader among them was the bishop of Rome, who had come to be known as the pope, or father. Most of the German invaders were also Christians. However, they had been converted to Arianism, a different kind of Christianity from Catholicism.


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Clovis, King of the Franks. He founded the Merovingian dynasty, which was in power for many years.

Italy, which had been the nerve centre of the old Roman Empire in the days of its greatness, held the stage for some time after the fall of the last Western emperor. Odoacer, who had deposed this emperor in 476, continued to rule Italy for a time; but in the year 493 he was overthrown by another German, Theodoric, the leader of the Ostrogoths, or East Goths.

Theodoric was a strong ruler. He put the finances of the state in order. He restored the old roads and viaducts and public buildings, which were in a sad state. On the whole he was a just man. He was a firm believer in the Arian form of Christianity, but he did not persecute those who did not believe as he did. He dealt fairly with Goths and Romans alike, and did what he could to bring the two peoples together. He named a number of Romans, including the famous philosopher Boethius (bo-ee′-thi-us), to high positions in the state.

Toward the end of his life Theodoric became suspicious of the Romans whom he had placed in office. He thought that they were planning to overthrow him because he was an Arian and they were Catholics. Accordingly he had Boethius and several others put to death. The King sickened and died not long after, in the year 526.

By the early part of the sixth century, therefore, the Ostrogoths were the masters of Italy. The Franks had established themselves just as firmly in Gaul, or modern France. In 476, as we have seen, they dwelt in the valleys of the Meuse, the Moselle and the lower Rhine. As the years went by they continued to push farther to the south.

The Franks did not form a single united kingdom; they belonged to different tribes, each ruled by its own king. Kings and people alike were heathens. They went to war half-naked; they fought with javelins and swords and with axes which they hurled at the foe. They had the reputation among the Romans of being very treacherous.

In 481 a boy called Clovis, or Chlodwig, became king of one of the Frankish tribes. He was an ambitious lad, who planned to become some day the ruler of all the Franks. His fellow-kings did not take him very seriously at first. But Clovis went ahead grimly to carry out his plans. He became master of one Frankish kingdom after another, sometimes by fair combat, more often through treachery and murder. By 491 all the Frankish tribes except one acknowledged his rule. The one surviving independent kingdom was that of Cologne, ruled by Sigebert, a friend and ally of Clovis.

In 492 Clovis married a Burgundian princess, Clotilda, who was a devout Catholic. This good lady persuaded her lord, who was still a heathen, to be converted to the Christian faith. So on Christmas Day, 496, Clovis and 3,000 of his followers were baptized at Reims. Clovis was the first barbarian king to become a Catholic; the rest had all been Arians.

Clovis added to his possessions by defeating the Alemanni, in the east, and the Visigoths, in southern France. In 510 he rounded off his domains by acquiring the last independent Frankish kingdom—that of Cologne. He persuaded Chloderic, the son of King Sigebert, to slay the old monarch, who had always been a faithful ally of Clovis. Thereupon Chloderic became king of Cologne. But now Clovis pretended to be very angry at the murder of Sigebert. He had Chloderic put to death and became master of Cologne.

Clovis died in 511. He was a most unpleasant creature—a hypocrite, a faithless friend, a cold-blooded murderer. Yet it can not be denied that he was one of the most important men of the Early Middle Ages. He founded a dynasty, or race of kings, that was to last for over two hundred years. It was called the Merovingian dynasty, from Merowig, the grandfather of Clovis.

Pope Stephen III, who persuaded Pepin, King of the Franks, to come to Italy.

The first kings of the Merovingian dynasty had considerable power. They made the laws; and the business of the state was carried on by officials named by themselves. The most important of these officials was the *major domus,* or master of the palace. He was in charge of the people who made up the royal household; he had many other important duties in peace and war. In the course of time, as we shall see, he was to become the most powerful man in the state.

In the year 525 the great Justinian mounted the throne of the Eastern Empire. He determined to bring back the glorious days of ancient Rome by regaining all the western possessions once held by the Empire. In 533 his general Belisarius invaded northern Africa and completed the conquest of the Vandal kingdom in that area in just one year. He captured Sicily in 535. In the following year he crossed over to the Italian mainland and drove the Ostrogoths from most of their possessions.

Belisarius was now recalled in order to lead the imperial armies in the East, where the Persians threatened. In the years that followed there was fierce fighting between the Ostrogoths and the imperial troops in the Italian peninsula. At last, in 552, the Ostrogoths were crushed in the fierce battle of Taginæ. They offered to leave Italy, if they were given safe-conduct. In 553 they made their way northward through the passes of the Alps and disappeared forever from the pages of history.

Italy was now firmly in the hands of the Eastern emperor. The chief imperial representative in the peninsula was the exarch (ek′-sark; from the Greek *exarchos,* meaning commander). The exarch's headquarters was in the city of Ravenna, on the eastern coast of Italy.

Justinian turned his attention next to the Visigothic kingdom in Spain. His generals managed to occupy a number of cities in southern Spain. The Visigoths, however, were too numerous to be conquered by the comparatively small imperial armies that were sent to that area. Justinian made no serious effort to invade France, where the Franks were altogether too strong. He had not succeeded in carrying out his entire program of conquest; yet by the end of his reign the Eastern Empire was again a power to reckon with in the West.

The sixth century marks the spread of monasteries in Western Europe. A monastery is a religious house, sheltering those who have withdrawn from the world in order to give themselves up entirely to the religious life. There had been monasteries in the West long before this time, but they were weak and badly organized.

In 529 good Saint Benedict founded a monastery at Monte Cassino, in Italy. For the guidance of the monks he set up a new and strict rule, or guide for conduct. The rule provided among other things that the monks were never to marry; that they were always to remain poor; that they were always to be obedient. He also insisted that they should perform helpful tasks.

The followers of Saint Benedict led good and useful lives. Soon other men, and women too, sought to follow their example. Monasteries and convents (religious houses for women) sprang up in other places. In

Charles Martel, leader of the Franks, at the battle of Tours, in 732. In this combat the Franks turned back the Saracens, who had invaded France.

the course of the centuries that followed, the monasteries of Western Europe became very numerous and powerful.

In the Early Middle Ages the monasteries served a most useful purpose. They offered a haven to people who were weary of constant upheaval and fighting and who longed to lead a peaceful life. In those days, too, the monks were pioneers. Wherever a monastery was set up, the forests were cleared, the marshes were drained and agriculture was developed.

Besides, the monasteries served to keep alive the spirit of learning at a time when men were more interested in weapons than in books. The monks taught the young in the monastery schools. Since Latin was the language of the Church, the study of this tongue formed a very important part of the instruction. In order to provide materials for their classes as well as for their own use, the monks patiently copied by hand many of the old Latin classics. By so doing, they preserved for later ages the treasures of Latin literature.

In the latter part of the sixth century the German people called the Lombards appeared upon the scene in Italy. Legend had it that they had once dwelt in Scandinavia. They had come to northern Germany, and from there had slowly worked their way down to the Danube River. In the summer of 568 the whole Lombard nation—men, women and children—crossed the Carinthian Alps and descended into the plains of northern Italy. They met with little opposition, for the imperial garrisons in that area were pitifully small.

The Lombards soon became masters of northern Italy. Their chieftain, Alboin, founded the kingdom of Lombardy, with its capital at Pavia. After his death the Lombards extended their conquests to the south. They did not stop to capture the cities that had strong imperial garrisons, but settled in the places that were weakly defended. As a result Italy came to present a curious checkerboard pattern, with Lombard and Eastern Roman districts existing side by side.

The Lombard invasion brought added power to the papacy—that is, the office of the pope. Among the districts that still acknowledged the rule of the Eastern emperor after the coming of the Lombards was the Roman Duchy, a district that included the city of Rome. The exarch at Ravenna found it hard to keep in touch with the Romans, and he rather neglected their interests. Hence they sought the help of the popes, who became the real governors of Rome.

In the year 590 Gregory I became pope. He is known in history as Gregory the Great; he was, indeed, one of the most distinguished leaders that the Roman Catholic Church has ever known. The people of Rome considered him their ruler; he served their interests faithfully and fearlessly. He raised soldiers to defend the city against the Lombards; he negotiated treaties of peace with the enemy.

Pepin the Short, King of the Franks.

He also carried out his religious duties most conscientiously. He sent out missionaries to many lands, including England, in order to convert the heathen. He exercised great influence over the Franks, who, as we have noted, were Catholics. He persuaded the Arian Visigoths who ruled Spain to adopt the Catholic faith. This was a death-blow to the cause of Arianism. In the course of several generations Catholicism came to rule everywhere in the Western World.

So esteemed was Gregory that the bishops of far-off lands sought his advice in matters of theology and church government. At his death in 604 the papacy enjoyed far greater prestige than ever before. From now on the popes become increasingly important.

The Lombards held their own in the seventh century. They were seriously threatened only once, when the Eastern emperor Constans II invaded Italy in 662. He managed to drive the Lombards out of southern Italy for a time; but his conquests were not permanent. In general the rulers of the Eastern Empire left the Lombards severely alone. The chief reason was

Both pictures, Culver Service

Childeric III, last of the Merovingian kings, is deposed and Pepin the Short is proclaimed king in his place. In accordance with the old Germanic custom, the newly proclaimed monarch is being raised aloft on his shield.

that they had to face a new and terrible foe, who threatened the very existence of the Empire.

In the early years of the seventh century an Arab called Mohammed founded a new religion. After his death in 632 his followers, called Mohammedans or Saracens, spread his teachings by force of arms. They swept into one province of the Eastern Empire after another. Before many years had passed they held Syria, Palestine and Egypt. By the end of the century all of northern Africa was in their hands.

Encouraged by their successes in Asia and Africa, the Saracens determined to extend their conquests to Europe. In 711 they began their invasion of the continent by crossing the Strait of Gibraltar and falling upon the Visigothic kingdom of Spain. In less than two years the Mohammedan invaders had subdued almost the entire country. Only the northwestern corner of Spain, the mountains and coastlands along the Bay of Biscay, continued to hold out.

After the conquest of Spain, the Saracens began to make raids into France. For some years these raids brought about no permanent results. At last, in the year 732, a mighty Saracen host, strengthened by reinforcements from Africa and the East, set out in good earnest to conquer the Western World. Fortunately for Christendom, the warlike Franks stood in the way.

The Saxons submit to Charlemagne in 785. They soon renewed the fight and were not finally subdued until 804.

In our description of the Frankish kingdom we pointed out that the most important official serving under the king was the *major domus,* or the master of the palace. As time went on the kings of the Merovingian line had become mere weaklings, whom men called scornfully "do-nothing kings." The master of the palace, on the other hand, had gathered more and more power into his hands. By the eighth century he was the real head of the state; the king was a mere puppet.

When the Saracens launched their great invasion of Europe in 732, the master of the palace was Charles Martel, or Charles the

Hammer; he had received this name because of the hammer-like blows he dealt his enemies. Charles gathered together a big army and he met the Mohammedan invaders near the city of Tours. The fate of Europe hinged on the great battle that now took place. The Saracens attacked the Frankish warriors but were thrown back again and again. So heavy were their losses that when night fell they fled from the scene of battle. Charles was hailed as the savior of the West.

When he felt his death near, in 741, Charles Martel determined to turn over his powers to his two sons Carloman and Pepin. After his death, Carloman became the master of the palace of the eastern part of the Frankish kingdom; Pepin, the master of the palace of the western part. They still hesitated to adopt the title of king. In fact, since there was no monarch on the throne at the time of Charles Martel's death, they sought out a member of the Merovingian royal house and had him crowned as Childeric III. He was as feeble a puppet monarch as ever pretended to rule.

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Unexpected visit of the emperor Charlemagne to a schoolroom.

In the year 747 Carloman decided to become a monk and Pepin became the sole ruler of the Frankish domains. Four years later he became king in name, as well as in fact. A national council, representing the whole kingdom, deposed the uncomplaining Childeric and declared Pepin king. Pepin was the first ruler of a new dynasty—that of the Carolingian kings, from the name of Charles Martel. (Charles is *Carolus* in Latin.)

The new king was called Pepin the Short, for he was a little man; but he proved to be a sturdy warrior, as the Lombards found out to their cost. For some time past the Lombards had been on bad terms with the Pope. In the year 753 their king, Aistulf, threatened the city of Rome with a large army. He demanded that the Pope should acknowledge him as sovereign and should pay an annual tribute.

The Pope, Stephen III, refusing these demands, set out for the court of the Frankish king near Bar-le-Duc, in northeastern France, and arrived there in January, 754. The Pope begged Pepin to help him against the insolent Lombard king, nor was his plea in vain. A few months later Pepin crossed the Alps with a big army, defeated Aistulf and made him promise not to molest the Pope any more.

Aistulf broke his promise soon afterward. Again Pepin crossed the Alps and inflicted a new series of defeats on the Lombards. This time Aistulf had to give up to the Pope a number of territories in central Italy that he had captured from the Eastern Empire a few years before. As a result of this gift, which is known to historians as the "donation of Pepin," the Pope became a powerful prince. He now ruled over a band of territory in central Italy extending from the Tyrrhenian Sea to the Adriatic. These new possessions of the Pope became known as the Papal States (see page 4325).

When Pepin the Short died in 768, he left his possessions to his two sons Charles and Carloman. Carloman died in 771, and thereafter Charles, like his father Pepin before him, reigned alone over all the Frankish kingdom. Charles was the mightiest figure in all the Early Middle Ages; men called him Charlemagne (shar′-leh-main), which means Charles the Great.

He was a mighty conqueror, worthy to be compared with Alexander the Great, Cæsar and Napoleon. His first important expedition was against the Lombards of Italy. The Lombard king, Desiderius, had quarreled with Pope Hadrian I. Like Stephen III before him, Hadrian called upon the king of the Franks for aid. Charlemagne made his way into Italy and utterly crushed the foe.

Desiderius was carried off to Germany as a captive, and Charlemagne annexed all the Lombard possessions in Italy to his own kingdom. Thereafter he called himself "King of the Franks and Lombards and Roman Patrician." (Roman Patrician was a title bestowed upon him by the Pope.)

Charlemagne fought several campaigns against the Saracens. In 778 he led an expedition into Spain at the invitation of a rebellious group of Saracens. He got as far as Saragossa, but then he had to return to his own kingdom without anything to show for his efforts. He was more successful in his later campaigns against the Mohammedans. He captured the islands of Corsica and Sardinia, which had been occupied fifty years before by the Saracens. He again invaded Spain. This time he succeeded in conquering a considerable area in northeastern Spain, including much of what is to-day the province of Catalonia.

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The emperor Charlemagne, a great and good monarch.

Perhaps the most difficult of all Charlemagne's wars were those he fought against the Saxons, who dwelt to the east of his domains. They fought fiercely and they did not know when they were beaten. Nine times in all did they yield and then rebel again. Only the iron will of Charlemagne enabled him to finally subdue them in 804.

Charlemagne also conquered and annexed Bavaria, on the upper Danube River. The Slavonic tribes, to the east of Saxony, and their southern neighbors, the Czechs of Bohemia, were forced to acknowledge Charlemagne as their master and to pay him tribute. Finally he invaded the land of the troublesome Avars, south of the Danube, and made them submit to his arms.

At the beginning of his reign Charlemagne was the king of the Franks; not long afterward, as we have seen, he became the king of the Franks and the Lombards. In the year 800 he received an even prouder title. On Christmas day of that year, while the King was kneeling in prayer in the old church of St. Peter in Rome, the Pope placed a crown upon his head and proclaimed him as the "great and peaceful Emperor of the Romans."

The sovereigns of the Eastern Roman Empire were more justified than Charlemagne, perhaps, in laying claim to be the successors of the old Roman emperors. But the men of the West had come to look upon the Eastern emperors as foreigners, unworthy of a great tradition. And so henceforth, in Western Europe, Charlemagne was held to be the lawful ruler of the Roman Empire, or, rather, the Holy Roman Empire —a mighty state under the guidance of the Catholic Church.

The extensive domains of Charlemagne were divided into a number of countships, each ruled by a count. To keep in touch with the outlying countships, the Emperor used to send *missi dominici,* or royal representatives, to the areas in question. These imperial agents listened to all complaints against the count or the local bishop. They either settled matters on the spot or brought them to the attention of Charlemagne.

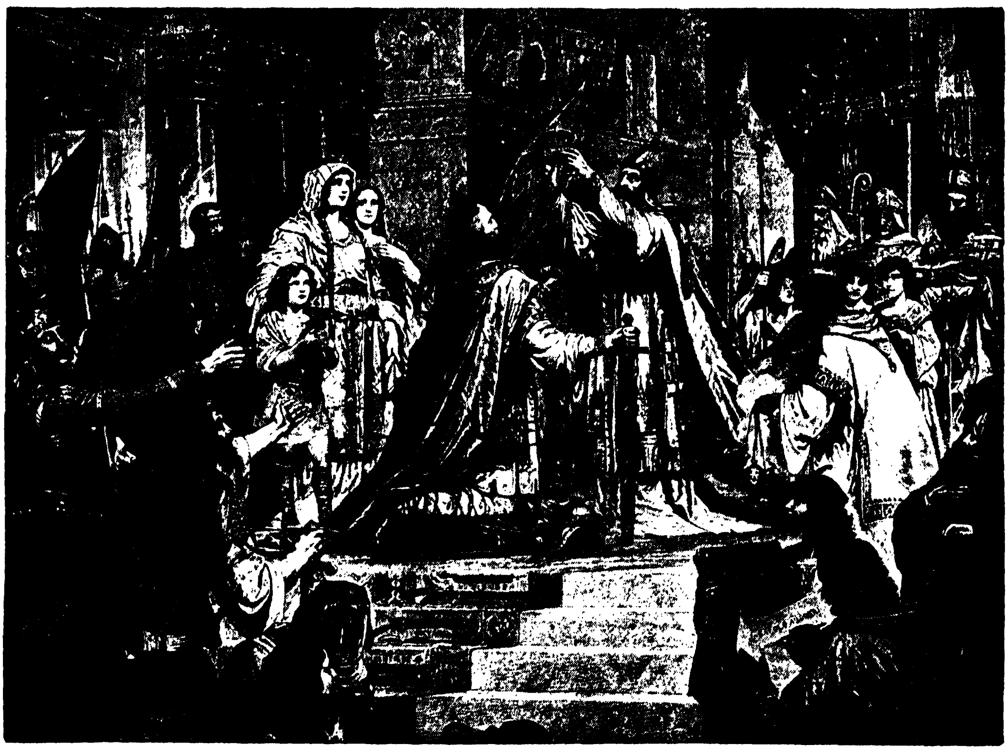
The Emperor was a lover of learning. He founded many schools and brought in learned men from various lands to serve as teachers. He promoted the study of the Latin classics. He set scholars to work to produce good editions of the Old and New Testaments; he had the old heroic epics of the Franks collected and put in writing.

Charlemagne died in January, 814, and was buried in the cathedral of Aachen. His name has been revered throughout the ages. He became a hero of romance and legend; many epics and ballads were written about him. He was credited with marvelous feats that neither he nor any other man had ever accomplished. Men spoke of entirely imaginary expeditions that he had led to Constantinople, Palestine and other lands.

It seemed to the men of Charlemagne's time that a new day had dawned. Europe, they thought, would enter upon a long period of unity, peace and prosperity under Charlemagne and his successors. These fond hopes, alas! were not realized; the empire that Charlemagne built up did not endure. Various reasons have been given. Some men point out that the great emperor's successors were not worthy of him. Others show that the absence of good roads made it hard for the central government to keep in touch with the far-off districts of the empire. All this is true enough. Yet perhaps the chief factor in the downfall of the empire was the rise of the feudal system.

The word feudal comes from the Old High German word *fihu,* meaning cattle or property. The entire feudal system was based on the giving or receiving of property in return for certain services. Traces of the system are to be found in the late Roman Empire; but it first began to take definite shape under the Merovingian kings.

These monarchs often gave their fighting men estates, which were called fiefs or feuds. In return, these warriors bound themselves to give faithful service to their mas-



Charlemagne is crowned emperor by Pope Leo III in the old church of St. Peter at Rome, in the year 800 A.D. He became, in name at least, the successor of the old Roman emperors—Augustus, Trajan, Hadrian and the rest.

ter. The possessor of a fief was called the vassal, or man, of the king. He was intrusted with great power in his fief. He administered justice, collected taxes and raised soldiers. The king was content to leave such details to his vassal, provided that the latter served him faithfully and turned over money and troops to him, as needed.

The possessor of a fief, therefore, was a powerful man. Sometimes near-by landowners found it advisable to seek his protection. They would give up their property to him in exchange for a promise to defend them against their enemies. Then they would lease the property back and continue to cultivate it as before. Naturally this would add to the vassal's possessions and increase his power.

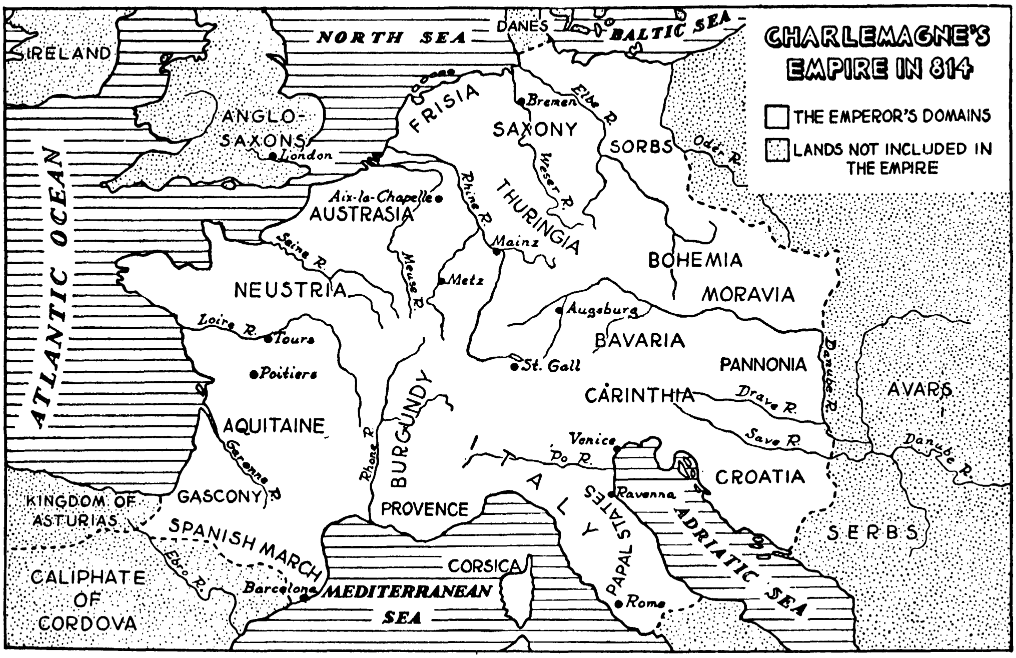
By Charlemagne's time these feudal relations had become widespread. Everywhere there were powerful vassals, who ruled like monarchs over their fiefs. They had vassals of their own, and their vassals, in turn, had other vassals. Naturally all this tended to weaken the central authority. It tended to divide the empire into a series of kingdoms within kingdoms.

Charlemagne managed to win obedience and loyalty from his feudal lords because he was a strong man, whom his subjects, great and small, feared and respected and obeyed. The rulers who came after him were not strong men. And so, in the course of the ninth century, the empire was broken up.

Charlemagne was followed on the throne in 814 by his son Louis the Pious. For a time all went well. But as men came to realize that their sovereign was a weak creature, who sought only peace and quiet, they lost their respect for his authority. His own sons turned against him again and again. In the last ten years of his reign there was almost continual civil war.

Louis died in 840, leaving the empire to be fought over by his three sons, Charles, Lothaire and Louis. At last they came to terms. By the Treaty of Verdun in 843, they divided up the former possessions of Charlemagne among themselves. Charles took over an area corresponding roughly to western France and northeastern Spain. Lothaire became the ruler of Italy and also of a strip of territory to the east of Charles' possessions. Louis received the German lands east of Lothaire's kingdom.

Only once more—in 884—were the former realms of Charlemagne united under a single ruler. This man, Charles the Fat of Swabia, became frightened at his great responsibilities and he abdicated after three short years. Again the empire was divided. One



Culver Service

Incident of the reign of Louis the Pious, successor of Charlemagne. In the year 833, following the revolt of his three sons, Lothaire, Louis and Pepin, the Emperor was publicly humiliated and forced to enter a monastery.

king ruled over France; another, over Germany; still another, over Italy. There was a fourth king in Upper Burgundy and a fifth in Lower Burgundy, or Arles. These kings were no longer the unquestioned masters of the state. The real power was generally in the hands of the feudal lords.

While the great empire of Charlemagne was being broken up, Western Europe was assailed on all sides by fierce enemies. The Vikings of Scandinavia and the Danes, who lived in what is to-day Denmark and Jutland, frequently raided the coasts of Germany and France; sometimes they made their way inland for considerable distances. The Saracens, who were still masters of most of Spain, invaded Italy and southern France again and again. As if all this were not enough, the Magyars, a savage race from beyond the Danube, threatened both Italy and Germany.

By the end of the ninth century, therefore, things looked dark, indeed. Yet the very feudal system that had undermined Charlemagne's empire was to preserve Western Europe in those troubled times.

Each feudal lord, as we have shown, was really a little monarch in his own right. As such he was responsible for the safety of those who served him. There were still royal armies, led by the king, but these could not be counted on. So the feudal lord organized his vassals into a powerful band of mounted warriors, heavily armed, well disciplined and faithful unto death. He also built himself a castle, which served as a fortress and a place of refuge.

In earlier days the German invaders of the Roman Empire had found little difficulty in overrunning the imperial provinces, once they had broken through the outer chain of fortresses that guarded the borders. There were no fortifications to speak of within the Empire; there was but little organized resistance once the imperial legions had been crushed. But by the year 900 things were quite different. All Western Europe was an armed camp, dotted with strong castles and bristling with hardy warriors. Invaders—Vikings or Saracens or Magyars—might win successes here or there but they could not hope to conquer the land. And so the Christian states survived.

With the triumph of feudalism the story of the Early Middle Ages comes to an end. In another article we shall tell you about the Feudal Ages that followed.

THE NEXT STORY OF ALL COUNTRIES IS ON PAGE 1564.

The American Museum of Natural History

As graceful as a gazelle! We understand these words when we look at these Grant gazelles with their beautiful, sweeping horns. They make their home on grassy plains in Africa. The oryx (left) has long, straight horns.

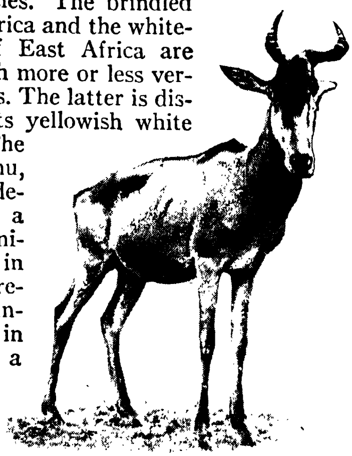
THE ANTELOPES, GIRAFFES AND OKAPIS

THE antelopes belong to the Bovidae, the same horned family as the cow, the sheep and the goat. The Bovidae are a family of ruminants, those cud-chewing animals which swallow their food in haste into a storage stomach, from which it is returned later to the mouth a little at a time to be thoroughly chewed. The cud-chewers are described on page 1264. There you see that they belong to a large group of even-toed ungulates, that is, they have two large toes, with hoofs, on each foot, and in some cases two small toes at the side. Few antelopes have the side toes, or lateral toes, as they are called.

Antelopes are found only in Africa and Asia. Africa is their true home. Over this vast territory they inhabit every type of country. In size they range from the eland, an animal as large as an ox, to the tiny royal antelope scarcely bigger than a hare.

One of the queerest of the antelope tribe is the hartebeest; it has an abnormally long face and doubly curved horns. This is an animal of the plains. Often many of the kind will congregate in large herds in company with gnus and zebras. Most of the forms of hartebeests are of a buffy brown color and stand a little over four feet at the shoulder. Close relatives of the hartebeests are the topi, tiang and korrigum, which are of a dark chestnut color with a black blaze on their faces. They are more normal in appearance; that is, their heads are more in proportion, and their horns less curved. The blesbok and the bontebok are smaller animals, with a white blaze on the face. These are no longer found in the wild state but occur only on some of the large African ranches in a semi-wild condition. The bontebok has become very scarce, and unless it is rigidly protected it will soon become extinct.

The gnus, or wildebeests, are queer-looking animals with horse-like tails, high shoulders and blunt muzzles. The brindled gnu of South Africa and the white-bearded gnu of East Africa are bluish gray, with more or less vertical dark stripes. The latter is distinguished by its yellowish white throat fringe. The white-tailed gnu, or black wildebeest, is really a dark brown animal, inferior in size to the two preceding, being under four feet in height. It has a flowing white tail and horns which curve forward and downward and then up. A tuft of hair on the nose adds to the queer appearance of the white-tailed gnu. In former years this gnu was found in vast herds on the plains of South Africa, but it is now restricted to a semi-domesticated condition on some of the ranches.



Hartebeests have long faces.

Throughout the forests and brush country of Africa are found groups of small antelopes called duikers or duikerbok. There are about twenty species of duikers and these have been divided into more than eighty forms. Most of them average about two feet high. Of these the most common is the gray duiker, represented by forms from the Cape of Good Hope to Ethiopia. It generally lives in bushy country, lying concealed until almost trod upon, when it dashes off after the manner of a rabbit. The red duiker also has an extensive range but it is more partial to forested country.

The largest of the duikers is the yellow backed, which inhabits the forests of western Africa and is easily distinguished by the presence of a long, yellowish patch on its back. It stands about thirty inches at the shoulder.

The blue duiker is of a smoky brown color and is much smaller in size, being about fourteen inches high. It is a forest animal and has the habit of hiding among the branches of fallen trees, often several feet from the ground. The most strikingly marked of all the duikers is the banded, or zebra, duiker. The color is orange-red with vertical black bands on the back. This pretty little duiker is found only in the forests of Liberia and Sierra Leone.

In the interior of Somaliland there is found a small, grayish fawn antelope with exceptionally large ears, known as the beira. It is about twenty-one inches high, inhabits the open deserts and is a very rare animal. The dik-diks are small, slenderly built antelopes standing about fourteen inches high. In general color they are gray on the back, with brownish legs and white underparts. Some forms have a short, trunk-like nose. They prefer semi-arid thornbush country, and when running off remind one more of a rabbit than of an antelope. Thousands of their skins have been exported to be made into gloves.

Pictures, New York Zoological Park
The white-tailed gnu or black wildebeest.

The oribi is found on the grassy plains of Africa. It has a wide distribution. It is brownish yellow and stands about two feet high; it has lateral toes, or hoofs. The male has horns which are upright, straight and annulated (ringed).

The suni is a small antelope about fourteen inches high, found in East Africa. It inhabits thick undergrowth and is brownish gray in color. The smallest of all the antelopes is the royal, or pigmy, antelope, about ten inches high. The sharply pointed horns are only about one inch long. This small antelope lives in west-African forests.

The steinbok, in outward appearance, looks much like the oribi but has larger ears and a longer tail; and it lacks the small lateral hoofs. This is an animal of the grassy plains. It spends the day hidden in the grass, feeding in the early evening and at night.

The grysbok is about the size and shape of the steinbok, but has the lateral hoofs. It is a beautifully colored animal, with a rich red coat mixed with pure white hairs. It is confined to South Africa.

Wherever in Africa there are mountains or large outcroppings of rocks, there you are likely to find the klipspringer, a small rock antelope living from the Cape of Good Hope to Ethiopia. It stands about twenty inches high. The hair is long and coarse, quite unlike that of any other antelope. Its color is a mixture of brown and greenish yellow. It is never found away from rocky territory. With amazing, sure-footed agility, the little klipspringer can climb up and down the steep sides of cliffs.

New York Zoological Park
When startled from their hiding-places, little duikerbok dash off like rabbits.

The waterbucks form a group of large antelopes standing about fifty inches in height. Their hair is coarse; their horns are long, growing slightly backward, upward, and forward toward the tips, and strongly ringed. The females are hornless. These animals are never found far from water. The common waterbuck occurs from South Africa north to British East Africa. It is distinguished by having a conspicuous white line encircling the rump. The defassa or sing-sing waterbuck is found in western and north-central Africa. Instead of the white ring on the rump, the sing-sing has a large white patch below the tail. The lechwe is a smaller animal than the typical waterbuck, with relatively longer horns. It is brownish yellow in color. It is common on the plains and swamps of Northern Rhodesia. In the Bargueolo marshes of Northern Rhodesia a black form of the lechwe occurs.

The most strikingly colored antelope of this group is the Nile lechwe or Mrs. Gray's waterbuck. This animal lives in the swamps along the White Nile. Old males are blackish brown with a white patch on the shoulders and upper side of the neck. Young males and females are chestnut.

The kobs have very much the appearance of the lechwe but are slightly smaller and have shorter horns. The white-eared kob, found in the regions of the upper Nile, is the handsomest in color. Old males are blackish brown, with white on the ears, a patch of white around each eye and on the throat and muzzle. The young males and females are reddish brown. The males and females of the Uganda kob are all reddish brown with white about the eyes and on the muzzle. The kobs of western Africa are smaller and have but a white line over the eye. The puku looks like a small kob, with heavier, short horns. It is of a uniform reddish yellow color, and the hair is longer, with a slight tendency to curl. This animal lives in certain swamps and plains of Northern Rhodesia and Nyasaland.

The reedbucks are found throughout much of Africa on plains, swamps and mountains, but not in heavy forest. They are generally yellowish red, with medium-sized horns that grow upward and then forward at the tip. They average about thirty inches at the shoulder, and their short, bushy tail is very similar to that of a white-tailed deer. They generally go about singly or in small family parties, and when alarmed utter a shrill whistle. The mountain reedbuck is smaller than the typical reedbuck and is of a grayish fawn color.

The Vaal rhebok is a close relative of the reedbuck but has upright horns, and the pale-gray coat is of a woolly nature. This animal is found about the mountains and hills of South Africa.

The dibatag, also known as Clark's gazelle, is a queer-looking animal with a long neck and tail. The horns of the male resemble those of the reedbuck, to which it may be distantly related. It is of a deep cinnamon color on the upper parts and has the face markings of some of the gazelles. It stands about three feet at the shoulder and is found only on the deserts of central Somaliland. When running, the dibatag has the peculiar habit of throwing its long neck far back and elevating its tail so that tail and neck nearly meet over the back.

The impalla is a common animal on the plains of East Africa. It is bright yellowish red, with long, lyre-shaped horns. The impalla goes about in herds of considerable size and is well known for its habit of leaping high in the air. It stands about three feet in height. A form of the impalla is also found in Angola.

The saiga is a remarkable-looking animal with a large swollen nose which forms a short trunk. It is about as big as one of our sheep. Its color is a grayish white. The horns are pale amber—on most antelopes the horns are dark. The saiga is found on the steppes of northern Turkestan and southern Russia.

On the high plateau of Tibet lives the chiru, or Tibetan antelope, which also has the swollen nose; but the swellings are on the side, and the nose lacks the trunk-like appearance of the saiga's. The horns are black and erect and may reach a length of more than two feet. To protect it from the severe climate, the animal is covered with a thick fur which is woolly near the skin. The general color of the chiru is light fawn, with dark brown or black face. The does have no horns.

Pictures, New York Zoological Park
The rare bontebok wears a white blaze.

The blackbuck, or Indian antelope, is restricted to the open plains of India. It frequently goes about in large herds and is very fleet of foot. The females and young males are reddish fawn, but as the males become older their coats become blackish brown. The horns are V-shaped and spiral slightly and are covered with rings throughout most of their length. The females are hornless, although there are a few exceptions to this rule.

The gazelles are medium or small-sized antelopes found in both Asia and Africa. They are generally of a sandy color and have a white streak along the sides of the face. There are more than twenty species in existence. One of the best known is the little dorcas gazelle which inhabits the dry lands of North Africa, Palestine and Syria. This animal stands about twenty-two inches in height. The Thomson's gazelle of Kenya and Tanganyika is well known to many sportsmen who visit that district. It stands about two inches higher than the dorcas. These gazelles are found on the grassy plains which are also inhabited by the larger Grant's gazelle, one of the largest of the gazelles, which stands about thirty-three inches high. The horns are long and slightly lyre-shaped. On the Grant's gazelles of Tanganyika the horns are widely spread so that the points are wide apart, and gazelles with this type of horns are known as Robert's gazelles. The largest gazelle is the dama, or addra gazelle. It stands about three feet at the shoulder and has a longer neck than most of its kin. It inhabits the desert regions of North Africa.

Gray's waterbuck.

A number of different gazelles inhabit the plateaus of central Asia. Among these are the Tibetan, Przewalski's, the Mongolian and the goitered gazelles. On the plains of India the chinkara, or Indian gazelle, lives. It is dull-fawn color and stands about twenty-six inches at the shoulder.

The springbuck differs from the true gazelles in having a line of pure white hairs extending down the middle of the hind parts of the back; these hairs can be erected and form a conspicuous patch when the animal is excited. Springbucks at one time traveled in vast herds on the plains of South Africa, but continuous hunting has caused them to decrease, so that now they are found in only a small portion of their former range. The springbuck owes its name to its habit of suddenly leaping high in the air.

The gerenuk, or Waller's gazelle, may be recognized by its extremely long legs and neck, reminding one of a small giraffe. Its general color is brown, with a broad band of

The reedbuck, an African antelope, gives a shrill whistle as a signal of danger.

The blackbuck needs to be fleet of foot for it lives on the open plains of India.

Pictures, New York Zoological Park

Springing high in the air is a habit of the springbuck, a native of South Africa.

darker brown extending down the middle of the back. The gerenuk stands a little over three feet at the shoulder. Its food consists of the leaves of trees and bushes, and it often feeds while standing on its hind legs.

The sable antelope is a large animal about four and a half feet high. It has long, sickle-shaped horns and an erect mane. As the male becomes older, its coat turns to a very dark brown or black. The young males and females are reddish brown. In Angola the sable antelope reaches its largest size. The horns of this form are sometimes over three feet long. The sable antelope is also found in the Transvaal and Rhodesia and in the coast districts of East Africa.

The roan antelope, although of slightly larger size than the sable, has shorter horns and a grizzled coat; it is not so handsome as the sable antelope. The roan is found throughout the plains of Africa north of the Orange River and has a much greater distribution than the sable. South of the Orange River, in South Africa, the blaubok, or blue buck, was formerly found. It had the general appearance of a small roan antelope. It became extinct about 1800.

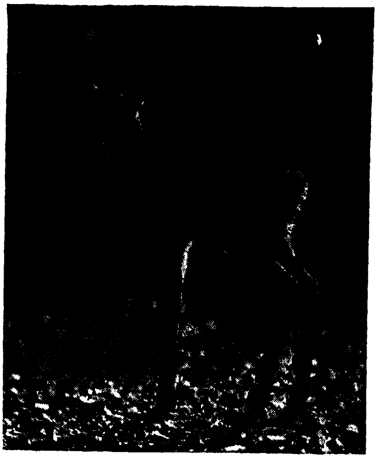
WHY IS THE GEMSBOK LIKE A CAMEL?

The gemsbok is an animal of the desert regions of Southwest Afirca. Its straight, spear-like horns may reach a length of four feet. It differs from most other antelopes in the fact that the horns of the female, although slimmer, are often longer than those of the male. The gemsbok is a grayish brown animal with a black stripe extending along the lower sides and upon the flanks. It stands about four feet in height. This animal is known to go without drinking for months at a time, obtaining what moisture it needs from the food it eats.

In East Africa the gemsbok is represented by the beisa, or oryx, a slightly smaller animal, which lacks the black on the flanks. The beisa found in Tanganyika is the fringed-eared oryx which has tufted ears. The Arabian oryx is a still smaller form, with a whitish body. It is confined to the deserts of central Arabia. The white oryx, the horns of which differ from the other oryx in being much more curved, is found in the deserts of North Africa. Its general color is white, with a reddish wash. The last color is strongly pronounced on the neck. The addax antelope is a close relative of the oryx. Its horns, however, have a spiral twist instead of being straight. The addax, like the oryx, is found on North-African deserts.

The four-horned antelope is a small animal found only in India. It is about two feet in height and its general color is yellowish brown. It is noteworthy for the fact that it generally carries two pairs of horns, the extra pair being on the forehead. These horns may be as much as two inches long, but they are frequently not more than short knobs, and are sometimes entirely wanting. The females are hornless.

The nilgai, or blue bull, is the largest of the Indian antelopes. The male stands about four and a half feet at the shoulder and is bluish gray. The females and young are yellowish brown. The nilgai is an ungainly looking animal with a long head and short horns; and the forelegs are considerably longer than the hind. Both male and female have an upright mane, and the males have a tuft of hair hanging down from the throat.



The renowned nilgai, largest of Indian antelopes, is highly prized by hunters.

The bushbacks, or harnessed antelopes, are a group of forest-living antelopes, generally under three feet high. The females are hornless, and in color are chestnut extensively striped with white. The males are generally darker and in some forms the white harness, or striping, is nearly absent. The horns of the true bushbucks form simple spirals and seldom reach a length of more than eighteen inches. Although generally forest-living animals, they are also found in the thick thornbush country and often come out to feed in the open, along the edges of the forest. Bushbucks are found in suitable localities throughout Africa, and many different forms have been described by travelers and naturalists.

One of the most beautiful of the antelopes, a relative of the bushbucks, is the nyala of Zululand and neighboring sections of southeastern Africa. It is about three and a half feet high. The males are slate gray and have a fringe of long, soft hair on the throat and underparts of the body, and a white crest along the back. The legs are tan. The female is bright reddish chestnut, with numerous white stripes, short-haired throughout.

Pictures, New York Zoological Park
The roan antelope, a plain-dweller of Africa.

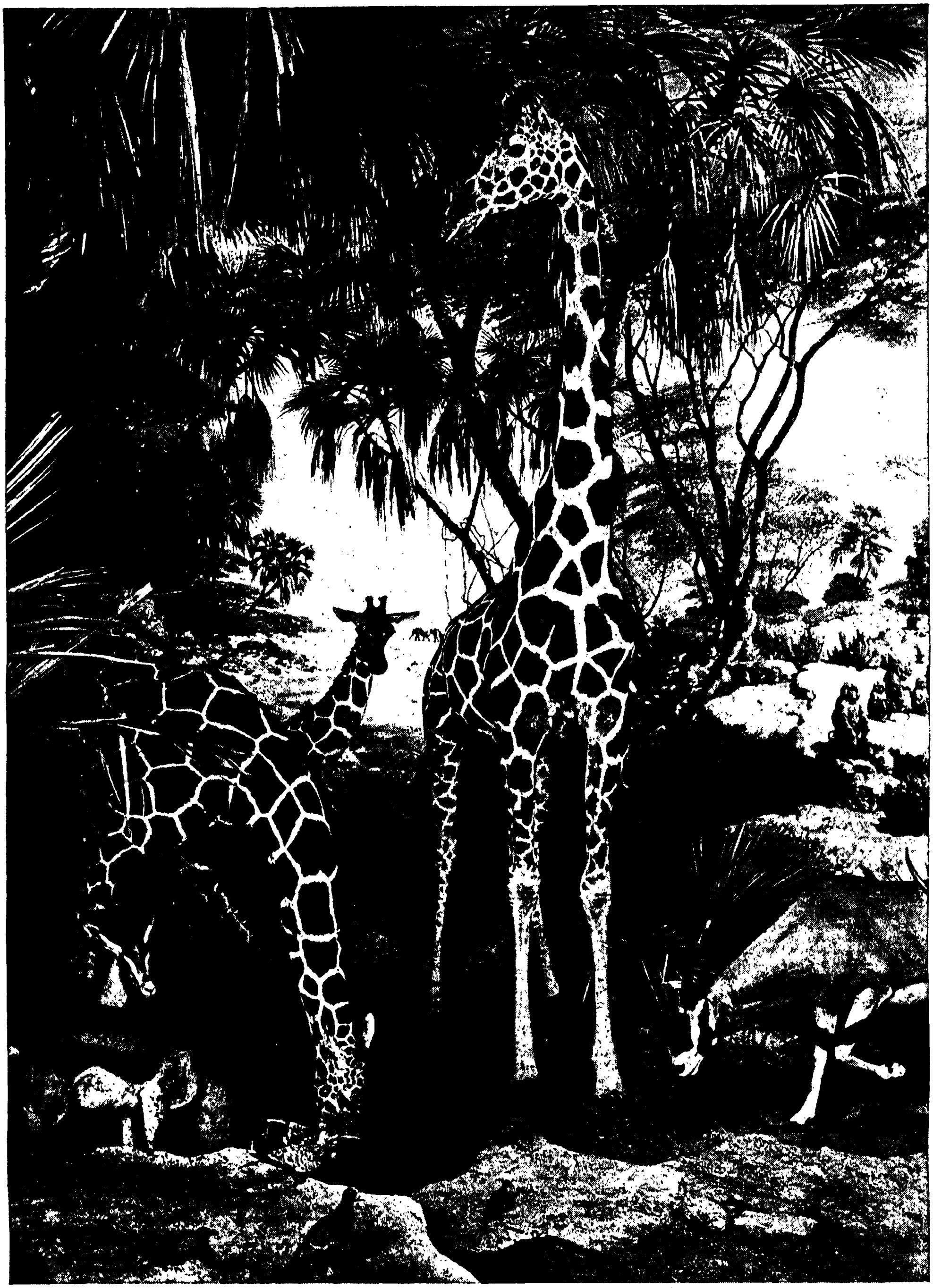
The mountain nyala of the highlands of southern Ethiopia is a much larger animal, about four and a half feet high. Although the back is fringed, this animal lacks the long hair on the underparts. The male and female are of the same general dark-brown color, striped with white bands. The horns are long and similar to those of the greater kudu, which we shall describe in a moment. But the horns of the mountain nyala seldom make more than one complete twist.

The situtunga is a water-loving animal that makes its home in the swamps and along the rivers of central and eastern Africa. It differs from all the other antelopes in having elongated hoofs which help to support its weight in the soft mud of the swamps where this animal makes its home. It stands about four feet high and has typical bushbuck horns, although longer, a set just under three feet having been recorded. Like the typical bushbucks, the female is bright chestnut, while the male is grayish brown. Both sexes have the white stripes.

The grandest and most striking of all the antelopes is the greater kudu, standing almost five feet in height, with long spiraling horns which may reach a length of over five feet, the longest recorded being sixty-six and a half inches. The kudu has a fringe of long hair extending down from the throat. Both sexes are grayish buff with vertical white stripes along the sides. The kudu prefers to live among rocky hills covered with thornbush, and its range is limited to this type of country.

The lesser kudu is much smaller, being about three and a half feet at the shoulder. It also differs from the greater kudu in being brighter in color, with numerous white stripes and in having no fringe on the throat. Its horns are shorter and closely spiraled. It inhabits the dry bush-covered plains, seldom emerging from the dense

GIRAFFES MEETING AT A WATER HOLE



American Museum of Natural History

The giraffe is its own watchtower. Tallest of mammals, it can see great distances. But it is almost voiceless.

thickets. It is found in north-eastern Africa.

The bongo is a forest-loving animal living in dense bamboo thickets. In general coloring it is bright chestnut-red, with numerous white stripes extending down along the body. The old bulls become much darker, almost black, about the head and neck. In height bongos are about four feet, and they differ from most antelopes in the fact that the females also carry horns. Bongos are found in the forests of western Africa and some of the mountain forests of British East Africa.

The greater kudu reaches a height of almost five feet.

The eland is the largest and most ox-like of all the antelopes. It stands five and a half feet at the shoulder and has a heavy body. Both sexes carry horns, which form a close spiral at the base and may reach a length of three feet. The horns of the female are more slender than those of the male. Both sexes also have a heavy dewlap, or fold of skin, hanging below the throat. Elands go about in small herds and are often found on the grassy plains in company with zebras and other antelopes. They are also found in the dry thornbush country. In the southern Sudan and in western Africa, a larger form of eland occurs, with longer and more massive horns. This is the giant eland.

Pictures, New York Zoological Park
Largest antelope of all—the eland.

The giraffe, while at one time thought to be related to the antelopes, is now believed to be closer to the deer, and with the okapi is placed in a separate family. The horns of the giraffe and okapi are short, covered with skin, and are never shed. The giraffe, because of its long neck, can never be mistaken for any other animal. It is the tallest of any existing mammal; specimens up to eighteen feet in height have been recorded. Although the neck is so long, the number of neck bones is only seven, the same number that is found in the cow or the mouse; but the giraffe's seven neck bones are very long.

The giraffe is a browser, not a grazer; that is, it does not crop grass off the ground but feeds on the leaves of trees. It is especially fond of the leaves of the acacia tree, and in many sections its food appears to be made up entirely of these small leaves. The tongue is long, sometimes as much as a foot and a half. The upper lip is long and flexible, and it is a fascinating thing to watch a giraffe grasping a tiny leafy morsel of food from a tree with its tongue and upper lip. The giraffe is an animal of the African plains and thornbush country. Its flesh is good for food, and over much of the vast territory which it once inhabited, especially in South Africa, it has been exterminated. However, in East Africa, where there are laws protecting the giraffe, the animal is still common.

Giraffes go about in small herds and depend upon their keen eyesight to warn them of their enemies. Although they occasionally visit water holes, they are capable of going without water for a long time. Some of the extinct ancestors of the giraffe were quite deer-like in form, and their fossil remains have been found in Europe and Asia.

The okapi, inhabiting the deep forests of the eastern Congo, is the only existing close relative of the giraffe. It was not until 1901 that this interesting animal became known to the outside world in its true form. As far back as 1890 Stanley brought out the first proof of the existence of a strange animal which he referred to as a donkey. In 1901 Sir Harry Johnston forwarded to the

The bongo, a forest animal.

British Museum portions of the striped skin, and on account of the markings the animal was thought to be a forest zebra. A few months later, the true character of the animal became known.

The okapi is closely related to giraffes.

A large okapi stands about five feet at the shoulder. It is dark brown in general color with numerous white stripes on the flanks and legs. The male alone carries horns.

The prong-horned antelope of the plains of North America is not a true antelope, but has characteristics of the goats, the antelopes and the deer. On account of its strange make-up it is placed in a family by itself, the Antelocapridae (antelope-like goats). Although it carries true horns that grow over a bony core, similar to those of the goat and the cow, it sheds them every year. However, the process of shedding is very different from that of the deer. In the fall or early winter the outside horn sheath falls off, but underneath, over the bony core, the new horn is already well formed. The new horn develops from the tip of the bony core and grows slowly downward to the base. When the new horn is fully grown the old horn loosens and drops off, leaving the new horn to take its place. This new horn is covered with skin and hair, but these soon dry and disappear. The horn of the prong-horned antelope has a single prong. Horns have been recorded up to twenty inches in length. Both the male and the female may carry horns, but those of the female are much smaller or may be absent.

A male prong-horned antelope stands about three feet at the shoulder and weighs a little over one hundred pounds. In color it is light reddish brown with a darker mane. The nose and a patch under the ear are dark brown. The underparts are creamy white. On the rear there is a large white patch in which the hairs are longer than the remaining hairs on the back. The prong-horned antelope has the power to raise and lower these hairs. When the animals are startled these hairs are raised and flash as a warning.

In olden days the prong-horned antelope rivaled the buffalo in numbers on our western plains. Constant hunting and the destruction of their range reduced their number until, in 1908, it was believed that there were not

Pictures, New York Zoological Park
The prong-horned antelope of North America.

more than twenty thousand left north of Mexico. Thanks to game laws, parks and refuges, the number has now been increased.

By T. Donald Carter.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 1505.

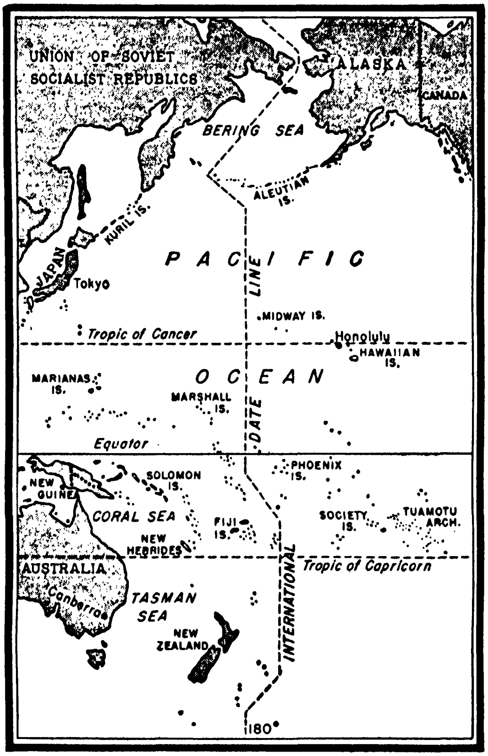
The sun god, Phoebus Apollo, drives the spirited, golden horses of the sun across the heavens. Before the brilliance of his flaming torch, night slinks away, and the moon and stars fade into nothingness.

WHERE DOES THE DAY BEGIN?

YOU know what the meridians are, on maps. They are the lines of longitude that are drawn from north to south. The longitude of a place is its distance in degrees east or west of the meridian which runs through Greenwich, England. The Greenwich meridian is numbered zero degrees, and it is from that imaginary line that we figure longitude, both east and west. For all the people living along one meridian, day begins at the same time. As the earth spins eastward on its axis, all the people along one particular meridian, except in the far north and the far south, will see the sun come above the horizon at the same time. For the people who live to the west of that particular meridian, the sun will not have risen yet. For those who live to the east, the sun will already be climbing the sky, or it may have crossed the sky and be setting in the west.

Since day is always beginning at some place, and always ending at some place, too, it is necessary to have some one meridian where we can say that the day begins. Otherwise, the day would constantly be chasing itself around the world, and no one would know whether it is today, tomorrow or yesterday. The meridian that has been chosen to mark the beginning of the day is known as the international date line, and it is out in the middle of the Pacific Ocean. It is halfway around the world from the Greenwich meridian and is numbered the 180th meridian. To the west of this line it may be, let's say, May 9. To the east of the date line it will be May 8. All the countries of the world use this line to mark the beginning of the new day.

The International Date Line is not a straight line. It has been made crooked so that it will not pass through the middle of any group of islands and give the people of the islands two different dates at the same time. If it were straight, the people of the Fiji Islands, for instance, would have



one date to the east of the line, and another to the west. This would be inconvenient for trade, and for many other affairs of life in common.

WHAT IS MEANT BY THE GREEK KALENDS?

There is no such thing as the Greek Kalends, although that expression is often used. In the ancient Roman calendar the first day of each month was called the Kalends. The Greek calendar, however, had nothing corresponding to the Roman Kalends. When we wish to speak of a time that will never come we may refer to it as the Greek Kalends. To say that a debt will be paid on the Greek Kalends means that that debt will never be paid.

WHAT IS THE MEANING OF ST. VALENTINE'S DAY?

The fourteenth of February is called St. Valentine's Day. On this day many people send valentines—loving messages or gifts—to those for whom they care. The day got its name as the feast day or name day of several of the early Christian martyrs who were named Valentine. The sending of valentines has nothing to do with these martyrs, however, and no one knows just where this custom began.

HOW CAN WE TELL THE NUMBER OF DAYS IN ANOTHER WORLD'S YEAR?

If we know how long a planet takes to go once around the sun, we know the length of its year. If we know how long it takes the planet to spin around once on its own axis, we know the length of its day. Then all we have to do is to divide the length of the year by the length of the day, and we have the number of days in the year.

Mercury, the little planet nearest the sun, travels around the sun once in every eighty-eight of our days. It also spins around on its axis once in eighty-eight days. Mercury's year, then, is one day long, since the length of its year divided by the length of its day gives the answer *one*.

HAS THE DAY ALWAYS BEEN DIVIDED INTO TWENTY-FOUR EQUAL HOURS?

No. In ancient days the Egyptians and the Greeks divided the daily periods of light and darkness into twelve hours each. As the periods of dark and light vary with the seasons, the length of the hour kept changing. At one season there would be something like sixteen hours of light and only eight hours of darkness—as we reckon hours today. This meant that the twelve hours of light would each be longer than the twelve hours of dark at this special time of year.

This arrangement was so inconvenient that in the thirteenth century an Arabian mathematician introduced equal hours all the year around. The length of the hour was based on a twelfth part of the period of daylight at the equinoxes, when day and night are of equal length. It was not until some time later, however, that this hour was generally adopted all over the world.

HOW DID WE GET APRIL FOOL'S DAY?

April Fool's Day is the day for playing practical jokes and for fooling people. We do not know how this day first came about, but we do know that the April Fool customs go way back in history. On March 31, the last day of the Hindu Feast of Huli, a spring festival, the Hindus sent people on April Fool errands, just for the fun of teasing them.

Some people believe that April Fool's Day began in 1564 in France, when a new calendar was adopted, making the new year begin on January 1, instead of April 1. The old new year's date was celebrated, not with gifts and New Year's messages, as it had been before, but with jokes and pranks.

HOW DID THE DAYS GET THEIR NAMES?

It is often said that the days of the week were named after the planets and the sun and the moon. It is much more likely that the days as well as the planets were named by the early peoples after their gods.

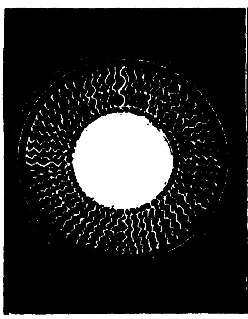
Before the telescope was invented, men could see only five planets, but they believed that the sun and moon were planets, or wanderers, too, making seven in all. Since seven was regarded as a magic number in those days, it may have seemed especially fitting to make the days of the week seven in number.

The names of the days as we know them in English came from the early Saxon or Norse day names. Sunday, of course, was the sun's day. Monday was named after the moon. Tuesday took its name from the Norse god of war, Tiw, who was much like the Roman god, Mars. Wednesday was named for the Saxon god, Woden, who corresponded to the Roman god, Mercury. Thursday was Thor's day—Thor was the Norse Jove or Jupiter. Friday was named for the Saxon Venus—Freya—the goddess of beauty. Saturday is Saturn's day.

HOW IS THE DATE OF EASTER FIXED?

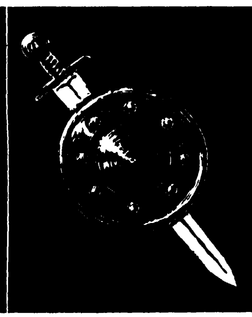
In early times all countries did not keep Easter on the same date. The churches of Asia Minor celebrated it on the same day as the Jews kept their Passover, while the churches of the West, remembering that Jesus rose on a Sunday, kept Easter on the Sunday following the Passover day. Various attempts to reconcile these two practices failed, and then the Council of Nicaea passed a decree that everywhere the great feast should be observed upon the same day, that day to be Sunday following the Jewish Passover. To prevent further disputes, four rules were laid down for the fixing of the date of Easter.

It was decided that March 21 should be regarded as the spring equinox—the time in spring when day and night are equal; that the full moon on that date, or the next after that date, should be taken for the full moon of the Passover month; that the Sunday following full moon should be Easter Day; and that if the full moon happened on a Sunday, Easter should be the Sunday after. This plan has been observed ever since, and by



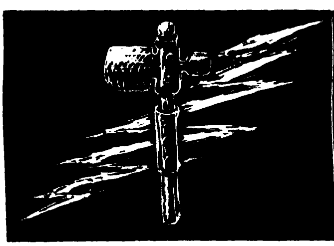
Sunday, named for the sun.

Monday, named for the moon.

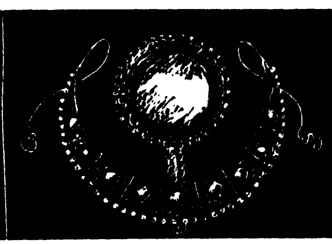


Tuesday, named for the Norse war-god, Tiw.

Wednesday, named for the Saxon god Woden.



Thursday, named for the Norse god Thor.



Friday, named for the Saxon goddess Freya.

Saturday, named for the planet Saturn.

it the date of Easter is fixed for every year.

In carrying out the arrangement for the fixing of Easter various difficulties have arisen during the centuries owing to the fact that the moons do not correspond exactly with the calendar. A series, or cycle, of 19 years has therefore been taken and numbered from 1 to 19, the numbers being known as Golden Numbers. Then to each of these years has also been given a number which is the age, reckoned in days, of the moon at the beginning of the year. The numbers in this second series are known as Epacts, and from the Golden Number and Epact the full moon for deciding the date of Easter in any year may be worked out.

It is curious that in arranging the date of Easter according to rule, the spring equinox is a calculated date and not the actual spring equinox; the moon referred to is not the actual moon shining in the sky, but a mathematically calculated moon; and full moon does not mean a complete circular moon, but a supposed full moon according to certain averaging over a course of years. All this is due to the imperfections of the calendar, which never corresponds exactly with the real movements of the sun and moon.

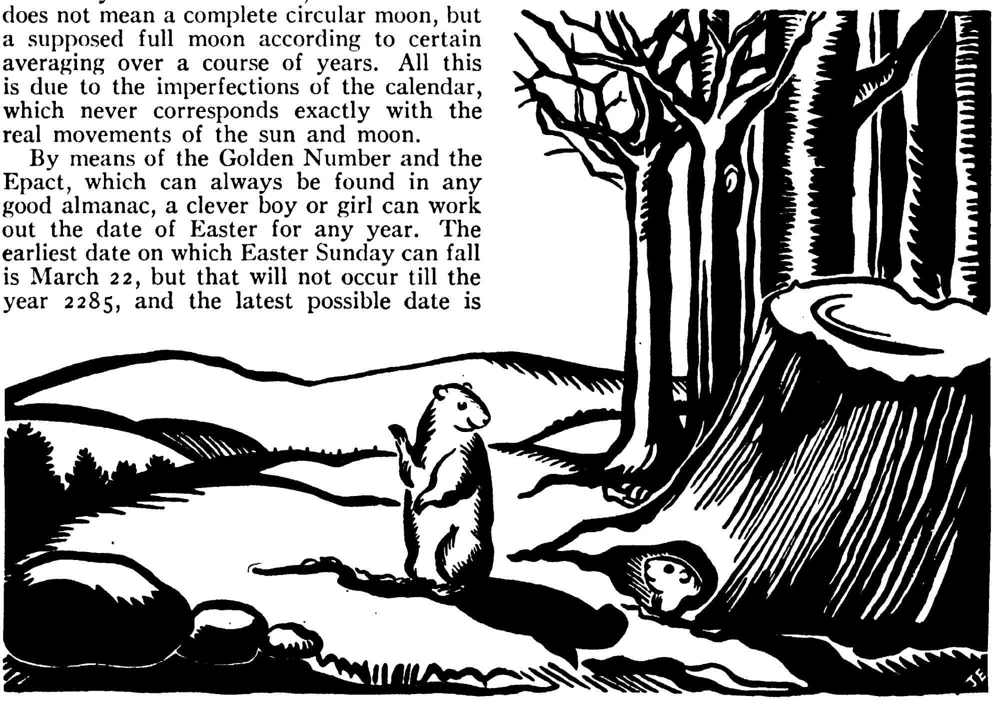
By means of the Golden Number and the Epact, which can always be found in any good almanac, a clever boy or girl can work out the date of Easter for any year. The earliest date on which Easter Sunday can fall is March 22, but that will not occur till the year 2285, and the latest possible date is April 25, which last fell in 1943.

The reason nineteen years are taken to form a cycle for reckoning the Golden Numbers is that after nineteen years on a given day of the month the moon is approximately in the same position in the sky as it was nineteen years before, so that nineteen forms a complete series.

WHAT IS GROUND HOG DAY?

There have always been a great many superstitions about the weather. One of the most interesting of these is connected with Ground Hog Day, February 2. The ground hog, or woodchuck, is a little animal found in the fields and woods over much of the North American continent. It is a burrowing animal and spends the winter hibernating, that is, sleeping snugly in its burrow. When spring comes, the gound hog awakens and comes out of its hole.

People used to believe that the ground hog woke up and came out every year on February 2. If there was enough sunlight for him to see his shadow, he was supposed to go back into his burrow and sleep for six weeks more—a sign of a late, cold spring. If he did not see his shadow, he stayed awake,



and the spring would be early and mild. Just why February 2 was chosen as Ground Hog Day is not known.

WHAT IS MEANT BY THE TERM RED-LETTER DAY?

A red-letter day is a day that is an especially important or happy day. The day when you first went to school was a red-letter day, as was also the day on which you were given your first puppy. In almanacs and calendars the dates of Sundays and holidays are often printed in red. In prayer books the days of special importance to the church are often printed in red numerals.

WHAT IS THE MEANING OF HALLOWE'EN?

Hallowe'en is related to an old, old festival. The Romans held a feast about the first of November, in honor of Pomona, goddess of fruit trees. In Britain the Druids celebrated a festival at the same time in honor of the sun-god, and in thanksgiving for harvest, and the two festivals seem to have become one in the minds of the Britons. When the people became Christians the early Church Fathers wisely let them keep the old feast, but gave it a new association by holding it in commemoration of all saints. The eve of the festival came to be called All Hallow E'en. The name comes from the old English word *halwe,* or, as we now say, holy. The Feast of All Saints occurs on November 1; the eve, therefore, is on October 31. Bonfires were lighted in ancient Hallowe'en celebrations.

Many beliefs grew up about this day, such as the belief that on this one night the spirits of the departed were allowed to visit their old homes.

HOW IS TIME DIVIDED?

The division of time into days and weeks and months and years is partly natural and partly artificial. There are longer periods of time, known as eras, which are usually reckoned from a given date.

The Christian Era is reckoned from the supposed date of the birth of Jesus. Events occurring before that time are said to have taken place in a certain year B.C., or Before Christ. Things happening since then are spoken of as occurring in such and such a year A.D., or Anno Domini—"in the Year of our Lord."

The Mohammedans reckon their dates from the Hegira, or flight of Mohammed from Mecca to Medina in 622 A.D. They speak of events as occurring in such and such a year A.H., or Anno Hegirae. January 1, 1950 A.D., for instance, was in 1369 A.H. The Mohammedan year is not the same length as ours and does not correspond to the seasons.

The Jews speak of any date as A.M., or Anno Mundi—"in the Year of the World"—dating everything from the supposed time of the creation of the world. In the Jewish calendar 1950 A.D. was A.M. 5710-11.

The Romans reckoned their dates as A.U.C., or Anno Urbis Conditae, which really means "from the Year of the building of the City," or the founding of Rome. During the first five centuries after the birth of Christ, Christians recorded time in the same way as the people among whom they lived; but in 532 A.D., when their numbers had increased considerably, Dionysius Exiguus, a monk of Scythia, proposed that Christians should date all events as from the birth of Christ.

He looked into the matter, and came to the conclusion that Jesus was born on December 25 in the year 753 after the founding of Rome. But, as the Roman year began with January, it was considered too inconvenient to have the Christian year beginning on a different date. It was decided that the beginning of the Christian Era should be reckoned as January 1, 754 A.U.C., which to Christians became known as A.D. 1. Therefore the first year of the Christian Era is not the year of the birth of Jesus, but what was then thought to be the year after.

Later researches showed that Jesus was probably born, not in 753 A.U.C., but more than four years earlier. Herod died in 750 A.U.C., and Jesus was certainly born before that. Jesus was probably born about 6 B.C.!

There are only three natural divisions of time—the day, the month and the year. Of these, the day and the year are more suitable for reckoning than the month. A day is the interval of time which elapses between two successive appearances of the sun at the same point in the heavens. A year is the length of time the earth takes to travel once around the sun. The month, or *moonth,* is roughly the time taken by the moon in traveling once around the earth.

These natural divisions of time date back to the days before history was written. The divisions of time into weeks, hours, minutes and seconds are not natural divisions as are the year, the day and the month.

THE NEXT WONDER QUESTIONS ARE ON PAGE 1605.

A Religious Procession in the Square of St. Mark, painted in the year 1496 by Gentile Bellini.

THE MAKERS OF VENICE

VENICE, the Queen of the Adriatic, is old, but age does not disfigure her. She is very beautiful in her old age, and very pathetic. All her glories belong to the past.

She stands like some lovely vision upon the sands of the seashore, and as we see her image reflected in the gleaming waters of the lagoon we may wonder if it is not some fairy fancy that we see. Cities such as Venice seem to belong more to dreams and poetic visions than to this world of ours. Before asking who made Venice, we must for a moment recall the means by which this strange city came into existence.

Many hundreds of years ago, when barbarians overthrew the might of Rome, a few descendants of the Romans were driven before the conquering Goths and Lombards down to the coast of the Adriatic Sea. They hid in swamps and in the little islands formed near the coast. Many years passed, and the handful of people who had fled in terror from the Goths became noted as bold fishermen and sailors.

Each island was controlled by its own tribune, chosen by the people of the island, and each island was quite independent of the others. After two centuries, however, the people of the islands joined together in a republic. They chose one man a duke, or doge, to rule over them all. In time the islanders became rich and powerful. No longer did they fear attack from the mainland. They constructed bridges to join the islands together, and canals were made along the channels where the water had previously flowed unchecked. They built a powerful fleet, and this fleet they sent, in 828, to Alexandria, where it is said to have recovered and carried back to Venice the body of St. Mark. In honor of this saint the Church of St. Mark was built.

Venice became a crowded, wealthy and important city. She sent out her soldiers and her ships with the Crusaders. She built up an enormous trade. She bought from the East and sold to the West. She bought from the West and sold to the East, and her own manufactures became famous. She made conquests on the mainland, and she captured islands at sea.

Venice became one of the richest cities in the world. Her decline began when America was discovered, and when the new route to India was found, as we read on page 83. After varying fortunes in war she eventually lost her independence, and is now a part of Italy.

While her citizens were so prosperous they had ample means for making their city beautiful. In this they followed the example of Florence, whose story we tell you in the article beginning on page 1731. Florence, Venice and Rome—these three were great above all other Italian cities in Renaissance architecture, sculpture and painting.

In Venice, a city of small islands, massive types of architecture were out of the question. So we find palaces of gleaming marble that seem to rest lightly on the earth, casting their fairy-like reflections in the water. Besides palaces, the Venetians built gorgeous churches, council halls, museums and libraries.

The widespread trade of Venice brought her into relationship with all the civilized world, and she gleaned knowledge from all. The fall of the Eastern Empire sent a number of learned Greeks to Venice for refuge. They taught the Venetians all that they knew, gave them the treasures of the old writers, and so implanted a love of learning in them that it is to the Venetians we owe some of the finest things in our literature.

Ancient works which might have perished forever were translated by the Greek refugees, and preserved for all the world. The Arabs, who were then among the masters of learning in the world, taught the Venetians how to make gunpowder and how to make glass, and taught them also their principles of the noble decorative art.

East and west, wherever they went, the Venetians were always learning. In Persia, they learned the art of weaving costly fabrics, and gained there a knowledge of architecture.

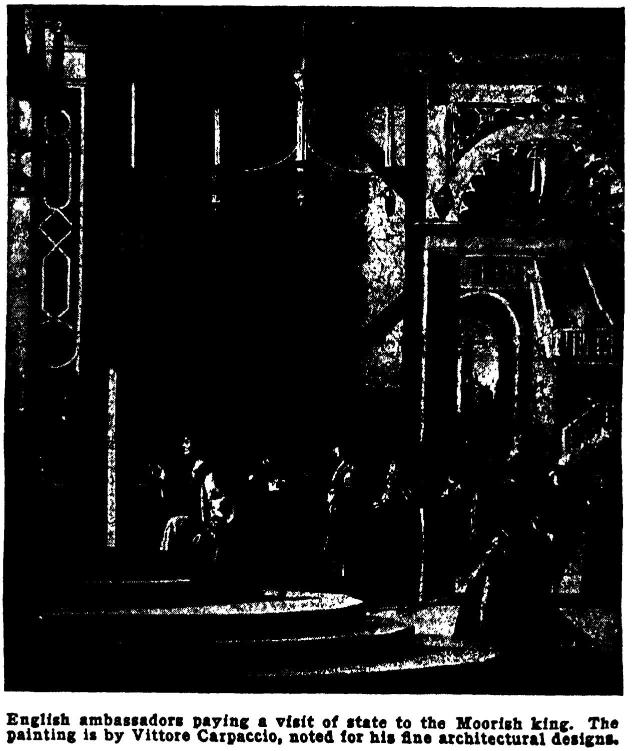
Their early building combined many styles, which included the elaborate fancy of the East with the sterner simplicity of the northern countries of Europe. But all was beautifully blended, producing a distinct Venetian style; there was nothing to be found in the world quite like it. In their conquests they destroyed old buildings so that they might have the marble for their own city. They used brick for the inner walls of their palaces and public buildings, but they covered the bricks with slabs of marble. Their mortar was not suitable because it would not withstand the action of sea water; so they needed the right lime, and they also needed marble.

In those days, the city-states of Italy were constantly at war, often changing sides, forming new alliances, and breaking them. So it was that the Venetians found, or took, many of the things they needed.

One of their victories opened the way to rich quarries of red marble near Verona, and with this they were delighted. At about the same time a victory in Padua gave them possession of a hard lime for making mortar that would defy the sea water. These two examples show us how keenly alert they were to improve their beloved city.

The building of St. Mark's Church held the attention of doge after doge, as it went on through generation after generation, for hundreds of years. The square in which this rare building stands was formerly a field with a canal running through it, and two churches in turn had been built on the same site, to hold the relics of St. Mark, before San Marco as we know it now was begun.

Wherever success attended the armies of Venice, or whatever men could buy, other places were deprived of their treasure to enrich the walls of the Church of St. Mark. A good example of this we find in the four bronze horses above the main western door-



English ambassadors paying a visit of state to the Moorish king. The painting is by Vittore Carpaccio, noted for his fine architectural designs.

way of San Marco, which were brought from the arch of Emperor Nero, in Rome.

For century after century the church grew; its shape was altered, its treasures increased, until, in the beginning of the nineteenth century, the great Napoleon conquered Venice, and the usual course of the city's life was interrupted. This cathedral possesses a rich collection of church plate, and its retable, or altar-piece, called the Pala d'Oro—a marvelous piece of work in gold, jewels and enamels, which stands behind the altar—is without equal. It is a picture of Christ, attended by archangels and angels and prophets. The entire work is in precious metal and valuable jewels, and most beautiful enamels, through which the rich gold setting shines. The Pala d'Oro was ordered made at Constantinople in the year 976.

The T. F. Healy Collection
A doge of Venice and his lady.

The Doge's Palace is another of the wonders of the city. It takes the place of older buildings which were pulled down piece by piece to make room for the new one as it rose. It was begun about 1300 by a great doge named Pietro Gradenigo, but before it was finished 250 years had passed.

After nearly a century, when the new building had been well advanced, and part of the old palace was still standing, the Venetian Council decreed that things should remain as they were, and that anyone daring to propose any more building on the new palace should be fined 1,000 gold ducats. In spite of this threat, Doge Tomaso Mocenigo dared to make the proposal. He paid his fine; the rest of the council agreed, and they put the money intc the building fund. The enlarging and beautifying of the palace began again in 1424, and did not stop until the work was finished, in the middle of the sixteenth century.

It was in connection with this palace that the Bridge of Sighs was built. The state prisons had once been on the ground floor of the Doge's Palace. In 1588 the Venetians began to build a new prison on the opposite side of the canal, and the bridge was made to let the prisoners pass unseen along one passage from the prison to the palace, for trial, and back by another passage to the prison, where their miserable lives would end.

The man who built the Bridge of Sighs built also the famous Rialto Bridge; and he was known as Antonio of the Bridge. Very

Metropolitan Museum of Art

A Doge in Prayer Before the Redeemer, by Tintoretto. If you study the paintings shown in these pages, you will learn much about the way wealthy people of Venice lived and dressed, in the days of the Renaissance. No matter what the subject, the artist was sure to put into his painting something of the life around him.

Gramstorff Brothers, Inc.

Albrecht Dürer, the great German painter and engraver, in his studio at Venice. Dürer went to Italy to improve himself in painting, but the Italian artists who came to his studio also learned a great deal from him.

nearly three years were spent in building the Rialto Bridge, which was finished in the year 1591.

Not many of the architectural works of Venice can be pointed out as having been done by this man or by that one. Their building took too long, and engaged too many men in successive generations. Thus it was with the famous Campanile of St. Mark's, the magnificent bell tower standing apart from the cathedral. This was ordered by Doge Pietro Tribuno about the year 900, but not until 1131 or later was the main tower finished. It was a noble piece of work. When, after nearly 300 years, the great summit, or lantern, with its pyramid roof, was added, the whole structure was about 325 feet in height. The Campanile stood until 1902; then, because of age and alterations, it fell to the ground. The Venetians have since rebuilt it upon the old foundations.

One name which we must not overlook stands out among these old-time architects—the name of Fra Giovanni Giocondo, who was born at Verona, Italy, about the middle of the fifteenth century and died at Rome in 1515. He was a scholar and student all his days, as well as a gifted architect, and many famous men were numbered among his pupils. He traveled a great deal, and worked wherever he stayed.

Thus he built a fine bridge and a palace in Paris; he made a design for the building of St. Peter's at Rome; and he gave Venice some of her noblest palaces; while for Verona he designed a beautiful town hall, or Palazzo del Consiglio. You can see it now, though not quite as he planned it, for changes have been made in modern times.

Another of the men of this era was Michele Sanmichele, who was trained in the school of Bramante, a great artist, whom we meet among the makers of Rome. Sanmichele, like so many other men of artistic genius, was also a soldier, and the work of fortifying cities engaged in the wars of the period occupied more of his time than did art. However, he found opportunity to build for Venice and Verona city gates and palaces which show great power and simplicity. The fine Palace of Grimani in Venice is now used as one of the courts of justice, and remains a noble monument to the man who planned it amid wars and rumors of wars.

A greater architect than Sanmichele was Jacopo Tatti Sansovino, who was born at Florence about 1477, but lived in Venice from 1527 up to his death in 1570. Several churches stand to his credit in Venice, but the work which immortalized him was the building of the famous library of San Marco and the Mint, which adjoins it. He built them at the same time, joining wall against wall, to form the most striking contrast. The library, now called the Royal Palace, is a splendid building, with two stories, each in a series of arches. It illustrates Sansovino's use of proportion and graceful ornament.

Next followed Andrea Palladio, who was born at Vicenza in 1518 and died there at the age of sixty-two. After studying the old Roman style of architecture, he brought it back into use in the buildings he planned; therefore his churches and palaces and villas had noble proportions and dignity. The buildings he designed for Venice were all churches or structures connected with churches. The books he wrote about architecture had a great influence upon the work of Inigo Jones, the famous English architect; and Thomas Jefferson gathered from them the ideas which he carried out in the buildings of the University of Virginia.

We must leave the story of the architecture, and turn for a moment to the sculpture of Venice. This art in Venice remained chiefly a part of architecture. The architect was sculptor, too. The reasons were twofold. In the first place, the city clung to the examples of the East, which did not provide statues apart from buildings. In the second place, there was a strong desire to keep such open spaces as there were in Venice free from statues.

The Assumption (rising to heaven) of the Virgin, by Titian, a favorite subject of painters.

The native sculptor counted for so little in Italy that several of the doges in the Middle Ages were buried in tombs which had been carved in the East hundreds of years before. But about the middle of the thirteenth century an awakening began. Farther south than Venice, in Tuscany, Niccola Pisano, his son Giovanni, and the son's famous pupil, Andrea, in their work in marble and bronze for the ornamentation of churches, wrought forms more interesting and lifelike than men in Italy were used to seeing. These helped to arouse a new feeling in favor of native Italian sculpture.

Soon, instead of bringing sculptural decorations from other lands, as they had been in the habit of doing, the Venetians employed their own citizens, or, at any rate, men living in their midst. The first sculptors of note were the Massegne family, who lived in the fourteenth century and the early half of the fifteenth century. Next came Pietro Niccolo, of Florence, and Giovanni di Martino, of Fiesole, who worked together and produced, among other things, a fine tomb for Tomaso Mocenigo, the doge who had insisted on continuing the building of the Doge's Palace. Antonio Rizzo, of Verona, who was one of the architects of the Doge's Palace, and also carried out important military engineering work, proved himself a gifted sculptor, but did not greatly influence Venetian sculpture.

A family of architects and sculptors, called the Lombardi because they came from Lombardy, worked for the beautifying of Venice. Pietro Lombardo, the best-known of these artists, was truly Venetian in his fanciful and charming sculptured decorations for the Church of Santa Maria dei Miracoli and in other fine buildings which he planned. His sons, Tullio and Antonio, who worked with him part of the time, were not the equals of their father.

In the workshops of the Lombardi many other sculptors received their training, among them being Alessandro Leopardi, whose name is familiar to every visitor in Venice. Born in the latter half of the fifteenth century, he died about 1522, but his fame remains fresh. For two things especially is he remembered—the handsome bronze bases for the flagstaffs in front of St. Mark's, and the work which he did in connection with the statue of Bartolommeo Colleoni, a famous soldier of Venice who lived in the fifteenth century.

Colleoni's deeds of war are of no account today; he is of no more importance to the world than if he had never lived, but he is of interest as having called forth a supreme work of art. He gained great wealth from the wars, and at his death he left money and horses and arms to the state, on condition that a statue should be raised to him.

The Venetians faithfully carried out their part of the bargain. Although Venetian sculpture was making progress, they could not trust one of their own citizens to do this work. They sent to Florence for Andrea del Verrocchio, who is famous as painter, sculptor and goldsmith, and memorable to us as a teacher of Leonardo da Vinci. Having been born in 1435, Verrocchio was forty-four when sent for to make the Colleoni statue. He had only nine years more to live, and we might fancy that he realized that this was to be his last and greatest work.

He devoted to the task all his strength and skill and art, but death overtook him before he could make the bronze casting of the statue of horse and rider. Soon after he had finished the model, he died. Venice had upon her hands the finest model of a horse and rider that had ever been made in the history of the world, but who was to cast it and set it up? There was only one man—Alessandro Leopardi. But he had fallen into evil ways, and some years before had been driven from the city, charged with fraud. In their need the Venetians recalled him to make the casting.

He atoned for his wrong-doing by the way in which he executed this task. The pedestal of marble with a bronze frieze he designed and made himself—a base in every way worthy of the statue.

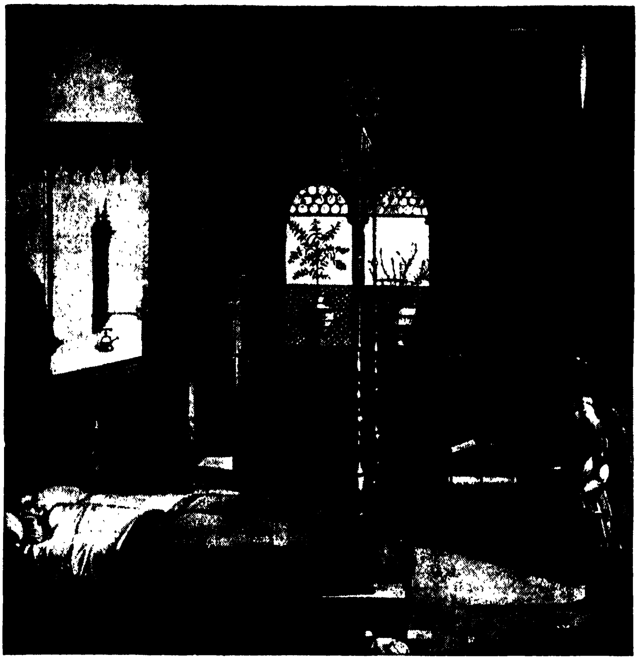
The statue is still without comparison. Horse and man seem alive. John Ruskin thought it one of the noblest monuments ever set up on the face of the earth. Colleoni rides there, defiant of feature, proud in his strength as a man, fierce and disdainful in his skill as a general. The horse moves heavily, but with great strength, as upon some dreadful battlefield. Leopardi was not satisfied with the fame which the pedestal gave him, but wrote his name upon the girth of the horse, as though the whole design had been his. But nothing can rob Verrocchio of the honor of modeling an almost faultless masterpiece.

Madonna and Child, by Giovanni Bellini, who loved to paint religious subjects.

Yet, after all, the great splendor and wonder of Venice belong to her paintings. There never was another place where a more brilliant kingdom of pictorial art grew up. Venice is as happy in this respect as she is in the beauty of her situation and buildings. Her distinction was not soon won. For a long time she had painters of no special merit—men who painted, not in oils, but in distemper. (Distemper is a mixture that will dissolve in water. It has not the lasting quality of oil paint, and pictures painted in distemper are often more crude than oil paintings.) These early pictures were not lifelike, nor did they express any high ideal. It was just the old kind of Italian art that they represented, wooden-looking pictures done in churches and on the walls of other buildings.

Then the Bellini family arose, and with them came new light. The glory of Venetian art dawned at last. The Bellinis began to paint finely in distemper before ever the art of oil painting had been heard of in Venice.

The improvement began with Jacopo Bellini, who was born probably about 1400 and died about 1464. Jacopo was a pupil of a



The Vision of St. Ursula, by Vittore Carpaccio.

famous artist named Gentile da Fabriano, a native of Fabriano, who died in Rome about the year 1428. Jacopo followed his master to Florence, where he met all the great Florentines of the time.

Bellini had two sons. The first, born in 1426, he named Gentile, after his old master. The younger son, born in 1428, he named Giovanni. Jacopo never became a very great artist himself. His work was an improvement upon anything ever done before in Venice, but his chief credit is that he was the father of two notable sons who carried out his admirable ideas in art.

They worked together with him; and all the young artists of Venice who desired to learn all they could about their art flocked to the Bellini studio to become pupils. Giorgione and Titian were of the number. Gentile Bellini painted scenes from the life of Venice; Giovanni Bellini painted religious subjects as Venice had never before seen them painted. Gentile painted portraits, and gained such fame that he was sent for by the Sultan of Turkey and asked to paint his portrait at Constantinople.

Gentile went and painted a famous picture of the cruel man who then ruled over Turkey. This wretch one day wished to show that Bellini had not correctly painted the head of John the Baptist after death, so he drew his sword and cut off the head of a slave standing near. So horrified was the artist that he never rested until he got back to Venice.

But a great change was beginning to show in the art of Venice. An artist named Antonello, of Messina, had come to the city, bringing with him a new art. He had learned from Hubert and Jan van Eyck, the great Flemish artists, their secret of painting in colors mixed with oils. Let us look for a moment at a scene painted for the stage of a theater; it is done in distemper, the medium in which the artists of Venice had been working. Then let us remember one of the oil paintings at the Metropolitan Museum, which is the kind of work that Antonello introduced. It set all Venetians wondering.

The story runs that Giovanni Bellini went in disguise to Antonello to have his portrait painted, solely that he might learn for himself the great secret. Whatever the truth of this story, we know that the valuable secret was soon mastered in Venice, and that the Bellinis were the first to help make it broadly known through their work. Venice was now glorified by many brilliant works of the brothers. They had the happiness, too, of seeing young artists promising to become even greater than themselves growing up about them.

But the Venetian authorities feared that death would come too soon and carry off Giovanni Bellini before his work for them was done. Though they paid very poorly for the work, they loved his art, and were determined to get as much out of him as possible. They therefore decreed that he should work every day in one of the great state apartments which he was decorating, and that he should have assistants.

These young men had only four or five ducats a month as payment, and Titian himself was one of the workmen appointed as painters on these terms.

The document stating the terms of Titian's engagement refers to him with as little ceremony as if he were a poor man called in to whitewash a ceiling, yet he became one of the greatest painters of all time, supreme in the use of colors in oil. The mighty genius of Titian might never have developed in the way that it did had not Jacopo Bellini and his two illustrious sons given a new turn to the world of Italian art.

Gentile Bellini died in 1507, nine years before his brother Giovanni. Both of them had the happiness of meeting Albrecht Dürer, Germany's highly gifted painter. Born at Nuremberg in 1471, Dürer had a hard struggle for education. His father was a poor goldsmith with a family of eighteen children, and Albrecht had for a time to support his aged mother and a brother, as well as his own family. He worked like a slave to master the elements of painting.

There was little money for Albrecht in Nuremberg, but elsewhere others made money by copying his designs and selling the copies as his work. These pirated copies reached even Venice, and it was to prevent this dishonest trading in his productions, and to sell works which were genuinely his, that Albrecht, in 1505, went to Venice. His paintings astonished the Venetians.

ALBRECHT DÜRER GIVES A PAINTING LESSON TO THE FAMOUS GIOVANNI BELLINI

The younger men were envious and curious. Not so the Bellinis. Giovanni went to Dürer as modestly as if he had been an apprentice, and asked to see the German painter's work. He could hardly understand how some of the things Dürer had painted could have been done. Giovanni asked to see the brushes with which the work had been accomplished. Even then he could not understand, so Dürer picked up one of the brushes, and, while the aged artist looked on, painted a lock of hair so much like nature and so beautiful that it might have been taken from a human head and laid upon the canvas.

Giovanni praised and honored the young German, and gave him an order for his portrait. Dürer's style was broadened and improved by his acquaintance with Italian art, especially that of Bellini, whom he greatly admired. He died at his home in 1528. A great painter and skilled engraver, he was also the father of etching. Here we note him as one of the men whose art helped Venice forward toward the goal to which she was tending.

One of the first of the new school of artists to be influenced by the Bellinis was Vittore Carpaccio. He was born about 1450, and lived seventy-two years. We have seen how the idea of painting scenes of *life* began to take the place of the same subjects painted again and again in the same flat old style. Carpaccio carried on the work in a most interesting way. Some of the painters of his age took subjects from heathen books for their pictures. Carpaccio painted upon his canvases pageant pictures, which told the romantic stories of the lives of saints and heroes; they were made to appeal to the mind and the soul—not, like some others, merely to the eye.

Like many other artists of that age, Carpaccio was always comparatively poor, and we find a curious letter written by him to a rich nobleman describing a panorama picture of Jerusalem which he wished to sell. The picture, he said, was twenty-five feet long and five and a half feet wide, and he wished to send it to the nobleman, "rolled round a piece of wood." Carpaccio had a very satisfying way of painting the settings for his scenes—buildings, costumes and details. They have an out-of-doors feeling. There is usually a dog in the picture.

Metropolitan Museum of Art

Carlo Crivelli's Madonna, dressed in gorgeous fifteenth-century manner.

Another great man arose in these days. Soon after the birth of Titian—that is, about 1477—Giorgione was born. Giorgione ennobled and extended the art schemes of his masters, the Bellini family. He not only enriched the city by his frescoes and other paintings, but had a most powerful influence upon the artists of his own day—upon Titian among them, and upon the artists who followed. His art has a singing beauty, like music and poetry. Giorgione did not attain a great age, but died, all too soon, when only thirty-three.

The name of Titian runs like a bright thread through the tapestry of Venetian story. Born in Cadore among the Alps, Tiziano Vecelli often put mountain landscapes into the settings of his pictures. Going to Venice to live when nine years old, there, for the most part, he lived and painted until, in 1576, he died of plague, when almost a hundred. He early came to be considered the leading painter

Pope Paul III and two other members of the Farnese family, by Titian. The Pope was a patron of art.

in Venice and was honored by rulers from other countries. For the emperors Charles V and Philip II he painted splendid portraits and other works. When nearly seventy, he went to Rome at the request of the Pope. For Venice he painted portraits of the doges, besides large pictures to adorn the ducal palace and various churches.

This was a remarkable age for Venice. Every rich man was willing to employ artists, though in truth they did not always pay well. We find Giorgione and Titian and others painting lovely works on articles of furniture, and other artists rivaling the goldsmiths in the splendor with which they decorated the outside of buildings with the glories of the brush.

Some of the artists would do anything for money, and Titian was, perhaps, the most grasping of them all. Much as we may admire his works, some things indicate that the nature of the man was far from lovely. His meanness is most noticeable in the story told of his treatment of Tintoretto. This artist's real name was Jacopo Robusti, and he was born in Venice in 1518 and died in 1594. His father was a dyer—a *tintore*—and so they called Jacopo, his son, Tintoretto,

A Venetian Senator, by Tintoretto. His heavy silk or velvet robe was lined with fur. Note the jeweled ring.

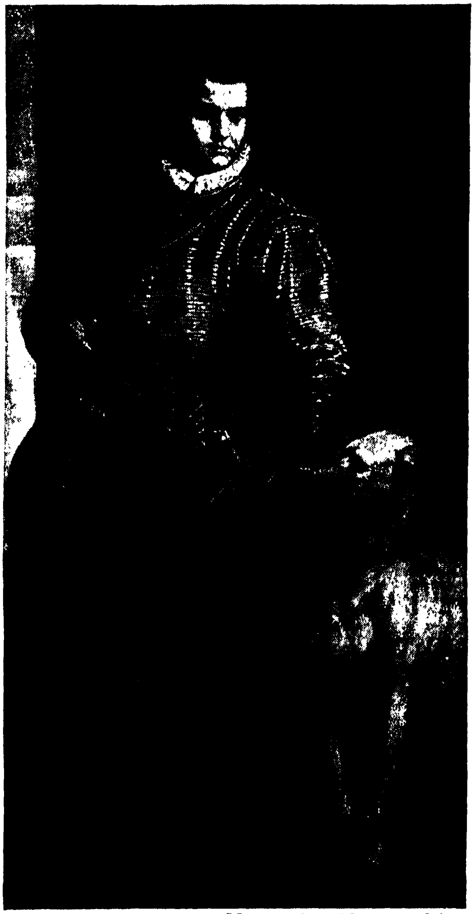
or Tintorettino, meaning the "little dyer." The clever boy was a born artist, as was soon to be discovered.

He used to dabble in his father's dyes and to splash the colors all over the walls and furniture until his parents must have found him a nuisance. Seeing which way the lad's genius was inclined, the father took him to the studio of Titian. Jacopo's apprenticeship lasted no longer than a few days.

Titian, the story goes, went into the studio one morning and saw, lying on the floor, papers covered with drawings. He picked them up and asked who had done them. Little Tintoretto shyly confessed that he had. Titian saw that they were the work of a genius; he saw that this boy might soon become a rival to himself. He left the studio at once, and that same day had the ambitious boy turned out.

It was a hard experience, but young Tintoretto was not to be beaten. His life became a miracle of activity. He set before himself two models—Michelangelo for design, Titian for color. Whenever he could see a work by either of these two he studied it. He copied antique statues. He made numberless drawings to perfect his style. He studied the human frame as a whole and in its various parts.

He made models of wax on which to hang draperies for the figures he meant to paint. He copied tombstones and bits of broken statuary. He studied the methods of every artist in every studio into which he dared to peep. He went down into the square where the poor painters worked who painted common furniture and cabinets for sale, and studied how they got some of their effects. He followed the work of architects. He used to beg builders to let him decorate houses which they were erecting. Once he painted designs all round a clock which the builders were erecting in a tower. Another builder was putting up a new house, and Tintoretto insisted on painting the walls with lovely frescoes, simply for the cost of the materials he used. He would do paintings for chapels and churches and other buildings and charge practically nothing.



Metropolitan Museum of Art

Boy with a Greyhound, by Paolo Veronese. Veronese was the last of the great Venetian painters.

He did anything and everything to perfect his art and make his name known. He worked with marvelous speed, and, of course, the effect was not always good. They called him "Il Furioso" (the fiery one). But in time he made a very great name. One famous story will show his passion for work, and some of his astonishing ways.

The ceiling of the San Rocco School was to be decorated with a painting, and the artists of Venice were asked to send in sketches for the work. There were not many days for the preparation. The other artists made their rough plans. Not so Tintoretto. He had the space measured, and, with that zeal and speed which nobody could match, he painted his whole picture, and had it secretly fixed up on the ceiling and covered over.

When the day of trial came, the others showed their sketches, while Tintoretto stood by. At last he twitched aside the linen covering the ceiling, and the company saw his splendid picture already fixed. Everybody was amazed. The authorities, when they recovered their breath, protested that they had asked only for designs, not for a finished picture.

The other artists, however, examined the work, and, seeing how great and exquisite it was, they withdrew from the competition. But the authorities were very angry indeed, and still grumbled furiously.

"Oh, very well; there is the picture!" said Tintoretto. "If you will not pay me for it, then I will make it a present to the saints."

After that the city authorities calmed down, and, deciding that the work was one of rare merit, they at last agreed to pay the artist fairly for it.

The last of the greatest Venetian painters was Paolo Veronese. He was born in 1528 at Verona, whence his title, his real name being Caliara, or Cagliari. He lived in Venice from 1555 till his death, in 1588. His pictures glow with the brilliance of coloring which belongs to works of the great Venetian school, but he had caught the spirit of painters in Rome, and gave to his work greater splendor, more grace of pose and ease of movement than had been introduced before his day.

Paolo Veronese was a painter more for the palace than for the church. His scenes were scenes of splendor, of great space and riches and luxury, so that it has been said that one of his paintings would convert a garret into a palace of vast size and delight. He was a great worker, but different in type from Tintoretto, taking careful pains with all that he painted, yet with no display of effort or cleverness. He was the portrait painter of a people even more than of the individual.

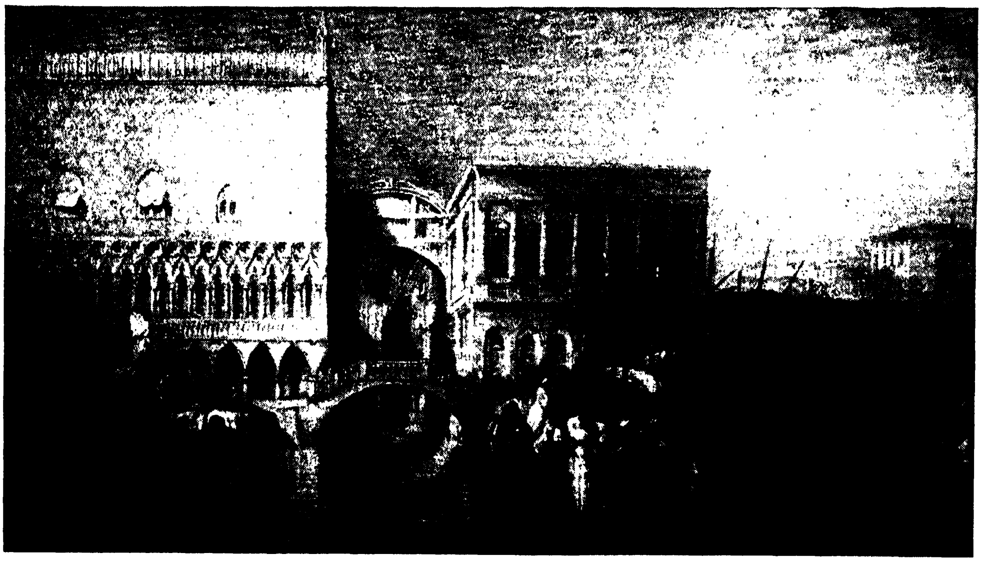
In the Louvre at Paris hangs his picture called The Marriage Feast at Cana, showing no fewer than 160 portraits of people who lived in Venice in his day. This is a fine example of the pageant-like pictures which Venice loved — pictures presenting themes from the Bible or some old story in scenes of Venetian glory, and with portraits of Venetians, playing the parts, so to speak, of the characters in the story.

With the death of Veronese the sun of the best Venetian art set. But the afterglow has lighted the world for more than 350 years, firing the enthusiasm of all the artists who have lived since.

While the glory of Venice as a maritime and trading power is departed forever, her more lasting glory as a patron of art will never die. The color and gleam of the rich fabrics, the jewels and the gold that came into Venice from the East were caught up into the thought of the painter, and set forth in gorgeous effect upon wall and canvas.

On pages 1109 to 1112 you will find reproductions of paintings by Titian, Giovanni Bellini, Paolo Veronese and other painters of this period.

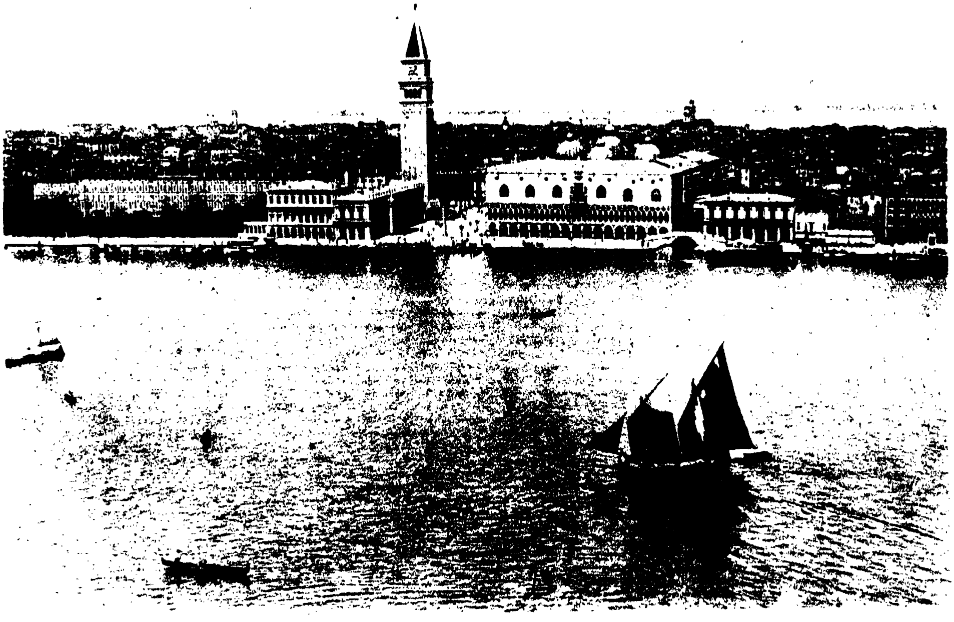
THE NEXT STORY OF FINE ARTS IS ON PAGE 1494.



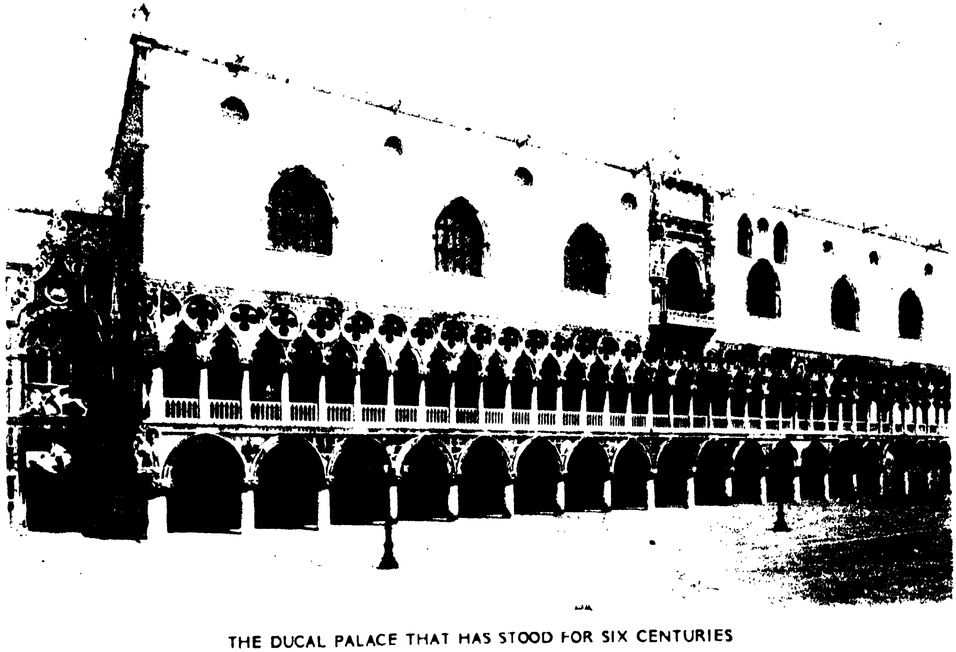
The T. F. Healy Collection

Doge's Palace (left) and prison, connected by the Bridge of Sighs. This picture was made in a later century than the ones we have been discussing; but it shows the Grand Canal as it looked in the days of Titian and Veronese.

VENICE IN ALL HER GLORY

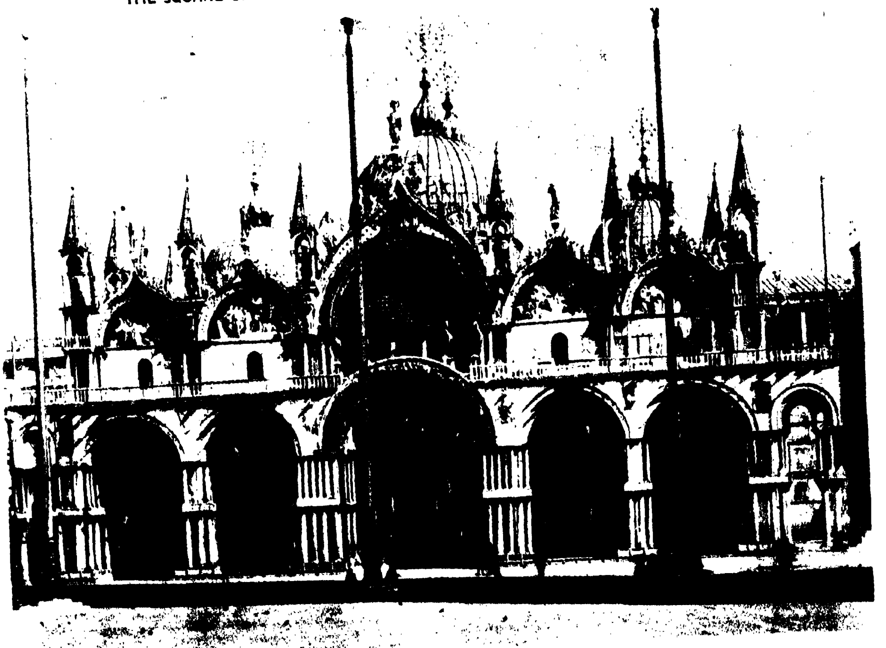


VENICE—QUEEN OF THE ADRIATIC

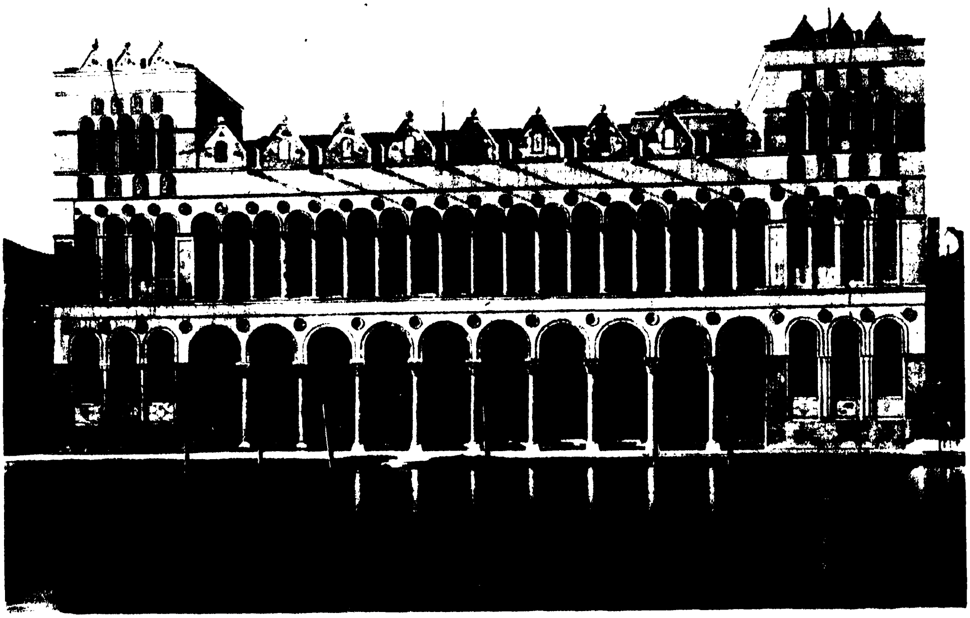


THE DUCAL PALACE THAT HAS STOOD FOR SIX CENTURIES

THE SQUARE OF SAN MARCO WITH THE OLD CAMPANILE THAT FELL DOWN



SAN MARCO, THE MARVELOUS DOMED CATHEDRAL OF VENICE

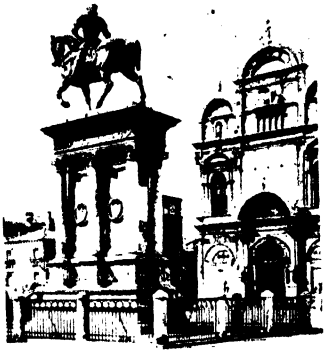


THE LOVELY COLUMNS OF A VENETIAN PALACE

RARE TWELFTH-CENTURY WORKMANSHIP ABOVE THE DOORS OF SAN MARCO

A SQUARE IN VENICE

THE OLD COLUMN OF ST. MARK



THE COLLEONI MONUMENT

A STAIRWAY IN THE MINELLI PALACE

DOORWAY OF THE DUCAL PALACE

ONE OF THE BEAUTIFUL DOOR WAYS OF SAN MARCO

A FIGURE IN A CHURCH OF VENICE

THE BRIDGE OF SIGHS BETWEEN PALACE AND PRISON

Courtesy, New York Botanical Garden

At the left is a wild dahlia of Mexico, ancestor of some highly developed varieties like those on the right.

WHAT MAN CAN DO WITH PLANTS

MOST of our fruits, flowers and garden vegetables differ very much from those common a hundred years or more ago. The grains which feed us are also improved. In another place (pages 1389-90) we have told you some of the story. Here we shall tell you more in detail what man has done.

Men to-day breed plants just as they do animals. They seek to introduce a new quality such as earlier ripening, greater size, better flavor in a food plant, resistance to disease, or to get rid of some quality which is not liked. They seek new colors in flowers, different shape, or greater size. In nurseries, in experiment stations, and in private gardens, thousands of men are constantly working to improve the plants upon which we depend for food, or which give us pleasure.

There are four great methods by which man may improve plants. They are (1) Cultivation; (2) Selection; (3) Preservation of "Sports"; (4) Crossing or Hybridization. We shall take them up in turn, explain what they mean, and show how they improve plants. These methods may improve animals also, but here we shall speak only of plants.

Sometimes change of surroundings will greatly improve a plant. Giving it a little more water, a different climate, or soil, that is cultivating it, will sometimes make great changes. Many plants brought from Europe or Asia do much better in America than in their native homes. These changes do not really change the race, however, and disappear if they are neglected or are taken back to their original home.

Now let us speak of Selection, which was formerly the most important method and still is constantly used. In a field of plants no two are precisely alike. In fact, it is safe to say that no two living things are exactly alike. These differences are called variations. Often the differences are slight and of no importance. Sometimes they are undesirable. Occasionally a single plant, or a few, seem to show some desirable difference.

The seeds are sown separately and the young plants are carefully watched. Some seem to show no differences from the ordinary plants; some seem about the same as the parent, but often a few will show the desired quality more strongly than the parent. All the other plants are destroyed and the seeds from the best are again sown and watched. Great patience is required. Luther Burbank, the famous California plant-breeder, is said to have saved the seeds from one plant out of two hundred thousand he had grown. The others were destroyed. This Selection is done again and again, and in a few years we may have a much improved variety. The differences seem to pile up.

The Shirley poppy was developed in this way from the common wild red corn poppy of the English fields. An English clergyman found in his garden one example with a thin edge of white. Seed from this was saved and planted. Out of about two hundred plants four or five were saved. The process was repeated for several years until the blossoms became pink and white. He then set out to make the centre yellow or white instead of black, and succeeded. Luther Burbank by the same method changed the yellow color of the so-called California poppy into red.

THE IMPORTANCE OF MUTATIONS IN PLANTS

Occasionally some great change appears all at once in one of a field of plants, or in one branch on a tree or shrub. This is called a *"sport"* or a *mutation* (from the Latin word meaning change). Why it occurs we do not know. If preserved it will more or less breed true, though it, too, may be improved by Selection.

Over a hundred years ago one branch of a beech tree in Scotland had reddish leaves instead of green. Grafts were taken from it, and other grafts from them. From this one branch have come all the copper beeches so often found on lawns. The nectarine is a sport from the peach. White cardinal flowers sometimes occur as sports. Many of our most prized apples, plums, peaches and pears originated as sports. Many roses, dahlias and chrysanthemums which we admire first occurred as mutations of other varieties.

In a college greenhouse a pink pompon chrysanthemum suddenly showed one branch which bore bronze flowers. Cuttings were made from this branch and from another branch bearing pink flowers, and were planted. One plant bore bronze flowers, the other pink, and their successors bred true year after year.

WHAT CROSSING OR HYBRIDIZATION MEANS

You know of course that flowers contain stamens, which produce tiny grains of pollen, and pistils which contain the ovules (little eggs). These are the male and female elements. The ovules are fertilized by the grains of pollen from the same plant or other plants, and seeds develop. Crossing means the transfer of pollen from one plant to the pistils of another of the same kind. Hybridization means the transfer of pollen to a plant of another variety or even another species. When flowers are self-pollinating the stamens are clipped off before the pollen is ripe; and the flowers are covered with paper bags. When flowers do not pollinate themselves, the flowers are also covered to prevent any but the desired pollen from reaching the pistils. A camel's hair brush is used to transfer the pollen, or else it is blown into the bag.

Men have been doing these things for a long time, but since the discovery of Chromosomes and Genes (about which we tell in Volume 15, pages 5613-17) they have been able to work more intelligently. They know which plants can be hybridized successfully and which are likely to fail. They are not likely to succeed with plants with widely differing numbers of chromosomes unless they are arranged in a particular way. Some plants have two chromosomes of the same kind, others three, and still others four or more. The raspberry has fourteen chromosomes arranged in groups of two, while the dahlia has sixty-four. It is highly complex, but men are constantly studying the subject.

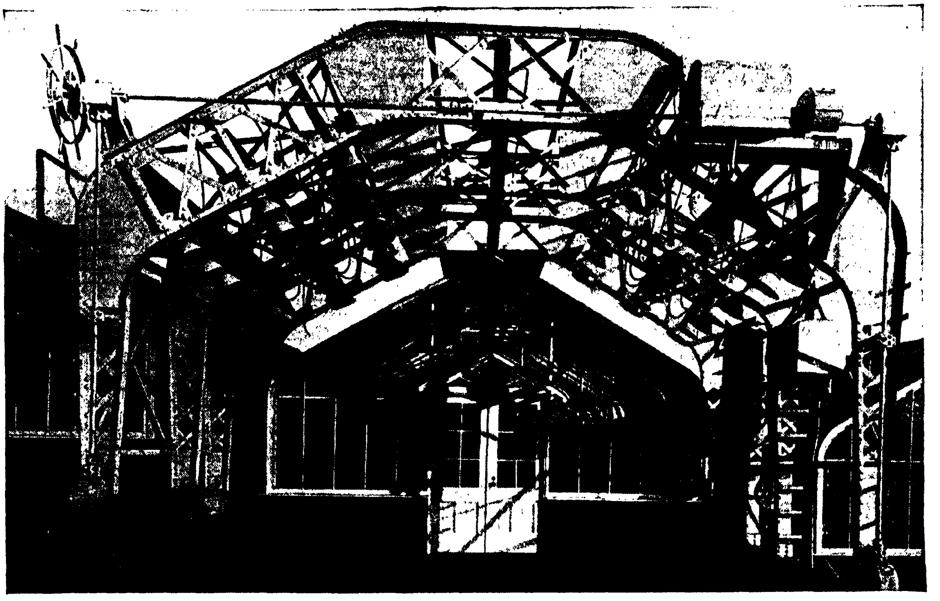
SOME OF THE EXPERIMENTS IN BREEDING WHEAT

There is hardly a flower, shrub, vegetable, fruit or grain upon which men have not experimented. One of the most important is wheat. There are now something like three hundred varieties of wheat, though probably some of these are alike. Formerly most of the varieties arose from selection or from chance crossing, or, perhaps, from differences in soil and climate. Red Fife, so popular in Canada, is possibly a sport. It developed from one stalk which grew from a lot of wheat supposed to have come from Russia.

Both in the United States and Canada men have been breeding wheats for a long time. Perhaps the most romantic story is that of the Saunders family in Canada.

Doctor William Saunders, when director of the Dominion Experimental Farms of Canada, began crossing wheats in 1888. What he sought was a wheat which would yield well, have good gluten, and would ripen before frost, which sometimes caught Red Fife and other popular varieties. He had the assistance of his two sons, A. P. Saunders, and Charles E. Saunders. Many crosses were made and several worthwhile varieties were developed, but none was the ideal wheat.

STUDYING THE EFFECT OF LIGHT



Scientists are studying every factor in plant life, and some interesting experiments are being made to discover the effect of different amounts of light on plants. This gantry crane carries forty-eight 1000-watt lamps and can make a room as light as day. It can be run to any part of the great greenhouses.

This picture shows the effect of varying amounts of light on tomato plants. The plant in the left had a day of only five hours, while the sixth had a day of twenty-four hours until it died, apparently because it did not have a daily period of rest. The fifth plant lived but bore no fruit. The plant on the extreme right was grown under natural light. Courtesy Boyce Thompson Institute for Plant Research, Inc.

In 1892 Dr. A. P. Saunders made a cross of Red Fife and Hard Red Calcutta, an East Indian wheat which ripened early, but did not yield well. Many of the plants grown from this cross were worthless, but some had promise, and so selection was continued for about ten years. Then the grains from one head were planted separately by Dr. Charles E. Saunders; twelve plants grew; the heads ripened early, had good color, strong straw, and good gluten. Selection was continued, and tests were made in many places. Marquis wheat was given to the world and soon became the most popular wheat in both Canada and the United States.

So many other men in Canada and the United States have worked with wheats that we can not name them all. Earlier and earlier wheats have been developed until the cultivation of the plant has been pushed far to the north. Where the climate is not so severe other wheats have been developed.

WHY MARQUIS WHEAT IS NO LONGER SO POPULAR

Though Marquis was called the "king of wheats," it failed when stem rust invaded the Canadian fields. In 1916, and again in 1935, thousands of acres were not worth harvesting. Breeders in both Canada and the United States have been working on the problem. Thatcher, developed in the United States, has good qualities, and the Dominion Rust Laboratory has developed Renown and Regent which show great promise. Apex, a variety developed at the University of Saskatchewan, is also doing well.

This subject of plant diseases is also important in fruits, and in many of our garden vegetables. Several varieties of tomatoes, for example, which yield large crops of attractive fruits, are no longer grown because they are subject to disease. Occasionally a plant disease becomes so common in a locality that the growers are in danger of ruin. Here the plant-breeder may make new varieties which resist the disease.

Many men have worked on corn. Some have been chiefly interested in yield, others in uniformity of ears, and interesting results have been achieved. Some varieties have been developed which are ready for use in seventy days from the time the seed is planted; others stand cold weather better than varieties known before.

Improving fruits growing on trees is more difficult because several years must elapse before the results can be known, but nevertheless good work has been done. Dr. William Saunders, already mentioned, crossed the small hardy Siberian crab apple with many of the cultivated varieties, and then back-crossed the result with cultivated varieties. He secured trees which bore good apples and could grow farther north than apples had ever grown before. The work is being continued in the Prairie Provinces. Many breeders in the United States are also at work.

The United States Department of Agriculture has improved citrus fruits with success. The tangerine was hybridized with the grapefruit, and the tangelo orange which resulted is high in quality, yields well, and resists scab. By hybridizing a lemon and a lime, a very hardy lemon has been produced. Grapefruits have also been much improved.

Small fruits have been greatly improved. One instance is the blueberry. Dr. F. V. Coville of the United States Bureau of Plant Industry, hybridized some of the best specimens of wild blueberries he found in New Hampshire and New Jersey, and out of 68,000 seedlings developed fifteen varieties, all larger and better flavored than their wild ancestors.

THE GREAT IMPROVEMENT SHOWN IN GARDEN VEGETABLES

Garden vegetables are being constantly changed. Better varieties of tomatoes, peppers and eggplant are being grown. New varieties of lettuce and other salad plants have been developed. Beans without strings came into being. Muskmelons which are firm enough to stand shipping across the continent are found on city breakfast tables.

In staple crops the most work is done by the experiment stations, national, state or provincial, but in flowers the private growers are more active. Since most flowers produce large numbers of seeds, it is possible to secure a great number of seedlings from which to select, and of course the number of sports may also be large. It may happen that of a thousand plants grown from the seed of a cross, only one or two show promise.

Not so long ago the dahlia was usually a stiff, formal flower which appeared in few colors. A Mexican variety was discovered, different from any known to European or American breeders. In the latter part of the nineteenth century it was largely used in hybridizing, and many new varieties were developed. Now there are more than seven thousand named varieties, and the flower appears in many colors, sizes and shapes.

The chrysanthemum introduced from Japan less than a hundred years ago has also been developed in many different forms, until now there are thousands of named varieties. Some have been secured by hybridization and selection, and there have been many sports.

Almost the same may be said of the rose. It is one of the oldest of our cultivated flowers. It is mentioned in the Bible and in Greek and Roman mythology. You remember, of course, the Wars of the Roses. It was also grown in China many centuries ago. Many of the foreign varieties did not do well in the United States. For forty or fifty years, however, the development of new varieties has been rapid.

As the result of the crossings he had made, one breeder grew 2,500 seedlings. Within two years the number was reduced to 800. The next year the number was reduced to fifteen, some of which have been very successful, and others show promise. Since the rose of to-day is mixed in origin, there is great variation in the plants grown from seed. However, roses are usually increased by rooting cuttings, and the fact that the seed do not breed true makes little difference to the ordinary grower.

Many other flowers have been greatly improved but we can not tell of them here. The zinnia has been changed since the writer was a boy. The delphinium seems a different flower. Carnations are different. The freesia appears in new colors. If you will compare the flowers you will see in an old-fashioned garden with those on exhibition in a great flower show you will readily see the difference.

NOW MEN ARE GROWING PLANTS WITHOUT SOIL

Men have proved that soil is not necessary for the growth of plants. Formerly it was thought that the roots ate the soil. In the seventeenth century Jean Baptiste van Helmont, a Belgian, planted a willow in a pot and kept it there five years, giving it only water. The willow gained 164 pounds and the soil lost only two ounces. Why did the willow gain?

More than a hundred years after van Helmont weighed his willow, Jan Ingenhousz, a Dutch physician, and Joseph Priestley, an English chemist, showed that green plants absorb carbon from the carbon dioxid in the air. This furnished an essential clue for the solution of the mystery of a plant's growth.

The glass jar supplies a continuous flow of a chemical solution to feed this sand-grown tomato plant. (*Below*) This plant shows well-developed tops and roots. The reservoir jar on the right renews the solution by means of a siphon.

Courtesy G. Freytag & Son, from *Soilless Growth of Plants* by Ellis and Swaney (Reinhold Publishing Co.)

The carnations (right) and the snapdragons (left background) are growing in beds of cinders. Once a week the chemical food solution is sprayed on the beds which are about 12 to 15 inches deep, until the cinders are thoroughly wetted. Every day or so, water is sprayed over the cinders to keep them moist. At the end of one week the entire system is flushed out with water and drained. Fresh solution is then added to the cinders and the process is repeated. Note that the potted tulips in the left foreground are soil-grown.

In the middle of the last century, Julius von Sachs, a German investigator, began to analyze the part that soil plays in the growth of plants. Using the somewhat inaccurate chemical methods of his day, he found which minerals are contained in soil. He even set plants growing in solutions of these minerals with some success.

There followed a long line of investigators who were interested in determining exactly what were the elements needed in soil for the best growth of plants. These scientists put plants in soil prepared in different ways. One batch of soil might have all the vital elements but in reduced amounts, another batch might have one or more of the elements missing, a third batch might have an extra amount of one or more of these elements. These experiments showed that the necessary elements could be classed, according to the amount needed, in two groups: the major elements and the trace elements. Different plants, however, do not require the same proportions of them.

The major elements required for plant growth are potassium, calcium, magnesium, nitrogen, phosphorus and sulphur. The trace elements—iron, boron, manganese, zinc, and perhaps copper—are so called because they are required only in the most minute amounts as compared to the major elements. Thriving plants require all of them.

These necessary elements must always be supplied to the plant in water solutions since that is the only way in which the plant can absorb its food, no matter where it may be growing. Air in the soil or in the food solution is found favorable to plant growth.

The results of all this work were brought to a startling conclusion by Dr. William F. Gericke of California. About 1929 he began to prepare shallow waterproof tanks. Across the top of the tanks he stretched meshed wire covered two inches deep with peat, or rice hulls, or pine shavings. Through the tanks he circulated water containing the major and trace elements. The

A PLANT GROWN WITHOUT SOIL

Photographs on pages 1473 and 1475, courtesy, J. W. Shive and W. R. Robbins, N. J., Agr. Exper. Station
A continuous flow of solution fed this large tobacco plant which was grown in sand in a 9-inch pot.

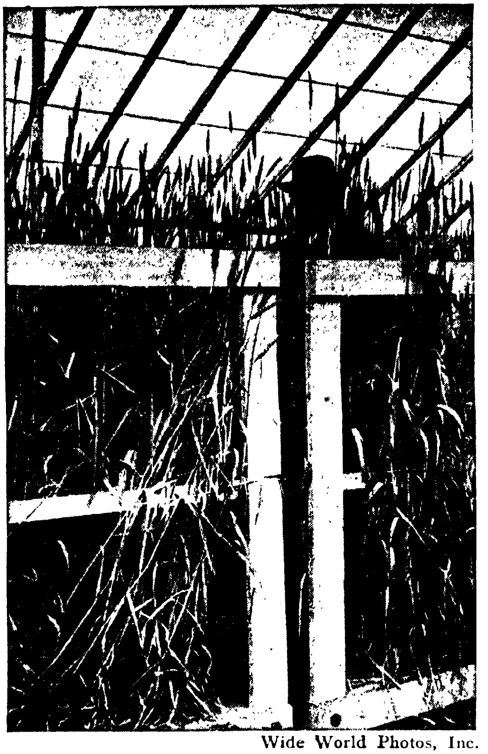
shavings picked up moisture from the circulating water solution. Dr. Gericke put plant seeds in the shavings. The seeds grew! Their roots reached through the meshed wire and dipped into the water solution. Then Dr. Gericke changed the amounts of the elements that he put into the solution until he achieved the best results for each kind of plant.

Dr. Gericke's method is known as the water culture method or *hydroponics*, meaning "labor of water." Another means for growing plants without soil is provided by the sand culture method which employs clean sand through which the water solution circulates. The sand in this case acts as the bed for the seed in the same manner as the wire net and the shavings in the other method.

For the best growth the culture solution must be "fitted" to the individual needs of different species of plants. Even the same plant requires changes in the solution at different stages in its growth or at different seasons for the best results. Thus, for high

Wide World Photos, Inc.

This soilless farmer is sowing corn. The roots reach down through the excelsior and draw nourishment from the chemicals circulating in the tank underneath.



Wide World Photos, Inc.

A bumper crop of tall, tank-grown wheat almost hides its grower, Dr. Gericke, who did much to develop successfully the water culture method of soilless farming.

production of good fruit, tomato plants require less nitrogen during the short, dark winter days than during the long, bright days in spring and summer.

Soilless agriculture has already been taken out of the laboratory. In California several water culture farms are being run as successful businesses. Some railroad dining car menus feature vegetables grown without soil. On tiny, soilless Wake Island in the mid-Pacific, a hydroponics farm provides fresh vegetables for the passengers of the China Clipper planes which stop there and for the inhabitants.

Though the preparation of the culture solution requires chemicals which are relatively inexpensive and abundant, the tanks used are very costly to build for large areas. This cost greatly limits the extent to which soilless farming can be used commercially. But the fact has been established that science can remove the dirt from dirt farming.

THE NEXT STORY OF PLANT LIFE IS ON PAGE 1623.

Culver Service

When John Bunyan was in Bedford Jail, his little blind daughter was allowed to visit him during the daytime.

DRYDEN, POPE, BUNYAN AND DEFOE

AFTER the splendid outburst of poetry at the end of the sixteenth century, with Shakespeare as its bright, particular star, there came a solemn after-glow in Milton. Then followed a period of a very different character.

With the return of Charles II to continue in England the line of Stuart kings, everything French was made the fashion, and in the writing of books, ideas outranked emotions. A French critic named Boileau set himself the task of teaching the world how to write according to classical models, and in France and England alike, in poetry and prose, writing became regulated by rules.

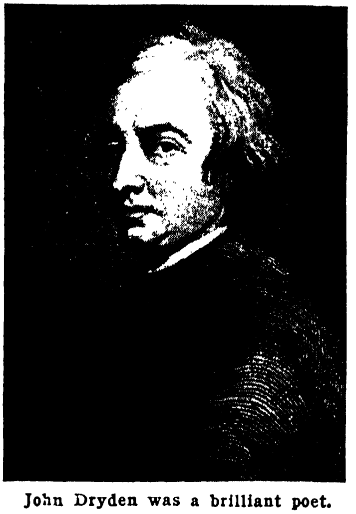
The two English poets of this formal school whose names stand out most boldly in the period from 1650 to 1750 are John Dryden and Alexander Pope. Two of the foremost prose-writers of the era are John Bunyan, author of THE PILGRIM'S PROGRESS, and Daniel Defoe, creator of that great character in adventure fiction, Robinson Crusoe.

John Dryden was born at the rectory of Aldwinkle All Saints, in Northamptonshire on August 9, 1631. We do not know much about his early life, except that he was educated at Westminster School, under Doctor Busby, a famous headmaster, who, although noted for his powers in thrashing his pupils, was admired and respected by all who came under his discipline. As a schoolboy Dryden was fond of writing verses, and, also, when he studied at Trinity College, Cambridge, he continued his poetic exercises; but he does not seem to have been a scholar of any particular note. He inherited a small income, not sufficient to support him; and shortly before his marriage with Lady Elizabeth Howard, the eldest daughter of the Earl of Berkshire, he turned to writing for the theater as a means of support. His plays contain many notable passages, a few of which can successfully be compared with the work of Shakespeare. Dr. Samuel Johnson, the greatest critic of his day, ranked Dryden high as a dramatist.

After Charles II died, in 1685, his brother came to the throne as James II. James showed a desire to make England once more a Roman Catholic country. Dryden at that time became a Catholic, and this is often mentioned to his discredit; but the poet was not guilty of changing his religion to curry favor with the new king. He had been tending for some years toward the Roman Catholic faith, and, later, when the Protestant William and Mary were called to rule the land after James had fled, Dryden remained a faithful Catholic, thereby losing what he had previously gained in the way of royal favor.

One of his most beautiful poems, THE HIND AND THE PANTHER, is written in praise of the Catholic Church, which he likens to the "milk-white hind, immortal and unchanged," the Church of England being the panther, "fairest creature of the spotted kind," while the other Protestant churches are likened to other animals of different kinds. The poem is interesting and unusual.

Dryden's great power took the shape of satire, and some of his finest verse is that in which he gives us biting pictures of historical personages. In his later years he adapted into English verse the works of the Latin poet Virgil, and although these translations were well received, they do not give us a very good idea of the original, which is warm with all the sunshine and glowing beauty of nature; whereas Dryden's verse is cold and glittering.



John Dryden was a brilliant poet.

He wrote some poetry that has genuine poetic quality. His ODE ON ST. CECILIA'S DAY and his earlier SONG OF PRAISE OF MUSIC are very good examples. This stanza from the SONG will show the poet's mingled sweetness and power.

What passion cannot music raise and quell?
When Jubal struck the corded shell,
His listening brethren stood around,
And, wondering, on their faces fell
To worship that celestial sound.
Less than a God they thought there could not dwell
Within the hollow of that shell,
That spoke so sweetly and so well.
What passion cannot music raise and quell?

Dryden also wrote ABSALOM AND ACHITOPHEL, the first published satire in the English tongue, except Samuel Butler's HUDIBRAS, composed about the same time. Satire is not a high form of poetry, but it often accomplishes something. It was used by the ancient poets to expose public abuses and wrong-doers and has often done much good in arousing honest instincts. On the other hand, it is often used cruelly, for scorn may be a foul weapon. People flayed by a clever poet's taunting words can rarely answer back in the same strain, even if they would. Besides, satire may sometimes take aim against goodness.

Dryden's satire, ABSALOM AND ACHITOPHEL, was written to prevent Charles II from nominating the Duke of Monmouth as his heir instead of his brother James II. Since Dryden's day all writers of English satires have had this poem in mind.

On May 1, 1700, Dryden died and was buried in Westminster Abbey. When he was an old man, the most eminent literary figure of his day, there were people always keen to see him on his daily visit to a coffee-house where many men of note were in the habit of meeting. It is said that one day, not very long before he died, the celebrated poet was pointed out to a little boy who had been brought there by a friend; and this pale-faced and delicate little fellow, when he grew up to be as famous as Dryden had been, never forgot this glimpse of him. Already, as a boy of eleven, Alexander Pope was an intense admirer of Dryden's poetry, and had begun to write poetry himself, imitating Dryden's style. Despite his delicate health and stunted form, Pope was a marvelous student when only a child, and by the age of twelve he had written some quite remarkable poems, at least one of which, ON SOLITUDE, might be taken for the work of a thoughtful man.

ALEXANDER POPE, A LITTLE MAN WHO WAS A GREAT POET

Alexander Pope was born in London on May 21, 1688. His father was a wealthy linen-draper, who had joined the Roman Catholic Church, like Dryden, and who, in disgust at the new reign of William and Mary, had withdrawn to a house near Windsor Forest, where the early years of his son Alexander were spent.

The boy received some instruction from priests and other masters, but had no regular education, though his great thirst for learning and the wonderful activity of his young mind perhaps did more for him than the ordinary course of education would have done. He was extremely well-read in the classic authors, and throughout his poetry we find him constantly making use of the ancient stories of gods and heroes of Greece. He was only sixteen when he determined to be a poet, and before he was twenty-three years old he had finished and published his famous ESSAY ON CRITICISM, a comparatively short poem, full of remarkable literary knowledge and ripe judgment. It contains many lines which are constantly quoted, such as "To err is human, to forgive divine" and "A little learning is a dangerous thing." This poem left no doubt that its young author was a genius.

Although Alexander could not be called a lovable character, he was probably a better friend, and kindlier, than his poems would suggest, for, like Dryden, much of what he wrote was inspired by the unfriendly spirit of satire. He was the very opposite of a natural writer, as every line was of clearly artificial style, even when full of force and vigorous movement. Thus, he was peculiarly unfitted to translate the great Greek poems of the ILIAD and the ODYSSEY, which are full of the grand and solemn music of nature; yet his translations of these books were so popular that he was paid $40,000 for the work. Less than sixty years before, Milton had received two payments of $25 for PARADISE LOST. If we were to reverse the two sums, we should be placing the proper values on the relative merits of the works.

With the money which he thus earned, Pope bought a beautiful villa on the bank of the River Thames at Twickenham. There, as the friend of most of the great men of his time, the rest of his life was passed, and other famous poems were written. The chief of these was THE DUNCIAD, in which he satirized all the lesser literary men of his day who did not happen to be his friends.

The lovely house above is Alexander Pope's villa at Twickenham, on the Thames River. Below is a picture of the poet himself.

THE ESSAY ON MAN was another of the notable works written at Twickenham.

If it is by no means a pleasant picture of the poet which we gather from his writings and the stories told about him, we have to bear in mind that all his life was spent in physical suffering. "When the poor little man got up in the morning," says one writer, "he had to be sewed into stiff canvas staves, without which he could not stand erect; his thin body was wrapped in fur and prunella; and his meager legs required three pairs of stockings to give them a respectable look." On May 30, 1744, this strange little poet died, and was buried at Twickenham, where Pope's villa is still one of the best-known houses.

His supreme claim as a poet was that he was the greatest of all masters of poetic form as it was admired in his day. The rule for the couplet, which he brought to perfection, was that in poetry lines should rime in adjacent pairs, and that a single thought should be compressed, if possible, into a single line, or at most into two lines. Here are two much quoted examples:

Hope springs eternal in the human breast;
Man never is, but always to be, blest.

True wit is Nature to advantage dressed,
What oft was thought, but ne'er so well expressed.

Here the lines are crisp and strong and packed with meaning. The thought may not be great, but it is neatly handed out. That is Pope's general style. It catches the ear and lodges in the memory.

John Bunyan (1628-1688) was in some respects the most remarkable man who ever gained immortal fame by the use of the pen. He was an uneducated tinker (a maker and mender of pots and pans), son of a traveling tinker. He had a rough but short soldier life behind him when he became a serious seeker after the peace which religion brings.

Two incidents are mentioned by him as turning points in his young life. One was a conversation about the blessings of religion between two pious, poor women sitting at their cottage door while he worked at his trade in the lane close by; and the other was two religious books brought by his wife into their scantily furnished house when they were married. These were THE PLAIN MAN'S PATH TO HEAVEN, and THE PRACTICE OF PIETY. Probably these books marked the turning point in the life of Bunyan and put into his mind the idea of writing books.

Culver Service

Bunyan's dream of PILGRIM'S PROGRESS: a picture in the 1680 edition of the book.

One of the first and best books that John Bunyan wrote, GRACE ABOUNDING, was a sketch of his own early life. It contains many of the qualities of his later works; but it must not be accepted without reserve, for Bunyan's description of his conduct as a young man, and his "sins," as he called his doings, is the pricking of a very tender conscience.

BUNYAN WAS A GENTLE SOUL BUT STRONG IN HIS FAITH

John Bunyan believed himself to have been a very bad young man, and to have had a long and anxious wrestle with himself—or with Satan—before he became an active Christian and an eager and popular Nonconformist preacher.

He had been a vigorous, worldly minded youth, fond of sports, and a victim to the bad habit of coarse language; but he was only twenty when he married the thoughtful wife who brought him pious books to read and who was a companion in his search for a better life. When he was twenty-seven his wife died, leaving him with four little children, one blind. He was now a lay preacher, and years later he was ordained a regular minister.

But this change did not alter his mode of life. Like the apostle Paul, he earned his living by the work of his hands while preaching the Gospel in all the country round. By day he mended kettles and pans, and by night he drew crowds to hear his homely teaching of the Christian faith. At the same time he began to write, and when he was thirty he had published three books, all plain and vigorous and brightened by humor.

John Bunyan was twenty-one years old when Charles I was executed. For eleven years thereafter he lived in the soberminded England of the Puritans and the Nonconformists, an England to his liking.

In 1660, when he was thirty-two years old, the son of Charles I was invited to go home to England from his exile on the Continent, and be crowned king as Charles II. The period of his reign is known as the Restoration, and in this period many things were restored along with the monarchy.

Gaiety and frivolity and lightness of spirit came back. People who had worn dull and simple clothing for eleven long years blossomed out in laces and ruffles; at least, those who could afford such luxuries now reveled in them. Many went to foolish and even sinful extremes of gaiety. Serious souls like John Bunyan were horrified and asked themselves "What is the world coming to?"

Bunyan preached openly in the marketplaces, urging all who heard his voice to hold fast to the virtuous life of the old Biblical Fathers.

With the Restoration, however, came edicts against Nonconformist preaching of the Gospel. In other words, all English subjects were supposed to conform to the state Church of England, and preachers who tried to win converts away from it were punished. John Bunyan was not the man to be daunted by threats of punishment. Of course he went on preaching. He was respected and he was popular, and the local justices shirked taking on themselves the shame of punishing such a man, so they shut him up in prison to prevent his breaking the law he would not promise to keep; and through the troublous times that followed, twelve years of Bunyan's life were spent in prison.

BUNYAN WROTE HIS GREATEST WORK WHILE IN BEDFORD JAIL

He was released at last, but later thrown into Bedford jail for another six months, and in that half-year he wrote the first part of the book that brought him lasting fame, THE PILGRIM'S PROGRESS. The work is an allegory. That is, it preaches under the cloak of fiction. Such good and exciting fiction it is that we read it now chiefly for the story, though the lessons are plain and can not be missed.

THE PILGRIM'S PROGRESS is the tale of a hero named Christian and his adventures on a long journey. This story is regarded by some scholars as the forerunner of the English novel.

After his release from his long imprisonment Bunyan lived nearly sixteen years, preaching and writing books. The laws against Nonconformists were relaxed. The tinker-preacher became a national character and his PILGRIM'S PROGRESS was beginning to be felt as a glory to English literature. Since his time it has been translated into a hundred languages.

The secret of this great book is that a man with spacious imagination and religious feeling of high intensity found the means of expressing his vision and his faith in simple language. He used the common speech of his day, so refined as to preserve dignity without ever losing extreme simplicity.

John Bunyan never wrote a page that anyone of ordinary intelligence could not understand; but he wrote hundreds of pages which by their perfection in style and thought will charm forever students of the literatures of all nations.

Daniel Defoe (1660?-1731) was a Londoner born, who was educated to be a minister but turned aside first into business and then into politics and journalism.

Unquestionably Defoe, who wrote the immortal ROBINSON CRUSOE, was the founder of English journalism. He was the first man of note who combined the professions of journalist and political agent. A journalist is one who writes on topics of the day in which everyone is interested. The word comes from the French *jour*, day. Whether it was party politics, or religion, or finance, or trade, or family life, or business, or ghosts, or gossip, or the lives of people who were being talked of, Defoe immediately produced a life of them for everyone to read.

He began with pamphlets; then he went on to start a newspaper of his own, once a week, twice a week, thrice a week as the demand for his work grew; and all the while he was working with one or other of the political parties, changing sides from time to time.

It was not, however, in Defoe's pamphlet-writing, nor in his newspaper work, though he was a great journalistic pioneer, nor in his biographies or travels, though they are interesting and show us what England was like in those days, but in his fiction that Defoe has won for himself a distinct and original place in English literature.

That originality is seen in all his best books—in his JOURNAL OF THE PLAGUE YEAR, his MEMOIRS OF A CAVALIER, his MOLL FLANDERS, his CAPTAIN SINGLETON, and most strikingly in ROBINSON CRUSOE. Defoe believed that people are never so much impressed by reading what they know is fiction as by what is, or seems, true. Defoe's literary secret was to write always as if what he said were true. All of these books are fiction told as if it were fact.

DEFOE COULD MAKE IMAGINARY EVENTS READ LIKE TRUE STORIES

By the time ROBINSON CRUSOE was written Defoe had had great practice in making the dreams of his own mind seem entirely real happenings, and taking as the groundwork of his book an experience of a shipwrecked sailor, Alexander Selkirk, he wrote a book out of his own head that is more real than almost any other man's account of events he had actually experienced. In doing this Defoe not only told a tale we all like to read again and again, but he proved in the English tongue the superiority of plain, clear, simple writing. But behind this easy writing was one of the most imaginative of minds.

THE NEXT STORY OF LITERATURE IS ON PAGE 1619.

Courtesy, Canadian Pacific Railway

This picture shows a typical railway station in the days when the transcontinental railways were being opened up.

CANADA—A MODERN NATION

IN the year 1850 the Canadian nation was no more than a dream in the minds of a few hopeful men. The framework for a united Canada existed, for there were towns and cities and farming communities and trading posts from Atlantic to Pacific. But there were also great spaces of wilderness between these settled areas, and the means of communication from one to another were slow and difficult.

On the Atlantic were Prince Edward Island, Nova Scotia and New Brunswick. The commercial interests of these provinces lay more with the New England states than with the province of Canada on the St. Lawrence River and the Great Lakes. Between New Brunswick and Quebec lay a barrier of rough and rocky country; and in the winter when the river was closed, travel became exceedingly difficult.

The largest and most progressive part of British North America was the province of Canada, formed in 1840 by uniting the colonies of Upper and Lower Canada. In this area French and English were trying to live together under one government, and to work together in the tasks of building the canals and making the roads which their country needed. The co-operation of the two colonies united in the province of Canada was especially necessary because of the canals which were being built around the St. Lawrence River rapids and past the falls at Niagara. The cost was great, but the result was a clear channel for ocean-going ships into the upper lakes.

A thousand miles farther west, beyond the rocky wilderness that lies north of Lake Superior, there was a tiny settlement at Red River, governed by the Hudson's Bay Company. Across the wide stretches of the prairies the trading posts of the fur traders were scattered, and on the other side of the Rockies there were small settlements on the Pacific coast.

Could these separate parts be brought together to form one nation, reaching from east to west across the continent? The chances did not seem very great in the year 1850. There were, however, important reasons why such a nation should be formed.

Railways were the key to the problem. The new steam railway could bridge the great gaps which separated the parts of

British North America. But only by forming a union, or confederation, could the people of these provinces raise enough money to build the railways that would bind them together.

Local railways had already been built in British North America. The first Canadian railway was the Champlain and St. Lawrence, opened in 1836. It was a short line, less than fifteen miles in length, connecting Montreal with the Richelieu River, and was meant to be only a kind of link in the chain of water communication running south from the St. Lawrence. It was, however, a beginning, and the celebration that took place when the small puffing engine made its first trip over the wooden iron-bound rails marked the beginning of a new age in British North America.

THE BEGINNING OF A GREAT RAILWAY NETWORK

The most important railway in Canada before Confederation was the Grand Trunk. This was built during the 1850's, and it ran from the United States border at Sarnia to Montreal, and from there southeastward to the town of Portland in the United States. A line was run also to the city of Quebec and farther east along the river to Levis. The Grand Trunk served many purposes. It was a main line of communication for the settlements of the St. Lawrence Valley. It gave a route to an ocean port (Quebec), both winter and summer, for the products of the Canadian farms. It also offered to the mid-western United States a short and easy rail connection with the sea. By 1860 the Grand Trunk had 1,200 miles of line, and had become one of the longest railways in the world.

Other railways were also built in Canada during this period, connecting the farming communities with trading centers such as Toronto and London. Gradually a railway net spread itself over the St. Lawrence Valley. In Nova Scotia and New Brunswick, too, there were beginnings at railway building. Lines were laid from Halifax and Saint John, reaching out toward other centers in Canada and the United States. One of these roads had the ambitious name of European and American Railway. But railway building was costly, and none of these eastern roads did more than serve local needs.

There were two lines of railway which British North America needed greatly, and which the separate provinces could not build themselves. One was the road running from Nova Scotia and New Brunswick to Quebec. The second was a line through the rugged country north of Lake Superior to the prairies, and then on to the Pacific. The need for these two railways was one of the great forces that led the provinces to pool their strength by forming a confederation in 1867.

There were other reasons, too, leading toward federation. The union of Upper and Lower Canada in 1840 had not proved entirely satisfactory. French and English each had their own ideas about education and about the local government. There were also many changes in government from year to year, because of the even balance between French and English. Men soon began to think that some new arrangement would be necessary. The solution that seemed best was to form a federal government, letting each of the two sections of Canada control its own local affairs, and giving to a central government authority only over general matters which touched the lives of all alike. But if such a federal system could be made to include French and English Canada, it seemed that it could also include the other provinces as well, and perhaps in the end be made to reach to the Pacific. In this way, out of the trouble which the people of Canada were having in governing themselves during the 1850's, there grew the idea of a newer and larger state built on a federal system.

WHY PEOPLE WANTED MORE AND MORE RAILWAYS

There were economic reasons also for the movement toward confederation in Canada. The commercial life of all the British North American provinces was based on some kind of export. First it had been furs, together with fish in the maritime areas. After 1800 there were new goods to send to markets abroad—timber and wheat. For many years both these products of the New World were welcomed in England, so that good markets were developed there. Timber was the first to become important in the export trade. Every year there came down the Ottawa and the St. Lawrence rivers countless rafts with square timbers cut in the forests where new settlement was taking place. In the 1830's as many as 1,300 ships a year sailed from Quebec for England, carrying timber. Once the canal system had been completed, wheat and flour also were shipped to the ports of Montreal and Quebec for the English markets.

During the 1840's the people of England

decided that they would change the system by which they gave a preference in their market to goods from British colonies. In 1846 the Corn Laws, which made customs duties low for Canadian wheat and flour, were repealed. Canadian wheat had then to compete in the English market with wheat from the United States, which could be shipped more cheaply. During the same period, the timber of all countries was admitted freely to England, and Canadian timber was pushed out of the English market by timber which came from the Baltic countries.

A TRADE AGREEMENT IS MADE WITH THE UNITED STATES

Having lost these markets, the Canadians found new ones in the United States. In 1854 an agreement was made between Canada and the United States known as the Reciprocity Treaty by which many of the goods of the two nations could be exchanged freely across the border. This treaty helped Canadian trade, and it helped the trade of the maritime provinces of Nova Scotia and New Brunswick. It was known, however, that the agreement had many enemies in the United States, and many people feared that it would be brought to an end. This very thing happened in 1866.

The need for markets led people in British North America to wonder whether they could not develop a market of their own for more of the goods which they produced. For this reason, they thought about banding together all the provinces into one federal system within which goods could be freely exchanged. Once the railroads had been built, fish from the Maritime Provinces, articles from the factories of the St. Lawrence Valley, or coal from Cape Breton could be traded within the new federation. Trade, then, was another reason which led men to make plans for a federal system.

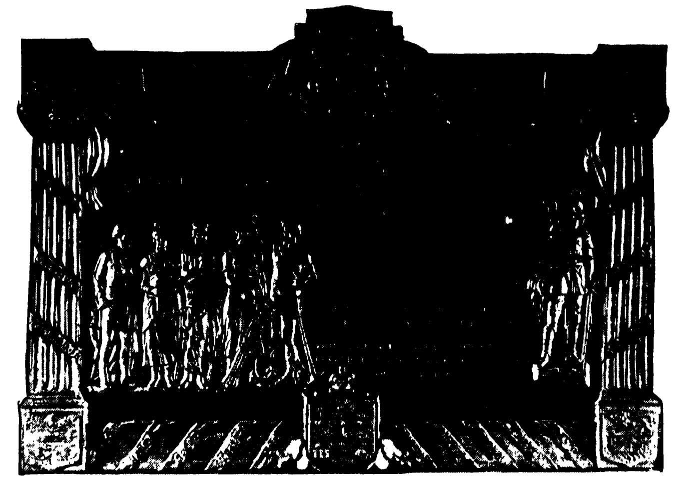
There were still other causes for federation. One was the existence in the West of the great prairie land, still in the possession of the Hudson's Bay Company. It was natural that this area should be joined to Canada, but it seemed that only a federation including the provinces by the sea would be strong enough to take over and govern so large an area. There was a military question also in the movement for federation. The years after 1860, during the great Civil War in the United States, were the last period during which Canadians had any reason to fear their neighbors to the south. The danger was not great even then, but there seemed to be a chance of trouble. There had been a number of disputes between the United States and Great Britain during the Civil War, and it was possible that these would not be settled peaceably. There was also trouble with the Fenians, certain Irishmen in America who had the idea that they could help Ireland by attacking the English in Canada. There were a number of raids across the border, and for a time it was feared that these Fenian raids might lead to disputes with the United States. If the British North American provinces could be united, and connected by good roads and railways, the danger from across the border might be lessened, or more easily met if it grew threatening.

There were many reasons, therefore, which led the people of British North America to turn toward federation. The idea was present in every part of the country, and a very promising beginning had been made toward a local federal union in the Maritime Provinces in 1864. At that time a new government was formed in Canada, made up of men from the two strongest parties, the Conservatives, led by John A. Macdonald, and the Reformers, or Grits, led by George Brown. This new government at once sent a delegation to Charlottetown, in Prince Edward Island, where leaders from the three eastern provinces were meeting, to discuss local union. From this meeting came the suggestion that a general federal union should be formed. The Charlottetown conference was adjourned, to meet again soon afterward at Quebec where a plan for confederation was worked out in detail. The plan was then considered by the governments of the various parts of British North America and finally taken to London where it was presented to the British government. There it was considered and passed in the British Parliament in an act known as the British North America Act. This became law on July 1, 1867. On that day the modern federal state, Canada, came into existence.

THE FIRST PRIME MINISTER OF THE DOMINION

The real father of Canadian confederation, and the first prime minister, was John A. Macdonald. As a boy he had come to Canada from Scotland, and he was trained as a lawyer. He practiced law in Kingston, and in the 1850's he began to make a name for himself in politics. He had great qualities, for he was a fine speaker, and he knew how to make friends with men and win their confidence. Gradually a political party began to form under his leadership. This party came to be known as the Conservative party, and it had in it people from both French and English-speaking parts of Canada. Macdonald's closest political associates were Alexander Galt and George Etienne Cartier. In the work of bringing about confederation, Macdonald was helped by some men who had been his enemies in politics, the most important of whom were George Brown and William McDougall.

The British North America Act of 1867 created the Canadian Confederation. It provided for a central government to have charge of all matters of general importance. Such subjects as defense, customs duties, railways and canals, currency, banking and criminal law were given to the federal government. It was also decided that the central government should have power to pass laws in times of national emergency on any subject, if such action were necessary for the good of the country. This part of the British North America Act has made it possible for the Canadian people to meet the demands which two world wars have made by preparing on a national scale.



This tablet at Charlottetown honors the birthplace of Confederation.

Under the Canadian federal system, matters of local concern, education and laws concerning property and civil rights have been given to the provinces. Roads and highways, control of water power and of natural resources such as forests and mines and the right to dispose of all public lands are among the powers of the provinces.

In many ways the British North America Act was little more than a promise of the Canadian nation which had yet to be built. In 1867 there were only four provinces in federation, and only about three million people. Prince Edward Island had not yet joined, the great prairies of the West had yet to be claimed, and on the Pacific coast the colony of British Columbia had not yet been included.

Gradually the new Canada was rounded out to its full size. In 1870 the Hudson's Bay Company territories in the West were turned over to the Dominion and became part of Canada. In 1871 British Columbia became a member of the Confederation on the promise that a railway would be built to the Pacific Ocean within ten years. Two years later Prince Edward Island joined the Dominion, so that Canadian territory now stretched in an unbroken line from Atlantic to Pacific. In 1880 all the northern territories, including the islands of the Arctic Ocean, were turned over to Canada by the British Government, and became part of the Northwest Territories which the federal government still controls.

The new Dominion had many pressing duties. First of all, it had undertaken to build a railroad to connect the provinces of Ontario and Quebec with the ocean at Halifax. The Government at once began to construct this line. It lay through difficult rocky country, and the work was costly and dangerous. It was nevertheless completed in a remarkably short time. The line, the Intercolonial Railway, which later became part of the Canadian National, lay along the south shore of the St. Lawrence, passed through northern New Brunswick and reached the sea at the great ocean port of Halifax.

Even more difficult were the problems which faced the new Dominion in the West. The prairies were rapidly slipping from the control of the Hudson's Bay Company, and only by moving quickly could the Canadians make sure that the western regions would not become a separate dominion, or drift into the United States.

Arrangements for transferring the territory to Canada were easily made with the British Government and with the company, which agreed to surrender its ancient charter in return for a sum of money and a grant of land. But the people who lived in the only large settlement in the West, on Red River at Fort Garry, were displeased with these plans. Most of them were men of French-Canadian and Indian stock who had settled down, after spending a few years in the fur trade, to farm a few acres of land on the banks of the Red River. They were afraid that the new government might take their land away from them, and they thought that at least they should enter Canada as members of a province.

When the first governor from Ottawa, William McDougall, reached Red River in 1869 he found his way blocked by barricades, and the settlement at Fort Garry in the control of armed French-Canadian-Indian settlers, who were called métis. They had found a leader in a young man named Louis Riel, who had a number of demands to make, including local self-government and the promise of a railroad. For a few months the settlement remained in the hands of Riel and his followers. During this time a military expedition was formed in Canada, which went west in the spring of 1870 by the difficult water route of the old fur-trade days, by Rainy River and Lake of the Woods to Lake Winnipeg.

THE AGREEMENT THAT LED TO THE FOUNDING OF MANITOBA

In the meantime, however, a solution had been reached, by which it was agreed that the area around Red River should enter Canada as a new province, which was called Manitoba. Unfortunately, while he was in control, Riel had ordered the execution of a young man from Ontario, Thomas Scott, who had been resisting his authority. Fearing that he would be punished for this act, Riel fled to the United States, and the military expedition under Colonel Garnet Wolseley met no resistance when it reached Red River.

One of the first acts of the Canadian Government in the West was to create the famous Mounted Police. The men of this force were given uniforms with bright red tunics, and fine horses to ride. They had to keep order over all the prairie regions. There were never many of them, and they were forced to deal with problems created by Indians, fur traders, and settlers, together with all the stranger characters that find their way to a frontier. The record of the Mounted Police was excellent, and they managed to keep peace on the prairies by winning and holding the confidence of all who lived there. The one occasion when the Canadian Government had trouble in the frontier regions was through no fault of the Mounties, for they had seen it coming and tried to prevent it.

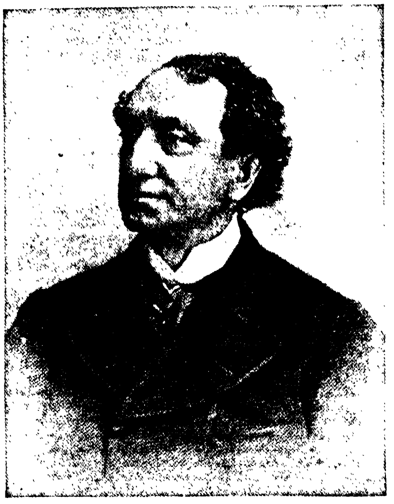
THE SECOND REBELLION WHICH WAS HEADED BY LOUIS RIEL

In 1885 there was a brief, sharp rebellion in the Saskatchewan Valley region, in the northwest. The rebellion, like the one of 1870 at Red River, grew out of the fears of the métis that they would lose their lands, and this revolt, like the earlier one, was led by Louis Riel. He was helped by a few bands of Indians, under the leadership of an able chief, Poundmaker. A military force was quickly organized in eastern Canada and sent west. The rebellion collapsed quickly, and Riel was captured and executed. If the Saskatchewan River settlers had been promised the ownership of their land, and if the Indians had been helped in finding food at a time when the great buffalo herds were disappearing, the rebellion need never have happened. As it was, most of the Indians and settlers in the West took no part in it.

Besides the problem of keeping order, the Dominion Government had also to undertake the task of building a railroad. A promise had been made both to Manitoba and to British Columbia that a line would be built. It was a costly and difficult undertaking, but the new federal government at once set about making plans. Land was offered as a gift to any company which would build the road, and in 1872 a contract was almost signed with a group of men who were willing to do the work. At the last moment, however, it was found that these men had given large sums of money to Macdonald's Conservative party. The public thought that the company had bribed the Government into giving it the contract, and because of this, which was called "the Pacific scandal," Macdonald was forced to resign in 1873.

Macdonald was succeeded as prime minister by the leader of the Liberal party, Alexander Mackenzie, who, with his followers, won the next elections. Mackenzie governed Canada during a difficult period, for the whole world was suffering from economic depression, and it was difficult to find money with which to carry out the important enterprises to which the new Dominion was pledged. It was decided to try building the Pacific railroad as a government undertaking, and a start was made on the prairies east and west of Red River. Progress was slow, however, and the people of British Columbia became very discontented because the railway that had been promised them was still a long way from completion. In 1878 Mackenzie and his party were defeated in the elections. Macdonald returned to office, and he at once set about the work of finishing the Pacific railroad.

The story of the building of the Canadian Pacific is one of rapid achievement in the face of tremendous difficulties. Fortunately the men who formed a company and undertook to build the road had already had experience in railroading, in the northern United States. They had to carry their line through the rocky and desolate country north of Lake Superior, a thousand miles across the prairies, and then over some of the most rugged mountains in the world. They had to face almost every kind of engineering problem known to railway men, from swampy muskeg where the track sank from sight, to steep and narrow mountain passes where the line doubled back on itself in huge hairpins. The railroad-builders had also to face difficult financial problems. The Government gave them a large land grant and a generous sum of money. But the line had to be built through unpopulated country, and years had to pass before the farm lands given to the company could be sold. Many times the company was near collapse, and the men who built it put their whole personal fortunes into keeping it alive. In the meantime, they pushed ahead with the building of the road, and in 1885 it was completed.


Sir John A. Macdonald.

The Pacific railroad made possible the development of western Canada as a great farming area. At first there were many disappointments. Rainfall on the prairies is not great, and methods of farming had to be found which would preserve moisture. There are also early frosts, which sometimes destroyed wheat before it ripened. In answer to this problem, varieties of wheat were developed which ripen early, so that the grain can be harvested before the first frosts come.

There were other great tasks connected with the opening of the West. The millions of acres of land on the prairies had to be placed in the hands of settlers. It was decided that the homestead system should be used; and 160 acres of land were given free to any settler who would go and live on his farm and cultivate it. Beside every 160 acres of free land, there was other land that the farmer could buy, either from one of the private companies with land to sell, or from the government. In this way it was possible for settlers to secure good-sized farms, with pasture, and sometimes with wood lots, as well as fields for growing grain.

Except for a short period after 1872, Macdonald continued to be prime minister of Canada until his death in 1891. Not only was he the chief founder of Confederation; it was he, more than anyone else, who kept the new Dominion alive during the first difficult quarter century of its life. Those were discouraging years, and there were many times when it seemed that the experiment in building a nation out of the scattered British North American provinces might fail. Macdonald never lost faith, however, and by the time he died the worst dangers had been overcome.

Macdonald's Conservative party was greatly weakened by the death of its leader, and there was at that time no new young man to take over the reins from the old chief. The Conservatives had long been in power, and there were new and pressing questions facing the Government which they seemed unable to solve. One of them was a dispute between the province of Manitoba and the federal authorities over the kind of schools which should exist in the province. The question was one over which French and English people in Canada were deeply divided, and the Government did not seem to be able to come to any clear and satisfactory solution. In elections in 1896 the Conservatives were defeated, and a Liberal government took office under the leadership of Sir Wilfrid Laurier.

Laurier was a young French-Canadian

lawyer who had risen to the leadership of the Liberal party because of his ability and because of his genuinely progressive ideas. He believed that the people of French Canada could enter into a real partnership with political leaders from English Canada; and he won the confidence of French and English people alike. One of his first acts as prime minister was to find a solution to the difficult and bothersome Manitoba school question.

Laurier and his party governed Canada during years of great expansion, from 1896 to 1911. Canada grew rapidly in many different ways. In Ontario the foundations were laid for the growth of manufactures and heavy industries which have made that province the richest in the Dominion. In Ontario also there were important mineral discoveries in the country north of the Great Lakes which resulted in the growth of an important mining industry.

NEW PROVINCES ARE FORMED IN THE GROWING WEST

It was in the West, however, that the greatest change took place. Up until 1900 there had been no great movement of people to the prairies. There had been a slow but steady stream of settlers, and the groundwork had been laid for later growth in population. The early settlement had taken place for the most part from Ontario and from the western United States. There had also been a few settlements by Europeans, the Mennonites and the Icelanders being the most important. After 1896 the Government decided to hasten the settlement of the West by encouraging immigration, and after the turn of the century a great flood of people began to come from Europe. Many of them came from eastern European countries, and settlements of Poles, Ukrainians, Russians, Doukhobors, Hungarians and Germans took up land on the prairie during this period. The Government helped to pay their passage from Europe and gave them free land. The population of the prairies increased rapidly.

With more people in the West, it was possible to set up provinces there, and in 1905 Alberta and Saskatchewan were created. A few years later Manitoba was increased to its present size. The areas administered by the federal government directly were now confined to the Yukon and the Northwest Territories. Canada took on its modern appearance, with nine provinces reaching from Atlantic to Pacific.

The Laurier period was also one of important railway construction. Two new transcontinental railways were undertaken at this time, and many branch lines were constructed, especially on the prairies where railways were built to carry the pioneers into unopened farming country. One of the transcontinental railroads was built by the Grand Trunk and the federal government together. The government constructed a line from Moncton and Quebec westward, through the northern part of the provinces of Quebec and Ontario, to Winnipeg. From there the Grand Trunk built a line through the northern part of the Prairie Provinces to the Yellowhead Pass in the Rockies and on to the port of Prince Rupert. These lines, called the Grand Trunk Pacific in the west and the National Transcontinental from Moncton to Winnipeg, were to be operated as part of the Grand Trunk system.

The third transcontinental railway was constructed piece by piece under the direction of two men, Mackenzie and Mann, who started with a small railway, the rights to which they bought in Manitoba. They acquired some land grants and they were given some assistance by local governments, and gradually they extended their road by new purchases and by construction until it, too, reached from ocean to ocean.

THE CANADIAN NATIONAL RAILWAYS SYSTEM IS FORMED

The first World War in 1914 came at a time when neither of these new transcontinental roads was firmly established, and both of them very rapidly fell into financial difficulties. The federal government was soon forced to take a hand in their affairs, and eventually both roads became the property of the Government. The Dominion already owned the Intercolonial Railroad running to Halifax, and all these lines were put together and made into the Canadian National Railways.

The Canadian people thus became owners of a great railway system, with lines running into every part of Canada and even with some lines running into the United States. Under the direction of Sir Henry Thornton, the Canadian National was built during the 1920's into an efficient company. Its lines were improved and extended, and one very important addition was made, a pioneer railway to Hudson Bay.

Sir Wilfrid Laurier ceased to be prime minister in 1911, and was succeeded by Sir Robert Borden who had become leader of

SOME OF CANADA'S VARIED INDUSTRIES

Macdonald's Conservative party. Borden had not been prime minister for long when the country was faced with the first World War. The war broke out in August, 1914, and it was quickly decided that the danger to England and western Europe was also a danger to Canada, and that the Canadian people should take part. Canadian military forces were called together, and before many months a division had been sent overseas. Other forces followed, and before the war was over the Canadian Corps consisted of more than four divisions. Canadian troops took part in some of the most famous battles of the war, and at Vimy Ridge in northern France there now stands, on territory which has become Canadian soil, a great memorial to the thousands of Canadian soldiers who gave their lives in the war. At home, the country turned its attention to producing supplies, and many kinds of small munitions were manufactured in Canada.

CANADA BECOMES A FULLY INDEPENDENT NATION

One result of the war was to make Canada into a nation fully free, not only in her home affairs, but in her relations with other nations as well. The Canadian people have become free and self-governing by a very gradual process, which began, with what was called Responsible Government, in the 1840's. At that time it was thought that some important questions, such as trading policy and foreign policy, should not be controlled by the Canadian government but by the mother-country. There has been no revolution in Canada, by which the country has suddenly broken free from the controls of the mother-country, but one by one these controls have been surrendered. By 1860 the Canadians had made clear their right to have customs duties which were based on different principles from those of England. By 1870, when Canadian matters were involved in important discussions between the United States and Great Britain, the Canadian Prime Minister was one of the British negotiators who visited Washington. During the South African War, in 1900, the Canadians made a voluntary contribution of men and material to the British forces which were fighting there, and in 1914-1918 her part in the war was so important that when peace came, she signed the peace treaty as a separate nation. Canada now began to make her own treaties, to appoint her own ministers and ambassadors abroad, and generally to conduct her own foreign policy.

The position of the governor-general also changed during this period. Even after Confederation, the governor-general had continued to be a representative in Canada of the Colonial Office in London; and he had a good deal of influence in Canadian affairs. After World War I, however, it was recognized that the English government no longer had any right to interfere in Canada, even in an indirect way through the governor-general. It was agreed, therefore, that the governor should be regarded only as the personal representative in Canada of the king, and that his duties should become altogether the formal ones exercised in normal times by the monarchy.

These decisions, which applied to the other dominions as well as to Canada, were taken at an Imperial Conference which met in London in 1926, and were made law in the Statute of Westminster, in 1931. The Statute of Westminster was an act of the British Parliament recognizing the equality of the various members of the British Commonwealth of Nations.

In the years after the war, Canada went through a further period of expansion. Industrial development, in particular, was increased in the 1920's, with electric power playing an important part in this growth. Canada has tremendous resources in water power. Her great rivers, as well as the countless smaller waterways that thread her north country, have many locations where it is possible to install power plants and develop electricity from water power. Numerous power houses were built on sites of this nature, and great transmission lines were constructed, linking the power systems of various parts of the country, and sometimes carrying the electricity for hundreds of miles.

OPENING UP THE TREASURE LANDS OF THE NORTH

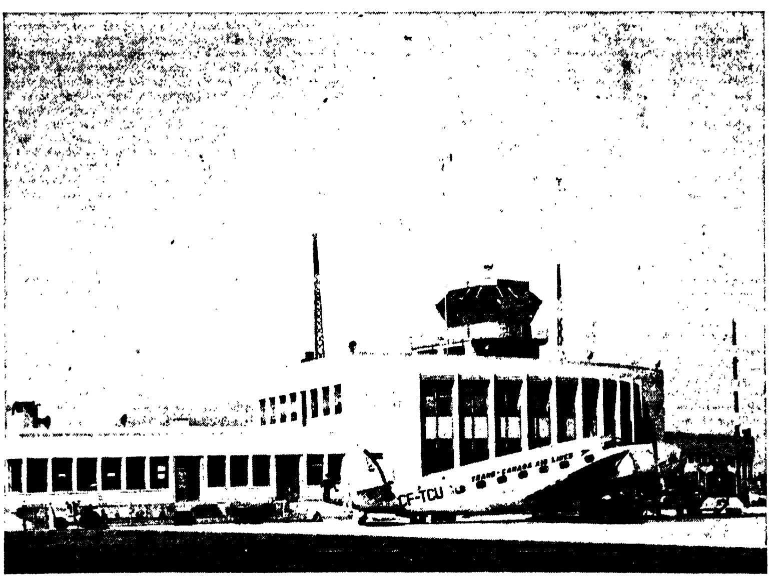
During these years also the great Canadian northland began to be opened. Previously it had been known only to its Indian and Eskimo inhabitants, to a few fur traders and missionaries, and to the men of the Royal Canadian Mounted Police who patrolled it. Gradually, however, explorers came to have a better idea of the country, and important deposits of gold and other minerals were discovered. In various parts of the country, railways were built reaching up toward the northern wilderness. The Temiskaming and Northern Ontario Railway and the Algoma Central in Ontario were both pioneer roads built into mining and forest country. The former reached the waters of Hudson Bay, and so did a railway built in northern Manitoba to Fort Churchill. The Hudson Bay Railway not only tapped mineral areas; it also provided a northern route by which the wheat of the prairies could be taken to a new ocean port and there shipped to Europe.

Another great wave of immigration came to Canada during the post-war years, and the population of the prairie farming areas and of the industrial cities was increased by the newcomers, most of whom came from central Europe. The prairies now became one of the richest wheat-growing areas in the world. In good years, when the growing season was right, the prairie farmers could produce almost 500 million bushels of wheat, and many other farm products as well. In many places, farming became mechanized. Tractors replaced horses when the land was worked; and huge combines reaped and threshed the grain in one operation. Many farmers began to use their own co-operative organizations for marketing their products, and an enormous co-operative called the Wheat Pool was developed for the purpose of selling grain.

For most of the twenty-five years following the first World War the Canadian prime minister was William Lyon Mackenzie King, who had succeeded Laurier as leader of the Liberal party. There were three periods of Conservative government, two under the leadership of Arthur Meighen, and one, between 1930 and 1935, under the leadership of R. B. Bennett. The years during which Bennett was prime minister were exceedingly difficult ones, for Canada suffered very heavily from the great world depression in trade and from severe droughts in the prairie regions. Bennett tried hard to lighten the burden of people in the farming areas where crops were scorched in the field summer after summer, and he tried also to find new markets abroad for Canadian manufactures. In 1935, however, his government was defeated in an election, and Mackenzie King again became prime minister.

One of the most important influences in Canadian life which developed during the years after the first World War was the growth of aviation. Distance has always been one of the hardships which Canadians have had to overcome in building their nation, especially in the unsettled north where travel has been by canoe in summer and dog-train in winter. The airplane has helped people in Canada to close up the spaces which separate them. The airplane has made it possible to open up the north country. In the 1930's an air-line system called Trans-Canada Airways was opened by the Government and the Canadian National Railways, operating from coast to coast. From the base provided by this line, independent operators began to provide services into the mining and forest areas of the north. Eventually, many of these pioneer lines were gathered together into a system operated by the Canadian Pacific Railways. The transportation of freight by air rapidly became a business of great importance in Canada; and the "bush pilots" who flew over the lakes and forests and tundras of the Northwest Territories helped Canadians to learn about their own unknown hinterland.

When war came again to the Canadian people in 1939, the beginnings which had



Courtesy, Trans-Canada Air Lines

A passenger plane waiting to take off on her daily flight from Montreal airport.

been made in a national system of aviation proved of great importance. The great majority in Canada realized that the war in Europe was something which endangered their own country and their own way of life, and Canadian troops were on their way across the Atlantic within a few months of the outbreak of the fight. It was in the air, however, that Canada gave most aid. It was soon realized that a great allied air force would be necessary and that the flying fields of England, which were very close to the front line in the early days of the war, would be too exposed to the enemy and too busy with the tasks of war to allow for proper training. It was therefore decided that training for airmen from England and from the dominions should be centered in Canada. The arrangement was known as the British Commonwealth Air Training Plan. It made use of many air fields which were hastily built across Canada. Thousands of airmen from England and the various dominions and from many other countries, too, were passed through the schools set up in Canada under this plan. They provided a large part of the man-power for the great air assaults which Great Britain and the dominions helped to launch upon Germany. The Royal Canadian Air Force itself was much enlarged during the war, and thousands of young Canadians took to the air to man Canada's fleets of fighters and bombers.

CANADIAN LAND AND SEA FORCES HELP TO WIN ANOTHER WAR

The Canadian Army and the Royal Canadian Navy were also greatly expanded during the war. Canadian military forces to the strength of an army were built up in the United Kingdom under the leadership of General A. G. L. McNaughton. Units from this army took a major part in the costly but informative landing at Dieppe in 1942, and part of the Canadian Army joined in the invasion of Italy. When D-day came, and allied armies landed in Europe, Canadian forces were alongside their British and American companions on the beaches of Normandy; and they joined in the great battles by which the German armies were driven from France, from Belgium, from Holland, and finally were defeated on German soil.

The Canadian Navy had consisted of only a few ships at the beginning of the war. Ships were rapidly added, and thousands of men were recruited. The particular work in which the Royal Canadian Navy specialized was convoy duty and submarine patrol in the north Atlantic; and during the latter part of the war this work was done for all the allies by Canadian ships.

On the home front, the Government made use of the special authority which had been given to it in the British North America Act and set about preparing the country for war. Strict rationing was enforced of all goods of which there were shortages, prices were controlled, production was directed. A tremendous industrial program was undertaken, and many different kinds of light munitions, as well as tanks and airplanes, were produced in Canadian factories. The Government had power to move men from one occupation to another, and it made certain that the industries supplying war goods were given enough labor.

THE NATION LOOKS TO THE FUTURE WITH CONFIDENCE

Canadian people approached the post-war period with a new confidence because of their experiences in the conflict. They had been drawn into closer association with the United States by their partnership in the war, and they had also grown in importance in their relations with other nations. They knew, however, that they would have many problems to solve when peace was made.

Most important of these problems was that of the federal system itself. Canada had grown both in size and strength since 1867, and the men who wrote the British North America Act had little idea about the new problems which governments would have to face. The depression of the 1930's had made clear that the federal government did not have enough power to deal with a great national emergency in peacetime. A Royal Commission, sometimes called the Rowell-Sirois Commission after two of its members, was appointed in 1937. It made certain suggestions about the Canadian federal system; but these were not acted upon because of the war. Most Canadians believed, however, that some changes in the relations between the provinces and the Dominion would be needed after the war.

Canada, in her seventy-five years as a nation, has been tested in many different ways. The venture which was undertaken in 1867 has justified the faith of the men who made it. The four provinces have increased to nine, Canada looks out upon both the Atlantic and the Pacific, and in the north her flag flies over the outposts of the Arctic.

By R. G. RIDDELL.

THE NEXT STORY OF CANADA IS ON PAGE 1555.

MEMORABLE EVENTS IN CANADIAN HISTORY FROM 1783 TO 1946

1783—United Empire Loyalists founded Kingston, Ontario, and Parrtown (Saint John), New Brunswick.

1787—Charles Inglis was appointed Anglican Bishop of Nova Scotia (and all British America). This was the first colonial bishopric in the British Empire.

1791—The Constitutional Act created the provinces of Upper and Lower Canada.

1792—Sep. 17, Upper Canada's first Legislature met at Newark (Niagara); Dec. 17, Lower Canada's first Legislature met at Quebec.

1793—Yck (Toronto) founded by Simcoe.

1809—The first Canadian steamer ran from Mntreal to Quebec.

1811—Lrd Selkirk's Red River Settlement was funded.

1812—The United States declared war on Great Britain, June 18. Much of the land fighting was on Canadian soil. The war lasted a little over two years.

1814—Treaty of Ghent, signed Dec. 24, ended the war between Britain and the United States.

1826—Bytown (Ottawa) was founded.

1829—The first Welland Canal was opened, Nov. 27. McGill University, Montreal, opened.

1836—Canada's first railway, from Laprairie to St. John's, Quebec, was opened.

1841—Upper and Lower Canada united as the Province of Canada, with Kingston as the capital, Feb. 10. The first United Parliament met June 13.

184—Victoria, British Columbia, was founded.

18—The first Canadian telegraph was started by the Toronto, Hamilton and Niagara Electro-magnetic Telegraph Company.

18—On Dec. 31, Ottawa (Bytown) was selected by Queen Victoria as the future capital of Canada.

1 6—The Canadian Legislature met at Ottawa for the first time on June 8.

67—The British North America Act received the Queen's assent on March 29, and came into effect on July 1. This confederated Upper Canada (Ontario), Lower Canada (Quebec), Nova Scotia and New Brunswick, and thus created the Dominion. The first Dominion Parliament met on Nov. 6.

1870—The new province of Manitoba was admitted into the Dominion.

1871—The first Dominion census was taken on April 2. British Columbia entered the Dominion on July 20.

1873—Prince Edward Island entered the Dominion, July 1. The North West Mounted Police force was established.

1876—A branch of Laval University was established at Montreal. This is now the University of Montreal.

1885—On Nov. 7, the last spike of the Canadian Pacific Railway main line was driven at Craigellachie.

1886—Archbishop Taschereau of Quebec was made the first Canadian Cardinal, June 7.

1896—Gold was discovered in the Klondike.

1902—In December, the first wireless message from Canada to the British Isles was sent by way of Cape Breton.

1905—The provinces of Alberta and Saskatchewan were created on Sept. 1.

1909—The first Canadian airplane flight was made by McCurdy's Silver Dart, Feb. 23.

1914—Britain declared war on Germany on Aug. 4. A special war session was held by the Dominion Parliament, Aug. 18-22. The first Canadian Contingent (33,000) landed at Plymouth, England, Oct. 16.

1916—Fire destroyed the Houses of Parliament in Ottawa, Feb. 3. The corner-stone of the new Houses was laid by the Duke of Connaught, Sept. 1.

1925—On June 10 the United Church of Canada was inaugurated.

1927—Canada was elected a member of the Council of the League of Nations.

1931—The Statute of Westminster, establishing equality of the Canadian and British Parliaments, became effective on Dec. 12.

1939—Their Majesties King George VI and Queen Elizabeth arrived on May 17, to visit Canada. On Sept. 10 Canada declared war on Germany. On Dec. 17 the first Canadian troops landed in Britain, and the Commonwealth Air-Training plan was signed in Ottawa by the United Kingdom, Canada, Australia and New Zealand.

1941—On December 7, Canada declared war on Japan as a result of the Japanese attacks in the Pacific area.

1943—The first Quebec Conference of Allied leaders, including Prime Minister Churchill and President Roosevelt, opened Aug. 10.

1944—The second Quebec Conference of United Nations leaders held in September.

1945—Announcement was made of the development of the atomic bomb by Canada, Britain and the United States, August 6.

1945—Canada signed Japanese surrender terms which ended the Pacific war, Sept. 2.

PICTURES BY THE SPANISH ARTISTS

St. Basil, painted by El Greco.

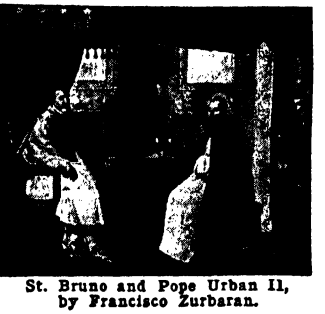
The Infante Philipp Prosper, by Velasquez.

The Adoration of the Shepherds, by José Ribera.

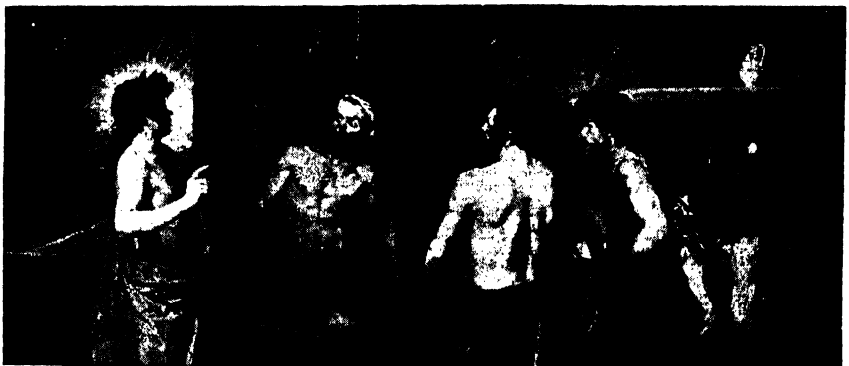
The Infant Jesus and the Infant St. John, by Murillo, in the Prado, Madrid.

The Miracle of St. Hugo, by Francisco Zurbaran.

The Infant St. John, by Murillo.



St. Bruno and Pope Urban II, by Francisco Zurbaran.



The Forge of Vulcan, by Velasquez.

THE SPANIARDS AND THEIR PICTURES

WHEN Ferdinand and Isabella drove the Moors out of Spain they set back by centuries the civilization of the country. Instead of planting in the rich soil of Moorish culture they allowed the land to become desert. The wider the possessions of Spain grew, the more her soul was shrunken. She was too busy wielding the sword to learn the delicate art of holding the brush. The beautiful warmth of the Gothic movement passed her by, and it was not till the sixteenth century that she was stirred to real activity in the direction of art.

Her early painters were cold, monkish men. There was Morales (1509–86), who never seemed to tire of painting his sad-faced Madonnas and Saints. After him came Domenico Theotocopuli, a Cretan, known as El Greco. He lived from about 1545 to 1614, and worked chiefly at Toledo in Spain.

El Greco seemed sorry to be alive at all, and tried to explain all about it in his pictures. They are queer, distorted religious subjects, not pleasantly out of drawing like the saints of the Sienese school, which appear to have been painted by happy children dreaming of the heavenly land; rather are they the work of a man whom some inward sorrow kept from seeing the lovely and the fair either in men and women or angels. But El Greco is one of those artists of whom people will think more and more, because of what he was trying to express.

He was a pupil of Titian at Venice, then went from Venice to Rome. Probably about 1577 he arrived in Spain, going to Toledo to paint. Instead of following Titian's gracious light and coloring he used a pale, strange coldness of color. His lights and shades became harsh and exaggerated, like those of the realists in the decadent years of Italian art. It was as if he dared not do otherwise and had a horror of drawing faces that smiled naturally.

His last work is extraordinarily distorted and queer. That he was capable of composition, movement and energy is quite plain from his picture of Christ driving out the traders from the Temple, in the National Gallery, London. Some of his portraits have a fine dignity. His masterpiece is the Burial of the Conde de Orgaz, at Toledo. It is now thought almost as fine as the work of Velasquez.

El Greco was a voice crying in the wilderness, preparing for the beauty to come; a figure in the shadows, peering for the dawn that was presently to make a sudden glory in Spain.

In the meantime, Ribera, who had studied with the realist Caravaggio in Italy, was painting striking pictures—pictures where color had become a bleached and angry light, and shadows looked as if they had been dug with a spade out of a black pit; where men's muscles seemed ready to crack, and where there was scarcely a face that was not expressive of violent emotion or pleated with the lines of age. From El Greco's sacred gloom we thus step into the fierce and artificial light of Ribera's harsh realism.

WHAT IS MISSING IN THE GREAT SPANISH PICTURES

Ribera, who lived from 1588 to 1656, was a mixture of Spanish and Italian realism; he had a considerable effect on the Seville school of painting and also on the men who came after. Italian realism, we know, started with Caravaggio, the Neapolitan artist. We remember how angry this man had been with painters who were content with imitating others, and how he went to a sorry extreme of brutality in trying to show that it is better at all costs to give expression to oneself. Ribera, who had sat at the feet of Caravaggio a long time, carried on his work, and for about two hundred years the spirit of his pictures acted and reacted on European art.

There was something in the Spanish country and character that made an excellent soil for Ribera to work in. The Spaniards, as a race, were unimaginative and a little cruel. These qualities showed themselves in the times of the Inquisition, and persist even to this day in the national sport of bull-fighting.

The pictures of these old Spanish painters have nothing of the spiritual beauty of imagination. You are never allowed to guess, in looking at their work, that something is hiding behind the picture; you never feel the soft rain, and the scent of the roses in the background; you do not guess that the woman painted has just stopped saying something you want to hear and presently will go on with her song and her sorrow.

THE GREAT MISTAKE THE REALIST ARTISTS MAKE

Remember that in the country surrounding the people of Spain there is no touch of illusion. Their eyes are trained to harsh lights and shadows. The sun takes away from their landscapes the dewy greens and gentle tones native to more northern countries.

Ribera made the great mistake of realists in thinking that in order to paint what he saw he must needs paint unpleasant things. It was necessary for a greater than he to show the beauty of actual objects. But Ribera unconsciously prepared the way for the genius of Spain. He had turned people's eyes from the strange, distorted religious paintings of El Greco, and at times in his own work there is a hint of nobility.

Of the many artists who followed in Ribera's path the most memorable was Zurbaran. He lived from 1598 to 1662, and was a painter who devoted himself to studies of monks and saints. A famous picture of his is the kneeling Dominican, in the National Gallery, London. The man is praying with great fervor; and as one looks at the picture it seems that the inward radiance of the soul is stronger than the actual light falling across the hood on to the uplifted face.

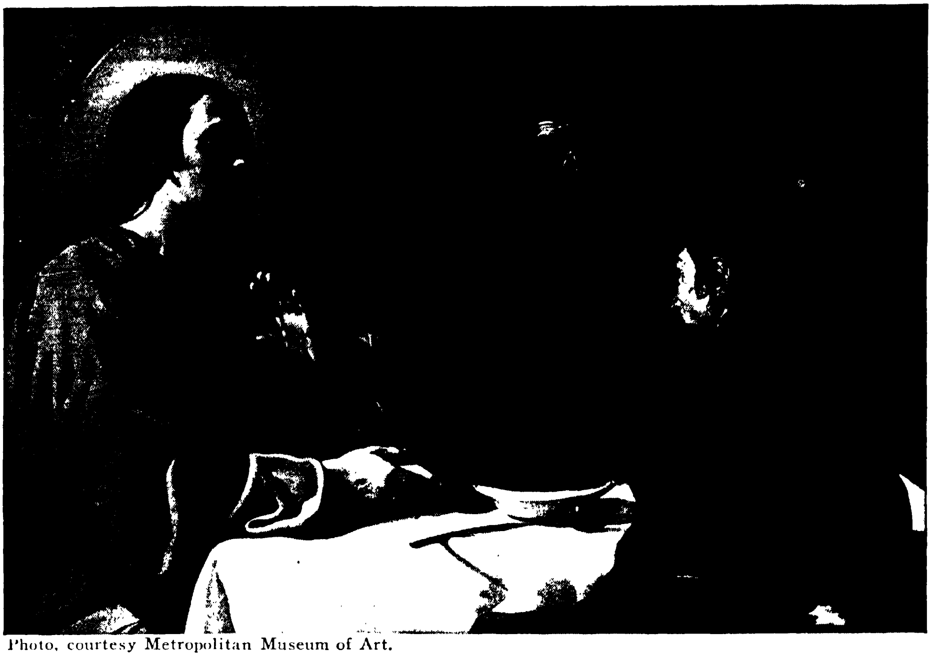
Another of Zurbaran's pictures showing his straining after effect and his violent realistic treatment is the group of St. Bonaventura and St. Thomas Aquinas, in Berlin. The painting of St. Bruno and the Pope, in Seville, is a curious and interesting study of still, monkish men, their garments seeming to be the heavy casings of lifeless bodies; the faces, stamped by thought and suffering and ambition, make the only spots of life in the picture.

THE GREATEST GENIUS OF TECHNIQUE THE WORLD HAS KNOWN

Don Diego de Silva y Velasquez, the great genius of Spain, emerged into the tumult and activities of the realists like a great ship gliding over waves which unsteadied smaller craft. He lived from 1599 to 1660 and appeared from the beginning to be set apart for high deeds. Like Queen Elizabeth, he "could always count much on fortune." Poverty and disgrace, disappointment and loneliness never cross-starred his path. He was healthy and happy and sane; and he shook from him, as a dog would shake water from his coat, the influences which were weighing heavily on the Spanish artists of his day. He believed in what he saw, being a true son of Spain; but he had "a new kind of artist's eyesight, a new conception of realism," and what he saw was beauty incarnate.

In any art gallery where Velasquez's

THREE FAMOUS PICTURES FROM SPAIN



Photo, courtesy Metropolitan Museum of Art.

Christ and the Pilgrims of Emmaus, by Velasquez, in the Metropolitan Museum of Art, New York.

The Madonna and Child, by Murillo, in the Pitti Gallery, Florence.

The Madonna and Angels, by Murillo, in the Louvre, Paris.

paintings are hung we may see artists peering and studying, sketching and copying, trying to read the secret of his unapproachable greatness. He is the mightiest genius of technique the world has ever known. His strength lay not in form or in color, but in revelation of light. He did not gloat over the human body as Michelangelo did, but when he had to paint it he painted it flawlessly.

He was not seized with the passion for brilliant hues that marked the Venetian painters, partly because color as color does not exist in Spain as it does in Venice, and partly because he was sensitive to something greater—light. Velasquez, like other Spaniards, loved neutral tints; he was a master of grays. But El Greco's and Ribera's grays are cold and stone-like; Velasquez's grays are silver and pearl, shining like the gray dew of dawn.

PORTRAITS THAT BRING SEVENTEENTH-CENTURY SPAIN TO LIFE AGAIN

It is probable that artists of many more generations will still strive to find how Velasquez got such radiance into his grays. Light seemed to hide in his palette and cling to his brush. He did not do much preliminary drawing, but painted at once upon the canvas. Of his many imitators no one has come within speaking distance of his style; the secret of his genius has not been found out.

Velasquez became artist to Philip IV of Spain. For forty years he was attached to the court, and during the latter part of this period became a kind of confidential secretary—"gentleman of the household." After the heavy routine of court life had swallowed his nights and days for some seven years he yielded to the persuasion of Rubens, who was then in Madrid, to escape for a holiday to Italy.

Velasquez managed to have two summers there before he returned to his post. Twelve years later he visited Rome and Venice again. Except for these lulls his working life was given up to the Spanish monarch, to painting the series of portraits which have brought seventeenth-century Spain to life before our eyes to-day.

DIFFERENT WAYS OF PRESENTING THE CRUCIFIXION

There were intervals when he painted pictures of another kind, classical subjects, and religious subjects, like his Christ on the Cross, and the Madonna, in Madrid, and St. Bridget, in the National Gallery, London.

The Crucifixion, as painted by Velasquez, presents a noble and dignified study—a study that makes one think profoundly without being tortured by the terrors which some painters worked into their pictures. Whenever, in pictures of the Crucifixion, we see that the painter has shown only the horror of physical pain and overlooked the agony of the soul, we know that that picture is poor art—bad taste—appealing to the senses and not the mind, in a study of the most unearthly sorrow that ever befell a human spirit.

It was for the great good fortune of people who live in a world unlikely to produce another man like Velasquez that the great Spaniard escaped two or three times to Italy. In those years he breathed a different air from the stifling atmosphere of the court, and he developed another activity. Without having had those visits he would not likely have painted in his later years (when men are generally content to repeat their successes and imitate their own inspirations) two such masterpieces as The Tapestry Weavers and The Maids of Honor. These two pictures alone would have set Velasquez on the heights of genius.

THE MAN WHO MIGHT HAVE BEEN THE GREATEST LANDSCAPE-PAINTER

The Tapestry Weavers is a giant composition, a superb study of peasant women at work; its final greatness is in the amazing treatment of light. The light not only falls in a clean shaft behind the central archway, it plays hide-and-seek with the solid forms and properties of the workers in a way that no one save Velasquez has ever seen and painted.

The Maids of Honor is another triumph of the lighted interior. Radiance creeps softly into the room, resting on the little pathetic princess with her waiting-women, and presently touches the older figures in the background, silhouettes the man in the open doorway beyond, and catches the face and brush of the painter himself. This picture illustrates remarkably the "perspective of light," a new phase of perspective whose use was perfected by Velasquez. He shows not only direct light but reflected light, passed from one surface to another, and light in the veils of atmosphere, for he knew that "light is elastic and illuminates the air."

TWO PICTURES OF SPAIN BY GOYA

The Parasol, a cartoon for tapestry, by Goya, in the Prado, Madrid.

Photo, courtesy Metropolitan Museum of Art.

Bull Fight, a painting by Goya, in the Metropolitan Museum of Art, New York.

Velasquez's greatest work of a decorative nature is The Surrender of Breda; and there it seems that though he found an intense interest in painting the cavaliers, his happiest moments were when he worked at the landscape in the background and bathed it in a lovely glow. This picture alone makes one guess that had Velasquez lived in another age and in another country he would have been the greatest landscape-painter the world has known.

His portrait work centres round the royal and aristocratic personages of Philip's court. There Velasquez is himself a prince among princes. All the hauteur and coldness of the Spanish king is painted by a man who knew that pride and personal dignity are true qualities of kingship.

COURT FOLK WHO STILL LIVE AS VELASQUEZ PAINTED THEM

The pictures of the young Don Carlos and of Maria Anna of Austria, in Madrid, show like characteristics. Poor great lady! She is condemned to live forever in the world's eyes a fantastic, pathetic figure, burdened by an outrageous headdress, and clothed in so heavy a garment of silk and brocade and velvet that one wonders how she managed to move about. Velasquez's incomparable touch rests on the soft and shining texture of her gown; its tissues seem still brilliant and alive; in contrast, the face above the gown is cold and unhappy.

Excellent paintings by Velasquez in America are to be found in Boston and Philadelphia, as well as in the Metropolitan Museum and the Hispanic Society's collection in New York.

After Velasquez's day the ranks of little men closed in again on the art of Spain. There were one or two portrait-painters, like Carreño de Miranda, a court artist, and then, except for one man, no one of importance until Goya came. The one man was Murillo. He lived from 1617 to 1682, most of the time at Seville, where there are many of his paintings. If you look first at a picture of Velasquez's and then at one of Murillo's, it will seem that Velasquez was a cold aristocrat, caring far less about the people he painted than did Murillo. A kinder, milder spirit than that of the earlier days had brought a happier mood into the life of Spain, and Murillo reflects this change.

HOW MURILLO BRINGS ART TO THE LEVEL OF EVERYDAY LIFE

Murillo was not a genius like Velasquez, but he had a warmer heart. He is an artist we speak of affectionately. The people of his own day loved his pictures, too, for they could easily understand them. His gentle-looking saints and tender, happy children were the very sort of persons that were all around them.

In contrast with the figures of El Greco and Ribera and Zurbaran, his pictured children and Madonnas are natural and lovable. We can note this feeling in the well-known Immaculate Conception, in Madrid, and in many of the other religious pictures which came from Murillo's brush. Look at The Children of the Shell, the little Jesus with St. John, shown on page 1494. The symbols of the staff and the lamb show that these are the holy children reverenced by the Christian Church, and their attitudes are somewhat idealized. But the boys themselves are just beautiful, warm-skinned, graceful little lads of Spain.

Not all Murillo's pictures had religious subjects; some were *genre* groups —of beggar-boys or peasants. From his early style of rather cold, hard painting he passed through a middle period of warmer coloring and stronger contrasts, to the misty, vaporous light effect that floats about the figures in his later work.

GAY CANVASES THAT GLOW WITH PICTURES OF SPANISH FOLK

Goya (1746–1828) was a kind of miracle that descended on Spain at a time when hardly anyone knew how to paint, a century after Murillo had produced his pleasant pictures. Distinctly Spanish, loving the gay life of the people and thoroughly acquainted with the ways of the bull-ring, Goya left a great number of pictures which mirror the society of Spain during his lifetime. The men and women he represents in portraits or in picture-telling groups are strong and active and living.

In making studies for tapestries he was unequaled, and his drawings and etchings are even better known than his paintings. His draftsmanship was superb and masterly. Both Velasquez and Goya tremendously influenced the art of Europe. Of the artists of Spain since Goya's time we shall get a glimpse later.

THE NEXT STORY OF THE FINE ARTS IS ON PAGE 1585.

SOME PORTRAITS BY VELASQUEZ

PHILIP IV OF SPAIN IN HUNTING COSTUME, IN THE PRADO GALLERY, MADRID

MENIPPUS, IN THE PRADO GALLERY, MADRID

ALESSANDRO DEL BORRO, IN THE BERLIN MUSEUM

PRINCE BALTHASAR CARLOS, IN THE PRADO GALLERY, MADRID

THE DUKE OF OLIVARES, IN THE PRADO GALLERY, MADRID

KING PHILIP IV, IN A PRIVATE COLLECTION

QUEEN MARY OF HUNGARY, BERLIN MUSEUM

PRINCE BALTHASAR CARLOS, SON OF PHILIP IV,
IN THE PRADO, MADRID

PRINCESS MARGARET, DAUGHTER OF PHILIP IV,
IN THE VIENNA GALLERY

PORTRAIT OF A LADY, IN THE BERLIN MUSEUM

POPE INNOCENT X, IN THE DORIA GALLERY, ROME

FRANCESCO D'ESTE, IN THE MODENA GALLERY

QUEEN MARIANA OF AUSTRIA, VIENNA GALLERY

American Museum of Natural History, New York

Group of caribou. The caribou, which is one of the largest members of the deer family, dwells in the northern areas of North America. This sturdy animal differs only in name from the reindeer of Europe and Asia.

THE DEER FAMILY

THE deer belong to a separate family, the Cervidae. They have many things in common with the antelopes which, with the cattle, sheep and goats, belong to the family Bovidae. Both the deer and the antelopes are ruminants, or cud-chewers; both feed on grass, leaves and other vegetation. Both are the principal food of many of the large flesh-eating animals, and for protection depend upon their ability to hide and on their fleetness of foot.

The greatest difference between the two families is their horns and antlers. The horns of the Bovidae are made of the same materials as hoofs, fingernails, toenails and hair; that is, they are the hardened outer layer of the skin. The horn grows over a bony core which is part of the skull, and is retained throughout life. After death this sheath, or horn, may be easily removed from the core. The old-fashioned powder horn is a cow's horn so removed. In most cases both the male and the female of the Bovidae carry horns, but there are many exceptions to this rule.

The "horns" of the deer are called antlers and are true bone. They are shed and regrown periodically, generally once a year, and are carried by the male only. An exception to this is the caribou and the reindeer, in which species the females also carry antlers.

The growth of a deer's antlers is one of the wonders of nature. In northern latitudes, either in late fall or early winter, the antlers break off from their pedicles, or sockets, which are part of the skull. When they have broken off they leave a scar, which is quickly covered over with skin. In a short time small knobs appear, velvety in texture and full of blood vessels. They are very tender

U. S. Forest Service Photo

Large round-horned stag at Wallowa Lake, Oregon. This animal is sometimes wrongly called an elk. It is not related to the true elk of northern Europe, but to the red deer of Europe and the white-tailed and other American deer. Stag is a name given to red deer, though properly stag means male deer of any species.

and the animal is very careful not to hurt them. Within these knobs a bony structure forms. This grows rapidly and soon the antler takes shape, still covered with velvet and filled with blood vessels. For large deer, such as the wapiti and the moose, this growth continues for months, but by late summer or early fall the center hardens, the blood leaves the velvet, and the velvet dries and peels off, leaving the new antler hard and firm, and the owner full of confidence.

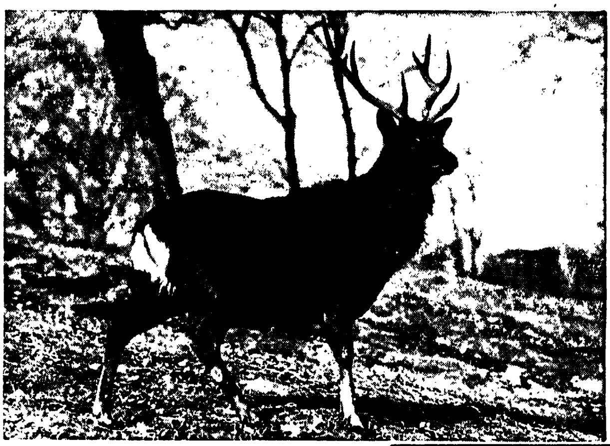
The antlers of the different kinds of deer vary greatly, and it is often by the type of antler that a deer can be most easily recognized. Therefore, it is important that the different types of antlers be explained and the different parts named. The main part of the antler, that is, the part extending up from the head, is called the beam. From this beam grow branches. These branches are called prongs, or tines. These tines are all named. The first that comes out over the forehead is the brow-tine, the next above it the bez-tine, the third the trez-tine, and the smaller tines about the top of the antler are called royals or surroyals. Some deer, such as the European red deer, have all these tines, while others have more simple antlers.

The red deer of western Europe is perhaps the best-known deer in the world. Much has been written about the hunting of the stag, as the male of this deer is called. The red deer is still found in many of the forested parts of continental Europe. In the British Isles it is most common in Scotland. A large stag will stand as high as four feet at the shoulder. It is reddish brown, grayer on the head and legs. There is a large patch of yellowish white about the tail. The antlers are generally large and often form a cluster of points near the end. There are usually three other points or tines along the main beam, the first or brow-tine extending out over the forehead.

The red deer of Europe differ in minor details in many parts of the continent. In Sweden the deer is large, with large antlers containing many tines. In Norway it is smaller and of a lighter color in summer. In Germany it is large, and the light patch about the tail generally has a black border around it. The Spanish red deer is of a grayer color. On the islands of Corsica and Sardinia is found a smaller race. The red deer has been introduced into New Zealand where it has done remarkably well, grows to a large size and has exceptionally fine antlers.

Wherever the red deer is found, the habits are very similar. These deer prefer woodland, except in Scotland where they inhabit the open hills. They are generally found in small herds made up chiefly of hinds, as the female red deer is called, the stags keeping to themselves. The young, as is the case with many of the deer, are spotted at birth.

Along the eastern border of the Caspian Sea, through the Caucasus Mountain region, and as far west as the Crimea, there is found a close relative of the red deer known as the maral. The maral is a large, heavy-set deer with large, heavy antlers and generally fewer tines.



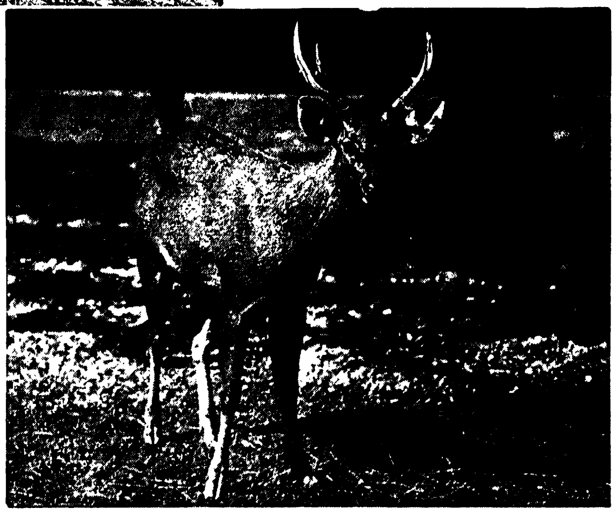
The Pekin Sika deer.

The only deer believed to be a native of Africa is the Barbary red deer, a large deer with a grayish brown streak down the center of the back, and spotting on the flanks and sometimes on the back also. It is very rare and found only in certain parts of Tunis and Algeria.

Other deer belonging to the red-deer group are the hangul from Kashmir, the Yorkand stag from eastern Turkestan, the shou in Bhutan and the Tibetan frontier, and Thorold's deer of central Tibet.

Western North America and central Asia are the home of the wapiti, which are among the largest of the deer, only the moose and the Old World elk being larger. In North America, unfortunately, the wapiti is known as the elk. Properly the name elk belongs to the Old World moose. The wapiti in North America originally used to roam throughout most of the United States and well up into Canada, but with the advancement of civilization the wapiti was exterminated in the East and also over much of its western range. It is now found in a limited area in the Rocky Mountain districts of Colorado, Wyoming, Idaho, Montana and Alberta. It is also found in Saskatchewan, Manitoba, the coasts of northern California, Oregon, Washington and Vancouver Island, and in a few places in southern California.

A large bull wapiti will stand over five and a half feet at the shoulder and may weigh 600 pounds. In color it is a grayish brown, becoming darker on the neck, head and legs. About the tail there is a light-colored spot. The wapiti along the Pacific coast are much darker in color, and the one in south-central California is much smaller. The outstanding characteristic of the wapiti is its massive antlers with their numerous points, or tines. These antlers may reach well over sixty inches in length. At present there is a great concentration of wapiti at Jackson Hole, Wyoming, where the animals are fed by the United States Government during the winter. Wapiti have been brought back in the Adirondacks and in other places in the eastern United States, and introduced in New Zealand. The Asiatic form of the



Both photos, N. Y. Zoological Society

The big sambar deer, which lives in central and southern Asia.

wapiti is found from the Tien Shan (mountains) in northwestern China northeast to northern Manchuria.

Another deer from China is Père David's deer, or mi-lu, which has a most remarkable history. It has never been known in the wild state in recent times. It is believed to have been originally a native of northern China, but has been known only as a captive deer in the imperial hunting park near Peiping. At the present time the only known specimens are in a deer park in England. The mi-lu is an odd-looking deer with a long, bushy tail reminding one of a mule's and unlike that of any other deer.

The Sika deer is a smaller, dark-colored animal about three feet in height. It is found in northern China, Manchuria, Japan and Formosa. The color is reddish chestnut with numerous white spots in summer, but much darker in winter when the spots either disappear or become indistinct. The antlers are shorter, seldom over two feet long. They generally have only four tines.

The swamp deer, which is also called the barasingha, is a native of northern and central India. It stands about three feet, nine inches high, and is rufous (reddish) brown, sometimes speckled with white. The antlers of the male have a long brow-tine, but no bez or trez-tines, the beam forking about halfway in its total length. Both of these branches again fork, giving a cluster of four tines. The swamp deer prefers somewhat open country, feeding in the swamps and grasslands. In winter the animals gather into bands of thirty or forty and sometimes even larger numbers. Like most deer, the young are spotted at birth.

Another deer closely related to the swamp deer is the Schomburgh's deer of Thailand. The horns differ from those of the swamp deer in the fact that the beam is very short between the brow-tine and the branches, giving the antlers a very flat, bushy look. This animal was very rare and is now believed extinct.

The Eld's deer and the thamin are two very closely related deer, the former found in Assam and the latter in Burma, Thailand, Indo-China and on the island of Hainan. The antlers differ from those of any other deer in the fact that the curved brow-tine forms a continuous curve with the beam. Thus the antlers give the impression that they are the rockers of a rocking-chair placed on the crown of the deer's head. In habits and color these deer are similar to the swamp deer.

The sambar deer range from central China south through India, Ceylon, Burma, Indo-China, the Philippines, Thailand and on through Sumatra and Borneo. The antlers of the sambar deer have but three tines, lacking the bez and trez. It is a large deer, about four and a half feet in height. The dark grayish brown hair is coarse and the tail is bushy. On the Philippines it is small, and a number of forms occur.

N. Y. Zoological Society

The fallow deer. It is found in many areas.

The rusa deer is similar to the sambar, but the ears are smaller, the tail is slimmer, and the underparts are whitish. The antlers are more slender. This deer is found on Sumatra, Java, Celebes, the Moluccas, Timor and neighboring islands.

A smaller deer with antlers similar in type to those of the sambar is the hog-deer of eastern India, Burma and Thailand. The color is yellowish brown with a spotting on the back. In the winter the color is darker.

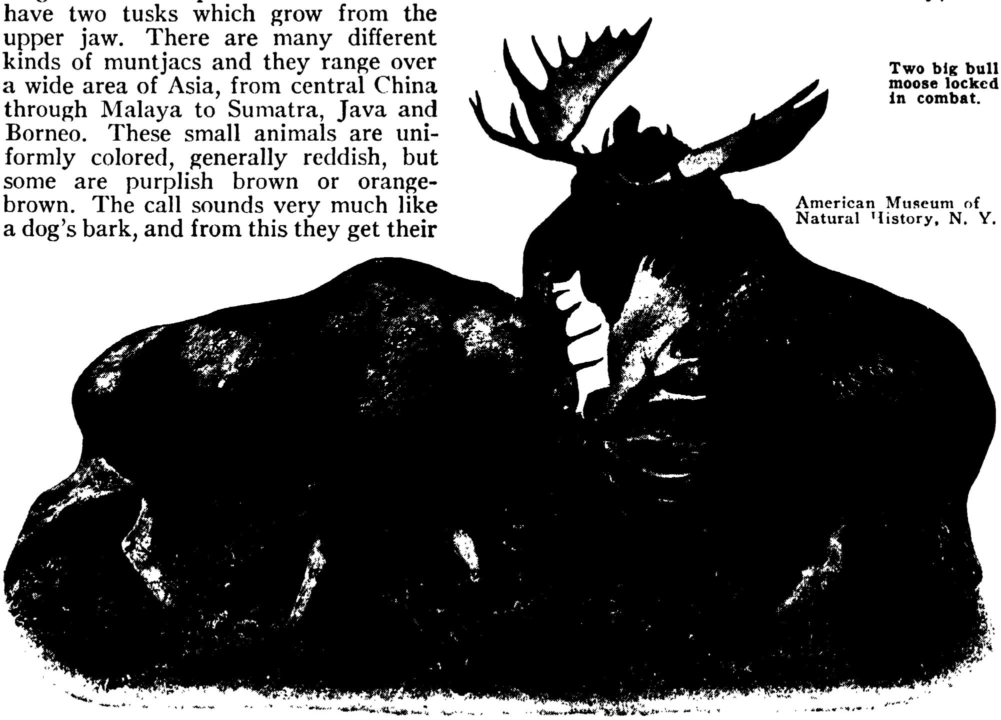
The axis deer, or chital, is sometimes known as the spotted deer. It is found in India and Ceylon, and is regarded as the most beautiful of all deer. It stands about three feet at the shoulder. The antlers usually have but three tines and often reach a length of over three feet. Axis deer generally go about in herds of twenty or thirty individuals, but often the herds number many more. They frequent open forest lands, generally near water, which provides a fitting setting to show the beauty of this deer.

The fallow deer is about the same size as the chital but with entirely different antlers. The horn is palmated at its end, which means that the horn becomes broad and flattened, similar to the palm of the hand. From this palm a number of tines extend. The fallow deer is spotted, but in winter most of these spots are lost. This animal originally came from the countries bordering the Mediterranean Sea, from Spain to Iran and Mesopotamia. At one time it was also found in Tunisia and Algeria in northern Africa, where it is believed to have been introduced many hundreds of years ago; but it is probably no longer to be found there. The fallow deer has been introduced also into Great Britain and other sections of Europe. It is a hardy animal and is one of the most common in parks.

The semi-domesticated fallow deer vary a great deal in color. The original wild deer was yellowish brown, darker on the head and neck, and marked by a number of white spots, with white underparts. In the semi-domestic state there is a dark-brown variety which shows little or no spotting; and albinistic, or white, specimens are frequent. In the parks may be found specimens exhibiting every gradation in color from black to white.

The muntjac, or barking deer, is a small Asiatic deer quite different from any of the preceding animals. It is only about twenty-two inches high and its antlers, which are small, with but one small tine, grow from a long skin-covered pedicle or base. The males have two tusks which grow from the upper jaw. There are many different kinds of muntjacs and they range over a wide area of Asia, from central China through Malaya to Sumatra, Java and Borneo. These small animals are uniformly colored, generally reddish, but some are purplish brown or orange-brown. The call sounds very much like a dog's bark, and from this they get their popular name, barking deer. In western China there is another deer closely related to the muntjac. It is called the tufted deer, and while the pedicles are long, the antlers themselves are very short. This animal is grayish black in color.

Throughout the Northland there is a large deer well adapted to the ice, snow and cold of its home. This animal is called the reindeer in Europe and Asia, the caribou in North America. For many years the reindeer has been domesticated in Lapland, where it is trained to draw sleds and do other service for man. The flesh is eaten, the skin makes clothing, and the sinews make strong thread. The reindeer is also milked as cows are milked in other countries. Without the reindeer the Lapps would have difficulty in living. The Indians and Eskimos of northern Alaska were dependent on the wild caribou for their living, but the wild caribou became scarcer and food became a problem, so the United States Government imported reindeer from Lapland, and these have been established and are now being raised. The caribou and reindeer have long hair to protect them from the cold, and broad hoofs to keep them from sinking into the snow. Cattle or horses would soon starve to death in that country, but



Two big bull moose locked in combat.

American Museum of Natural History, N. Y.

A NORTH AMERICAN DEER AT HOME

American Museum of Natural History, New York

The white-tailed deer, which ranges over a vast area of North America. It is distinguished by its bushy tail.

these deer dig down through the snow and find the lichens and reindeer moss upon which they thrive. In the United States caribou have become nearly extinct, but they still exist in large numbers in the northern barren grounds of the continent. The caribou of the New World are divided into three types, the barren ground, the woodland and the mountain caribou. These names are characteristic of the country in which they are found. The antlers of the male caribou and reindeer are often extensively palmated. These are the only deer in which the females also carry antlers.

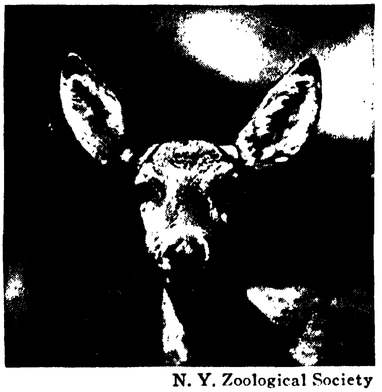
The roebuck is a native of Europe and Asia. It is a small deer standing about twenty-six inches high. The antlers seldom reach the length of twelve inches and generally have but three tines. In winter the roebuck is dark brown; in summer it is reddish. It is still found in the wild state in Scotland and throughout the greater part of Europe, northern Asia to Siberia and in northern China.

The largest of all the numerous deer family is the animal which is known as the moose in North America and as the elk in Europe and in Asia. This striking animal is notable, among other things, for its large, palmated antlers. It grows to its largest size and produces the largest antlers in Alaska. An exceptionally large moose may measure over seven feet at the shoulder, and the biggest horns recorded measure seventy-eight inches in spread. The moose is a creature of the northern forests and feeds chiefly on the leaves, twigs and the bark of trees. It is very fond of water and during the summer, when the flies are troublesome, spends much of its time standing in the water of the lakes, feeding on the water plants.

The moose is found in the forested lands of Canada and Alaska and south into Wyoming and northern Michigan and Minnesota. In the East it formerly ranged south through the mountains of New York into Pennsylvania. The Indians of the north woods are dependent on the moose for a living, for it furnishes them with both meat and clothing in winter.

Of the deer of North America, the white-tailed is best known. It has the greatest range of any of the large game animals, being found from the Atlantic coast as far west as British Columbia, Washington and Oregon, and from central Quebec, Saskatchewan and Alberta, south to central South America. Over this vast territory the deer varies in size and color, and many different forms have been described. As a rule, the larger forms are found in the north and the size decreases to the south. The white-tailed deer is distinguished by its rather long, bushy tail which is white on the underside. When bounding away from an intruder, the tail is raised, making a very conspicuous mark known as a "flag." This deer was of great importance to the early colonists. It furnished the principal food, and the skins were used as clothing.

The horns of the bucks (males) differ from those of other deer in the fact that the main beam rises from the head and then sweeps forward in an outward curve. The tines arise from the upper surface of this main beam. Civilization does not worry the white-tailed deer. It prefers the bushy second growth which springs up after the forests are cut down, and the old brushlots on abandoned farms are very much to its liking. If this animal is given some protection, it is well able to take good care of itself. This has been proved in the region about New York City, where the white-tailed deer is even on the increase. In the north the white-tailed bucks shed their antlers in late December or January, and by September the new horn is fully formed and the velvet has been rubbed off. The spotted-coated fawns are born in late May or June. Twins are the rule but a young doe may give birth to a single fawn. Occasionally there are triplets.



N. Y. Zoological Society

This guemal lives in South America.

The mule deer is an animal of the mountains, foothills and plains of western North America. It is about three and a half feet in height and is more heavily built than the white-tailed deer. Its tail is rounded and has a black tip, and the ears are larger than the ears of the white-tailed deer. The antlers differ in having an extra fork on the main tine. When in a hurry, the mule deer has a peculiar, stiff-legged, bounding gait, all four feet leaving and hitting the ground at the same instant. In many parts of its range the mule deer is known as the black-tailed deer.

On the Pacific slopes of the Rocky Mountains, from California to southern Alaska, is found the true black-tailed deer. From northern California to British Columbia it is known as the Columbian black-tailed, while in southern Alaska it is called the Sitka deer. The shape of the horn is much like that of the mule deer; but the tail is more like that of the white-tailed, though not so long and bushy, and darker above. The black-tailed is a smaller deer than either the white-tailed or the mule deer and lives in the forests, quite unlike the mule deer which prefers the more open country.

The marsh deer of Brazil and Argentina is the largest of the South American deer, being somewhat larger than our northern white-tailed. The antlers are short and heavy, the two prongs again forking, making at least four tines for each antler, and these again are sometimes forked. The marsh deer prefers the dense jungles along rivers and is seldom found far from water.

The pampas deer, much smaller than the marsh deer, lives on the open grasslands from Brazil to northern Patagonia. The first tine of the antler is simple and the second is forked.

The guemal is slightly smaller than the white-tailed deer and is a mountain animal found in the high Andes from Ecuador to Patagonia. The antlers of this deer have but a single fork, thus forming two tines.

The brockets are small deer living chiefly in forested areas from Mexico to southern Brazil. They have simple spike-like antlers without any forking. Many forms of this deer have been described by naturalists.

The smallest of all the true deer is the pudu, found in the Andes of Chile and Ecuador. It is about thirteen inches at the shoulder. The antlers consist of a small spike.

The Chinese water deer and the musk deer are distinguished from all other deer in the fact that the males do not have antlers, but the males of both these deer have long canine teeth extending down from the upper jaw. The water deer is about twenty inches in height, of a brownish yellow color, and is found in Korea and eastern China. It is partial to thick reed beds and is said to be common in the extensive swamps along the lower Yangtze River. A peculiarity of this deer is the large number of young it may have; instead of a single fawn or twins, as in the case of most deer, the water deer may have as many as five or six in a litter.

The musk deer is small, about two feet in height. It is found in Tibet, western China and as far east as Korea. It has coarse, brittle hair of a dark-brown coloring, more or less spotted with gray. This forest-loving animal is extensively hunted for its musk, a substance found in a small sac on the abdomen. Musk is used to a small extent in medicine. Its chief value is for perfumes.

By T. DONALD CARTER.

THE NEXT STORY OF ANIMAL LIFE IS ON PAGE 1595.

U. S. Forest Service Photo

Group of mule deer. The mule deer lives in western North America. It is something like three and a half feet in height and is rather heavily built. In some parts of its range it is known as the black-tailed deer.

TIME AND THE SEASONS

Illustrated by Erika Weihs

The Round of the Year

By COVENTRY PATMORE (1823-1896)

THE crocus, while the days are dark,
  Unfolds its saffron sheen;
At April's touch the crudest bark
  Discovers gems of green.

Then sleep the seasons, full of might;
  While slowly swells the pod
And rounds the peach, and in the night
  The mushroom bursts the sod.

The winter falls; the frozen rut
  Is bound with silver bars;
The snow-drift heaps against the hut,
  And night is pierced with stars.

Days

By RALPH WALDO EMERSON (1803-1882)

DAUGHTERS of Time, the hypocritic Days,
  Muffled and dumb like barefoot dervishes,
And marching single in an endless file,
Bring diadems and fagots in their hands.
To each they offer gifts after his will,
Bread, kingdoms, stars, and sky that holds them all.
I, in my pleachèd garden, watched the pomp,
Forgot my morning wishes, hastily
Took a few herbs and apples, and the Day
Turned and departed silent. I, too late,
Under her solemn fillet saw the scorn.

Time, You Old Gipsy Man

By RALPH HODGSON (1871-)

TIME, you old gipsy man,
Will you not stay,
Put up your caravan
Just for one day?

All things I'll give you
Will you be my guest,
Bells for your jennet
Of silver the best,
Goldsmiths shall beat you
A great golden ring,
Peacocks shall bow to you,
Little boys sing,
Oh, and sweet girls will
Festoon you with may.
Time, you old gipsy,
Why hasten away?

Last week in Babylon,
Last night in Rome,
Morning, and in the crush
Under Paul's dome;
Under Paul's dial
You tighten your rein—
Only a moment,
And off once again;
Off to some city
Now blind in the womb,
Off to another
Ere that's in the tomb.

Time, you old gipsy man,
Will you not stay,
Put up your caravan
Just for one day?

The Garden Year

By SARA COLERIDGE (1802-1852)

JANUARY brings the snow,
Makes our feet and fingers glow.

February brings the rain,
Thaws the frozen lake again.

March brings breezes, loud and shrill,
To stir the dancing daffodil.

April brings the primrose sweet,
Scatters daisies at our feet.

May brings flocks of pretty lambs
Skipping by their fleecy dams.

June brings tulips, lilies, roses,
Fills the children's hands with posies.

Hot July brings cooling showers,
Apricots and gillyflowers.

August brings the sheaves of corn,
Then the harvest home is borne.

Warm September brings the fruit;
Sportsmen then begin to shoot.

Fresh October brings the pheasant;
Then to gather nuts is pleasant.

Dull November brings the blast;
Then the leaves are whirling fast.

Chill December brings the sleet,
Blazing fire, and Christmas treat.

*Reprinted from Poems, by Ralph Hodgson, by permission of the publishers, The Macmillan Co.

Written in March

By William Wordsworth (1770-1850)

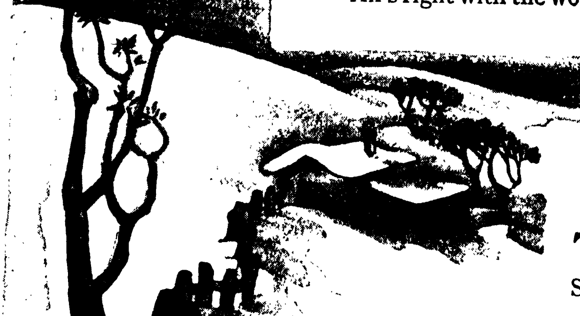
The cock is crowing,
The stream is flowing,
The small birds twitter,
The lake doth glitter,
The green field sleeps in the sun;
The oldest and youngest
Are at work with the strongest;
The cattle are grazing,
Their heads never raising;
There are forty feeding like one!

Like an army defeated
The snow hath retreated,
And now doth fare ill
On the top of the bare hill;
The plowboy is whooping—anon—anon
There's joy in the mountains;
There's life in the fountains;
Small clouds are sailing,
Blue sky prevailing;
The rain is over and gone!

Song from Pippa Passes

By Robert Browning (1812-1889)

The year's at the spring,
And day's at the morn;
Morning's at seven;
The hill-side's dew-pearled;
The lark's on the wing;
The snail's on the thorn;
God's in His Heaven—
All's right with the world!



Why It Was Cold in May

By Henrietta Ropins Eliot

The year had all the Days in charge,
And promised them that they
Should each one see the world in turn,
But ten Days ran away!
Ten Days that should have gone abroad
Some time in early May.
So when May came, and all was fair,
These Days were sent to bed,
And ten *good* Winter Days were sent
To see the world instead.

June

FROM THE VISION OF SIR LAUNFAL

By JAMES RUSSELL LOWELL (1819-1891)

AND what is so rare as a day in June?
Then, if ever, come perfect days;
Then Heaven tries earth if it be in tune,
And over it softly her warm ear lays;
Whether we look or whether we listen,
We hear life murmur, or see it glisten;
Every clod feels a stir of might,
An instinct within it that reaches and towers,
And, groping blindly above it for light,
Climbs to a soul in grass and flowers;
The flush of life may well be seen
Thrilling back over hills and valleys;
The cowslip startles in meadows green,
The buttercup catches the sun in its chalice,
And there's never a leaf nor a blade too mean
To be some happy creature's palace;
The little bird sits at his door in the sun,
Atilt like a blossom among the leaves,
And lets his illumined being o'errun
With the deluge of summer it receives;
His mate feels the eggs beneath her wings,
And the heart in her dumb breast flutters and sings;
He sings to the wide world and she to her nest,—
In the nice ear of Nature which song is the best?

Sumer Is Icumen In

This song was written by an unknown poet about the year 1250. *Lhude* means loud, *Awe* is ewe, *Lhouth* is loweth. *Murie* is merry, and *Swike* is stop.

SUMER is icumen in,
Lhude sing cuccu;
Groweth sed and bloweth med
And springth the wude nu.
Sing cuccu!

Awe bleteth after lomb,
Lhouth after calve cu;
Bulluc sterteth, buck verteth,
Murie sing cuccu.

Cuccu, cuccu,
Wel singes thu, cuccu:
Na swike thu naver nu;
Sing cuccu, nu,
Sing cuccu,
Sing cuccu, sing cuccu, nu.

When the Frost Is on the Punkin*

By James Whitcomb Riley (1849-1916)

When the frost is on the punkin and the
fodder's in the shock,
And you hear the kyouck and gobble of the
struttin' turkey-cock,
And the clackin' of the guineys, and the
cluckin' of the hens,
And the rooster's hallylooyer as he tiptoes on
the fence;
O, it's then's the times a feller is a feelin'
at his best,
With the risin' sun to greet him from a night
of peaceful rest,
As he leaves the house, bareheaded, and goes
out to feed the stock,
When the frost is on the punkin and the
fodder's in the shock.

They's something kindo' harty-like about the
atmusfere
When the heat of summer's over and the
coolin' fall is here—
Of course we miss the flowers, and the
blossoms on the trees,
And the mumble of the hummin'-birds and
buzzin' of the bees;
But the air's so appetizin'; and the landscape
through the haze
Of a crisp and sunny morning of the airly
autumn days
Is a pictur' that no painter has the colorin'
to mock—
When the frost is on the punkin and the
fodder's in the shock.

The husky, rusty russel of the tossels of the
corn,
And the raspin' of the tangled leaves, as
golden as the morn;
The stubble in the furries—kindo' lonesome-
like, but still
A-preachin' sermuns to us of the barns they
growed to fill;
The strawstack in the medder, and the reaper
in the shed;
The hosses in theyr stalls below—the clover
overhead!—
O, it sets my hart a-clickin' like the tickin'
of a clock,
When the frost is on the punkin and the
fodder's in the shock.

Then your apples all is getherd, and the ones
a feller keeps
Is poured around the celler-floor in red and
yeller heaps;
And your cider-makin's over, and your
wimmern-folks is through
With theyr mince and apple-butter, and
theyr souse and saussage, too!—
I don't know how to tell it—but ef sich a
thing could be
As the Angels wantin' boardin', and they'
call around on *me*—
I'd want to 'commodate 'em—all the whole-
indurin' flock—
When the frost is on the punkin and the
fodder's in the shock.

November in England

By Thomas Hood (1799-1845)

No sun, no moon!
No morn, no noon,
No dawn, no dusk, no proper time of day;
No sky, no earthly view,
No distance looking blue,
No road, no street, no "t'other side the way";
No end to any Row
No indications where the Crescents go;
No top to any steeple,
No recognition of familiar people,
No courtesies for showing 'em.
No knowing 'em.
No traveling at all, no locomotion,
No inkling of the way—no notion,
"No go"—by land or ocean—
No mail, no post,
No news from any foreign coast;
No park, no ring, no afternoon gentility,
No company, no nobility;
No warmth, no cheerfulness, no healthful
ease,
No comfortable feel in any member,
No shade, no shine, no butterflies, no bees.
No fruits, no flowers, no leaves, no birds—
November!

*From the Biographical Edition of the Complete Works of James Whitcomb Riley, Copyright 1913. Reprinted by special permission of the publishers, The Bobbs-Merrill Company.

The First Snow-Fall

By James Russell Lowell (1819-1891)

The snow had begun in the gloaming,
  And busily all the night
Had been heaping field and highway
  With a silence deep and white.

Every pine and fir and hemlock
  Wore ermine too dear for an earl,
And the poorest twig on the elm-tree
  Was ridged inch deep with pearl.

From sheds new-roofed with Carrara
  Came Chanticleer's muffled crow,
The stiff rails softened to swan's-down,
  And still fluttered down the snow.

I stood and watched by the window
  The noiseless work of the sky,
And the sudden flurries of snow-birds,
  Like brown leaves whirling by.

I thought of a mound in sweet Auburn
  Where a little headstone stood;
How the flakes were holding it gently,
  As did robins the babes in the wood.

Up spoke our own little Mabel,
  Saying, "Father, who makes it snow?"
And I told of the good All-father
  Who cares for us here below.

Again I looked at the snow-fall,
  And thought of the leaden sky
That arched o'er our first great sorrow,
  When that mound was heaped so high.

I remembered the gradual patience
  That fell from that cloud like snow,
Flake by flake, healing and hiding
  The scar that renewed our woe.

And again to the child I whispered,
  "The snow that husheth all,
Darling, the merciful Father
  Alone can make it fall!"

Then, with eyes that saw not, I kissed her;
  And she, kissing back, could not know
That *my* kiss was given to her sister,
  Folded close under deepening snow.

The Frost

By Hannah Flagg Gould (1789-1865)

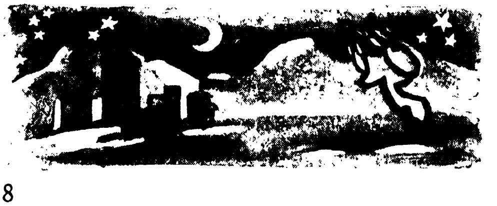
The frost looked forth, one still, clear
  night,
And he said, "Now I shall be out of sight;
So through the valley and over the height
  In silence I'll take my way.
I will not go like that blustering train,
The wind and the snow, the hail and the rain,
  But I'll be as busy as they!"

Then he went to the mountain, and powdered
  its crest,
He climbed up the trees, and their boughs
  he dressed
With diamonds and pearls, and over the breast
  Of the quivering lake he spread
A coat of mail, that it need not fear
The downward point of many a spear
That he hung on its margin, far and near,
  Where a rock could rear its head.

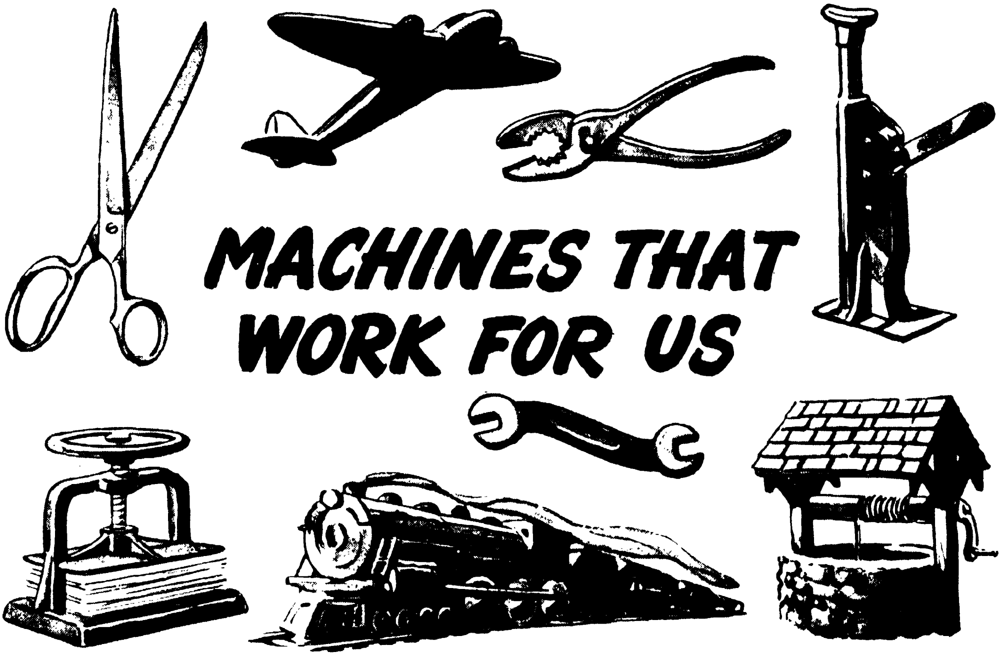
He went to the windows of those who slept,
And over each pane like a fairy crept;
Wherever he breathed, wherever he stepped,
  By the light of the moon were seen
Most beautiful things. There were flowers
  and trees,
There were bevies of birds and swarms of
  bees,
There were cities, thrones, temples, and
  towers, and these
  All pictured in silver sheen!

But he did one thing that was hardly fair,—
He peeped in the cupboard, and, finding there
That all had forgotten for him to prepare,—
  "Now just to set them a-thinking,
I'll bite this basket of fruit," said he;
"This costly pitcher I'll burst in three,
And the glass of water they've left for me
  Shall *'tchick!* to tell them I'm drinking."

THE NEXT POEMS ARE ON PAGE 1639.



MACHINES THAT WORK FOR US



The scissors, plane, pliers, jack, letter press, train, wrench and windlass shown above are all called machines.

WHAT is work? When we talk of work, we sometimes have in mind the sort of thing one does to earn a living—striking the keys of a typewriter or driving a locomotive or tending a big machine in a factory. This is just one meaning of the word. From the viewpoint of science, work is something quite different. It represents any effort, large or small, that brings about some kind of motion.

In this sense of the word we are doing work much of the time when we are awake. A golfer does work when he swings his golf club, whether or not he hits the ball. A schoolboy does work when he makes the lead point of a pencil move across a sheet of paper. He does work, too, when he sends a marble rolling with a flick of his thumb. Yes, from the viewpoint of science, rolling a marble is work—just as much so as digging a ditch or sawing a log in two.

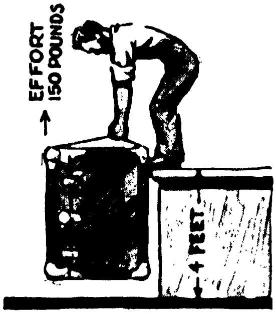
Some work is easy and we can do it with our own unaided strength. It is easy, for example, to push a pencil point along a sheet of paper, or to send a marble rolling, or to lift a telephone receiver off a hook or to open a book. But it is hard to pull a nail out of a board with just our fingers. It is hard to crack a Brazil nut between the thumb and first finger. It is hard to move a thousand-pound boulder out of the road by pushing and shoving at it.

All these things are hard to do. Yet, after all, carpenters must pull nails out of boards. Brazil nuts must be cracked before we can eat them. Boulders must be removed from our roads. We can do these things because we have certain tools that help us. Claw hammers help us to pry up nails from boards; nutcrackers help us crack nuts; crowbars help us move boulders.

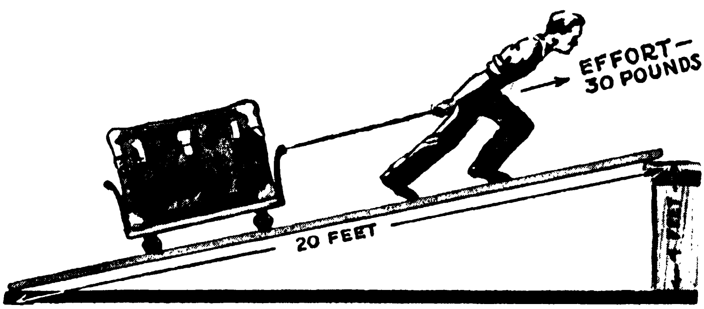
We have a special name for things that help us do work; we call them *machines*. We are all familiar with machines like locomotives and printing presses and power looms and steam shovels. But you have probably never thought of nutcrackers and crowbars and shears and doorknobs and sugar tongs as machines. Yet that is what they are, for they all help us do work.

We can do work more easily with machines because they make use of a very important scientific fact—that a small force or effort applied over a long distance can be made to take the place of a big force applied over a short distance. The machines that we are going to tell you about are all based on this principle.

A small force applied over a long distance can be made to take the place of a big force applied over a short distance. Let us show you what this means. Mr. Smith has to lift



1. Here the man is lifting the trunk by sheer strength.



2. Here the man is using a machine—the inclined plane—to help him do the job. He exerts an effort of only 30 pounds in lifting a 150-pound trunk 4 feet.

a 150-pound trunk onto a platform 4 feet high. If he were very powerful, it might be possible for him to brace himself on the platform and to lift up the trunk by sheer strength. In that case he would have to exert a force equal to the weight of the trunk—that is, a force of 150 pounds. (See Figure 1).

But Mr. Smith is not a powerful man and he would be unable to exert a force of 150 pounds. Yet he manages to get the trunk onto the platform without any trouble. He takes a plank 20 feet long; he places one end of it on the loading platform and the other on the ground. He puts the trunk on a dolly (a small wheeled truck). Then he pulls the trunk and dolly up the plank with an effort equal to only 30 pounds—that is, one-fifth the weight of the trunk (see Figure 2).

It is important to note that a machine does not make it possible for us to do less work in accomplishing a given task. Mr. Smith does just as much work whether he lifts the trunk up from the ground by sheer strength or whether he uses a plank. In the first case there is a big effort (150 pounds) with a short pull (4 feet). In the second case there is a much smaller effort (30 pounds) with a long pull (20 feet).

But the most important thing from Mr. Smith's point of view is the amount of effort he will have to exert in order to get his work done. If he is not strong enough to lift the trunk up all by himself, he is not impressed by the fact that he need only pull the trunk up 4 feet. On the other hand, if he can move the trunk without difficulty by using the plank, he is perfectly willing to pull the trunk a few more feet.

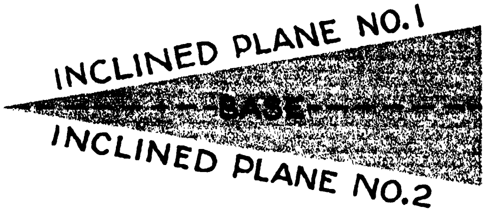
Our Mr. Smith really multiplies his strength by using the sloping plank, since an effort of only 30 pounds makes it possible for him to raise a weight of 150 pounds. In this particular case we say that the sloping plank gives him a mechanical advantage of 5. Mechanical comes from the Greek word *mēchanē,* meaning machine. Therefore mechanical advantage refers to the advantage you get by using a machine.

We are going to discuss here six types of machines—the inclined plane, the wedge, the lever, the wheel and axle, the screw and the pulley. These are very simple machines; yet they are of the utmost importance in doing the work of the world.

Mr. Smith got help in lifting the trunk by using a sloping surface. The sloping surface, then, was the machine that helped him to get his work done. We call a machine of this kind an *inclined plane,* which means sloping surface. A good many devices are based on the principle of the inclined plane. A staircase is an inclined plane provided with steps in order to help people keep their footing. You would not have to travel so far if you went up to the third story of your house by using a ladder instead of a staircase. But think how much harder it would be!

The *wedge* is still another form of the inclined plane; in fact it is really made up of two inclined planes having a common base (Figure 3). The wedge consists of a V-shaped piece of wood or metal. It is used for splitting various substances. It is also used to apply strong pressure, as when it is forced between two objects.

Figure 4 shows how the wedge works in splitting a block of wood. In A the wedge rests upon the block into which it is to be

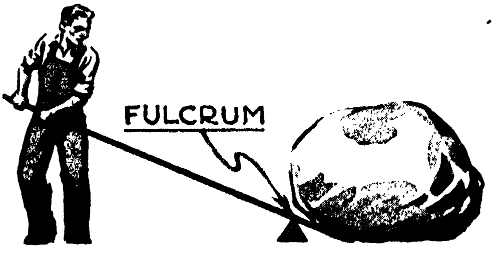


3. Diagram of a wedge. As you see, a wedge consists of two inclined planes with a common base.

driven by a blow of a sledge hammer. The resistance of the wood to the wedge, as you see, is straight upward, directly against the effort supplied by the sledge hammer.

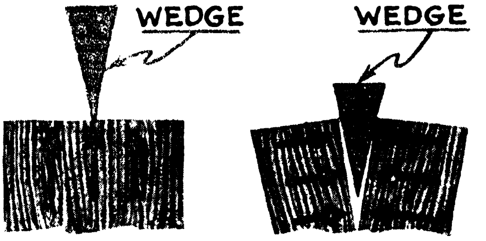
When the wedge is driven in, as in B, the resistance of the wood is no longer straight upward, directly against the force of the sledge hammer blow. The resistance is now directed at an angle, against the sides of the wedge. Therefore this resistance is not so effective as before. The wedge principle is used in scissors, chisels, knives, carpenters' planes and similar tools which have V-shaped cutting blades. It is also to be found in door stops (the kind you push under the door).

One of the most important of all machines is the *lever*. It was invented by Archimedes (ar-kee-mee'-deez), a famous Greek mathematician, who lived in the third century B.C. The lever is a solid, rigid (stiff) object that turns about a fixed point called a pivot or fulcrum (both u's are pronounced like the u in cup.) The crowbar, shown in Figure 5, is a common example of the lever. In using the lever we apply force at one point in its length by exerting force at another point. To gain mechanical advantage from the lever, the force we exert must be farther away from the fulcrum than the object to which the force is applied. The farther away from the fulcrum we exert the force, the less force we have to use. At the same time, the greater will be the distance over which the force in question will have to travel.



5. The man moves the boulder by means of a lever.

Let us show you how the lever works. The man in Figure 5 must move a heavy boulder weighing 500 pounds. He uses a smaller rock



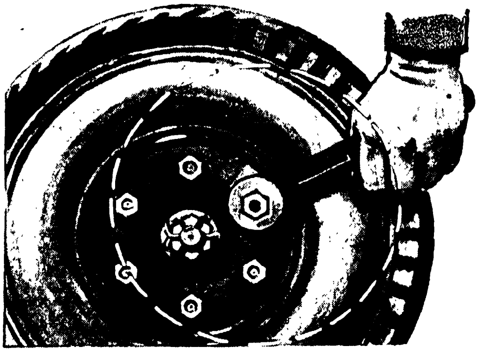
4. How a wedge works in splitting a block of wood. This is one of the commonest forms of the wedge.

as a fulcrum, shoves one end of the crowbar under the boulder and grasps the other end. He now brings his end down and the boulder is lifted up and pushed forward. If the distance between the end of the crowbar and the fulcrum is ten times the distance between the boulder and the fulcrum, the man will gain a mechanical advantage of 10. This means that he will be able to lift a boulder weighing 500 pounds by exerting a force of only 50 pounds. To gain this advantage, he will have to move his end of the crowbar ten times the distance that the boulder will travel.

The lever need not be in the form of a bar. It may be of any shape, so long as it is rigid and solid enough to withstand the force that is used on it. For example, the head of a claw hammer, used to pry up nails, is a lever. So is a pair of scissors; so is a nutcracker. The lever principle is also found in the oar, the wheelbarrow, the steam shovel and hundreds of other machines.

Next we come to the machine known as the *wheel and axle*. It consists of a large wheel and a smaller wheel, fastened to each other and moving around a common point. The wheel and axle is really a kind of lever; the fulcrum in this case is the common point around which both wheels move. As in the case of the lever, a small amount of force, moving over a long distance, overcomes a considerable resistance, moving over a shorter distance.

A good example of the wheel and axle is the wrench. Mr. Jones wants to turn a bolt on the wheel of his automobile. If he tries to turn it with his fingers, he will find the task much too hard. But if he fits a wrench to the bolt, as in Figure 6, he will not have much trouble.



6. A wrench is an example of the wheel and axle.

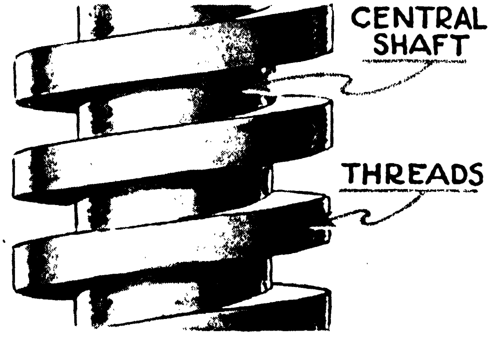
In this case the axle, or small wheel, is the bolt; the larger wheel is the circle described by the outer end of the wrench, as you can see by the illustration. The outer end of the wrench will have to move quite a long distance in order to make the bolt turn around just a little. But we do not care, since we would not be able to move the bolt at all without the wrench.

We find the principle of the wheel and axle in the doorknob. To see just how a simple machine helps us to do work, just try to open a door by turning the bar to which the knob is attached instead of the knob itself! The steering wheel of an automobile and the windlass by which one draws water from a well are other examples of the wheel-and-axle type of machine.

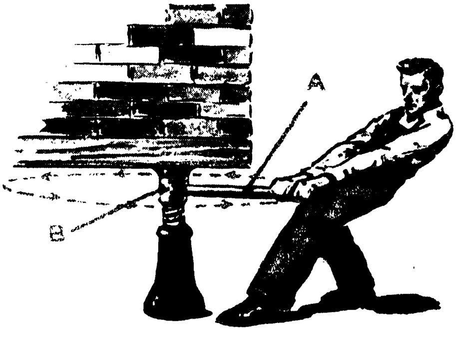
As you know, there are different kinds of staircases. Some go straight up; others wind around and around. A winding staircase is a good example of the machine that we call the *screw*. The screw is really an inclined plane that winds around a central shaft (Figure 7). Each turn of this inclined plane is called a thread; the threads are spaced evenly along the length of the central shaft.

The jackscrew shown in Figure 8 illustrates the screw principle. This machine is used to lift small houses and other very heavy objects. The effort is supplied by the man pulling at the bar A, which is slipped in turn into the various holes of the revolving (turning) part B. B is attached to a screw which moves within a nut fixed in the shell of the jackscrew. When the man pulls at the bar and makes B move, he is applying the principle of the wheel and axle. The large wheel in this case is formed by the path traced by the outer part of the bar. We indicate this path in the picture by dotted lines.

Now as part B goes around, the screw moves upward along the inclined plane formed by the threads of the nut. By the time B has made a complete turn, the building has been lifted up the distance between two threads. The force used by the man has moved around the whole circle described by the end of A. If the distance around this circle is 100 inches and if the distance between threads is one-half inch, then the man's force has moved 200 times as far as the load has moved. If the man can exert an effort of 100 pounds on the bar A, he will be able to lift a load of 200 times 100 pounds —that is, 20,000 pounds, or 10 tons. This is a fine example of the way in which a machine helps man to do work. Think how many workers would be required to lift the house if there were no machine to help!



7. Typical screw, with central shaft and threads.



8. This jackscrew illustrates the screw principle.

So, as before, we find that a comparatively small force applied over a long distance can be made to take the place of a very big force applied over a short distance. The screw principle is used in the automobile jack with which Father lifts his car when he has to change a tire. It is also found in the letter press, the vise and carpenters' bolts and screws.

THE MACHINE CALLED THE PULLEY HELPS US TO LIFT HEAVY WEIGHTS WITH EASE

We can gain considerable mechanical advantage from the machine known as the *pulley*. It consists of a rope or chain slung around a wheel or series of wheels. Figure 9 shows a weight W attached to a movable pulley. One end of the pulley rope is attached to an overhead beam; the effort, or pull, is applied at the other end of the rope.

Since half the weight of W is supported by the overhead beam, it will be necessary to use only half as much force to lift the weight as we would have to use if there were no rope and pulley to help us. We get a mechanical advantage of 2 in this case by pulling the weight twice as far as would be the case if we had no pulley.

To lift very large weights, a combination of pulleys called a block and tackle is used. The principle is the same as in the case of the single movable pulley; only here the weight is divided between a number of strands of rope. The mechanical advantage is greater than in the case of the single pulley; so is the length of the pull required.

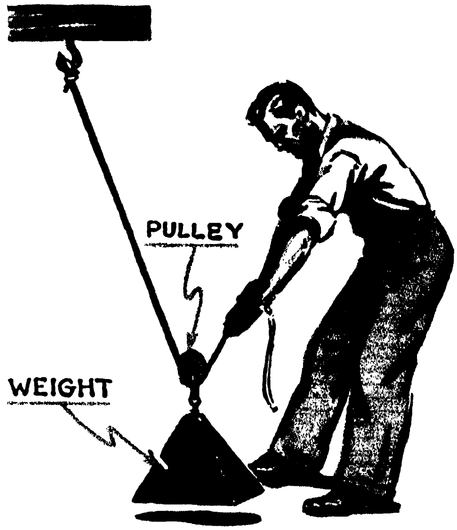
In all the cases that we have discussed hitherto, the purpose of the machine has been to enable us to apply greater force than we could if we used only our own strength. This is the case when we use a crowbar to lift a boulder, or a monkey wrench to turn a bolt or a nutcracker to crack a nut. Sometimes, however, we use a machine, not to provide additional force, but to cover additional distance. In other words, we use a considerable force, applied over a short distance, to take the place of a smaller force, applied over a longer distance.

WHY THE AUTOMOBILE WHEEL HAS TO BE SO MUCH LARGER THAN THE AXLE

Let us take a familiar example. The rear axle of an automobile is only an inch or two in diameter. Suppose the automobile wheels had exactly the same diameter. For every complete turn of the axle, the automobile would go forward a distance of only a few inches. The streets would be full of automobiles with tiny wheels crawling along at a pace slower than that of a walker.

To increase the distance that the automobile can travel with each turn of the axle, we make the wheels much larger than the axle. We now have the wheel-and-axle arrangement that we described before. But in this case we do not apply the power at the outer wheel over a long distance in order to produce much more power over a short distance. We apply the power at the axle.

The result is that for each complete turn of the axle, covering a distance of, say 6 inches, the outer wheel will cover a much greater distance, say, 6 feet. Much less force will be exerted at the outer wheel than at the



9. This picture shows how a simple pulley works.

axle. But this is not important. We are interested in getting added distance and speed rather than mechanical advantage.

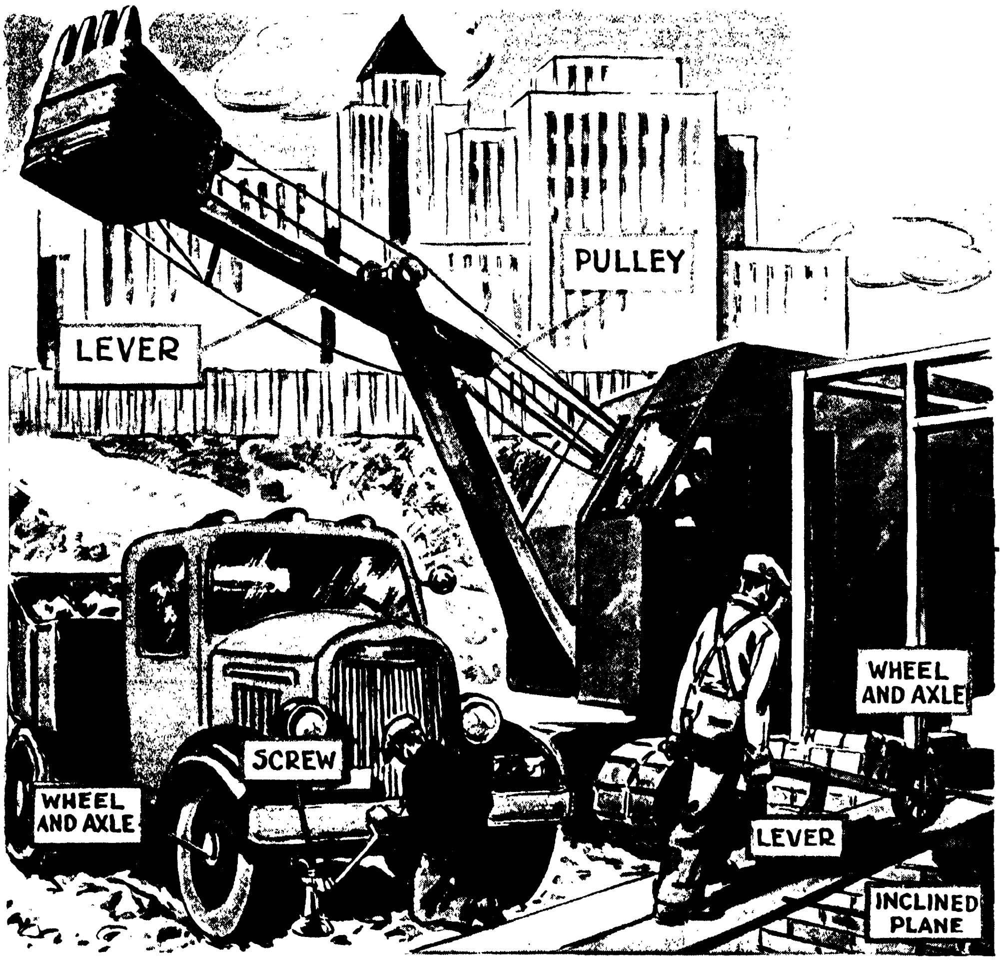
In the case of the lever, too, we are sometimes interested, not in added force, but in added distance. To gain mechanical advantage, as we have seen, the object that is acted on must be nearer the fulcrum than the force we exert. In order to gain in distance, however, the force must be nearer the fulcrum than the object to which this force is applied.

A pair of shears is a lever; the screw which holds the two blades of the shears together is the fulcrum or pivot. Now when a tinsmith wants to cut some zinc with a pair of tinner's shears, he has to exert a lot of power, since the zinc is tough. In the case of the tinner's shears, therefore, the handles into which the fingers are slipped are set at quite a distance from the screw, while the cutting blades are short and stubby.

On the other hand, a tailor cutting cloth with his shears is not interested in applying added pressure, since the cloth is easy to cut anyway. He wants to cut as much cloth as possible each time he brings the blades together. So in a tailor's shears the handles are set close to the connecting screw and the blades are long. The tailor exerts less pressure on the cloth than if the handles were farther away from the fulcrum; but since it is so easy to cut the cloth, this does not matter. What is important is that by bringing the handles together over a short distance, he can make the blades cut a large amount of cloth.

The inclined plane, the wedge, the lever, the wheel and axle, the screw and the pulley have been in use for hundreds and even thousands of years. They are very simple devices indeed. Yet the great machines of our own day—the printing press and the steam shovel and the locomotive and the airplane — are based, in part at least, on the simple machines we have just named. Let us pay tribute to their inventors; for they are among the great benefactors of mankind.

THE NEXT STORY OF SCIENCE IS ON PAGE 1579.



10. This drawing will give you some idea of the way in which machines are used on an ordinary construction job.

The Giant Who Had No Heart in His Body

By Kay Neilsen

ONCE on a time there was a King who had seven sons, and he loved them so much that he could never bear to be without them all at once, but one must always be with him. When they were grown up, six were to set off to woo, but as for the youngest, his father kept him at home, and the others were to bring back a princess for him. So the King gave the six the finest clothes you ever set eyes on, so fine that the light gleamed from them a long way off, and each had his horse, which cost many, many hundred pounds, and so they set off. Now, when they had been to many palaces, and seen many princesses, at last they came to one King who had six daughters; such lovely king's daughters they had never seen, and so they fell to wooing them, each one, and when they had got them for sweethearts, they set off home again, quite forgetting that they were to bring back with them a sweetheart for Boots, their brother, who stayed at home.

But when they had gone a good bit on their way, they passed close by a steep hill-side, like a wall, where a Giant's house was, and there the Giant came out, and set his eyes upon them, and turned them into stone, princes and princesses and all. The King waited and waited for his six sons, but the more he waited, the longer they stayed away; so he fell into great trouble.

"And if I had not you left," he said to Boots, "I would live no longer, so full of sorrow am I for the loss of your brothers."

"Well, but now I've been thinking to ask your leave to set out and find them again; that's what I'm thinking of," said Boots.

"Nay, nay!" said his father; "that leave you shall never get, for then you would stay away too."

But Boots had set his heart upon it; go he would; and he begged and prayed so long that the King was forced to let him go. Now, you must know the King had no other horse to give Boots but an old broken-down jade, for his six other sons had carried off all his horses; but Boots did not care a pin for that, he sprang up on his sorry old nag.

"Farewell, father," said he; "I'll come back, never fear, and like enough I shall bring my six brothers back with me;" and with that he rode off.

So, when he had ridden a while, he came to a Raven, which lay in the road and flapped its wings, and was not able to get out of the way, it was so starved.

"Oh, dear friend," said the Raven, "give me a little food, and I'll help you again at your utmost need."

"I haven't much food," said the Prince, "and I don't see how you'll be able to help me; but still I can spare you a little."

So he gave the Raven some of the food he had brought with him.

Now when he had gone a bit further, he came to a brook, and in the brook lay a great Salmon, which had got upon a dry place and dashed itself about, and could not get into the water again.

"Oh, dear friend," said the Salmon to the Prince; "shove me out into the water again, and I'll help you again at your utmost need."

"Well!" said the Prince, "the help you'll give me will not be great, I dare say, but it's a pity you should lie there and choke;" and he shot the fish out into the stream again.

After that he went a long, long way, and he met a Wolf, which was so famished that it lay and crawled along the road on its belly.

"Dear friend, do let me have your horse," said the Wolf; "I'm so hungry the wind whistles through my ribs; I've had nothing to eat these two years."

"No," said Boots, "this will never do; first I came to a raven, and I was forced to give him my food; next I came to a salmon, and him I had to help into the water again; and now you will have my horse. It can't be done, for then I should have nothing to ride on."

"Nay, dear friend, but you can ride upon my back," said Graylegs the wolf; "and I'll help you in your utmost need."

"Well! the help I shall get from you will not be great, I'll be bound," said the Prince; "but you may take my horse, since you are in such need."

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So when the Wolf had eaten the horse, Boots took the bit and put it into the Wolf's jaw, and laid the saddle on his back; and now the Wolf was so strong, after what he had got inside, that he set off with the Prince like nothing. So fast he had never ridden before.

"When we have gone a bit farther," said Graylegs, "I'll show you the Giant's house."

So after a while they came to it.

"See, here is the Giant's house," said the Wolf; "and see, here are your six brothers, whom the Giant has turned into stone; and see, here are their six brides, and away yonder is the door, and in that door you must go."

"Nay, but I daren't go in," said the Prince; "he'll take my life."

"No! no!" said the Wolf; "when you get in you'll find a Princess, and she'll tell you what to do to make an end of the Giant. Only mind and do as she bids you." Well! Boots went in, but, truth to say, he was very much afraid. When he came in the Giant was away, but in one of the rooms sat the Princess, just as the Wolf had said, and so lovely a princess Boots had never yet set eyes on.

"Oh! heaven help you! whence have you come?" said the Princess, as she saw him; "it will surely be your death. No one can make an end of the Giant who lives here, for he has no heart in his body."

"Well! well!" said Boots; "but now that I am here, I may as well try what I can do. I will see if I can't free my brothers, who are standing turned to stone out of doors; and you, too, I will try to save."

"Well, if you must, you must," said the Princess; "and so let us see if we can't hit on a plan. Creep under the bed yonder, and mind and listen to what he and I talk about. But, pray, do lie as still as a mouse."

So he crept under the bed, and he had scarce got well underneath it, before the Giant came.

"Ha!" roared the Giant, "what a smell of Christian blood there is in the house!"

"Yes, I know there is," said the Princess. "There came a magpie flying with a man's bone, and let it fall down the chimney. I made haste to get it out, but with all one can do, the smell doesn't go off so soon."

So the Giant said no more about it. That evening the Princess said: "There is one thing I'd be glad to ask you about, if I only dared."

"What thing is that?" asked the Giant.

"Only where it is you keep your heart, since you don't carry it about you," she said.

"Ah! that's a thing you've no business to ask about; but if you must know, it lies under the door-sill," said the Giant.

"Ho! ho!" said Boots to himself under the bed, "then we'll soon see if we can't find it."

Next morning the Giant got up cruelly early, and strode off to the wood; but he was hardly out of the house before Boots and the Princess set to work to look under the door-sill for his heart; but the more they dug, and the more they hunted, the more they couldn't find it.

"He has baulked us this time," said the Princess, "but we'll try him again."

So she picked all the prettiest flowers she could find, and strewed them over the door-sill, which they had laid in its right place again; and when the time came for the Giant to come home again, Boots crept under the bed. Just as he was well under, back came the Giant.

Snuff—snuff, went the Giant's nose. "My eyes and limbs, what a smell of Christian blood there is in here," said he.

"I know there is," said the Princess. "There came a magpie flying with a man's bone in his bill, and let it fall down the chimney. I made haste to get it out, but I daresay it's that you smell."

So the Giant held his peace, and said no more about it. A little while after, he asked who it was that had strewed flowers about the door-sill.

"Oh, I, of course," said the Princess.

"And, pray, what's the meaning of all this?" said the Giant.

"Ah!" said the Princess, "I'm so fond of you that I couldn't help strewing them, when I knew that your heart lay under there."

"You don't say so," said the Giant; "but after all it doesn't lie there at all."

So in the evening, the Princess asked the Giant again where his heart was, for she said she would so like to know.

"Well," said the Giant, "if you must know, it lies away yonder in the cupboard against the wall."

"So, so!" thought Boots and the Princess; "then we'll soon try to find it."

Next morning the Giant was away early, and strode off to the wood, and so soon as he was gone Boots and the Princess were in the cupboard hunting for his heart, but the more they sought for it, the less they found it.

"Well," said the Princess, "we'll just try him once more."

So she decked out the cupboard with flowers and garlands, and when the time came for the Giant to come home, Boots crept under the bed again.

Then back came the Giant.

Snuff—snuff! "My eyes and limbs, what a smell of Christian blood there is in here!"

"I know there is," said the Princess. "A little while since there came a magpie flying with a man's bone in his bill, and let it fall down the chimney. I made haste to get it out of the house again; but after all my pains, I daresay it's that you smell."

When the Giant heard that, he said no more about it; but a little while after he saw how the cupboard was all decked about with flowers and garlands; so he asked who it was that had done that? Who could it be but the Princess?

"And, pray what's the meaning of all this tomfoolery?" asked the Giant.

"Oh, I'm so fond of you, I couldn't help doing it when I knew that your heart lay there," said the Princess.

"How can you be so silly as to believe any such thing?" said the Giant.

"Oh yes; how can I help believing it, when you say it?" said the Princess.

"You're a goose," said the Giant; "where my heart is, you will never come."

"Well," said the Princess; "but for all that, 'twould be such a pleasure to know where it really lies."

Then the poor Giant could hold out no longer, but was forced to say: "Far, far away in a lake lies an island; on that island stands a church; in that church is a well; in that well swims a duck; in that duck there is an egg, and in that egg there lies my heart."

In the morning early, while it was still gray dawn, the Giant strode off to the wood.

"Yes! now I must set off too," said Boots; "if I only knew how to find the way." He took a long, long farewell of the Princess, and when he got out of the Giant's door, there stood the Wolf waiting for him. So Boots told him all that had happened inside the house, and said now he wished to ride to the well in the church, if he only knew the way. So the Wolf bade him jump on his back, he'd soon find the way; and away they went, till the wind whistled after them, over hedge and field, over hill and dale. After they had traveled many, many days, they came at last to the lake. Then the Prince did not know how to get over it, but the Wolf bade him only not be afraid, but stick on, and so he jumped into the lake with the Prince on his back, and swam over to the island. So they came to the church; but the church keys hung high, high up on the top of the tower, and at first the Prince did not know how to get them down.

"You must call on the Raven," said the Wolf.

So the Prince called on the Raven, and the Raven came, and flew up and fetched the keys, and so the Prince got into the church. But when he came to the well, there lay the duck, and swam about backward and forward, just as the Giant had said. So the Prince stood and coaxed it, till it came to him, and he grasped it in his hand; but just as he lifted it up from the water the duck dropped the egg into the well.

"Well, now you must call on the Salmon," said the Wolf; and the king's son called on the Salmon, and the Salmon came and fetched up the egg from the bottom of the well.

Then the Wolf told him to squeeze the egg, and as soon as ever he squeezed it the Giant screamed out.

"Squeeze it again," said the Wolf; and when the Prince did so, the Giant screamed still more piteously, and begged and prayed to be spared, saying he would do all that the Prince wished if he would only not squeeze his heart in two.

"Tell him to restore to life again your six brothers and their brides, whom he has turned to stone," said the Wolf. Yes, the Giant was ready to do that, and he turned the six brothers into king's sons again, and their brides into king's daughters.

"Now squeeze the egg in two," said the Wolf sternly. So Boots squeezed the egg to pieces, and the Giant burst at once.

Now, when he had made an end of the Giant, Boots rode back again on the Wolf to the Giant's house, and there stood all his six brothers alive and merry, with their brides. Then Boots went into the hill-side after his bride, and so they all set off home again to their father's house. And you may fancy how glad the old King was when he saw all his seven sons come back, each with his bride—"But the loveliest bride of all is the bride of Boots," said the King.

So he sent out, and called a great wedding-feast, and the mirth was both loud and long, and if they have not done feasting, why, they are still at it.

THE NEXT STORIES ARE ON PAGE 1689.

GOLDILOCKS AND THE THREE BEARS

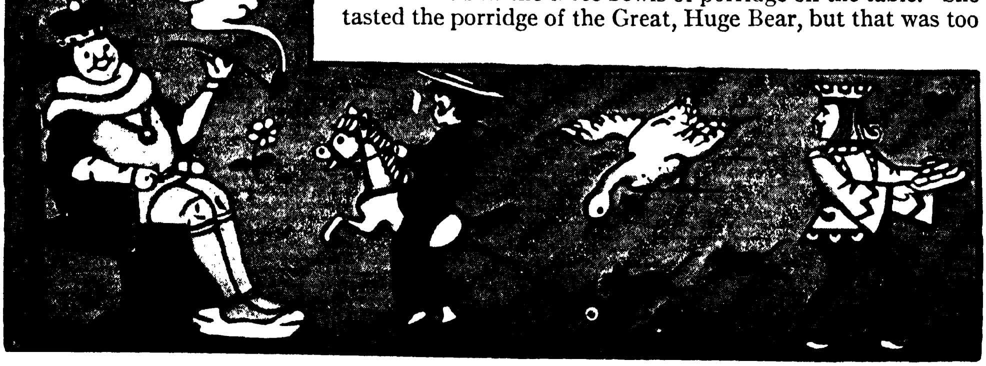
ONCE upon a time there were Three BEARS who lived together in a house of their own, in a wood. There were the father bear, the mother bear and the baby bear. The father bear was a GREAT, HUGE BEAR; the mother bear was a MIDDLE-SIZED BEAR; and the baby bear was a LITTLE, SMALL, WEE BEAR.

They had each a bowl for their porridge; a little bowl for the Little, Small, Wee Bear; and a middle-sized bowl for the Middle Bear; and a great bowl for the Great, Huge Bear. And they had each a chair to sit in; a little chair for the Little, Small, Wee Bear; and a middle-sized chair for the Middle Bear; and a great chair for the Great, Huge Bear. And they had each a bed to sleep in; a little bed for the Little, Small, Wee Bear; and a middle-sized bed for the Middle Bear; and a great bed for the Great, Huge Bear.

One day after they had made porridge for their breakfast and poured it into their porridge bowls, they walked out into the wood while the porridge was cooling so that they might not burn their mouths by beginning too soon to eat it.

And while they were walking, a little girl named Goldilocks came to the house. First she looked in at the window, and then she peeped in at the keyhole, and then she knocked on the door—knock, knock, KNOCK! Nobody answered! She lifted the latch and went in.

First she saw the three bowls of porridge on the table. She tasted the porridge of the Great, Huge Bear, but that was too



hot. Then she tasted the porridge of the Middle-sized Bear, but that was too cold. Then she tasted the porridge of the Little, Small, Wee Bear, and that was just right—so she ate it ALL UP!

Then Goldilocks sat down in the chair of the Great, Huge Bear, but that was too hard. Then she sat down in the chair of the Middle-sized Bear, but that was too soft. Then she sat down in the chair of the Little, Small, Wee Bear, and that was just right. So there she sat, and there she sat until the bottom of the chair came out, and down she came, PLUMP.

Then Goldilocks went upstairs into the bedroom. First she lay down upon the bed of the Great, Huge Bear, but that was too high at the head for her. Next she lay down upon the bed of the Middle-sized Bear, and that was too high at the foot for her. And then she lay down upon the bed of the Little, Small, Wee Bear, and that was just right. So she covered herself up and fell fast asleep.

By this time the Three Bears thought their porridge would be cool enough, so they came home to breakfast.

"SOMEBODY HAS BEEN
EATING MY PORRIDGE!"

said the Great, Huge Bear in his great, rough, gruff voice.

"SOMEBODY HAS BEEN
EATING MY PORRIDGE!"

said the Middle-sized Bear in her middle voice.

"SOMEBODY HAS BEEN EATING MY PORRIDGE, AND HAS EATEN IT ALL UP!"

said the Little, Small, Wee Bear, in his little, small, wee voice.

Upon this, the Three Bears, seeing that someone had entered their house, began to look about them.

"SOMEBODY HAS BEEN
SITTING IN MY CHAIR!"

said the Great, Huge Bear, in his great, rough, gruff voice.

"SOMEBODY HAS BEEN
SITTING IN MY CHAIR!"

said the Middle-sized Bear, in her middle voice.

"SOMEBODY HAS BEEN SITTING IN MY CHAIR, AND HAS BROKEN IT A-ALL DOWN!"

said the Little, Small, Wee Bear, in his little, small, wee voice.

Then the Three Bears went upstairs into their bedroom.

"SOMEBODY HAS BEEN
LYING IN MY BED!"

said the Great, Huge Bear, in his great, rough, gruff voice.

"SOMEBODY HAS BEEN
LYING IN MY BED!"

said the Middle-sized Bear, in her middle voice.

And the Little, Small, Wee Bear cried out in his little, small, wee voice:

"SOMEBODY HAS BEEN LYING IN MY BED—
AND HERE SHE IS NOW!"

When Goldilocks heard the three voices, she awoke at once. Up she started! And when she saw the Three Bears, she was so frightened that she tumbled herself out of the bed and ran down the stairs and out of the house into the wood. And the Three Bears never saw Goldilocks again.

WHY THE BEAR IS STUMPY-TAILED

A Norwegian folk tale from the collection of Asbjornsen and Moe, written about 1875

One day the Bear met the Fox, who came slinking along with a string of fish he had stolen.

"Where did you get those?" asked the Bear.

"Oh, my Lord Bruin, I've been out fishing and caught them," said the Fox.

So the Bear had a mind to learn to fish too, and bade the Fox tell him how he was to set about it.

"Oh, it's an easy thing to do," answered the Fox. "You have only to go upon the ice, and cut a hole and stick your tail down into it; and so you must go on holding it there as long as you can. You are not to mind if your tail smarts a little; that is when the fish bite. The longer you hold it there the more fish you'll get; and then all at once out with it, with a cross-pull sideways, and with a strong pull, too."

Yes; the Bear did as the Fox said, and held his tail a long, long time down in the hole, till it was fast frozen in. Then he pulled it out with a cross-pull, and it snapped short off. That is why Bruin the Bear has a stumpy tail.

THE NEXT READ ALOUD STORIES ON PAGE 1777.

"FIDDLE-DEE-DEE"*

By Eugene Field

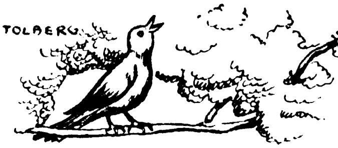
THERE once was a bird that lived up in a tree,
And all he could whistle was
"Fiddle-dee-dee!"—
A very provoking, unmusical song
For one to be whistling the summer day long!
Yet always contented and busy was he
With that vocal recurrence of "Fiddle-dee-dee!"

Hard by lived a brave little soldier of four.
That weird iteration annoyed him so sore;
"I prithee, Dear-Mother-Mine! fetch me my gun,
For, by our St. Didy! the deed must be done
That shall presently rid all creation and me
Of that ominous bird and his 'Fiddle-dee-dee!'"

Then out came Dear-Mother-Mine, bringing
her son
His awfully truculent little red gun;
The stock was of pine and the barrel of tin,
The "Bang" it came out where the bullet went in—
The right kind of weapon, I think you'll agree,
For slaying all fowl that go "Fiddle-dee-dee!"

The brave little soldier quoth never a word,
But he up and he drew a straight bead on that bird;
And while that vain creature provokingly sang,
The gun it went off with a terrible bang!
Then loud laughed the youth, "By my Bottle!"
cried he,
"I've put a quietus on 'Fiddle-dee-dee!'"

Out came then Dear-Mother-Mine, saying:
"My son,
Right well have you wrought with your little
red gun!
Hereafter no evil at all need I fear,
With such a brave soldier as You-My-Love here!"
She kissed the dear boy. The bird in the tree
Continued to whistle his "Fiddle-dee-dee!"



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Sing a song of sixpence
A pocket full of rye;
Four-and-twenty blackbirds
Baked in a pie;

When the pie was opened
The birds began to sing;
Was not that a dainty dish
To set before a king?

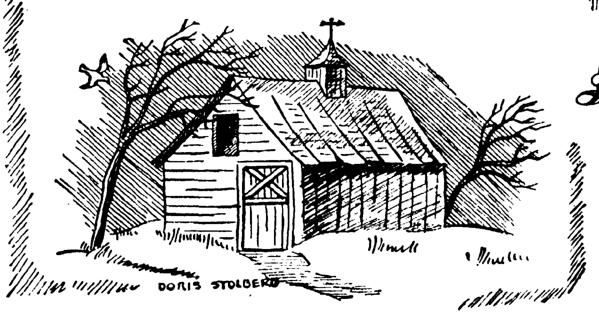
The king was in his counting-house
Counting out his money;
The queen was in the parlor
Eating bread and honey;

The maid was in the garden
Hanging out the clothes,
Down came a blackbird
And snapped off her nose.

The North Wind doth blow
And we shall have snow
And what will the robin do then,
poor thing?

He'll sit in the barn
And keep himself warm
And hide his head under his wing,
poor thing.

Little Miss Muffet,
She sat on a tuffet,
Eating of curds and whey;
There came a big spider
And sat down beside her,
And frightened Miss Muffet away.



Wynken, Blynken, and Nod*

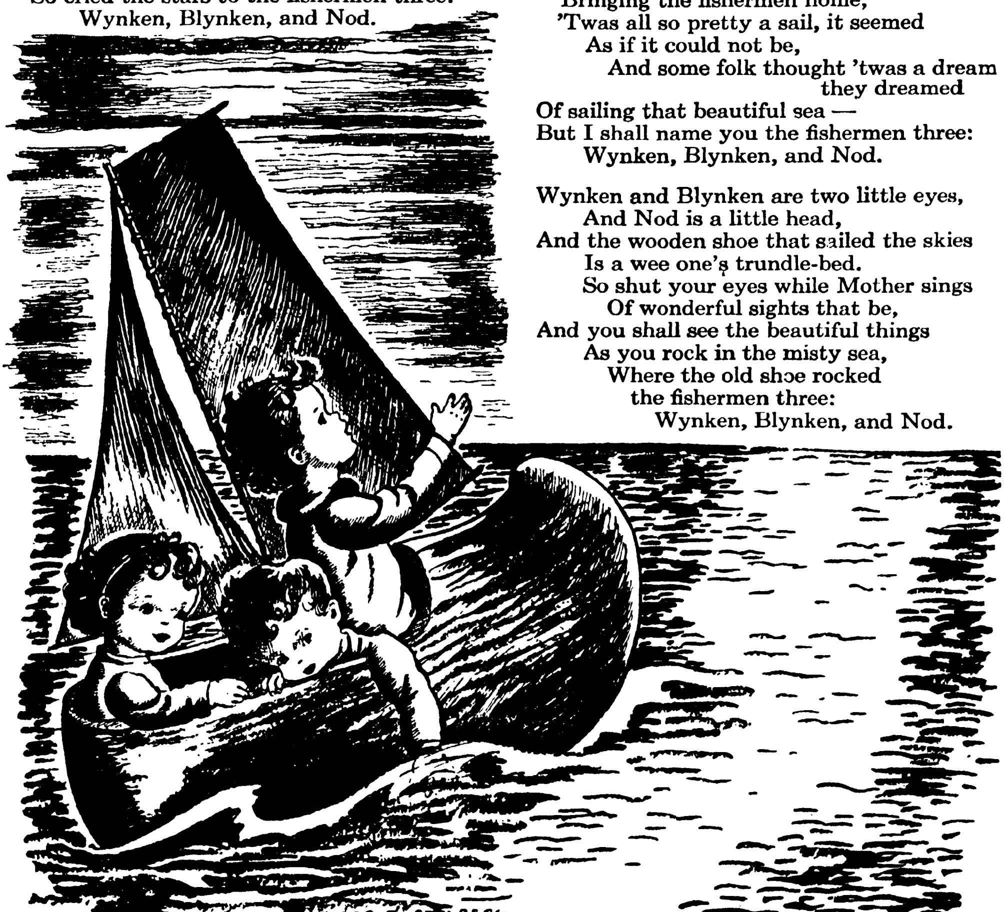
By Eugene Field

Wynken, Blynken, and Nod one night
Sailed off in a wooden shoe —
Sailed on a river of crystal light,
Into a sea of dew.
"Where are you going, and what do you wish?"
The old moon asked the three.
"We have come to fish for the herring fish
That live in this beautiful sea;
Nets of silver and gold have we!"
Said Wynken, Blynken, and Nod.

The old moon laughed and sang a song,
As they rocked in the wooden shoe,
And the wind that sped them all night long
Ruffled the waves of dew.
The little stars were the herring fish
That lived in that beautiful sea —
"Now cast your nets wherever you wish,
Never afeard are we";
So cried the stars to the fishermen three:
Wynken, Blynken, and Nod.

All night long their nets they threw
To the stars in the twinkling foam —
Then down from the skies came the wooden shoe,
Bringing the fishermen home;
'Twas all so pretty a sail, it seemed
As if it could not be,
And some folk thought 'twas a dream they dreamed
Of sailing that beautiful sea —
But I shall name you the fishermen three:
Wynken, Blynken, and Nod.

Wynken and Blynken are two little eyes,
And Nod is a little head,
And the wooden shoe that sailed the skies
Is a wee one's trundle-bed.
So shut your eyes while Mother sings
Of wonderful sights that be,
And you shall see the beautiful things
As you rock in the misty sea,
Where the old shoe rocked the fishermen three:
Wynken, Blynken, and Nod.



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