ELEMENTARY SCIENCE BY GRADES

Book Six

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EDITED BY

FRANK W. BALLOU, PH.D.

SUPERINTENDENT OF SCHOOLS, WASHINGTON, D. C.

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BOOK I. *By* ELLIS C. PERSING *and* ELIZABETH K. PEEPLES.

BOOK II. *By* ELLIS C. PERSING *and* ELIZABETH K. PEEPLES.

BOOK III. *By* ELLIS C. PERSING *and* ELIZABETH K. PEEPLES.

BOOK IV. *By* ELLIS C. PERSING *and* EDWARD E. WILDMAN.

BOOK V. *By* ELLIS C. PERSING *and* C. LOUIS THIELE.

BOOK VI. *By* ELLIS C. PERSING *and* JOHN A. HOLLINGER.

ELEMENTARY SCIENCE BY GRADES

BOOK SIX

A NATURE STUDY AND SCIENCE READER

BY

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EDITOR'S INTRODUCTION

The Elementary Science Series has been prepared because of the very earnest belief of the authors in the importance of the subject matter to be covered, in the interests of children in nature about them, and in their ability to profit by a study of it.

Throughout the series the authors have kept in mind the psychology of the child rather than the orderly scientific arrangement of the subject matter. The vocabulary of each book has been most carefully selected from and checked against accredited lists of words of highest frequency in the spoken vocabulary of young children. Moreover, the point of view of the authors is that of explaining to children the everyday world about them and making it an object of interest and profit to them.

Simplicity has been one aim in the preparation of the readers in order that the joy of the subject and the attitudes, habits, and ideals taught by them may not be lost in a maze of mechanical difficulties.

The general aims and objectives throughout the series are those set forth in the *Fourth Yearbook* of the Department of Superintendence.[1] The subject matter of the lessons has been selected with a view of making it possible for teachers to realize those aims and objectives.

The organization of the subject matter of the series agrees in the main with that of the *Fourth Yearbook* course and

[1] *Fourth Yearbook*, Department of Superintendence, Ch. IV, "Elementary Science and Nature Study" (Washington, National Education Association, 1926), pp. 59-112.

with other leading courses of study of the country. The course can be articulated with the more formal science course in junior-high-school grades.

The national policy of conservation of our natural resources is recognized and encouraged among pupils throughout the series. The protection of trees, wild flowers, and birds is specifically taught.

Each volume of the series is organized on the basis of seasons. For example, the study of flowers is increased in the fall and spring months, and minimized in the winter season. The physical sciences are largely taught during the winter months.

Each volume contains the material for a year of instruction. Each volume also carries suggestions to teachers on how to handle the activities; how to obtain materials; plans for field trips; preparation of school gardens, and other aspects of the lessons. Although each volume is a unit in itself, the series represents a unified program of instruction in elementary science and nature study. The series is built on the spiral plan and is progressive in content and style.

At the close of each chapter various suggestions and questions are offered under the heading "Some Things to Think About." These questions and suggestions are for the purpose of stimulating thought among the children either before or after reading the lesson.

The books are primarily designed as readers with science content for the school systems that have yet made no provision in the curriculum for instruction in elementary science and nature study. New-type tests have been included for the purpose of determining comprehension of the reading assignment.

For the schools that provide for science instruction as such even more important than the comprehension material are the suggestions contained under the title "Some Things to Do." Since much of the instruction covered in this series of books can be given objectively through the direct contact of children with the objects themselves, the authors of this series have indicated what may be properly done by teachers and pupils in making a study of elementary science more than a book subject. Suggestions of trips to the zoo, excursions to the country, trips to parks and woods, and observations of those activities within the home that are based on scientific principles taught in the books are the various ways suggested of making the instruction covered in this series of books more real and more vital than such instruction acquired exclusively from books.

The material in these books has been successfully tested out before publication under actual classroom conditions, both in schools that used the material primarily as readers and in schools that have permanent provision for instruction in elementary science.

Frank W. Ballou

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PREFACE

Elementary Science is the natural means through which a child becomes acquainted with the world about him. Without suggestion or direction some children acquire considerable knowledge of their environment; but more remain pathetically and dangerously blind and deaf to it. For the child's physical, intellectual, and spiritual good the educator should see that he is made aware of the phenomena within his observational scope, and his relations to them.

Elementary science, more than any other subject, supplies actual experience with concrete things. It is, therefore, an ideal study in elementary schools, and may be used as a basis of approach to practically every other subject. Present practice in the teaching of elementary science and nature study in the first six years has indicated the need for a graded series of readers having a science content that will conform generally in subject matter and organization to accepted requirements. It was in the hope of supplying such a need that this series, *Elementary Science by Grades,* has been prepared.

This volume of the series, *Book Six,* has been designed for use following *Book Five* of this series. In content, it meets the generally accepted subject matter requirements except for some minor modifications that were made as the result of testing the material in the classroom.

The vocabulary has been based upon the first, second, and third groups of Gates' "A Reading Vocabulary for the Primary Grades" and upon Thorndike's "The Teacher's Word Book."

Like other books in the series, this volume has been organized on a seasonal basis. Subject matter has been arranged throughout so it will be suitable for the season of the year in which it normally will be studied. In this book, for example, migration of birds, the mosquito, and certain flowers are studied in the fall. The chapters dealing with astronomy and the physical sciences come during the winter months. The latter part of the book, which ordinarily will be studied in the spring, includes chapters on trees, birds, gardening, and flowers.

To test reading ability, different forms of new-type tests have been included at the end of every chapter under the heading, "Some Things to Think About." Some teachers, of course, may desire to substitute other forms or to supplement those that have been prepared. Suggested forms for activities are given under the heading "Some Things to Do." Specific suggestions to the teacher on the teaching of each chapter are placed at the back of the book.

Acknowledgment is gratefully made to Miss Helen K. Brett, Principal of Doan Science Curriculum Center, Cleveland, for reading most of the manuscript and for helpful criticisms and suggestions; to Dr. Hanor A. Webb of George Peabody College for Teachers, Nashville, Tennessee, for reading the manuscript and helpful suggestions and criticisms; and to Dr. Edward E. Wildman, Director, Division of Science, Philadelphia; C. L. Thiele, Director of Exact Science, Detroit; Elizabeth K. Peeples, Principal of Brantwood School, Washington, D. C., for their helpful advice on the outline, their reading of the complete manuscript, for testing chapters of the manuscript, and for reading the proof; also to David W. Russell, of Hawken School, and Miss Agnes G. Strothman, both of Cleveland, for reading the manuscript; to Miss Arley B. Kelley and Miss Mildred Kearns, of Hazeldell School, Miss Cina L. Biszantz, Principal of Sterling School, Miss Margaret McCarthy,

Principal of Sowinski School, and Miss Helen G. Miller, of the Observation School, all of Cleveland, for testing chapters of the manuscript.

E. C. P.
J. A. H.

INTRODUCTION

HOW SCIENCE HELPS US

How does science help us to live better to-day than people did fifty years ago? What animals are our friends? What plants help to make us comfortable and happy? Are any of these plants and animals becoming scarce? Are people needlessly destroying them? In this book you will learn the answers to these questions and to other similar ones that must have occurred to you.

It is often difficult to determine what is right and what is wrong until you have all the facts before you. Is it right for us to use annually more lumber than grows each year in our forests? Is it right to hunt and trap animals? Should men continue to hunt and trap as freely in the future as they have in the past? Do such animals as antelope, deer, moose, elk, and beaver need protection? Are game preserves and game reservations needed?

Not so many years ago, there were in the Susquehanna River many, many shad. Now they are very scarce. Do fish need our protection? How can we keep fish in our streams?

Only about fifty years ago, passenger pigeons could be seen by the thousands during the migration season. Now it is thought that they are extinct—gone forever. Do you know why these birds have disappeared?

Photo by R. G. Varela. Courtesy U. S. Forest Service.
THIS TIMBER WAS WASTEFULLY CUT WITHOUT ANY IDEA OF CONSERVATION.

This book is intended to help you to understand why and how wild life should be protected. Throughout it runs the idea of conservation. Now *conservation* is a big word. It means to preserve, to guard, to protect, to keep safe, and it also means to use properly. To *conserve* our health and strength we must use our bodies properly. We must eat, drink, exercise, rest, and guard against disease. To *conserve* coal, we must *not* use it, for the coal that is used is gone forever. To conserve water power means to use it, for the water power that is not used is lost. To conserve water, wind, and sunshine, we must use them.

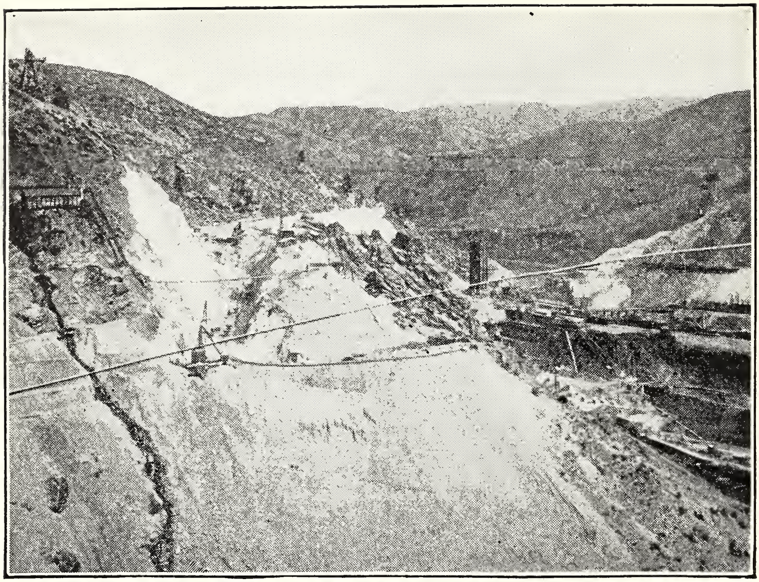
You will be interested, too, in learning more about

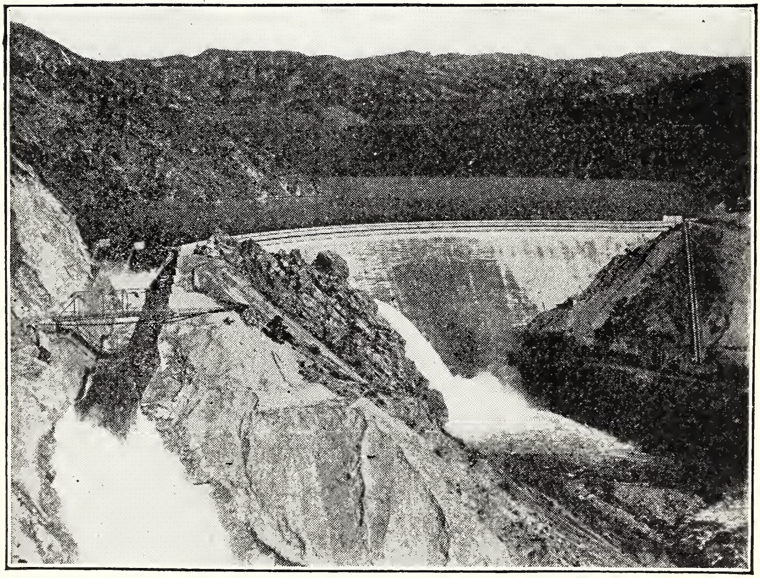
Courtesy of the U. S. Forest Service.

HERE IS A PATCH OF WOODS THAT HAS BEEN PROPERLY CUT. THE YOUNGER TREES HAVE BEEN LEFT TO GROW.

electricity, and in finding out how scientists have discovered ways of using it to send messages by telephone, telegraph, and radio. You will also be interested in learning about the locomotive, and the development of transportation. Scientists have, through useful inventions, created better means for the use of our natural resources.

Since the sun indirectly is the source of all the energy or power we have to use, you will want to learn a little more about the great solar system of which the earth is a part. Even though the energy comes to us for use in the form of electricity, water power, or stored in the bodies of plants, it came





HOW WATER MAY BE CONSERVED.

In these two pictures you may see how a small stream of water that never served any particularly useful purpose was dammed to play its part in irrigating many Utah farms.

originally from the sun's rays. In this book you will learn something of how this all works out.

It is important that we learn to use our resources wisely, and it is equally important that we learn to protect them for future generations. To conserve our forests we must protect the young trees and see that some new ones get a start each year. To conserve wild animal life we must guard and protect it when it needs protection.

Some of the most important problems of modern life are problems of conservation. This reader gives you facts that you must have in order to understand the problems.

CHAPTER I

THE TRAVELS OF BIRDS

1. What birds nest in your community?
2. Which of these journey southward to spend the winter?
3. What birds come from the north to spend the winter in your neighborhood?

September is an excellent month to study the birds. The nesting season is over, and the young birds are grown. It is moving time in the bird world. You may have watched the birds in your neighborhood make their preparations for their long southern trip and you may, too, have seen birds that spend neither summers nor winters in your community passing through on their way to the south. During this season when birds are moving from one home to another, or *migrating,* you may be able to observe many different kinds, particularly if you live on one of the main traveled routes.

Birds, you know, are great travelers. There are, of course, a few permanent residents which spend the whole year in one community, but their number is small indeed compared to the number of birds that migrate. Every state has its summer visitors that return spring after spring, build their nests, raise their young, and fly south again in the autumn. As these summer birds leave for their winter homes, other birds that have nested still farther north arrive to spend the winter. Even the northern states

Courtesy of U. S. Bureau of Biological Survey.

THOUSANDS OF DUCKS ARE RISING FROM A RIVER TO CONTINUE THEIR JOURNEY SOUTHWARD.

have their winter visitants. The horned lark, the snow bunting, redpoll, tree sparrow, and the nuthatch arrive in the northern United States in late September, October, or November, and stay until April.

Robins and swallows begin in July to prepare for their flight to the south. Perhaps you have watched them making short daily trips from their roosts to their feeding places. These flights strengthen their wings and increase their endurance, so that the long journey which they must take in order to reach their winter homes will not be too far or too hard for them.

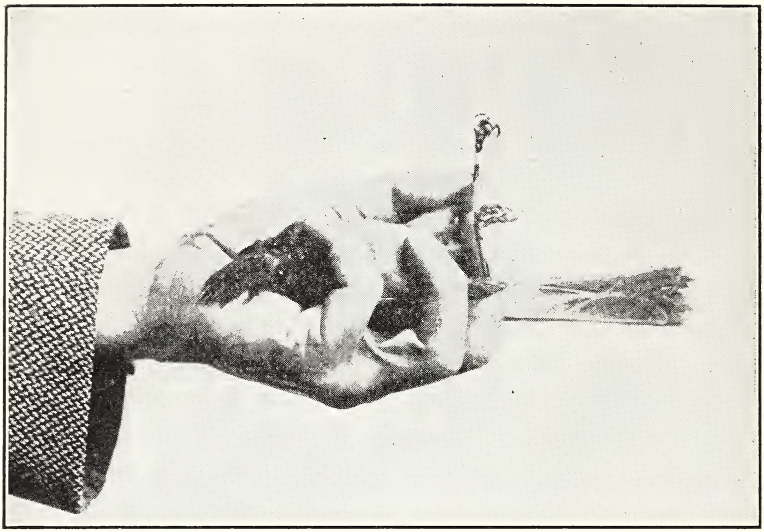
Two, and sometimes three, broods of young robins are raised during a summer. As soon as the first family leaves the nest, the father bird takes them to some spot in the woods to which they will return each night for the remainder of the summer. As soon as the second brood can fly, they join the first group, and, when the last family is ready to go to the roost, as the sleeping place is called, the mother bird goes with them. Each roost is used by many robin families. At the time of the long journey the flock may number thousands.

Swallows sleep among reeds and cat-tails in swampy places. Early in the morning they set forth in search of food, seldom returning until late afternoon. You may have seen them flying back and forth to their marshes, catching insects as they go.

Grackles, swifts, and gulls also make daily trips from sleeping places to feeding grounds and back again during the weeks that precede the long journey to their winter homes.

About the middle of August, bobolinks start on their southward flight. Early in September flycatchers, orioles, swallows, and warblers migrate. This migration continues until the end of November, when the summer visitants with their families have all gone, and the winter visitants have arrived at their winter homes.

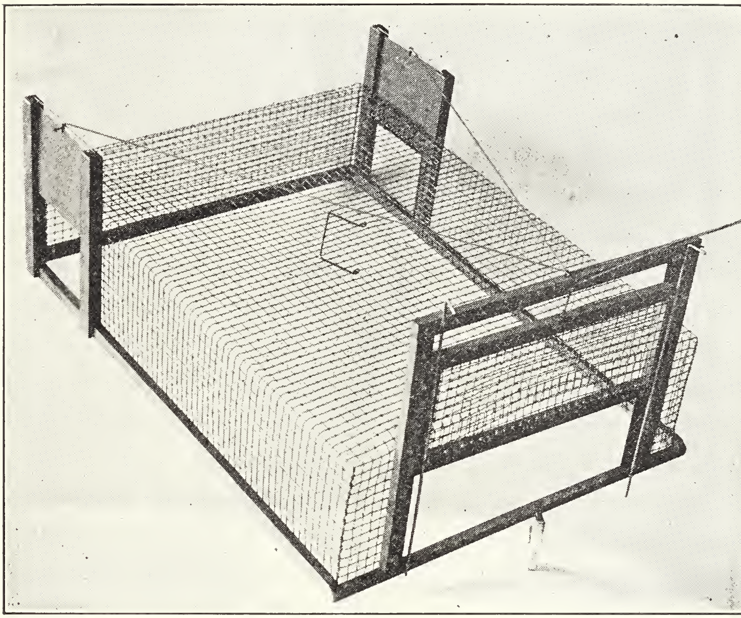
For centuries people have been fascinated and puzzled by the migration of birds. In recent years, however, bird-banding has provided a means of really learning more about it. Individual students



Courtesy of U. S. Bureau of Biological Survey.
THE SMALL BAND BEARING A NUMBER IS PLACED AROUND THE LEG OF THE BIRD.

of bird life have used this method of tracing birds in their flight for many years, but not until 1920, when bird-banding became a part of the work of the United States Biological Survey, was the experiment carried on in a large and scientific manner. Qualified persons in various parts of the country have been appointed to assist in the study. These persons are authorized to capture birds and place around a leg of each a small, aluminum, numbered band. A careful record is kept of the time, the place, and the number of the band. The bird, of course, is set free.

These field observers, whose duty it is to report any banded birds they are able to capture, are organized into four regional associations, each includ-



Courtesy of the U. S. Biological Survey.
SOME OF THE TRAPS USED FOR CATCHING BIRDS FOR BANDING ARE OF THIS KIND.

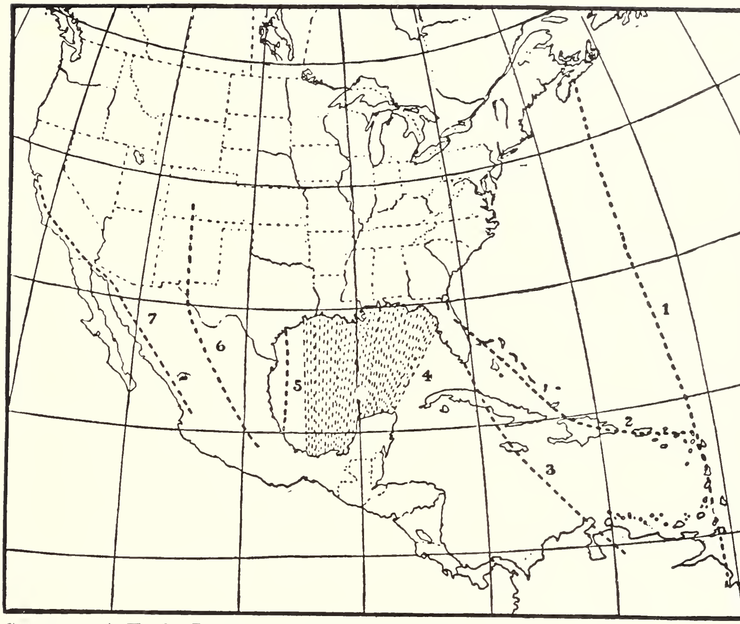
ing in its area at least one important migration highway. As the birds proceed in their flight from area to area, some of them are trapped and banded. Sometimes the same bird will be caught by different observers within a short time. By comparing records thus obtained, students are able to determine the migratory route and the rate of speed at which various birds travel.

The reporting of banded birds is a work in which many may share. You cannot, of course, set up traps as the regular field observers do, but whenever you happen to see a dead bird, you can look to see if it is banded. If you chance to find a banded bird, you should report the time, the place, and the number of the band, together with any other available information, to the United States Biological Survey at Washington, D. C.

We have spoken of "main traveled routes," and of the "important migration highways." Perhaps you have always thought that each bird flies southward directly from wherever he happens to have spent the summer, but this is not true. The birds have well-defined routes for journeying from their summer to their winter homes and back again. Year after year they follow the same routes. Dr. Frank M. Chapman, one of the great authorities on bird life, in his little book, *The Travels of Birds,* traces five distinct routes followed by birds leaving the eastern part of America to spend the winter farther south. These five routes and two others used by birds from the western part of the country are shown on the map on the following page.

The first, which Dr. Chapman considers the most remarkable of all, is over the Atlantic Ocean from Nova Scotia to South America. The second leads from the east coast of Florida to the Bahama Islands. A third route may be seen to lead from the tip of Florida to Cuba and then over the Caribbean Sea to South America. Route four is the one used by most migrants, even though this means a flight of from 500 to 700 miles across the Gulf of Mexico. You may easily trace the remaining three routes on the map.

During the fall migration season, a number of



Courtesy of U. S. Bureau of Biological Survey.

THIS MAP SHOWS THE SEVEN PRINCIPAL BIRD MIGRATION ROUTES.

species of the smaller land birds will be found in the Bermudas. Where they go from there is unknown. Dr. Chapman thinks that some of them may go southwest to the Bahamas. He suggests that it may have been a flock of these land birds, on their way from the Bermudas to the Bahamas, that Columbus saw when his discouraged sailors were ready to return home. On October 4, according to the diary, the voyagers were cheered by the appearance of land birds, which on October 7 became so numerous that the sailors changed their course to follow them. "So you see," says Dr. Chapman, "that it was due to the migration of birds not only that Columbus landed in the Bahamas instead of on the Florida coast, but perhaps that he landed at all."

If you trace the highways of bird migration on a map, you may notice that these routes are not always the shortest distance between the summer and winter homes; and if you trace the bird highways for the entire United States, you will find routes that are indeed surprising, so roundabout are they. Western bobolinks, from Utah and Montana, for instance, never fly southward through the Great Basin and Mexico, with their bird neighbors. The bobolink, you see, was originally an eastern bird that pushed its way gradually into the west. When it migrates, it first retraces its path to the east, and leaves the United States by way of Florida, crossing to Cuba, Jamaica, and Yucatan, wintering south of the Amazon just as its ancestors have always done. This is a very interesting example of the tendency of migrating birds to follow the paths of their ancestors.

Nesting from the coast of Maine northward to the very northern limit of land, and wintering along the borders of the Antarctic Continent, the Arctic tern has earned the title of the "world's champion migrator." Flying from far north to far south, these terns journey halfway around the earth every fall, and retrace their long flight every spring. Although the journey is made by thousands of them each season, the student of bird migration seldom sees one of them during the flight. It is thought, therefore, that they migrate far out at sea.

Some birds travel by day; others, by night. Those making the journey by day are usually the bold, strong-winged ones that get their food in open places —the robins, blackbirds, orioles, swallows, and the hawks, for example. Timid birds with feeble wings, such as the thrushes, wrens, and warblers, migrate at night when the dangers of the route are not so great. Their days are spent in feeding and resting in secluded spots.

Insect-eating birds, nature's guardians of forest, field, orchard, and garden, are among the greatest bird travelers. The dangers of the way are great, and many of them are killed each year by storms, lighthouses, towers, and by hunters. These birds are exceedingly useful to man and need man's protection. They are the chief means of keeping down such insect pests as the potato beetle, the cotton boll weevil, and the coddling moth—insects that seem to increase in number with the size of the crops upon which they feed. Without the friendly services of birds these insects would become very numerous and do great harm.

Think of the dangers encountered by migrating birds—poles, wires, lighthouses against which they fly, storms, and hunters! We cannot, of course protect them from all of these dangers, but we can prevent their destruction by hunters. Until a few years ago, when the United States government passed the Federal Migratory Bird Law, it was no uncommon sight to see migratory birds, the killing of which was forbidden in one state, hung up for sale in the markets of the next. The Federal law makes it illegal to shoot bird migrants in the spring, and permits hunting them only during a limited and specified time in the autumn. Insect-eating migrants cannot be legally killed at any season or any place in the United States.

SOME THINGS TO THINK ABOUT

Which of the birds that you have seen are summer residents? Where do they spend the winter?

Which of them are winter residents? Where do they spend the summer? Do they nest in your community?

Did you see any birds that spend both summer and winter in the neighborhood? What name is given to birds that do not migrate?

Did you see any species of birds that spend neither summer nor winter with you? Where did they come from? Where were they going?

SOME THINGS TO DO

Sit down in some quiet spot frequented by the birds and watch them. Make simple notes of what you see.

Watch for birds making their short daily trips from their sleeping to their feeding places and back again.

With the aid of a bird guidebook, identify as many as you can of the birds that you see.

CHAPTER II

MOSQUITOES

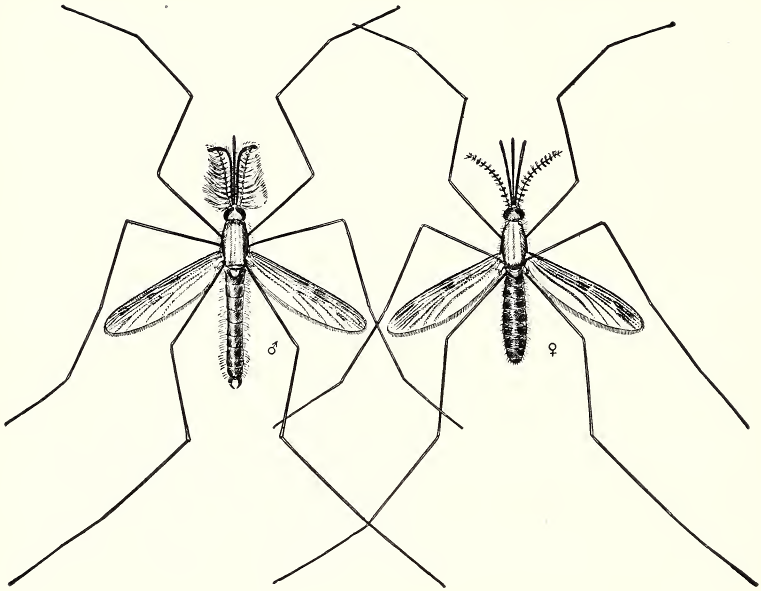
1. Have you ever been bitten by a mosquito?
2. Have you ever seen wrigglers, as the larvas of mosquitoes are called?
3. Where do the wrigglers live?

You are no doubt familiar with the common house mosquito, with its slender body, its long legs, and its persistent buzz. You probably do not enjoy hearing it buzz, because you know that very soon it may be piercing your skin.

Unlike the malarial mosquito, which it resembles in appearance, the common house mosquito carries no disease germs. It is, however, a great annoyance.

The common house mosquito is too well known to require description. There are, it is true, some species of flies that are quite similar to it in appearance. It is not hard to distinguish the real mosquito, however, because the wings of the mosquito are veined and have scales along their edges, whereas those of the flies are plain and smooth. The scales can be seen with the aid of a reading glass, a hand lens, or a microscope.

Here are pictures of the male and the female mosquito. Notice the antennas. They are organs of hearing. The antennas of the male are feathery; those of the female have scattered hairs. There is a

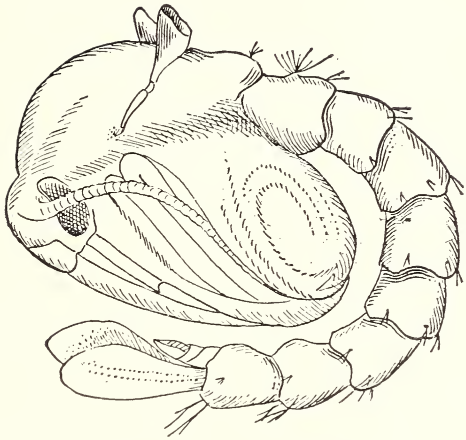


ONLY THE FEMALE MOSQUITO BITES HUMANS.

The male mosquito with its feathery antennas is on the left. These drawings are many times actual size.

difference, also, between the mouth parts of the male and those of the female mosquito. The female has piercing mouth parts with which she can drill into plants or cut through our skin to suck our blood. The mouth parts of the male are not so sharp and strong. He cannot pierce the skin of a person, but lives on nectar and juices from plants. So, when a mosquito bites you, you may be sure that it is the female and not the male.

Only a few mosquitoes live through the winter. During the cold weather they stay in some protected place. In the spring those that have survived come



THE WRIGGLER CHANGES TO A PUPA WITH A LARGE HEAD.

forth, and the females soon find a place to lay their eggs. On the surface of the water in a quiet pool or pond, or perhaps in a bucket of standing water, each female lays from 50 to 300 eggs. They are usually laid at night or in the early morning. The mass of eggs, which stand on end and cling together, looks like a tiny brown boat or raft floating in the water.

In one or two days they hatch into larvas that live for a time in the water, feeding on tiny animals and plants, and sometimes on other larvas. Because they swim by wriggling the body, they are commonly called wrigglers. On the back of the wriggler's body is a small tube which it pushes up through the surface of the water to take in air.

The wriggler grows rapidly for from five to ten days. During this time it sheds its skin four times, and then it changes into a pupa. An insect is called a pupa during that stage of its life in which it develops from a larva to an adult. The pupas of mosquitoes are strange creatures. They seem to have very large heads for their bodies. In fact, to you they may seem to be all head.

The pupa stage in insect life is a resting and changing period. The moth larva spins a cocoon for itself in which it lives as a pupa and eventually becomes a moth. The moth pupa does not move about at all. The pupa of the mosquito swims a little, but is much less active than either the wriggler or the adult mosquito.

It requires but two or three days for the pupa to become an adult mosquito, full-grown, and ready to buzz with its fellows. The females immediately hunt a place to lay their eggs, which in a week may develop into another generation of adult mosquitoes. Do you wonder that there are so many of these insect pests?

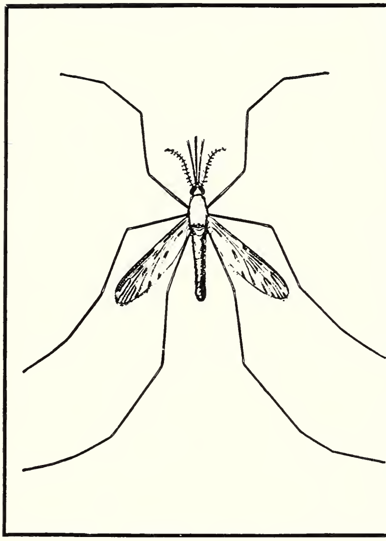
Disease-Carrying Mosquitoes

In 1897, two English physicians, Dr. Ronald Ross and Sir Patrick Manson, proved that malaria germs were carried by mosquitoes. In the Roman Campagna in Italy, a region filled with malaria, they lived from July to October in a screened house completely protected from mosquitoes. Neither contracted the disease. Then they sent mosquitoes that had been allowed to suck the blood of malaria patients to England, where two young men submitted to their bites. Both developed malaria.

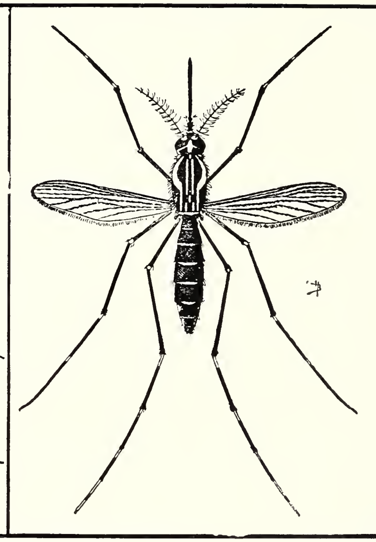
Similarly, the conquest of yellow fever is a tale of heroic sacrifice. In 1898, when the United States took charge of Cuba, this disease was raging in Havana. Dr. Walter Reed, a United States Army surgeon, and a corps of scientists, were sent to Havana to study the situation. These men, suspecting that the yellow-fever germs, like the malarial germs, were carried by mosquitoes, conducted an experiment to find out whether their suspicions were true. Some of them lived in close contact with the patients, even sleeping in the same room with them, but all the time carefully protected from mosquitoes. Others submitted to being bitten by mosquitoes that had sucked blood from the yellow-fever patients. The experiment proved beyond a doubt that yellow fever is contracted, not from direct contact with the patient, nor by breathing the air which he has breathed, but from the bite of a mosquito, a different species from either the common house mosquito or the malarial mosquito. Dr. James W. Lazear, who submitted to the bite of one of the mosquitoes, lost his life in the experiment. The world owes much to the brave men who made this study. On the tablet marking the grave of Dr. Walter Reed is the inscription: "He gave to man control over that dreadful scourge, yellow fever."

The sick in Havana were moved to screened hospitals, and war was declared upon the mosquitoes. Their breeding places were drained or covored with oil, and Havana became one of the most healthful cities in the world.

The terrible loss of life from malaria and yellow fever made early attempts at building the Panama Canal very difficult. When the United States de-



MALARIAL MOSQUITO.



YELLOW-FEVER MOSQUITO.

cided to undertake the task, it profited by the experiences of other countries, who had tried it and failed, and planned to rid the Canal Zone of disease so that men could work there safely. Surgeon General W. C. Gorgas was chosen to head a sanitary commission selected for this task. For almost two years before the engineering work was started, the Zone was in their charge. Their campaign against malaria and yellow fever, which succeeded in making the fever-haunted Canal Zone a healthful spot in which to live, was largely a fight against the two species of mosquitoes that carry the germs of the fevers. Pure water supplies were provided, stagnant water was drained off, and every possible breeding place for mosquitoes was destroyed. "A single buzz will bring a half-dozen sanitary police," wrote a visitor in the Zone while the work was under way.

In this picture you see two kinds of mosquitoes. One is the malarial mosquito, and the other is the yellow-fever mosquito. As you see, they are all quite similar in appearance, but the malarial mosquito can be recognized by the black spots on its wings and by the position of its body when at rest. Notice that the common house mosquito holds its body parallel with the surface upon which it is resting, whereas the malarial mosquito's body is tilted upward from the surface. The yellow-fever mosquito is smaller than either of the other two species and has light bands around its body and on its legs.

The malarial mosquito is found east of the Rocky Mountains from Canada southward, but it is much more abundant in the warmer regions of the south than it is in the north. The yellow-fever mosquito is never found north of the latitude of Memphis, Tennessee.

The eggs of these two disease-carrying mosquitoes do not cling together in masses on the surface of the water as do those of the common house mosquito. Each egg is deposited singly. The steps in the life history of the three species, however, are almost the same.

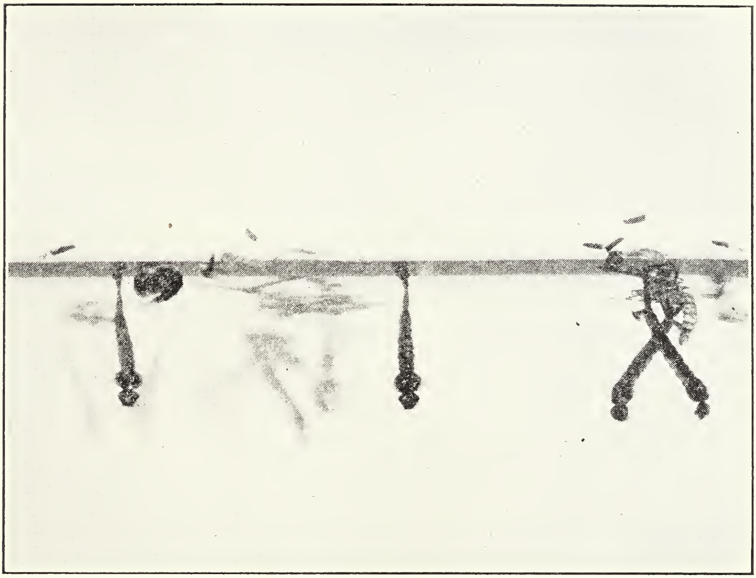
The germ that causes malaria is a tiny animal, made up of just one cell. We call single-celled animals, *protozoa*. When these protozoa get into the body, they enter the red corpuscles of the blood. There each one grows and divides into many parts which in turn become new germs. As the corpuscles are filled with germs, they burst, and the germs enter other corpuscles.

When a malarial mosquito sucks blood from a person having malaria, the protozoa enter its stomach. They live there for about twelve days. Then they pass through the mosquito's stomach walls and get into its saliva. When the mosquito bites another person, malarial germs will be poured into the wound with the saliva.

The germ causing yellow fever was not discovered until some years after people knew that it was being carried by the mosquito. It is a very small, spiral germ that wriggles and twists in the blood-stream of the patient. A vaccine has been developed to aid in the treatment of the disease, but the most effective way to fight either yellow fever or malaria is to make war upon the kinds of mosquitoes that carry the protozoa.

Control of Mosquitoes

From what you have already learned of the life history of the mosquito, you can readily understand that the most efficient means of getting rid of this insect pest is to destroy its breeding places. You have learned that the eggs are laid in standing water in pools and marshes, or even in buckets of water. In fact, mosquito eggs have been found in a puddle of water on a lawn in a large city. Of course, the wrigglers will be killed if the water dries up before they become adult mosquitoes. However, if the water remains until their life changes are complete,



Photograph from Publisher s Photo Service.

WRIGGLERS HAVE TINY TUBES THAT THEY PUSH ABOVE THE WATER TO GET AIR.

thousands of mosquitoes may come forth from even a small puddle.

Sometimes breeding places may be destroyed by drainage. Drainage on a large scale has been going on in New Jersey and California. Where this cannot be done, kerosene or oil may be poured on the water. You will remember that the wriggler has a tiny tube that it pushes up through the surface of the water to get air. When oil gets into this tube, the wriggler dies.

In small pools, goldfish or minnows will eat many wrigglers. Minnows have sometimes been placed in water where for some reason oil could not be used.

Certain birds and bats feed on mosquitoes. In camp, the smoke from a slowly burning fire will drive mosquitoes away, and nettings and veils may be used to screen them out.

In regions where malaria or yellow fever is common, windows and doors should be well screened in order to prevent the bites of germ-carrying mosquitoes that have survived in spite of all efforts to destroy them.

Even the mosquitoes that do not carry disease annoy us. Now that we know their life history, we are prepared to declare war upon them. We can win, too, if we continue our battle from year to year.

SOME THINGS TO THINK ABOUT

Pick out the correct ending for each sentence:

1. The male mosquito feeds on { nectar and juices of plants. / the blood of people. }

2. Mosquitoes lay their eggs { in the water. / on the bark of trees. }

3. Mosquito larvas live { on land. / in the water. }

4. Mosquitoes carry the germs of { typhoid fever. / malaria fever. }

5. The most effective way to control mosquitoes is { to catch them in traps. / to destroy their breeding places. }

6. The germ that causes malaria is { a tiny plant. / a tiny animal. }

SOME THINGS TO DO

Catch some mosquitoes and examine them with a hand lens or a reading glass. To which of the three species about which you have just read do the mosquitoes you have caught belong?

Place a pan of water outside on the windowsill, or in the back yard, and watch for mosquito eggs. You will have to look carefully to find them.

If you find the eggs, put them in a glass of water and watch for the wrigglers and pupas. Do not allow the adult mosquitoes that develop to fly away.

CHAPTER III

INSECTS OF THE HOUSEHOLD

1. Are ants helpful or harmful creatures? Why?
2. Have you ever been troubled by clothes moths?
3. Name as many insects as you can that live with us in our houses if we permit them to do so.

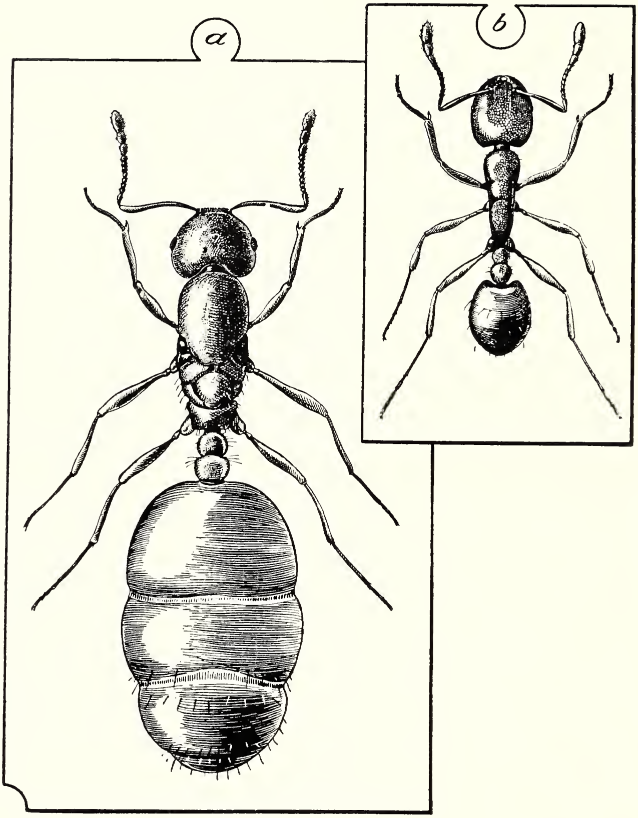
Ants

You may have learned to think of ants as most interesting insects because of the many striking facts about the social manner in which they live and work together. However, when they come into your home and get into your food, your problem is not to learn more about how they live, but how to get rid of them. Although they are comparatively harmless insects so far as your health is concerned, ants may become a great nuisance and may do considerable damage in your houses.

There are several widely known species of ants, of which the little red ant is perhaps the most common. These ants are not more than one-sixteenth of an inch in length. They make their homes in the walls of houses or under the floors; and so tiny are they that it is not difficult for them to creep through cracks or between boards into the pantry and kitchen. Although particularly fond of sweet things, such as jellies, cakes, sugar, syrup, fruit juices, and the like, there is scarcely a kind of food that will not attract them. Like other ants, they live in colonies, and have a very highly organized group life. When one of their number, out scouting for food, is successful in its hunt, it returns to the ant hill, and large numbers of ants start out immediately for the new food supply. This is merely the advance guard of a great army that seems, to the worried housekeeper, to be almost inexhaustible. She may sweep them away, poison them, drown them, scald them. She may kill them by the dozens and hundreds, but as long as the food remains, the ants will continue to come.

When these little red ants have entered a house, almost the only way to get rid of them is to discover and to destroy their nest. There the queen lives, and as long as she is allowed to live, she will lay eggs. The eggs will develop into new members of the ant community and they will take the places of the ones that have been killed. Once the nest is found, the colony can be destroyed by pouring carbon bisulphide or kerosene into it. The difficulty lies in reaching the nest. Sometimes it is necessary to take up a board in the floor of the house. Now this is a difficult task, but it probably can be accomplished. If the nest happens to be in the wall of the house, however, it may be impossible to reach it.

Another method of destroying the nest is to put a few drops of a poison solution such as antsol or borax and sugar on a small piece of bread or cake, which is placed where the ants will find it. They will carry the poisoned food to the nest for the queen and



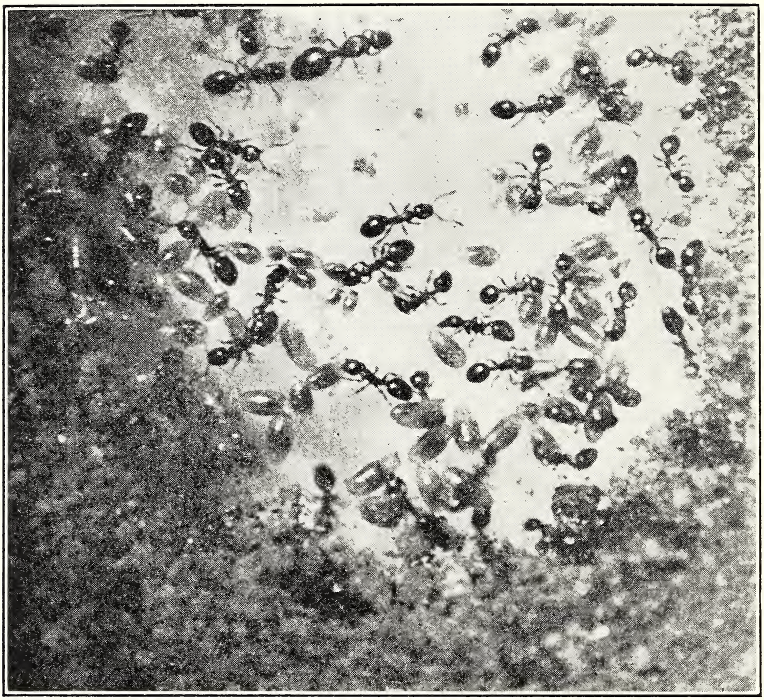
THESE ARE VERY MUCH ENLARGED DRAWINGS.
FEMALE (*a*) AND MALE (*b*) RED ANT.

young ants. Thus a colony may be destroyed easily. For the success of this plan it is necessary to keep other sweet foods so the ants cannot reach them.

If both these methods fail, it will be necessary to prevent the ants from getting at the food, or to kill them after they have come into the house. It is a good thing to keep the food that attracts them tightly covered, or to place it where they cannot get at it. Sometimes, where they are very annoying, the legs of the table holding the food are set into little pans filled with water and kerosene. Gum camphor, either loose or wrapped in paper, will sometimes keep ants from the pantry, but if the insects cannot find food in other places, they will come in spite of the camphor.

Borax and sugar are sometimes dissolved in boiling water, making a syrup. This is placed in dishes about the room. The ants are attracted to the syrup by the sugar in it, and when they eat it the borax poisons them. If small sponges, soaked with sweetened water, are scattered about, the ants will crawl into the pores. Two or three times a day the sponges may be placed in boiling water. Ants will usually continue to come to a place where many of them have been killed, but if, day after day, the workers are destroyed in large numbers, the colony will sometimes abandon a house and seek a new food supply.

The little black ant is almost as troublesome as the red ant, which it resembles closely, except in color. It builds its nest in the open, or under a large stone. You have surely, at some time in your lives, poked and scattered sandy little ant hills, just to see the ants scurry about in great excitement. You probably did less damage than you imagined, however, for these small pyramids of fine soil are only the protecting doorways to the ants' homes. The real nests are underground. In each nest live one or two females, or queens, as they are called, thousands of workers, and many soldiers which attempt to protect the col-



Photograph by Paul Griswold Howes.

UNDERGROUND IN THE ANTS' HOME LIVE ONE OR TWO QUEENS, THOUSANDS OF WORKERS, AND MANY SOLDIERS.

The large ant near the top of the picture is the queen. The workers are caring for the larvas.

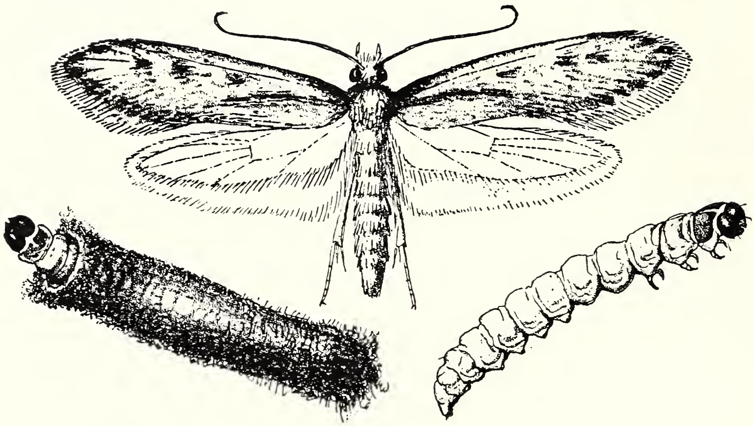
ony from enemies. These little black ants usually can be traced to their nests, which can be destroyed by pouring boiling water, carbon bisulphide, or kerosene, into them.

The pavement ant was brought into this country from Europe long ago. In Europe it lives in the meadows. In this country it makes its nest under pavements or large stones in the yard. It sometimes gets into houses, and may become as troublesome as the red ant. It is not hard to trace the pavement ant to its nest, however, which, unless entirely protected by the pavement, can be destroyed by the methods suggested for the homes of the black and the red ants.

Clothes Moths

A very few small holes will ruin a dress or a suit of clothes. If a careful watch for clothes moths is not kept, many a valuable woolen suit or dress, carefully put away in the closet in the spring, will come out in the fall full of tiny holes.

The three species of clothes moths common in this country are the case-making moth, the webbing kind, and the tapestry moth. The case-making moth lays its eggs in the spring on your woolen clothing. From these eggs hatch grayish-white caterpillars with light-brown heads. You know that the eggs of insects produce larva forms. These little caterpillars are larvas of the case-making moths, and begin at once to feed upon your dress or suit, and to make cases for themselves out of the lint. As they grow, they find it necessary to enlarge their cases. This they do in a very strange way. They slit the sides of the case and work in new material. This makes the case larger in diameter. When it needs to be lengthened, the larva repeats the process, doing its work at the ends of the case, rather than at the sides. If the larva moves from time to time from cloth of one color to another, its case will show a varied pattern corresponding to the different colors of the materials in which it has been working. The



THIS SHOWS THE LARVA OF THE CASE-MAKING MOTH IN ITS CASE, THE LARVA ALONE, AND THE FULL-GROWN MOTH (MUCH ENLARGED)

method of enlargement will be clearly shown in these colors.

When the larva is full grown, it attaches itself either to the material upon which it has been feeding or to some other object, and goes through the pupa stage. This, you will no doubt remember, is the resting and growing period during which an insect develops from larva to adult. The case-making moth remains in the pupa stage for three weeks, and many wonderful changes occur in its body. At the end of the period, an adult moth crawls out of the case.

With wings expanded, this moth measures about one-half inch across. Its forewings are grayish yellow; its hindwings are white or gray. Its flight is unsteady, but it can run rapidly. In clothing, in the cracks of boxes, or in the corners of clothes closets, it lays its eggs—eggs so tiny they can be seen

WEBBING CLOTHES MOTHS AND LARVAS ON A WOOLEN COAT.

only with a magnifying glass. The life of the adult moth is short. It does not live long after its eggs are laid.

In the northern states, only one generation of case-making moths develops each year. The adult moths are seen from June to August. In the southern states, two or more generations develop in a year, and the adult moths are common from January to October. They are frequently seen flying about the lamps at night.

The webbing clothes moth is found in the latitude of New York and south to that of Washington, D. C. Its larva spins a cobwebby path wherever it goes. When full-grown, it makes a silken cocoon, sometimes cementing in bits of wool. From this point its life story is much the same as that of the case-making moth, and the adult moths of the two kinds are very similar in appearance. Two generations of the webbing moth are produced each year, even in the northern states.

The tapestry moth is larger than the other two kinds, and feeds on coarser, heavier materials, such as carpets, tapestries, and horse blankets. The adult measures about three-fourths of an inch across when its wings are expanded.

Clothing used from day to day is not likely to be damaged by the larvas of moths. It is the woolen material packed away in trunks and closets that is in danger. Most of you can probably think of some closet or chest at home, in which your mother stores "winter things." She hangs them in large paper bags, wraps them in newspapers, or packs them away in boxes, to prevent moths from laying eggs in them. Such storage places usually smell of tobacco, camphor, naphthalene balls, or cedar chips. These are used because moths do not like their odor. However, if the eggs are in the material before it is put away, the odors will not prevent the larvas from developing and eating the cloth. Eggs and larvas of the several kinds of clothes moths may be removed by frequently beating, shaking, or brushing material in the open air and sunlight.

Unused furniture upholstered with woolen cloth should be examined thoroughly and brushed at least once a month. If any traces of moths are found, it should be sprayed with naphtha. Care should be taken, however, not to use naphtha near a flame, for it is very inflammable.

Furs should be beaten and combed with steel combs to remove eggs and larvas, after which they may be packed in boxes lined with tar paper. Even when these precautions are taken, it is advisable to re-examine them every two to four weeks to make sure that no damage is being done. A still better method of protection is to keep furs in cold storage when they are not in use, for the larvas of clothes moths are not active in a temperature of 40 degrees or below.

It is not easy to prevent moths from attacking furs and woolens, but it can be done. The first step is to attempt to prevent the moth from laying its eggs on the material. The next is to remove the eggs and larvas of any adult moths which have managed to outwit you.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

The three species of ants described in this chapter are the .... ant, the .... and the ..... ant.

The three species of clothes moths described in the chapter are the .... moth, the .... moth, and the .... moth.

SOME THINGS TO DO

Make a collection of household insects. Mount them in an insect case and label them.

If possible, collect insects in the various stages of development—egg, larva, pupa, and adult.

Write to your State Department of Agriculture for a list of bulletins on household insects.

CHAPTER IV

PLANTS WITH QUEER HABITS

1. Do you know of plants that get their food from other living plants?
2. Can you name plants that live upon dead and decaying vegetable matter, making no food for themselves from air and sunshine, as green plants do?
3. Have you ever heard of a plant that eats insects?

The Dodder

In your recent rambles through woods or park, have you, by chance, noticed a long, almost colorless stem or plant that twists itself about grasses and low bushes like a tangled network of string? You may have caught your foot in the stem, and tripped; or you may have been forced to go around a group of bushes made impassable by the twining of this tough, cord-like plant. If so, you have met the dodder. The dodder has neither roots nor leaves like most other seed plants. Its slender stems cling to other plants by means of suckers, which enter the bark and steal life-giving juices. The dodder is a *parasite.* Plant parasites feed upon the living tissues of other plants. The plant that supports a parasite is called a *host* plant.

Because it steals its food in this way, the dodder has no need for green leaves. The leaf is the part of

Photograph by L. W. Brownell.

THE DODDER TWINES ITSELF ABOUT GRASSES AND LOW BUSHES.

the plant that usually makes the food. The *chlorophyll* (klō′rō-fĭl), which is the green coloring matter of the leaf, absorbs energy from the sunlight. The leaf also takes carbon dioxide from the air, and water is brought up to it from the roots. By means of the energy taken from the sunlight, the carbon dioxide and water are changed into plant food. In later chapters of this book you will learn more of the work of the green leaf.

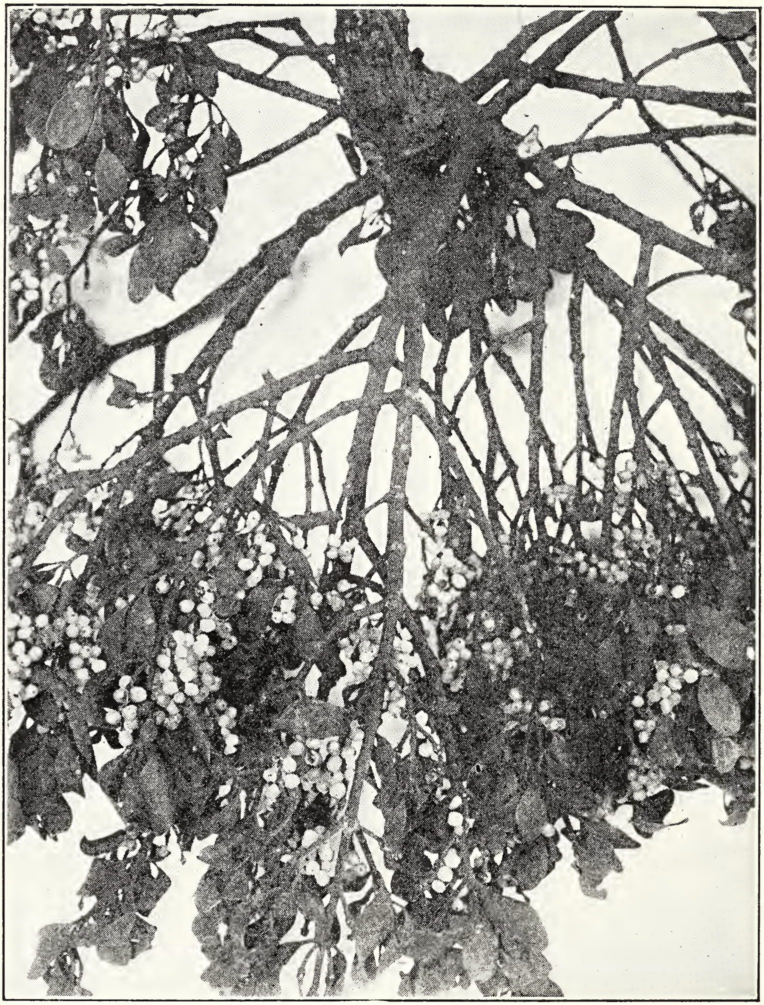
The dodder has no chlorophyll. Its stems are yellowish or reddish. Its small white flowers that you may see in the illustration above appear in the summer or in the autumn.

Many species of this strange plant are scattered over North America. Its twining stems are often so interwoven among other plants as to form a jungle through which it is hard to pass. So tough and flexible are these stems that they can be made to provide a temporary substitute for twine. You may be glad to use them some day in field or camp. The dodder injures or kills the plant upon which it feeds. Wherever it is found it should be destroyed, for it has no known value to warrant its being allowed to live and injure other plants.

The Mistletoe

The mistletoe, which brightens and cheers our homes at Christmas time, is also a parasite. From New Jersey to Ohio, Indiana, and Missouri, south to Florida, Texas, and New Mexico, it grows on walnut, red maple, oak, sour gum, and other trees. It is the state flower of Oklahoma.

There is an old Norse nature myth that explains how the Christmas custom of kissing under the mistletoe arose. The mother of Balder, the darling of the gods, put all living things except the mistletoe, which she thought too small and innocent to be dangerous, under a vow not to harm him. One of Balder's brothers was blind. Loki, who was jealous of Balder, gave this brother the mistletoe and told him



Photograph by L. W. Brownell.

MISTLETOE, WITH THICK GREEN LEAVES AND WHITE WAXY BERRIES, IS MUCH USED FOR CHRISTMAS DECORATIONS.

to throw it at Balder, just in fun. He did so, and Balder was killed. Since the mistletoe had not wished to kill Balder, it was not punished, but was given to the goddess of love, who ruled that whoever passed under it should receive a kiss as a token of love and not of vengeance.

Unlike the dodder, the mistletoe does not depend entirely upon its host for food. It has thick, fleshy, green leaves. The leaves have only about two hundred "breathing" pores to the square inch, which is not nearly so many as the average green plant has. This means that less carbon dioxide can be taken in, and the leaves therefore cannot manufacture as much plant food as can the average green leaf. However, the pores help to provide the plant with food.

The mistletoe has two kinds of greenish flowers. Some are pollen-bearing, and others seed-bearing. The seed-bearing flowers develop into small, fleshy, white berries. Birds eat the berries and scatter the seeds far and wide. Some seeds cling to the bark of trees and grow there. Rootlets enter the bark and grow inward to the *cambium,* the living layer of wood just beneath the bark, and get food from the tissues there.

Hanging gracefully from the branches of thousands of trees in southern United States, mistletoe adds greatly to the beauty of the southern forests. With its bright green leaves and white berries, it has become a traditional part of the Christmas decorations in innumerable homes. It may be gathered freely, for if it is allowed to grow unchecked, it injures the trees that serve as its hosts.

Indian Pipes and Beechdrops

Perhaps, in the dim woods during July or August, you have seen waxy white plants standing three to nine inches high beside decaying stumps or rotten logs, like ghosts in the shadows. They are Indian pipes—queer, uncanny little plants that get their living by means of small mold-like plants attached to their roots. Immediately after being picked, the Indian pipe begins to blacken, and a pressed specimen is entirely black.

A curious Indian legend is told of the Indian pipe. Wychonda, the daughter of a medicine man, wished her husband to be chosen chief of the tribe. To bring this about she stole a magic pipe, which brought them nothing but misfortune. After her husband's death, Wychonda confessed and was condemned to be burned. Her ashes were scattered to the four winds, and where they fell Indian pipes sprang up, miniatures of the ceremonial magic pipe, memorials of her offense, and warnings to wrong-doers.

The flower of the Indian pipe grows in a drooping position, with four to five oblong petals and ten to twelve stamens. The plant has no leaves and no chlorophyll, and so makes none of its food. It lives on the decayed bodies of other plants.

Plants that get their food from dead and decaying plant matter are called *saprophytes* (săp′rō-fīts), a word that comes from the Greek and means "rotten plant." Like plant parasites, saprophytes make none of their own food. The parasite gets its food

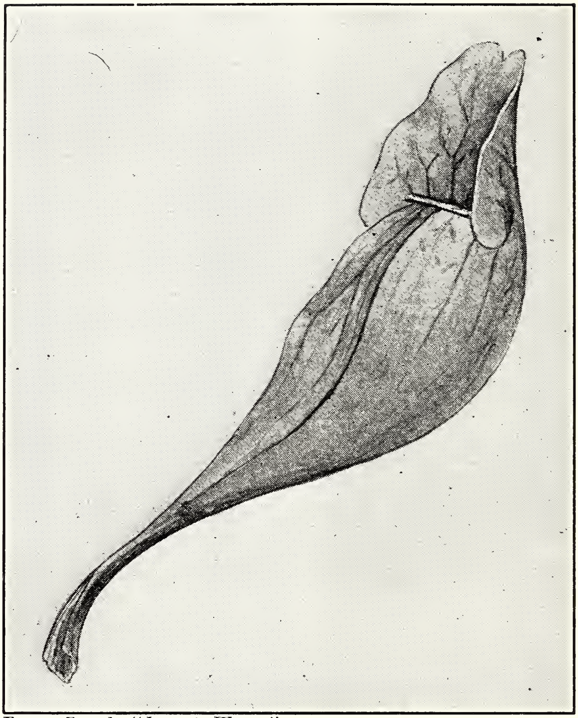
Photograph by L. W. Brownell.

INDIAN PIPES GET THEIR FOOD FROM DECAYING PLANTS.

from living plant tissues; the saprophyte gets its food from the tissues of dead plants.

False beechdrops, or pinesap, is another saprophyte. It is a member of the Indian pipe family, differing from the Indian pipe in its pale tan, lemon-yellow, or reddish color. Also, its stem bears more than one flower, whereas the Indian pipe has but one blossom. From three to ten of the vase-shaped flowers of the false beechdrop appear on a stem. They are smaller than the flowers of the Indian pipe, and they may be slightly fragrant.

False beechdrops grow in woods where there is an abundance of leaf mold. They are most often found under oak, pine, or fir trees. Both these plants and the Indian pipes give a real thrill to



From Weed, "Insect Ways."

THE STEM AND LEAF OF THE PITCHER PLANT FORM A DEEP HOLLOW PITCHER WITH A LIP.

the person who finds them. They do no harm, and should not be picked, but should be allowed to remain where they grow so that they may spread their seeds and increase in number.

Insect-Eating Plants

Does it seem strange to you that some plants catch and eat insects?

The pitcher plant and the sundew grow where the

WHEN THE PITCHER PLANT IS IN BLOOM, IT IS A PARTICULARLY BEAUTIFUL PLANT.

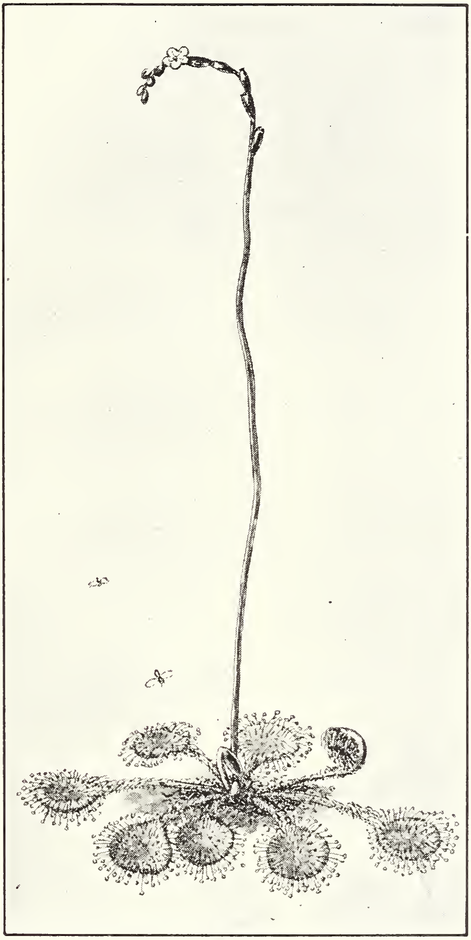
soil is moist and where insects live in large numbers. Both of these plants are excellent natural traps for insects.

In the pitcher plant, the *petiole* (pĕt′ĭ-ōl), or leaf stem, has grown into a tube. This tube, with the blade of the leaf, forms a deep hollow pitcher with a lip or spout. Inside the pitcher's rim is a fluid that attracts insects to a fatal feast. The victims find it very easy to climb over the rim of the pitcher and reach the fluid. Inside the pitcher there is a band of stiff hairs pointing downward. These hairs make entrance to the trap easy, but escape almost impossible. Walking on the smooth inner surface below the hairs is difficult, and the trapped insect soon falls into the fluid at the bottom of the pitcher. When the wings are wet, the struggle to get out becomes more difficult, and, after a few vain attempts, the victim sinks exhausted into a watery grave. The pitcher plant usually holds a considerable number of drowned insects, which it digests by means of this same fluid, and then absorbs into the pitcher walls.

There are two species of pitcher plants. One is found in peat bogs from Labrador westward to the Canadian Rockies, and in Pennsylvania, Florida, Kentucky, and Iowa. This species is also called the sidesaddle flower, huntsman's cup, Indian cup or pitcher, flytrap, and meadow or fever cup. It blossoms in May or June, bearing a single, nodding, deep purple, or occasionally yellow, flower two inches or more in diameter.

The other species is found in bogs from Virginia and North Carolina to Florida, and west to Louisiana. It is sometimes called the trumpet-leaf or water-cup.

These beautiful and interesting plants are very rare, and they should never be pulled up by the roots or destroyed. In addition to their beauty and their



From Weed, "Insect Ways."

THE LEAVES OF THE SUNDEW CLOSE ON THE INSECTS AND HOLD THEM FAST.

interesting life habits, the various kinds of pitcher plants are very useful, doing much good by their destruction of insects.

The sundews are bog or swamp plants with sticky, hairy leaves coated with a sweet, sticky "dew" that tempts insects. Charles Darwin wrote that he thought the Venus-flytrap, which belongs to the sundew family, the most wonderful plant in the world.

On the surface of each leaf grow three or more fine, tapering, bristles. When these bristles are touched ever so lightly, the leaf closes, and the little spikes with which the leaf is edged interlace firmly. When an insect, attracted by the sticky fluid, or "dew," lights on the leaf, and touches the hairs, it is held fast in the sticky fluid while the leaf closes. The spikes on the edges of the leaf interlace and hold the prisoner fast, its struggles to escape merely causing the leaf to close more firmly.

The plant then digests its victim. Small gnats are digested in two days; a longer time is required for larger insects. When one insect is digested, the leaf opens and the trap is ready for the next victim.

Sundews are beautiful plants. The round leaves, with their long, fine, red hairs have long stems, and lie flat on the ground or at least close to the ground. Often they are under our feet before we see them. They are like bits of glorious sunshine on the damp earth. As the name suggests, they brighten the dark bogs where they grow.

The flower stem is red and stands up very straight. In July or August each stem bears from one to twenty-five small flowers, the petals of which are white or varying shades of red. The petals are five in number. The blossoms open in the sunlight.

There are a number of kinds of sundews. They grow in bogs of wet sand from Newfoundland and Labrador to Alaska, and south to Florida. They are also found in the Rocky Mountains, the Sierra Nevadas, the Catskills, and in the mountains of Pennsylvania. They differ in the shape of their leaves. The round-leaved sundew is often called the dew-plant or eyebright.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. Plant ..... feed upon the living tissues of other plants.
2. ..... is the green coloring matter in leaves.
3. ..... and ..... are plant parasites.
4. ..... are plants which feed upon the decayed bodies of other plants.
5. Two such plants are the ..... and the ......
6. The ..... plant and the ..... are insect-eating plants.

SOME THINGS TO DO

Find out more about the interesting plants that are described in this chapter. If you have a school library, you may be able to find some interesting facts in books. The following books will help you, and perhaps your librarian or your teacher will suggest others:

Familiar Flowers, F. Schuyler Mathews (D. Appleton & Co., illustrated, $2.00).

The Book of Plants, Parker and Cowles (Houghton Mifflin Co., $.88).

Fieldbook of American Wildflowers, F. Schuyler Mathews (G. P. Putnam's Sons, illustrated, $3.50).

It would be even better if you could find growing plants and write in your notebook any additional facts which you may observe.

Write in your notebook a definition of a plant parasite, and give two or more examples.

Write a definition of a saprophyte, and give two examples.

CHAPTER V

NUT TREES OF THE FOREST

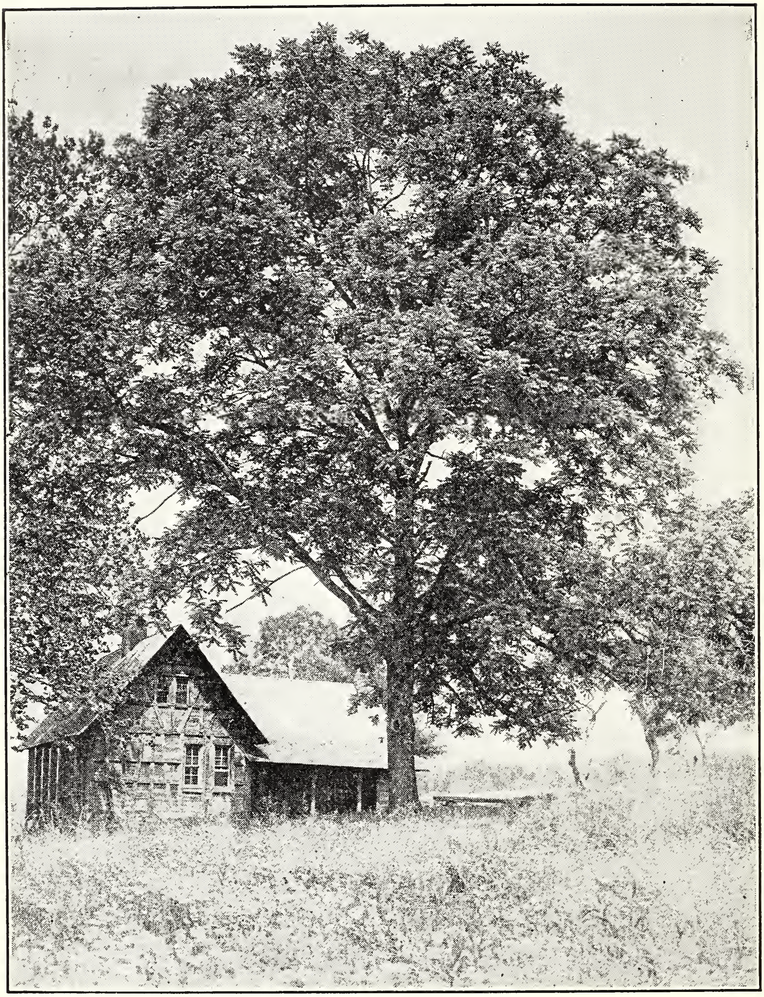
1. Have you ever gone into the woods to gather nuts?
2. What kinds did you get?
3. Have you seen squirrels, chipmunks, or other animals gathering nuts?

If you have walnut, butternut, or hickory trees near your home, you probably know what fun it is to go nutting in the autumn, gathering nuts to crack and eat on long winter evenings. These trees are found scattered through the woodlands of the eastern part of the United States, and wherever they grow, boys and girls, after the first autumn frosts, sally forth with their bags and baskets to gather the nuts.

Squirrels and chipmunks gather nuts, too, and store them away for their winter's food. They hide them in hollow trees and in all sorts of odd places, sometimes forgetting where they have put them.

The Black Walnut

The black walnut is truly a majestic tree. In the valley of the Ohio River, black walnut trees have reached a height of one hundred and fifty feet, with trunks eight feet in diameter. These great trees



Courtesy of U. S. Forest Service.

THE BLACK WALNUT IS TRULY A MAJESTIC TREE.

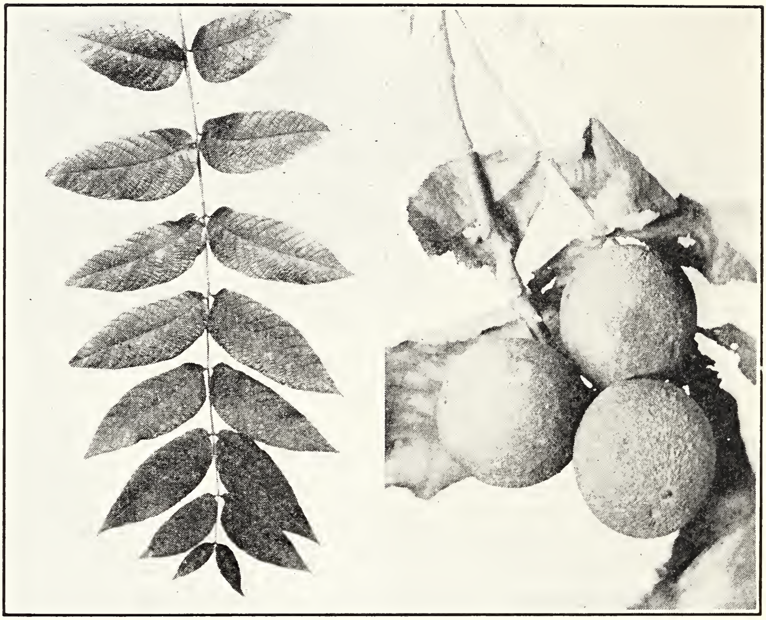
furnished the lumber from which so much of the fine furniture of the last century was made.

Black walnut is a rich, dark-brown, hard wood. It is very durable, and is in great demand for gunstocks, musical instruments, automobiles, and sewing machines. It is still very highly prized by furniture-makers, but it is hard to obtain, because the young trees, as well as those that were mature, have been cut down. This was indeed a short-sighted policy, for the walnut is a slow-growing tree. It requires almost a century to reach its largest growth.

Black walnuts are inclosed in thick green husks, which turn black after frost. These husks, when bruised have a very strong and peculiar odor. The nuts fall from the tree after the first frost in the fall. When they are gathered, the husks are removed, and the nuts are spread out to dry. Often they are kept in the attic. What fun it is to bring them down on cold winter evenings and crack them! The brown shells are hard and rough, but with an old flatiron or a smooth stone for a base, they can be cracked with a hammer, and the kernels are surely delicious.

Wherever black-walnut trees will grow, some nuts should be planted each autumn so that this valuable tree will not disappear from our forests. When these nuts are put into the ground in the autumn, the hard shells are broken by freezing, but the kernel is so well protected that the young plant is not killed. In the spring, the young tree will come up. It is best to plant the nuts right where the grown trees are wanted because long *taproots,* or main roots, develop during the first year, making the seedlings difficult to transplant successfully.

The leaves are *compound,* that is, they are made



Photographs by L. W. Brownell.

BLACK-WALNUT LEAVES ARE COMPOUND. THE NUTS ARE INCLOSED IN THICK HUSKS.

up of several parts. They have from fifteen to twenty-three leaflets on a stem, and often grow to a length of twelve inches. The leaflets are *sessile* (sĕs′ĭl), or attached directly by the base, without stem or petiole; and they have finely toothed margins. When crushed, they have an odor similar to that of the husk on the nut.

The black walnut is not a good ornamental tree, because its leaves appear very late in the spring, and they fall very early in the autumn. Then, too, its flowers are catkins, long, soft, and caterpillar-like, and they fall off during the summer months.

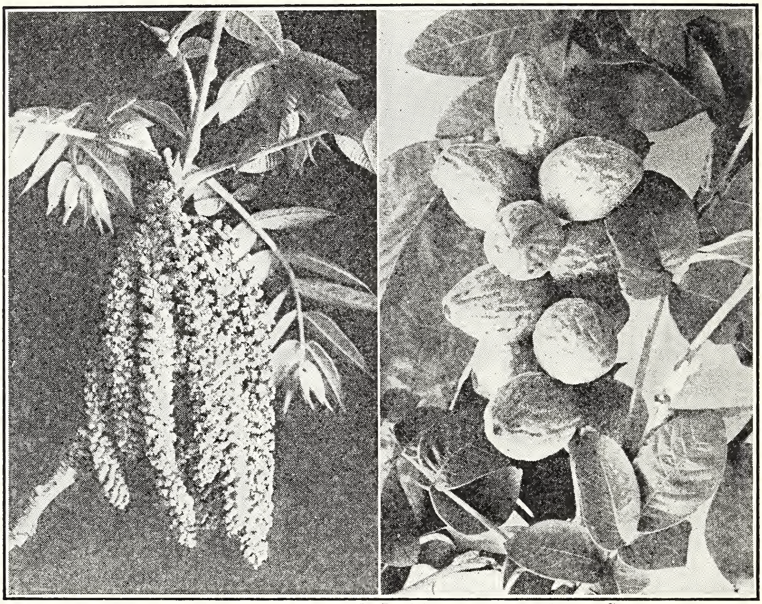
Photograph by Verne Morton.

LIKE THE BLACK WALNUT, THE BUTTERNUT HAS WIDE SPREADING BRANCHES AND COMPOUND LEAVES.

The Butternut

The butternut, like the black walnut, has wide spreading branches and large compound leaves. Each leaf has from nine to seventeen finely toothed leaflets.

The flowers appear just as the leaves are unfolding. Pollen-bearing and seed-bearing blossoms are found in separate groups on the same tree. The pollen-bearing blossoms grow in catkins that are often six inches long. Their pollen is scattered by the wind. The seed-bearing flowers grow singly or in groups of a few blossoms. They are green with strikingly colored stigmas. The stigma of a flower, you remember, is the part that receives the pollen



Photographs by L. W. Brownell and J. Horace McFarland Co.

THE CATKINS GROW IN GROUPS.

BUTTERNUT HUSKS ARE POINTED.

and makes the development of the seed possible.

Butternuts, like black walnuts, have hard shells and grow in husks. However, instead of being round, like the walnuts, they are long and pointed. The kernel is very good to eat. It has a flavor that is sometimes described as being smoky.

Butternut trees do not grow so large as the black walnuts, but they are found farther north and higher up on the mountain sides. They seldom reach a height of more than a hundred feet, and their trunks seldom exceed three feet in diameter. The wood is similar to walnut, and it, too, is used in house-finishing and cabinet-making.

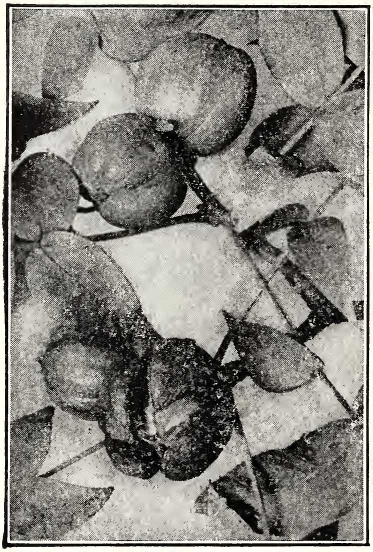
Butternut trees are best grown by planting the nuts right where the trees are wanted. The long taproot, which forms during the first year, makes transplanting difficult. They are not good ornamental trees. The leaves appear late in the spring, and they fall early in the autumn. The catkins fall off also. Even under the most favorable conditions, their branches often die. Sometimes the whole tree dies for no apparent reason before attaining its growth. The butternut, however, is valuable for its wood and for its annual crop of nuts, and some of the nuts should be planted each autumn in field and forest.

The Hickories

Several species of hickory trees are found in America. The shellbark, or shagbark, as it is sometimes called, is a tall, spreading tree that often grows to a height of seventy to ninety feet. It has been known to reach a height of 120 feet. Its size and its clear green foliage make it a tree of unusual beauty.

The gray bark is but loosely attached to the trunk, hanging in strips about a foot long and six inches wide, the ends of which curve away from the trunk. This loose bark gives the tree a shaggy appearance, which accounts for the name, *shagbark*. The younger branches are also gray, but they are smooth.

The leaves are compound. They have either five or seven sharp-toothed leaflets. The petiole is rough and somewhat enlarged at the base. Usually there



Photographs by L. W. Brownell, courtesy of "Nature Magazine."

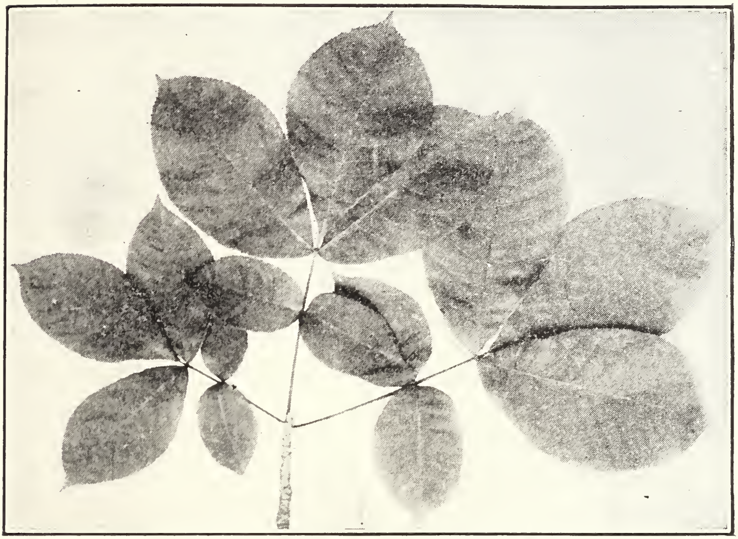
HICKORY NUTS GROW IN GREEN HUSKS.

THE SHAGBARK HICKORY HAS LONG PIECES OF LOOSE BARK.

are five leaflets, each of which is from four to six inches long. In color they are yellowish green.

Shellbark hickory nuts are only about half the size of black walnuts. They are round, slightly flattened at the sides, with hard, white shells. The nut grows in a thick, hard husk that splits into four separate sections. The large, sweet kernel of the nut is very delicious.

Hickory heart wood is light tan in color and the sap wood is nearly white. It is exceedingly tough and hard, and is used in the manufacture of agricultural implements, ax handles, and farm wagons. Some hickory nuts should be planted each year for the wood is in great demand and the trees are becoming scarce.



Photograph by L. W. Brownell, courtesy of "Nature Magazine."

HICKORY LEAVES ARE COMPOUND, USUALLY HAVING FIVE OR SEVEN LEAFLETS ON A STEM.

There is a rather rare species of hickory known as the large shellbark. It differs from the regular species in having seven, and occasionally nine, leaflets on each compound leaf. The strips of bark are narrow, and the young branches are somewhat orange-colored. The nut is considerably larger than the nut of the regular shellbark, being from one inch to two inches in diameter, and is usually pointed at both ends.

Other species of hickory trees get their names from the character of their nuts. There is the mockernut tree, which bears large thick-shelled nuts with small badly flavored kernels. The nuts of bitternut and pignut trees are extremely bitter. The small fruit hickory bears a small nut, not more than half an inch in diameter.

The pecan is the largest of the hickories, sometimes growing to a height of 170 feet. Its compound leaves have from nine to fifteen leaflets. The leaves have a warm, deep green color and are finely toothed, slender, and pointed. These trees are found growing wild in the rich soil near the streams of Iowa, Illinois, and Indiana, south of Louisiana and Texas. Orchards of selected varieties have been planted in many of the southern states. They grow rapidly and begin bearing in their ninth or tenth year.

These cultivated varieties bear nuts that grow to an inch or an inch and a half in length. They have very thin shells and are known in the market as paper-shell pecans. The pecan nut grows in a yellow, hairy husk, which splits into four sections almost to the base, discharging the nut. The husk remains on the tree throughout the winter.

It is hard to estimate the value of America's forests. Our trees are one of our greatest natural resources. The original forest wealth of the country was indeed tremendous. A great part of it has been thoughtlessly and wastefully used. You have read how the great walnut trees of the Ohio River valley were cut, and with them the young and growing trees that would have taken their places. The land was cleared for farming. We have now come to realize that the clearing of wooded lands will mean a shortage of lumber and other losses which you will read about in later chapters; and that tree-planting is an important service to the nation.

The Boy Scouts of America, realizing that our valuable black walnut trees were rapidly decreasing in number, have planted many memorial groves and trees, using as seed walnuts gathered from groves associated with the lives of Theodore Roosevelt, Robert E. Lee, and George Washington, thus making their tree-growing program a living tribute to these great Americans.

Wherever walnuts, butternuts, or hickories will grow, some nuts should be planted each year. Tree-planting, however, is not sufficient to insure the future of our forest trees. Woodlands must be protected from forest fires, from insects that destroy trees, and from diseases; in addition there should be a system of scientific forestry. There is a time in the life of a tree when it has attained its greatest growth and is ripe for the harvest. When a forest is cared for scientifically, only mature trees are cut. Such a woodland will yield an annual crop of wood because the cutting of mature trees makes room for the young ones to attain their growth, and some trees will mature each year.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. Walnut, butternut, and hickory trees are valuable for ..... and ......
2. They have ..... leaves.
3. There are ..... of these trees now than there were many years ago.

4. Black walnut trees have grown to be ..... feet high.
5. The ..... is the largest of the hickories.
6. If only ..... trees are cut, a forest will yield an annual crop of .....
7. The shagbark hickory tree has loose, gray ......

SOME THINGS TO DO

If walnut, butternut, or hickory trees grow in your neighborhood, bring a few nuts to school and plant them. Mark the place well so that you can watch for the little trees in the spring. Remember to plant them far enough apart so that each tree can grow to its full size.

If these trees do not grow in your community, describe in your notebook some of the valuable trees that do grow there. Perhaps you can find some pictures for illustrations.

CHAPTER VI

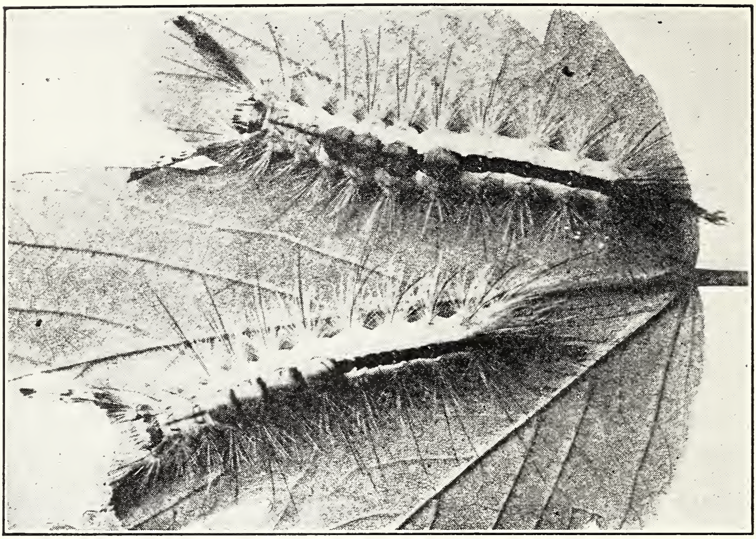
INSECTS THAT DESTROY TREES

1. Have you ever seen caterpillars feeding upon the leaves of trees?
2. Do these caterpillars injure the trees?
3. Why do people sometimes spray trees?

The greatest enemies of our trees are insects. Every autumn, insects of various kinds lay their eggs on forest, shade, or fruit trees. When the spring comes and the bright new leaves begin to open, these insect eggs begin to hatch. From the eggs emerge almost an army of insect larvas, or caterpillars, which begin at once to feed upon the fresh foliage. You have learned how important leaves are in the life of a plant, and can readily understand that these caterpillars do a great deal of harm.

You have probably never seen an adult tussock moth, for they seldom fly during the day. Their egg-masses, however, are frequently seen throughout the eastern part of the United States, where the moth is common. Masses of 300 to 500 eggs are found clinging to the cocoon from which the female moth has emerged. The cocoons are usually attached to the bark of forest or shade trees.

In the late summer or early autumn, almost immediately after she leaves her cocoon, the female moth deposits her eggs upon it, covering them with

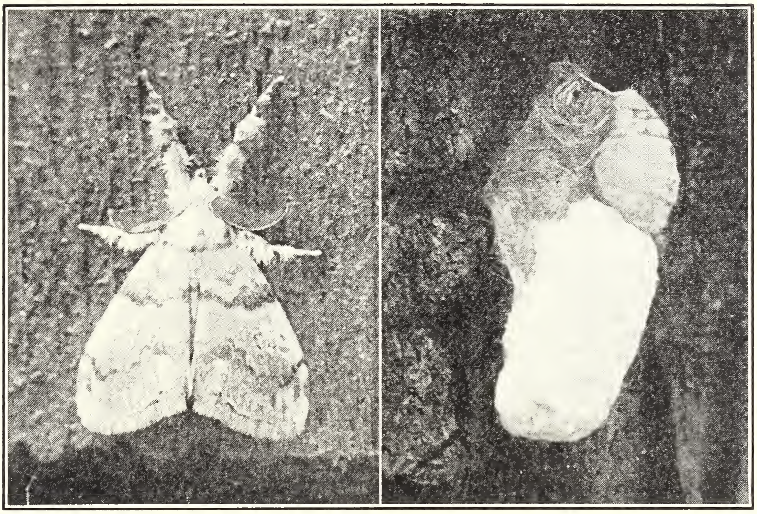


TUSSOCK CATERPILLARS ARE WHITE BANDED WITH BLACK.

a white froth that soon hardens. Thus protected, the eggs remain throughout the winter, and hatch in the spring when the leaves come out.

The tiny caterpillars that come from the eggs begin at once to feed upon the young green foliage of the trees. Their bodies are white, banded with black, and adorned with four tufts of cream-colored, black-tipped hairs standing upright on their backs, and a tuft of bright red on their heads. The young larvas are able to spin threads, by which they can lower themselves when disturbed and later regain their position in the tree.

The caterpillar grows rapidly until it reaches an inch in length. It then spins a cocoon of combined hairs and silk, attaching it to the bark of a tree or a twig. Inside this cocoon it lives during the pupa



Photographs by L. W. Brownell.

THE MALE TUSSOCK MOTH AT REST ON A TREE. THE FEMALE LAYING HER EGGS ON HER COCOON.

stage. During this period it develops into an adult moth that emerges in the late summer or early autumn.

Here are pictures of both the male and the female white-marked tussock moth. With outstretched wings, the male measures about one inch across. It lacks the bright colors that characterize so many species of moths. Its wings are gray with white spots. The female, as you see, is wingless, and travels about very little during her short life. She emerges from her cocoon, deposits her eggs on the outside of it, and dies a few hours later.

The best method of protecting trees from tussock moths is to gather the egg-masses in the autumn or winter. For each mass of eggs you are able to destroy, there will be from 300 to 500 fewer caterpillars devouring the leaves of the trees in the spring. By collecting and burning egg-masses, you may be able to save many valuable forest and shade trees from losing their leaves.

Spraying trees to destroy the tussock moth and other insect pests is becoming a very common method of protection. In the autumn a creosote solution is used that prevents the eggs from hatching. In the spring this is followed by treatment with various kinds of poison in order to kill any young caterpillars feeding upon the leaves. In some cities spraying of shade trees is done by a department of forestry. There are also individuals and companies that make a business of spraying trees on private grounds.

Have you ever seen a roll of sticky cotton tied around the trunk of a tree? It is a detour sign for female tussock moths and caterpillars, preventing them from crawling up the tree.

The Gypsy Moth

A few gypsy moths were brought into this country from Europe in 1866 to determine whether or not their larvas might prove valuable as silkworms. While the experiment was under way, several of the insects escaped into a near-by woods. The gypsy moth has now spread over the eastern part of the United States, and the descendants of those few moths have multiplied into so many thousands in the New England States, in New York, and in New

Photograph by Paul Griswold Howes.

THIS PICTURE SHOWS THE VARIOUS STAGES OF THE GYPSY MOTH.

Jersey, that larvas or caterpillars of these moths have become exceedingly destructive to the forest trees in those states.

The gypsy moth belongs to the tussock moth family. The male is brown, and is a little larger than the white-marked tussock. Like the female tussock, the female gypsy moth does not fly. She has wings, but her body seems too heavy for them. Her wings are white.

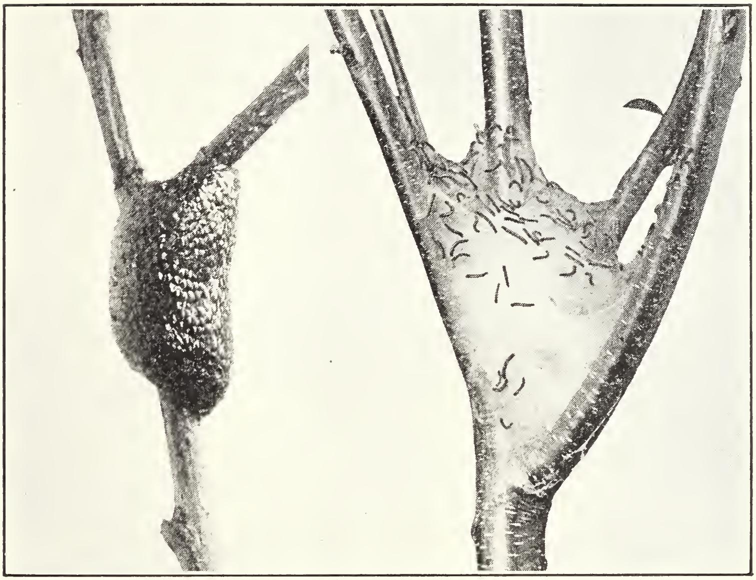
She lays her eggs in the late summer or early autumn, soon after she leaves her cocoon. In masses of 400 to 500, she deposits them on the trunks or limbs of trees, on stones, or other objects near the cocoon, for the female gypsy moth does not travel far.

In the spring the eggs hatch, and the young caterpillars begin at once to feed upon the bright green leaves of the trees. They will eat the leaves of almost every kind of forest tree.

Gypsy moths can be destroyed by the same method used for the white-marked tussock moths. The egg-masses or the cocoons may be gathered and destroyed, the tree sprayed with creosote before the eggs hatch, or the leaves sprayed with a poisonous solution after the caterpillars have hatched. Bands of sticky cloth or cotton will prevent the caterpillars and females from crawling up the trees.

Tent Caterpillars

Tent caterpillars are closely related to silkworms. Upon the branches and foliage of the trees these



Photographs by L. W. Brownell.

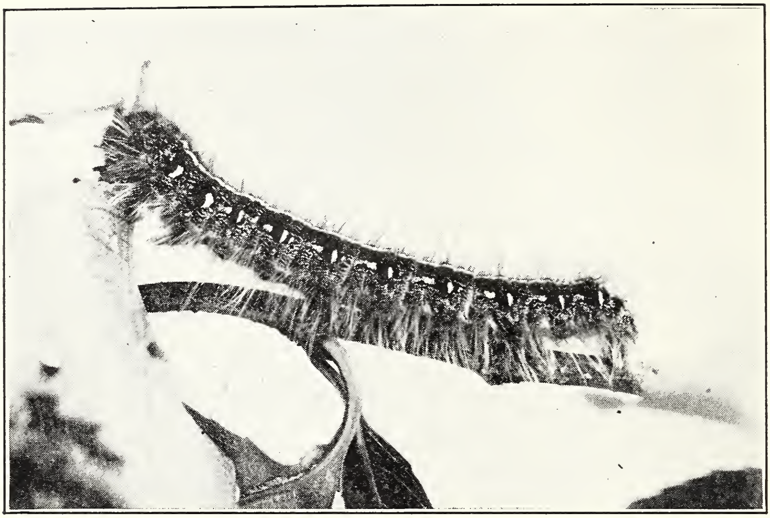
EGG-MASS OF THE TENT CATERPILLAR.

THE TENT HOME OF THE CATERPILLAR.

caterpillars spin large grayish white nests or tents of silk. From these they get their name.

In the autumn after the leaves have fallen from the trees, their ring-like egg-masses may be easily seen around the twigs of trees. Coated with a glue-like substance that serves as a protection against moisture and cold, they remain on the tree throughout the winter, hatching in the spring about the time the first buds open.

In a fork of the tree, not far from the egg-mass, the newly hatched caterpillars make their silken tent, which is enlarged as they grow. They feed upon the leaves nearest the tent, returning to it for shelter.



THE TENT CATERPILLAR IS BLACK WITH A WHITE STRIPE DOWN THE BACK.

The full-grown caterpillar is about two inches in length. Its body is black with a white stripe down the back, and is covered with yellow hairs of varying length. Along the sides are small, irregular, yellow streaks, and a row of oval, pale-blue spots.

In June, when the caterpillars reach their full size, they scatter in all directions. In sheltered spots, under loose boards or stones, or in fence corners, they spin about themselves spindle-shaped cocoons of white silk, and go into the pupal stage. This lasts from ten days to two weeks. The adult moths are of a dull reddish color, with two pale stripes near the middle of each forewing. With wings extended, the female measures about one and one-half inches, and the male measures about one inch across.

Although spraying will destroy many tent caterpillars, the most effective measures for their control are the collection of egg-masses, the burning of the tents with the young caterpillars in them, and the hunting of the cocoons.

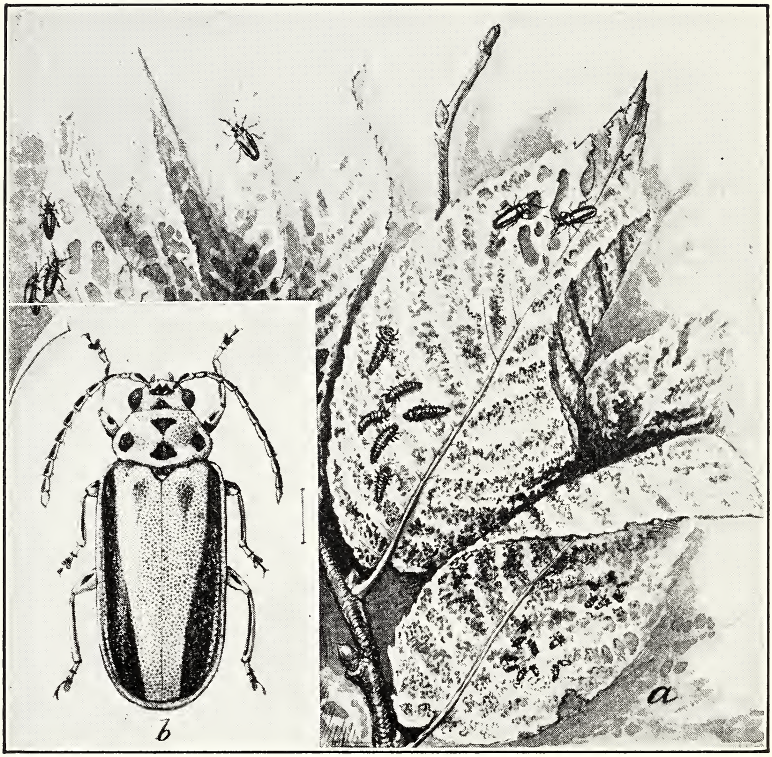
The Elm-Leaf Beetle

The elm-leaf beetle is another insect pest that was brought over from Europe. In 1838 it was found in large numbers in Baltimore. It has spread northward into the New England states, and westward to the Mississippi River.

In the picture you see the adult beetle. It is about one inch long and dull yellow in color. In some protected place, under a piece of bark or in the cracks of poles or houses, these beetles spend the winter. When spring comes, they fly to the elm trees to feed upon the leaves.

On the underside of a leaf this beetle lays from five to twenty-five orange-colored eggs, which hatch in about a week.

The small black grubs that come from the eggs feed upon the leaves of the tree and grow for several weeks, shedding their skins several times. Each time they shed their skins, or molt, they become lighter in color until finally, when full-grown, they are wholly yellow with three dark stripes. When they have reached their full size, they spin cocoons about themselves and go into the pupa stage, which lasts for three or four weeks. Then adult beetles emerge from the cocoon. So you see there are four



THE SMALL BLACK GRUBS FEED UPON THE LEAVES OF THE ELM.
INSET: THE ADULT BEETLE.

steps in the life of the elm-leaf beetle: the egg, the grub, the pupa, and the adult beetle.

Like the other insects you have studied in this chapter, the elm-leaf beetle can be destroyed by spraying. Since it lives and deposits its eggs on the underside of the leaf, the spray must reach this part of the leaf in order to kill the insect or prevent the eggs from hatching. Perhaps you have seen the spraying machine used for large trees. With such a machine, it is possible to reach either the under or the upper side of the leaves.

There are more than 200,000 known species of insects that injure trees. The damage is usually done by them when they are in the larva stage, for it is then that the insect needs large quantities of food. The larvas of the insects about which you have just read injure the trees by feeding upon their leaves. The larvas of certain other insects bore into tree trunks, destroying the cambium—the living and growing part of the trunk. Peach, apple, and other fruit-tree borers are common in our orchards. About the only method of destroying them is to probe in their holes with a wire or other sharp object, or to fill the holes with poison.

Then there are sucking insects, such as the oyster-shell scale or the San José scale, which suck the sap from the twigs and sometimes from the leaves, attaching themselves in the winter to the bark of the trees, under scale-like coverings from which they get their name. The sucking insects are more difficult to destroy than are the leaf-eating kinds. A spray to destroy the sucking insects must actually strike their bodies, and if any escape, they reproduce so rapidly that there are soon many of them.

There are insects, too, that attack the fruits of trees, and some which attack their roots. The coddling moth lays its eggs on the young apples just after the blossoms fall, and the larvas eat their way into the apples. To destroy coddling moths, trees must be sprayed about the time the blossoms fall.

You must not conclude, however, that all of the insects that live in the forest are harmful. In fact, there are some that are useful because they eat others that are harmful. Plant lice and scale insects are destroyed by the billion each year by lady-bird beetles. Indeed, the lady-bird beetles are considered so useful by fruit-growers that they are protected by them, and turned loose in large numbers at certain seasons of the year to feed upon harmful insects.

The birds are our greatest natural defenders from these insect enemies. It is said that if all the eggs laid by insects were to hatch, and the young grow to maturity, they could in one year destroy all the plants upon the earth's surface. How fortunate it is that insects are the main food supply of almost all of our common birds! The protection of insect-eating birds is an important step in the conservation of our forests and orchards.

SOME THINGS TO THINK ABOUT

Some of these sentences are true. Some of them are not true. On a piece of paper write the number of each sentence. If it is true, write *True* beside the number. If it is not true, write *False.*

1. The female white-marked tussock moth has no wings.
2. She deposits her eggs on her cocoon.
3. Adult tussock moths emerge from their cocoons in the spring.
4. The female gypsy moth has no wings.
5. The elm-leaf beetle lays its eggs on the undersides of leaves.

6. Tent caterpillars live in their tents through the winter.
7. Some insects damage trees by sucking the sap.
8. Some insects bore into the trunks of trees.
9. Lady-bird beetles are harmful to fruit trees.
10. Many birds eat insects that injure trees.

SOME THINGS TO DO

Hunt for the caterpillars, cocoons, and eggs, of the white-marked tussock moth, or of any other moths that are found in your neighborhood.

Make a collection of insects that injure the trees in your community. Collect eggs, cocoons, caterpillars, and adults if possible. Find out what can be done to destroy these insects.

Tie a roll of sticky cotton around a tree, and examine it a few days later.

CHAPTER VII

BIRDS OF PREY

1. What are birds of prey?
2. How are they fitted by nature to get their food?
3. Have you ever seen a hawk?

Birds of prey feed upon the flesh of other creatures. They are alert and fierce. Their eyes and ears are keen. Their beaks are sharply hooked and well fitted to tear the flesh of the captured victim. They move swiftly. Their wing muscles are strong, and their broad tails help them to change their course very swiftly.

Hawks are birds of prey. With their strong, sharp claws or talons, they seize their food, and hold it firmly while they tear it into pieces with their short, stout beaks. So fierce are they that a great hawk, the eagle, has been made the symbol of war.

The Sparrow Hawk

The most common member of the family, however, is the sparrow hawk, which is not much larger than a robin. You may know it by its long, pointed wings. The male bird has a back of reddish brown and black, wing feathers of blue-gray, tail of reddish

Photograph by Robert B. Rockwell.

SPARROW HAWKS FEED MOSTLY ON CRICKETS AND GRASSHOPPERS.

brown marked with black and white, and underparts of a rusty color spotted with black. The back, wings, and tail of the female are barred with reddish brown and black. Her underparts are white, streaked with reddish brown.

The sparrow hawk is a familiar roadside acquaintance throughout the greater part of the United States. Its sharp cry, "Killy, killy, killy," is often heard as it flies over the fields, or as it hovers over a spot where it sees something moving in the grass. It spends the winter in the southern states, migrating northward in February and March. In May, it builds a nest in a hollow tree, and in it lays from three to seven eggs, which are speckled with reddish brown.

In the summer sparrow hawks feed mostly upon crickets and grasshoppers. In winter they eat mice and other small mammals. When they come into town, they take shelter in the cornices, or eaves, and in other parts of buildings, often feeding upon the English sparrows whose nests they steal. From this habit they have received their name.

In some places these sparrow hawks are known as killy hawks. Sometimes they are called mouse hawks or rusty-crowned falcons.

Because some members of the family are chicken thieves, hawks have long been thought of as harmful birds. This is far from the truth, yet so generally was it once believed that some states have actually paid rewards for the killing of hawks.

It was the United States Department of Agriculture that finally learned the facts about the diet of the various kinds of hawks. They sent out a request that the stomachs of hawks that were killed be sent to them. The contents of thousands of stomachs were examined, and the examination proved that many species of hawks are among the farmer's best friends.

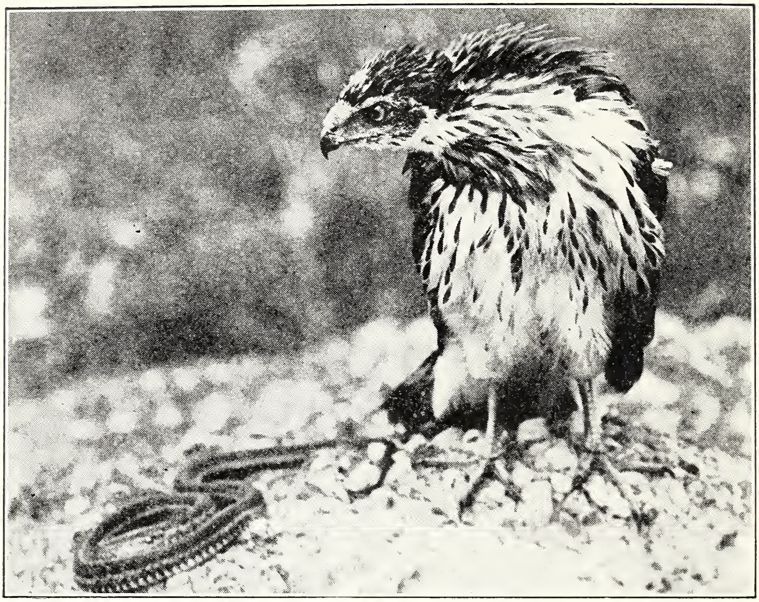
The red-shouldered and red-tailed hawks, which have for years been called chicken or hen hawks, very seldom visit the chicken yard. They feed usually on mice, grasshoppers, and similar pests. Poultry made up but 1 per cent of the food found in the stomachs of the red-shouldered, and but 10 per cent of the food of the red-tailed hawks. The marsh hawk, too, lives mainly upon rodents and insects. For the occasional chicken which they take, these hawks pay well by eating crop-destroying mice and insects.

The Red-Shouldered Hawk

If you live in Eastern North America, you have no doubt heard the call of the red-shouldered hawk. "Kee-you, kee-you," it cries as it circles about, high in the air. From northern Florida to Canada, this hawk is a permanent resident, living both in the woods and in open places.

The red-shoulder is a medium-sized, heavy-bodied bird. Its wings, when closed, reach almost to the tip of its tail. The adult bird has reddish-brown underparts and a black and white barred tail. The underparts of the younger birds are streaked with black, and their tails are gray-brown. Both the adults and the younger birds have upper wings of a rich chestnut color. From these they get their name—the red-shouldered hawk.

High in a tree, some thirty or forty feet from the ground, the red-shoulder builds a nest of sticks and twigs, lining it with moss, cedar bark, or other soft material. Sometimes the same nest is used year after year. Early in April three to five eggs are laid. They are white with brown spots, and are about the size of hen's eggs. The young red-shoulders, when hatched, are covered with white down. They are very helpless and stay in the nest until grown.



Photograph by Lynwood M. Chace.
THE RED-TAILED HAWK GETS ITS NAME FROM ITS REDDISH-BROWN TAIL.

The Red-Tailed Hawk

The red-tailed hawk is larger than the red-shoulder. Its wings, too, when they are closed, reach nearly to the end of its tail, which is a bright reddish brown with a narrow black band near the tip. It is by their red tails, from which they get their name, that we can tell this hawk from other kinds of hawks.

Like the red-shoulder, it is found throughout eastern North America. If you live in that part of the country, you have no doubt seen the red-tail and have heard its long-drawn, squealing whistle, which is quite unlike the note of the red-shoulder. Its favorite perch is the limb of a dead tree in the fields.

The red-tail builds its nest in a tree, some thirty or forty feet from the ground, and in April it lays from two to four eggs. They are dull white in color with brown spots.

Other Members of the Hawk Family

The marsh hawk flies low over the fields and marshes of eastern North America. You may have seen one watching a meadow mouse in the grass, turning sharply as it followed the movements of the little creature, and finally swooping down upon it. Usually it is silent, but in the mating season it occasionally utters a screeching note.

You can tell the marsh hawk from other species by its white tail feathers, which show clearly as it flies. It builds its nest on the ground in the marshes, and in May it lays from four to six white eggs.

The Cooper's and the sharp-shinned hawks are the real bird-killers. They are not often seen, for they avoid open fields, slipping quietly into the woods with their prey. The sharp-shinned hawk is not much larger than a sparrow hawk, and so can seize only very small or young chickens, but it eats many song birds. The Cooper's hawk is larger. It is the real chicken hawk.

Although it is not large, the sharp-shinned hawk is very fierce. Through the thick branches of trees and bushes, it dashes after its victims. It has a longer tail and shorter wings than the sparrow hawk,

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THE COOPER'S HAWK IS VERY FIERCE AND IS THE REAL BIRD-KILLER.

and its body is more slender. The sharp-shin hunts silently, but sometimes when we approach its nest, we hear its low cackling call.

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A YOUNG COOPER'S HAWK AND A GARTER SNAKE.

It builds a nest of sticks and twigs in a tree in the woods, usually from fifteen to forty feet from the ground. From three to six bluish white or cream-colored eggs are laid in May.

The Cooper's hawk is the real chicken hawk. Sometimes it is called the blue-darter or the bullet hawk. It shoots rapidly through the air and plunges down upon its prey. The adult is slate-blue in color. Unlike most other birds, the female hawk is larger than the male. The male Cooper's hawk is about the size of the female sharp-shin; the female Cooper's hawk is several inches longer. It is able to carry away a good-sized chicken. When these hawks have once found a chicken yard, they are apt to return to it again and again.

Like the sharp-shin, the Cooper's hawk nests in a tree some distance from the ground. Its bluish-white eggs are laid in late April or early May.

No longer does any state pay a reward for the killing of hawks. Instead, some kinds are protected by law. Since it is so difficult to tell one kind of hawk from another in the distance, a good rule to follow is to kill only the ones that are actually seen visiting the chicken yard, or killing other valuable birds; for if many hawks are killed, it is very certain that there will be an increase in the number of harmful mice and insects.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. The sparrow hawk is about the size of a ......
2. Its call is ....., ..., ...
3. The red-shouldered hawk feeds usually upon ..... and ......
4. The ..... hawk is the real chicken hawk.
5. The ..... hawk builds its home on the ground.

SOME THINGS TO DO

List the names of all the species of hawks that you know about, and opposite each, write how you can tell it from other species.

Watch for hawks in your neighborhood. If you see one, describe it in your notebook, telling where it was seen and what it was doing.

If you have an opportunity to visit a museum, study specimens of the different species of hawks.

Collect pictures of the different kinds of hawks for your notebook. Label them, as to species, if you can.

CHAPTER VIII

NIGHT-FLYING BIRDS OF PREY

1. Have you ever heard an owl?
2. Have you ever seen one?
3. Why are owls more often heard than seen?

The owl family, like the hawks, are birds of prey, but they are night-flyers. With their large, keen eyes they can see their prey in the darkness. With their soft, fluffy feathers they swoop down silently without warning. Soft fringes on their wing feathers "cushion the stroke upon the air." As the wing is raised, the feathers part to allow the air to pass through, thus lessening the resistance of the air to flight. On the downward stroke, these spaces between the feathers are closed tightly, lending force to the wing stroke. Such wings are a great help in swooping down and in rising quickly.

"Who, hoo-hoo-hoo, whooo, whooo," cries the great horned owl. Its deep voice, a little like the bark of a distant dog, can be heard for a half-mile. Sometimes, however, it utters instead a wild piercing scream, which sends chills over the listener who does not know the voices of the night.

Owls, being night-flyers, are more often heard than seen, yet their general appearance is familiar to most people. Their great round eyes, surrounded by a circle of stiff feathers, give a very solemn look

Photograph by H. Armstrong Roberts.

FROM THE FEATHER TUFTS ON ITS HEAD, THE GREAT HORNED OWL GETS ITS NAME.

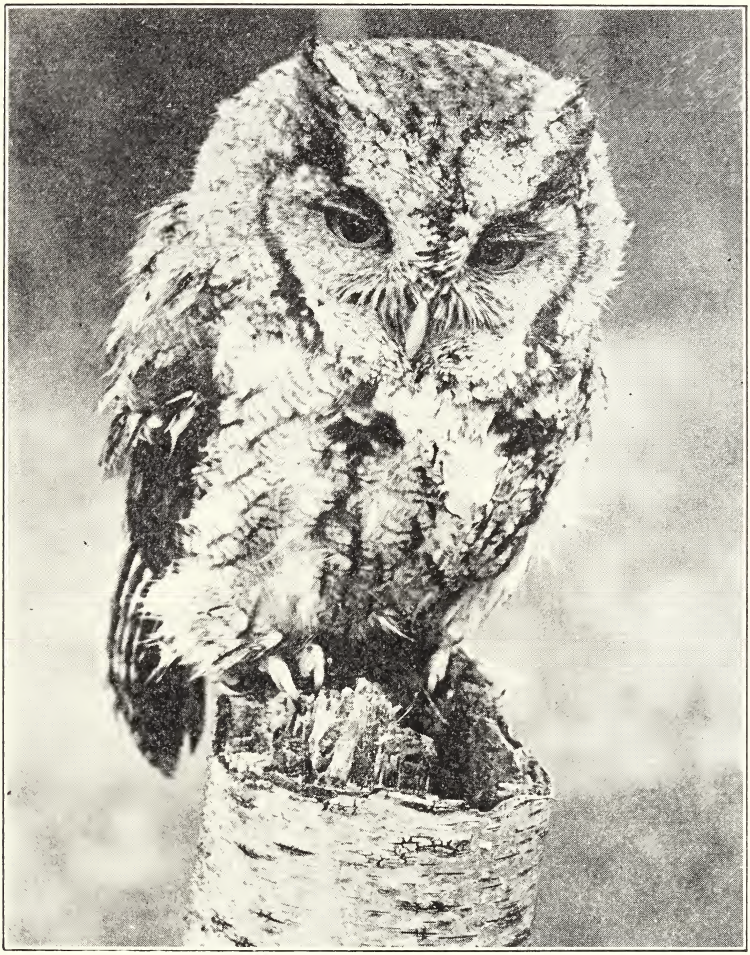
to the members of this family. They have long talons, sharp and curved, and their fourth toe can be turned backward or forward at will. When perching, the owl grasps its support, parrot fashion, two toes turned forward and two turned backward.

The great horned owl is the largest of the horned owls, which are so called because of the great feather tufts that grow on their heads. This great owl grows sometimes to a length of two feet. It is found only in the wilder and more heavily wooded parts of the country. As the trees are cut down, it disappears, and so, as the country becomes more thickly settled, these owls become scarcer. They feed upon rabbits, skunks, game birds, and other prey.

The great horned owl never builds a nest of its own. It prefers to help itself to one that has been abandoned by a hawk, a squirrel, or a crow.

The short-eared owl is a marsh owl, nesting in the grasses. Although it is a horned owl, its ear tufts are so small they can barely be seen. In almost every country of the world you can hear its cry, which is almost like the "ki-ki" of a small dog. In the dusk, and occasionally in the daytime, it may be seen flying low over the marshes in search of the meadow mice upon which it feeds. Its feathers are yellowish brown; its eyes are yellow. In this country, it nests from Virginia northward, and winters from New Jersey southward.

Commonest and smallest of the horned owls is the screech owl. Its tremulous wailing whistle is one of the best known twilight bird notes. In almost every part of the United States, these queer little creatures make their homes in hollow trees, boxes, or even in holes in houses. On first sight, as we see them sitting hunched up with "ears" pointed forward and



Photograph by Lynwood M. Chace.

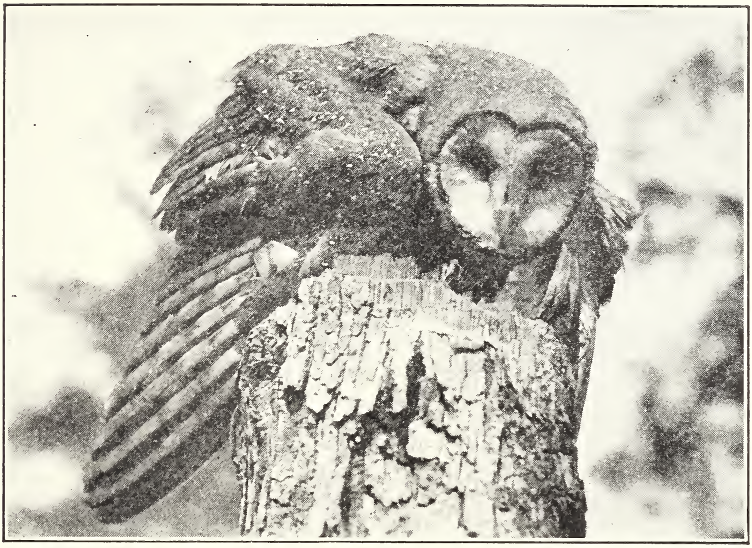
COMMONEST AND SMALLEST OF THE HORNED OWLS IS THE SCREECH OWL.

big yellow eyes glaring, they look like feathered cats. Since they live on mice, grubs, and insects, we are very fortunate when they make their homes near us.

In April the screech owl lays from four to six white eggs. The young owls are fed in the nest for about two weeks. Then they emerge to make their way in the world. With their soft downy feathers, lightly barred with black, they are quite unlike the parent birds, some of which are gray and some a reddish brown. This difference in color among adult screech owls has no relation to sex, age, or season, all colors sometimes occurring in the same brood. Its cause has never been learned.

Unlike the hawks, the owls do not usually hold their prey in their claws and tear it to pieces with their beaks before eating it. Instead, they swallow it whole. In its digestion, the bones, hair, and other indigestible parts, form oblong wads that are thrown out from the mouth. Hundreds of these pellets may often be found under an owl's perch. Examination of them tells us far more about the nature of the food that has been eaten than we could learn from looking at the inside of the bird's stomach. The pellets give us a record, not of one meal, but of many. It requires an expert, however, to identify all the little bones that will be found hidden in the hair. One examination of 200 pellets revealed the bones of 444 little mammals.

The barn owl lives in barns, in abandoned houses, or in church steeples. It is so light-colored that it looks almost white in the dusk. The rings of feathers around its eyes appear to set off its face from the rest of its body, giving it a monkey-like look that has earned for it the name, "monkey-faced" owl, by which it is sometimes called.



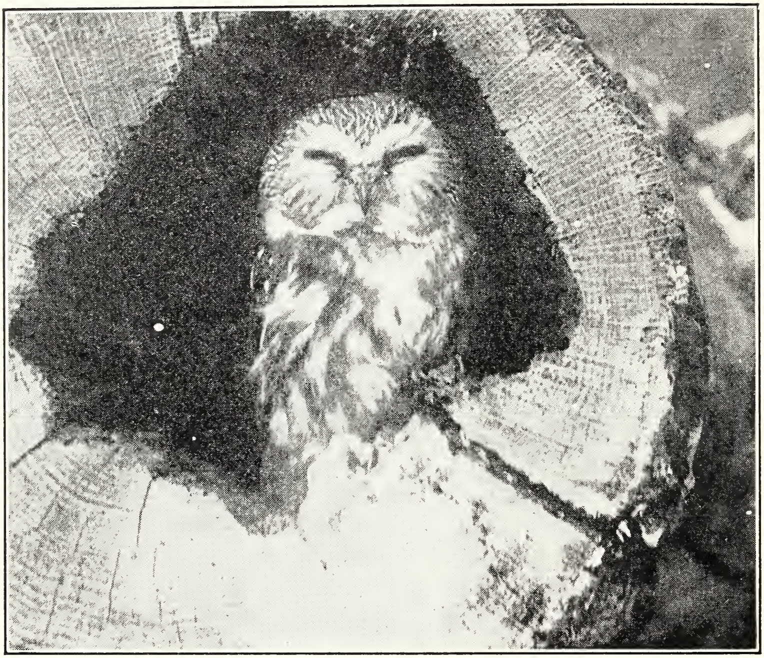
Photograph by L. W. Brownell.

RINGS OF FEATHERS AROUND THE EYES OF THE BARN OWL GIVE IT A MONKEY-LIKE LOOK.

A barn owl may live in a tower for years unseen by the villagers who hear its cries at night. Sometimes its call is a loud, sudden scream; sometimes it is a rapidly repeated "cree, cree, cree." In the tower, where it spends the days, it builds its nest, laying four or five white eggs in it sometime in April.

The barn owl is indeed a useful bird, feeding upon insects and beetles, mice, rats, reptiles, and bats. Although it does take an occasional small game bird or chicken, it pays well for it by devouring pests.

Of all the owls the saw-whet is the smallest. It is very seldom seen, for it passes the days in the dense growth of forest and grove, usually in the evergreens, alders, or vining plants. At night it



Photograph by L. W. Brownell.

SMALLEST OF ALL OWLS IS THE SAW-WHET.

utters the rasping call from which its name has come. Its note is thought to resemble the sound made by the whetting or filing of a saw. This little owl nests near the northern border of the United States or further north. In the winter it wanders southward, sometimes going as far south as Virginia.

The burrowing owls nest in holes in the ground. Sometimes they dig these holes for themselves; sometimes they take old rabbit holes for their homes. They are small birds with nearly naked legs and feet and with no ear tufts.

The barred owl makes its home in the woods. Its loud hooting, which may easily be mistaken for the howling of dogs, echoes through the woods at night. Sometimes, but rarely, it utters a shrill, weird shriek. Dr. Frank M. Chapman, in his book, *Bird Life,* describes a most peculiar duet in which these owls sometimes engage. One hoots rapidly about ten times. The other, in a slightly higher tone, hoots about half as fast. They end together with a long "whoo-ah." Among the owls, the barred owl is second in size, the great horned owl being the largest. The barred owl has no horns.

Unlike other members of the family, the snowy owl flies in the daytime rather than at night. It is a large, white bird with brown or black markings, and with no ear tufts. It nests in the Arctic regions, migrating southward in the winter, occasionally coming as far south as Ohio. It feeds on mice and birds.

On the whole, the owls are even more deserving of protection than are the hawks. They feed at night when mice are moving about, and by far the largest portion of their food consists of these destructive little rodents. It is true that owls do sometimes kill a valuable game bird or chicken, but they more than pay for it by their destruction of pests.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. Owls usually fly about during the ......
2. Owls have ..... eyes.

3. Screech owls feed on ....., ..., and ......
4. The barn owl is ..... than the screech owl.
5. The ..... owl flies about in the daytime.

SOME THINGS TO DO

List the names of all the different owls that have come to your attention, and opposite each name, list something interesting about the owl.

Draw pictures of the different kinds of owls.

Listen and watch carefully for owls in your neighborhood. If you see or hear one, tell about it in your notebook.

Visit a museum of natural history if you can, and study the specimens of owls which you find there.

CHAPTER IX

BIRD SANCTUARIES

1. Name some of the useful birds of your community, and tell in what way they are useful.
2. What are some of the dangers which these birds have to meet?
3. Can you do anything to protect them from any of these dangers?

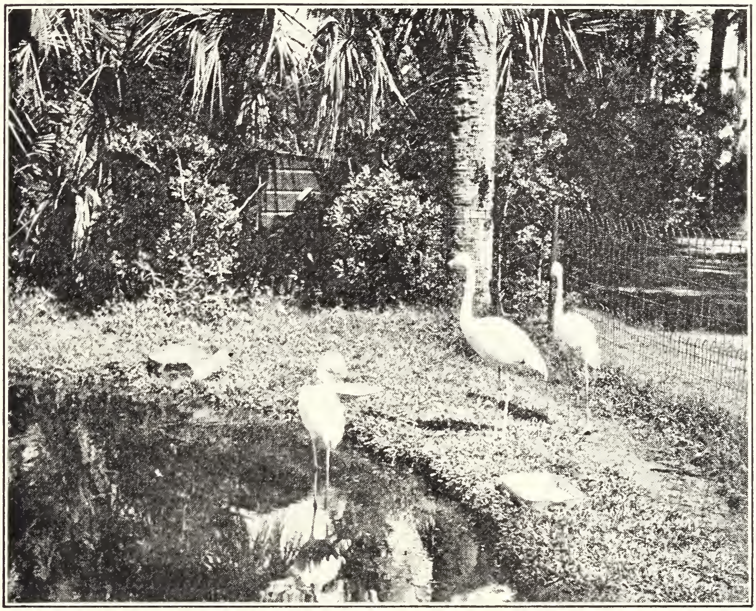
With the growth of cities, wooded areas are being cleared, and the natural nesting places of the birds are becoming fewer each year. For this reason, it is becoming more and more important that we provide bird refuges and homes. What a pleasure it is to watch the birds and to hear their songs! Aside from the joy of having them about us, however, they are well worth our protection for their services in protecting us from insect pests.

At Mountain Lake, in the center of Florida, the late Edward Bok established a bird sanctuary. It is a quiet, beautiful spot midway between the Gulf of Mexico and the Atlantic Ocean. There, protected from their enemies and supplied with food, water, and nesting places, thousands of birds make their homes all the year round. Others make it a wayside stop on their long journeys, finding it a haven of rest and safety. Twice a year, in their flight from their summer homes in the north to their winter

Photograph by Ewing Galloway, N. Y.

THE "SINGING" TOWER IN THE EDWARD BOK SANCTUARY IN FLORIDA.

homes in Cuba or the West Indies, migrating birds pass that way, for the Edward Bok Sanctuary is on one of the "main traveled" routes of birds. Within the sanctuary bushes have been planted that have



Photograph by Ewing Galloway, N. Y.

THE ONLY FLAMINGOES IN THE UNITED STATES ARE TO BE FOUND IN THE BOK SANCTUARY.

berries suitable for the birds to eat; feeding stations have been built, and bird baths are provided. Two lakes have been dug where teal ducks, wood ducks, and the only flamingoes in the United States live.

Visitors are welcome at the Mountain Lake Sanctuary. Indeed, Edward Bok himself declared that he established the sanctuary to impress those who might visit it with the power of beauty as it reaches out to them through tree, shrub, flower, bird, superb architecture, the music of bells, and the forest setting. At the entrance there is a sign which bears a quotation from John Burroughs: "I come here to find myself. It is so easy to get lost in the world."

In Canada, at Kingsville, Ontario, there is another great bird sanctuary. It was established by Jack Miner as a refuge for the thousands upon thousands of birds passing that way as they migrate in spring and fall. What a sight it is to see this sanctuary when the ducks and geese are stopping there! Mr. Miner tells us that he has seen the wild geese rise up so thick you could scarcely see the sky, while their honking could be heard for more than a mile. Each year he feeds thousands of bushels of corn to his bird visitors.

The ducks that visit the Jack Miner Sanctuary stay about three weeks. The geese stop from six to eight weeks. In the spring there are more birds than Mr. Miner can feed, and they scour the country for miles around in search of food. This gives the hunters a chance to shoot at them if it is during the hunting season, for when they leave the sanctuary, of course, they are no longer protected. When a bird is wounded, it usually attempts to return to the sanctuary to stay until it is able to go out again. One spring a duck that had been wounded about five miles from the refuge had just enough strength to fly back within the safety zone. It alighted and died within ten feet of Jack Miner's house.

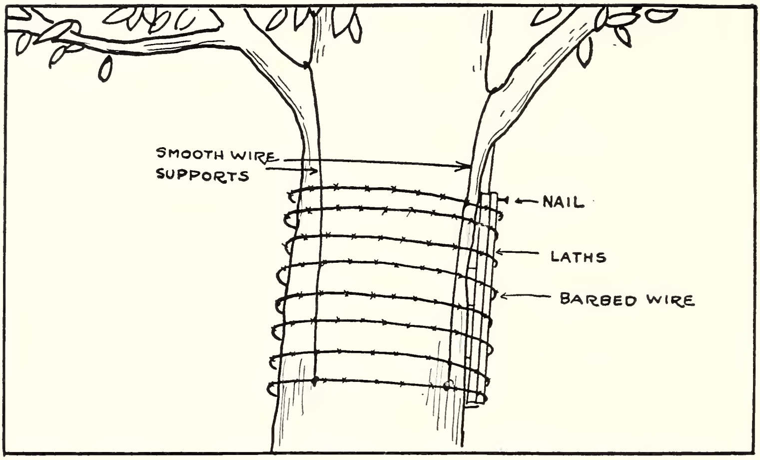
The conservation of bird life is a most important step in forest conservation, as well as in saving the farmer's crops from destruction by insect pests. For this reason, the Congress of the United States, in 1929, appropriated $8,000,000 to be spent within ten years for the protection of the birds of this country. More than a hundred bird refuges will probably be established along the main bird migration highways. You no doubt remember that the majority of our insect-eating birds are migratory.

When a sanctuary is once established, it does not take the birds long to discover it, and, safely protected from their enemies, they make good use of the feeding stations, drinking water, and bird baths that are provided for them. By the time you boys and girls who are now in school have become men and women, the sanctuaries that are just now being established will no doubt be filled with migratory birds each season. With increased protection, these useful birds will increase greatly in numbers.

Boys and girls can help, too, in this great work of conserving bird life.

They can establish small sanctuaries on the school grounds or in their own back yards. Nesting places must be provided, of course. The trees are the natural nesting places of the majority of birds. You have probably watched them building their nests. The woodpeckers, with their strong, chisel-shaped bills, drill holes in the wood in which they place their nests. Chickadees and bluebirds, unable to drill holes of their own, use those that the woodpeckers have left or find natural holes in the trees. Other birds, as you know, attach their nests to the branches. With the disappearance of the trees in a neighborhood, many birds have no places to build unless nesting boxes are provided.

Farther along in this book, there is a chapter that



TREE GUARDS HELP TO PROTECT THE BIRDS FROM THEIR ENEMIES.

tells you how to make different kinds of bird houses. Of course, these nesting boxes must be placed where the birds are safe from harm, and where the birds will nest in them. They should not be placed too near together, or too near to people, for birds do not like near neighbors. Bird houses should face away from prevailing winds and storms.

Birds have many enemies. Cats, ground squirrels, snakes, and other animals destroy thousands of birds every year. In creating a sanctuary, it is important to provide for the protection of the birds that are to live in it. A good fence is perhaps the best protection, but where this is not possible, tree guards made of sheet metal or of wire, as shown in the diagram, may be placed on nesting trees and bird-house poles.

You will want to be sure, too, that there is plenty of food for the birds in your sanctuary. One way to provide food is to plant trees, shrubs, and herbs, that produce seeds and berries that birds like to eat. Too often school grounds are bare and unattractive. What a nice thing it would be to grow trees and shrubs and to supply food for the birds and places for them to build their nests. The more common trees that produce seeds for the seed-eating birds, are the ash, box elder, alder, and birch. There are many plants whose seeds are eaten by birds—you can easily discover which ones by watching the birds in your neighborhood. Japanese millet is good because the seeds do not fall off until late in the winter. Sunflowers, poppies, asters, and forget-me-nots are easily grown, and their seeds will furnish many meals for the birds.

When snow covers the ground in the winter, food may be set out on shelves or racks especially made for that purpose. Suet or other fat, pork rinds, bones with shreds of meat on them, crumbs of bread, seeds, or grain will attract many visitors to your feeding station.

Water for drinking and bathing is also needed. A pool not more than a few inches deep, with the bottom sloping gradually upward at the edges, is best. The bottom should be rough enough so that the birds can get a footing. Birds like to take baths in winter, you know, and sometimes it is a problem to keep the water from freezing. If you can have running water for your bird bath, it will not freeze so readily. Otherwise the pool should be filled frequently.

Some bird clubs and schools have established sanctuaries on farms on a co-operative plan, the owner furnishing the land and the protection, and the club or school providing the bird houses, feeding stations, and fountains. Many schools and clubs in New Hampshire are maintaining sanctuaries in this way with good results.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. Edward Bok has established a .... at Mountain Lake, Florida.
2. The Jack Miner Sanctuary is at ....., ..., ...
3. The United States Congress appropriated ..... to be spent within ten years for the protection of birds.
4. Birds need water for ..... and ......
5. Birds have many enemies. Among them are ....., ..., and ......
6. Four seed-producing trees that birds like to eat are ....., ..., ..., and ......
7. Birds also eat the seeds of ....., ..., and ......
8. ....., ..., and ..... are good foods to offer the birds at your feeding station.

SOME THINGS TO DO

Have you ever heard of the Audubon Society? It is an organization that is working to protect bird life.

Organize a Junior Audubon Society. Write to the National Association of Audubon Societies, 1974 Broadway, New York City, for information about how to do it.

Write to the United States Department of Agriculture, Washington, D. C., for a list of their bulletins about bird life and its conservation. You may want to order some of these bulletins. They are very inexpensive, and they give you much interesting information about bird life.

Establish a bird sanctuary on the school grounds, or in some other suitable place. A back yard will do. Plant some shrubs or plants that will produce seeds for the birds. Establish a feeding station and a bird bath. Keep a record of the birds that come to your sanctuary.

CHAPTER X

OUR FRIENDS AND FOES, THE SNAKES

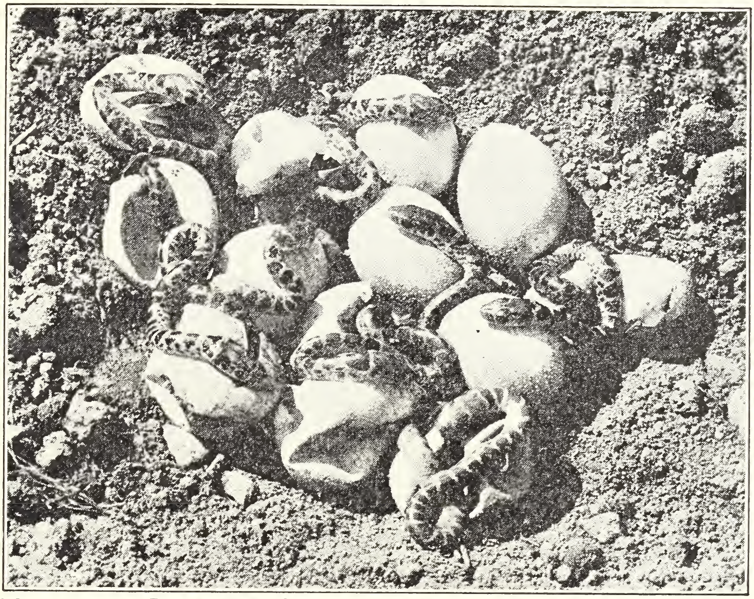
1. What kinds of snakes have you seen?
2. Did you ever notice the tongue of a snake?
3. Have you ever heard people tell curious stories about snakes? Were they true?

A snake is a strange creature. It can move swiftly and climb trees, but it has no legs. It can swallow things much thicker than its own body. It sheds its skin several times a year, crawling out of it and leaving it in field or meadow.

Perhaps it is because of such queer traits as these that so many curious myths have developed about snakes. You may have heard that they milk cows or charm birds, that they are slimy creatures, or that they are able to sting with their tongues. Some people believe that wearing snake skins will cure rheumatism. These beliefs are all false.

A great many people think that snakes are disgusting, harmful creatures that should be killed whenever possible. This is just as false as the idea that snakes can milk cows. Some snakes are poisonous and are therefore dangerous. Others are not poisonous and are deserving of protection because they eat insect pests.

Scientists who have studied the snakes have discovered many interesting things about them. You



Photograph by Lynwood M. Chace.
NEARLY ALL SNAKES EXCEPT THE GARTER SNAKE HATCH FROM EGGS.

have probably noticed how fast a snake can move over the ground. As you know, it has no legs. Instead, it has scales on the underside of its body. They are used to hold fast to the earth while the muscles draw the body forward. In the same way, the scales cling to the bark of a tree, enabling the snake to climb it.

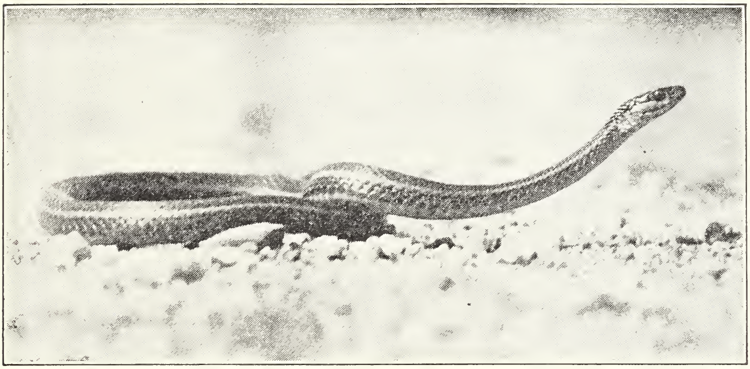
Have you ever found an old snake skin in the field or meadow? Several times a year the snake grows a new skin right under its old one. When the new skin is ready, the old one loosens about the jaws, so that the animal can crawl away and leave it. As the old coat loosens about the eyes, the eyes become milky, and the snake cannot see very well. This may have led to the belief that snakes are blind during the late summer, in what is called "dog days."

The snake's jaws are loose, and they spread apart widely when a large object is to be swallowed. Its sharp teeth, curved toward the throat, are well fitted to hold animals caught for food. In fact, they help to push the food down the throat. Birds and fishes are usually taken into the mouth headfirst. In this way the feathers and scales give the snake less trouble in swallowing. The snake's skin is elastic, like rubber, and stretches to make room for the food. Have you ever seen a snake with a large lump in some part of its body caused by some large object that has been swallowed—a toad, or a frog, perhaps?

The snake uses its long, thin tongue to frighten its enemies. The tongue is harmless, but some snakes have special teeth, called fangs, with which they can pierce the skin of a person and inject poison. These fangs are fastened to the roof of the mouth and are connected to the poison sac. When poisonous snakes are kept as pets, the fangs are sometimes removed. This makes them harmless until the fangs grow again, which they will do in a short time.

Garter Snakes

The common garter snake is found throughout the eastern part of the United States from Canada to Florida, and westward to the great plains. It is also



Photograph by Lynwood M. Chace.

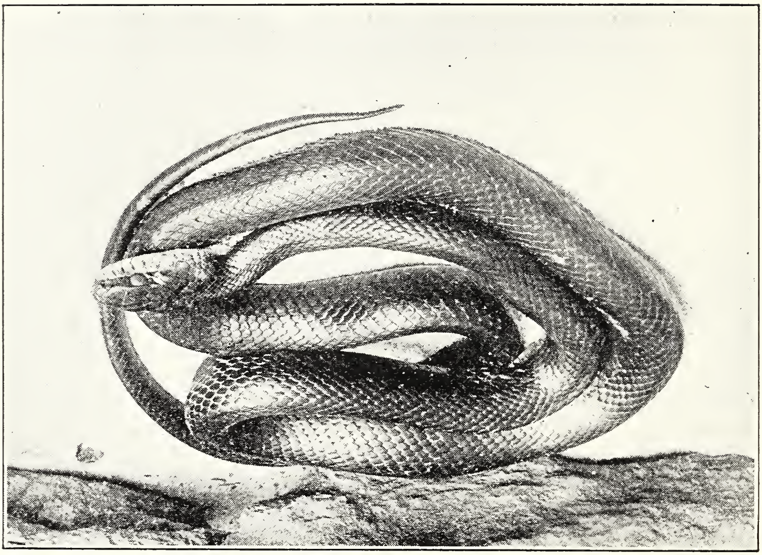
A YOUNG GARTER SNAKE IS AN INTERESTING ANIMAL TO STUDY.

called the garden snake and the ribbon snake.

You have no doubt seen these little snakes for they are widely distributed. They seldom measure more than three feet in length, and they vary greatly in color. They may be olive, black, or brown, with stripes of yellow, green, or white, and sometimes still other colors are found.

You may not care to have a snake for a pet, but a garter snake is harmless, easily tamed, and makes an interesting animal to study. When it is handled for the first time, it is apt to give off a very disagreeable odor, but when it becomes acquainted it will no longer do this.

Young garter snakes are born in August. They do not hatch from eggs as other snakes do. During the first season they feed on earthworms, but in the spring they eat small toads and frogs. Adult garter snakes feed on earthworms, insects, spiders, salamanders, and frogs. They have also been known to eat large numbers of grasshoppers when these in-



Photograph by Raymond L. Ditmars.

THE BLACK SNAKE IS SLATE BROWN IN COLOR.

sects are plentiful. Would you consider these snakes useful?

Snakes hibernate during the winter. Hibernation is really a prolonged winter sleep during which the body does little of its ordinary work. The heart action is slight, and the bodily temperature is low. The garter snake is one of the last of the snakes to go into the ground for the winter. It usually finds a slope facing southward, and then, burrowing into the ground about three feet or more beneath the surface. it lives sheltered from the cold until spring.

Black Snakes

Although the black snake is said to kill rattlesnakes, fight with men, and charm birds, it is really a very timid animal that will run from man with all possible speed. Some people believe, too, that the common black snake grows to an enormous size. The truth is that the largest ones seldom measure more than six feet in length.

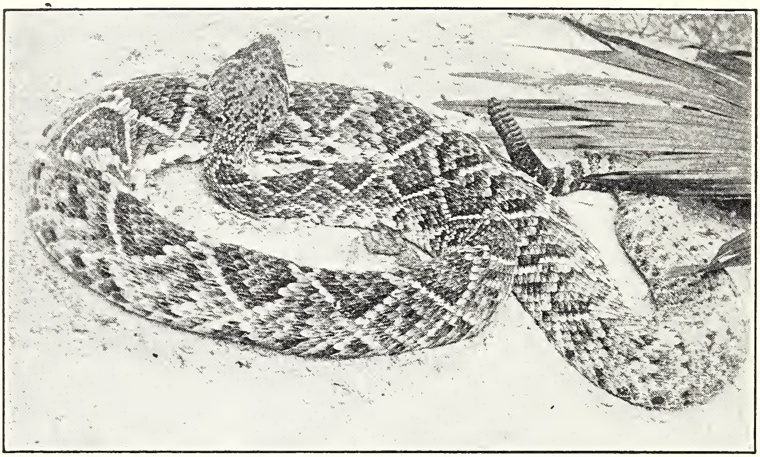
The common black snake, or black racer, is found in many places east of the Mississippi, while in the western states another member of the same family, the blue racer, makes its home.

In coloring, the adult black snake is a slate brown above and below, with a white chin and throat. In June or July, under stones or in soft soil, it lays from twelve to twenty-four eggs, which hatch in about a month or six weeks. You would hardly think that the young snakes belonged to the same species as their parents, so different are they in coloring. At first they are gray, with brown spots on their backs and black spots on their sides. By the second summer they have become darker, and the spots are not so easily seen, but they do not take on the adult coloring until the third year.

Poisonous Snakes

Although many of the common snakes are harmless, there are other species that are dangerous because they inject poison when they bite. In this country the poisonous snakes are the rattlesnakes, the copperheads, water moccasins, and coral snakes.

On camping trips it is well to remember not to pitch your tent in swampy places, or near rocky ledges, for the poisonous snakes live in just such



Photograph by Raymond L. Ditmars.

THE RATTLESNAKE IS ONE OF OUR MOST COMMON POISONOUS SNAKES.

places. It is well, too, to watch for snakes and to avoid putting your hands under stones or logs to lift them. Bedding and clothing should be hung up during the day if you are camping where snakes are numerous.

SOME THINGS TO THINK ABOUT

Some of these sentences are true. Some are not true. On a piece of paper, write the number of each sentence. If what it says is true, write *True* beside the number. If it is not true, write *False*.

1. Snakes sting with their tongues.
2. Snakes are slimy.
3. Snakes have many legs.
4. Snakes shed their skin.
5. Toads and frogs are swallowed by snakes.

6. Snakes eat grasshoppers and other insects.
7. The garter snake is not poisonous.
8. Young black snakes look like the parents.
9. Young black snakes hatch from eggs.
10. Copperheads and rattlesnakes are poisonous.

SOME THINGS TO DO

Make a list of the curious statements which you have heard about snakes. Which of them are true?

List the harmless snakes that live in your community.

Do any poisonous snakes live in your neighborhood?

You may have at home an old snake skin or the rattles from a rattlesnake. If you have, bring them to school so that the class can see them.

CHAPTER XI

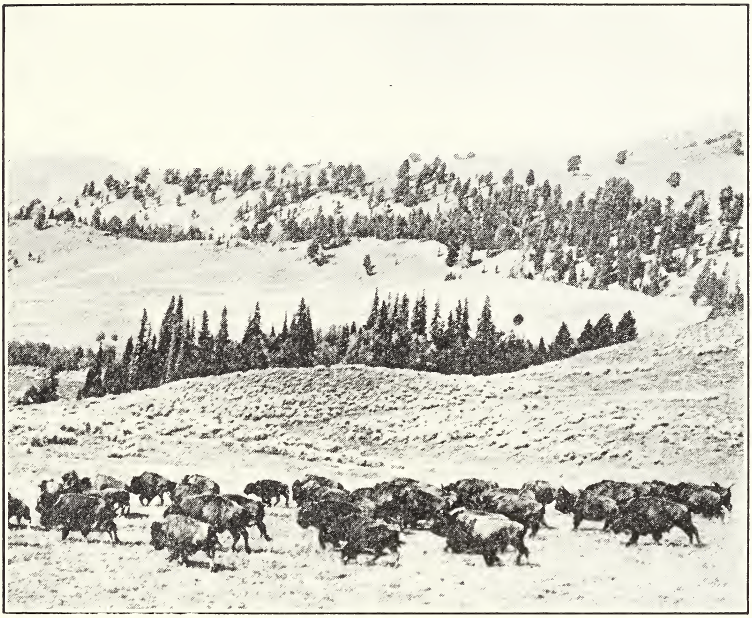
PROTECTING OUR WILD ANIMALS

1. Can you describe a bison?
2. Have you ever found antlers in the woods?
3. Why do you think wild animals should be protected?

Our wild animals need our protection to save them from disappearing completely from our forests and prairies. Men have become so wise in learning how to destroy animals for the mere sport of shooting or trapping, that animals can no longer escape. Just as thoughtless people have in years gone by wastefully cut down our forests, so hunters have killed so many of our wild animals that some of them have almost disappeared.

Great herds of bison or buffalo once ranged our western plains and prairies. East of the Mississippi River they were somewhat less abundant.

With the coming of the white men, these herds, which had numbered many millions, decreased rapidly. They were hunted not only for food, but for their skins. Sometimes 200,000 buffaloes were killed in one year for their hides, which were made into buffalo robes. From the white settlers, the Indians learned to use the rifle, and with it they killed many more buffalo than they had been able to kill with their former weapons. One writer esti-



Copyright Rodman Wanamaker, 1913.
GREAT HERDS OF BISON ONCE ROAMED OUR WESTERN PLAINS. NOW ONLY A FEW PROTECTED HERDS REMAIN.

mates that 2,000,000 buffalo were killed in one year by the Indians after they had learned to use the rifle.

By 1810 the buffalo had disappeared east of the Mississippi, and by 1890 it was estimated that only about a thousand remained in the whole country. From these herds animals were captured and placed in preserves where they were protected. By 1914 their number had increased to more than three thousand and has become greater since that time. Had they not been protected, there is little doubt that the last buffalo would have been killed.

The beaver, too, was once widely distributed and

Photograph by James V. Lloyd, courtesy of National Park Service.

THESE DEER IN YELLOWSTONE PARK ARE VERY TAME.

abundant until the great demand for its fur led to wholesale trapping. The Hudson Bay Company sold, on the average, more than 100,000 skins each year from 1853 to 1877. These animals were fast disappearing when laws were made for their protection. Since then, they have again increased in number. For the three years, 1919, 1920, and 1921, the number of beaver skins sold was about 420,000.

From these two illustrations you can readily see the need for wild-animal preserves. If the buffalo and the beaver had not been protected, they might have been lost forever.

There are in the United States more than twenty great national parks. Yellowstone is the largest, having an area of 3,348 square miles. This park is

Courtesy of the National Park Service.

ON EACH RUMP OF THE ANTELOPE IS A WHITE PATCH OF HAIR.

almost three times the size of the state of Rhode Island. These great national parks are widely distributed throughout the country, wherever there are spots of unusual natural beauty. Many of them are wild-animal preserves.

What a wonderful sight it is to see the deer, the antelope, the elk, the bison, and the beaver, protected from the hunter, living in wild and wooded regions just as they did in former times! They can go peaceably about in search of food, and if the food supply is scarce during a severe winter, they are fed and thus kept from starving.

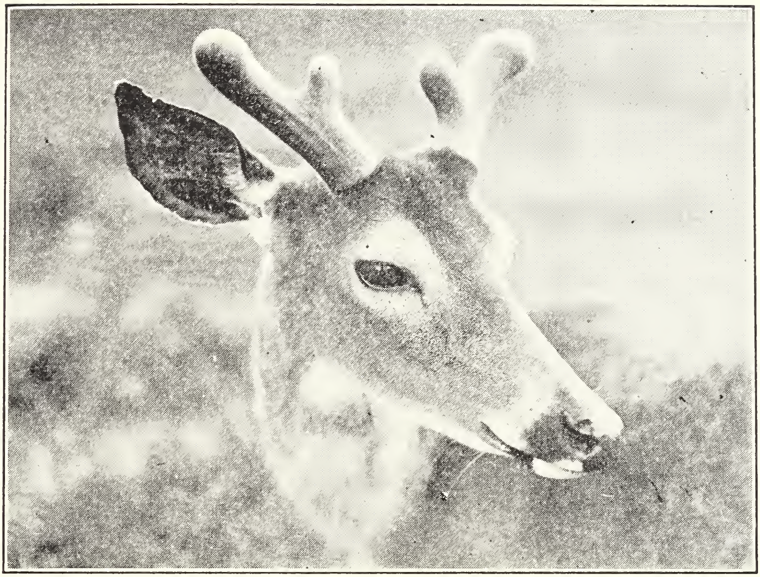
Antelope

The antelope, with its slender body and long slender legs, is fitted to run swiftly. In fact, it is thought to be next to the race horse in speed. It has large eyes and forked horns. On each rump there is a white patch of hair. When it is frightened, or in flight, this white hair rises up just like the hair on an angry dog's back, and can easily be seen for some distance. This patch of white hair serves as a danger signal and as a guide. Can you tell how?

In winter antelopes live together in flocks or herds. When spring comes, before the young are born, the females leave the flock and the bucks wander about by themselves. In autumn the bucks again join their mates and the young ones. Thus the herd increases in size.

These animals have great curiosity which has often led them into serious danger. In the early days the hunter could sometimes draw them within range of his gun by hiding and waving a handkerchief from the end of a stick.

Antelope feed on the grass, sage, and cactus of the dry plains. They cannot live on the grasses that grow east of the Mississippi River. In captivity they are fed clover hay, and a very little green grass. They are found to-day from Texas north to Canada, and thence westward. In early times they ranged over a much wider area. Once there were millions of these animals; it has been estimated that there are about 30,000 of them living. Young ante-



Photograph by L. W. Brownell.

THE FRIENDLY HEAD OF A YOUNG WHITE-TAILED DEER SHOWING ITS HORNS IN "VELVET."

lope cannot be born in captivity; therefore their protection in game preserves is exceedingly important.

White-Tailed Deer

You have probably seen the white-tailed deer in a park or a zoo, if you have not seen it in the woodland. In early times this animal was common over the entire country, and a few are still to be found in almost every state. It is also called the Virginia deer, or just the white-tail.

Like the antelope, it has a graceful body, and legs that are well fitted for speed. The deer is a good runner, and it can make high jumps over logs and bushes. It often goes to the water when it is hunted. Its senses of hearing and smell are very acute, and the hunter has learned that he will seldom get within sight of a deer unless he approaches against the wind. Can you tell why?

The white-tailed deer, when it is full-grown, is about three feet high and six feet long. A large buck, or male deer, will weigh 300 pounds.

The buck white-tailed deer, like his cousins, the elk and the moose, wears on his head antlers of solid bone. These start to grow in the spring and by late summer are full-grown. While the antlers are growing, they are covered with soft hairy skin and are supplied with blood. This skin is called the "velvet."

As the antlers become nearly full-grown, the blood supply is cut off and the antlers become bony in appearance. During the winter the deer drops his antlers and is ready for a new set the following spring. Until the deer is several years old, each new set of antlers is larger and has more points than the preceding pair.

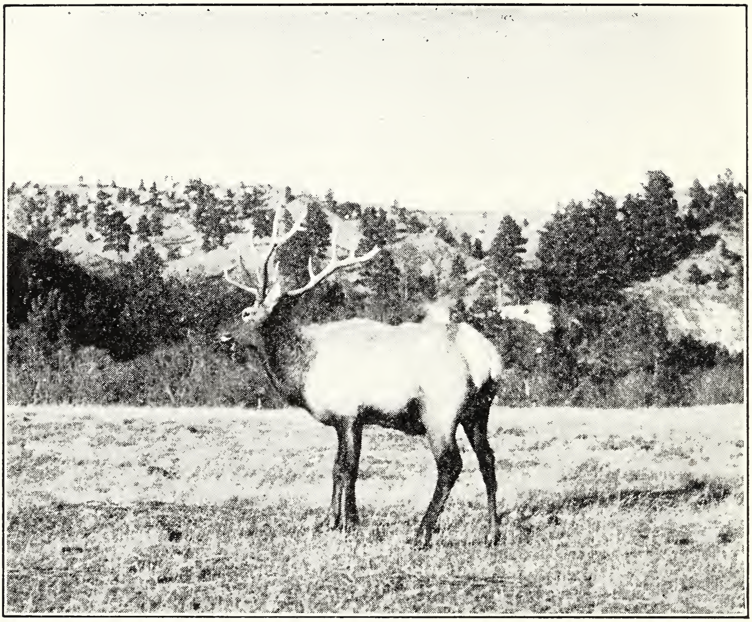
Deer sometimes make nice pets, but it is dangerous to try to make a pet of a male deer after it is two years old. The bucks may come up to you and want to play, but when you touch their antlers, the struggle begins. Unless you receive help, they may hurt you badly. When bucks are alone in an enclosed space, or corral, they are most dangerous.

The deer finds its food in the woodland. It feeds on acorns, chestnuts, beechnuts, blackberries, persimmons, grasses, buds, leaves, and the boughs of trees and bushes. Deer like the water and will wade into rivers and lakes to feed on marsh and water plants. Sometimes they go into the fields and eat corn and vegetables. In winter they feed on twigs and on dry grasses that they dig from beneath the snow.

In April the spotted young deer, or fawns, are born. They are small, usually weighing about four-and-a-half pounds at birth. Often they are two in number. The mother cares for them well, hardly going out of hearing distance of their squeak except for water. Instead of building a home for them, she often finds a fallen tree top where she can hide them. If you approach a fawn and frighten it, it is likely to "play dead." It cannot run away, you see, and this is its way of protecting itself.

Like other wild animals, the deer has several enemies that threaten its destruction. The hunter with a rifle and the deep snow are most dangerous. Deep snow robs the deer of its great speed and makes its capture by the cougar and the wolf easier. The lynx and the wolverine are also foes, and the fox, although it will not attack the full-grown deer, will kill a fawn if it finds it unprotected.

In spite of its enemies, the white-tail has not only been able to live in its former haunts, but it has spread into the western and northern states. Of course, this would not have been possible had it not been protected by law during certain seasons of the year.



Photograph by courtesy of Biological Survey.

AN ELK IS ABOUT THE SIZE OF A HORSE.

Elk

The elk is the second largest of all the deer families. It is about the size of a horse and carries a beautiful pair of antlers on its head and a heavy mane on its neck. Like the antelope, but unlike other deer, the elk has a light rump patch.

Also unlike most deer, elk are not active during the night. They usually feed in the morning and in the afternoon, resting during the middle of the day. They eat the grasses and many of the weeds. In their forest home they feed on leaves and twigs of trees and bushes and on the bark of the basswood and the birch.

In May or June, in some secluded spot, the fawn, or the calf as it is sometimes called, is born. It is hidden for several days and is then brought out to join its fellows.

The fawn's coat of hair is beautifully spotted with white, and remains so until autumn, when the old coat is shed.

In early times elk were found scattered over most of the United States and southern Canada. There were millions of them. By 1900 it is estimated that their numbers had been reduced to about 50,000, and about 20,000 of these were in Yellowstone Park and the surrounding country. Elk are no longer found in the eastern or central states, but in parks, such as Estes and Yellowstone, they are living to-day just as they did in the early days. When they are properly protected by game laws, they may be found again in other places.

Moose

The moose is the largest of the deer family. It is taller than a horse and measures about seven feet high at the shoulders. In appearance it is quite unlike other kinds of deer found in this country. Its body is short, its ears are large, and its throat has a large growth of skin and hair called the "bell."

Because of his large antlers, the bull moose is considered a prize by the hunter. The young bull grows his first antlers during the second summer, but it is not until his seventh or eighth year that

Photograph from Publisher's Photo Service.

LARGEST OF THE DEER FAMILY IS THE MOOSE.

they are full-grown. The Alaskan moose sometimes has antlers that measure seventy-eight inches in spread.

The bull moose is not so dangerous as the male of some other species of deer. He has been known to play with cattle and children and has been trained to do tricks with balls. It is best, however, to approach him with some care.

Moose are found in the forests of northern North America. Their range has changed very little since early times. They do not venture into the open, but they are fond of water and often wade in lakes and ponds.

When a moose is frightened by a bright light at night, it bounds forward in the direction it is facing. A moose, frightened by a flashlight, has been known to wreck the canoe from which the light has come. Edwin Lincoln Moseley, in *Our Wild Animals,* tells a story of a moose that, when startled by a light, leaped entirely over a canoe at about the second or third jump from where he was standing. The hat of one of the men in the canoe was knocked off by one of the animal's feet.

When frightened at some distance from its customary feeding grounds, a moose will usually attempt to get back into the woods with which it is familiar. Moseley tells the story of a friend of his who, with two other moose-hunters, called a bull moose across a wide lake by using a birchbark horn or megaphone with which they could mimic the call of the cow moose. When the bull had nearly reached the shore —in fact, when he was nearer to the shore than were the hunters in the canoe, they turned on the flashlight. After a few leaps forward, he turned and swam back to the woods from which he had come, although in doing so he passed almost within arm's length of the men in the canoe.

Hunters have learned to call the bull moose by imitating the love call of the cow moose. In this way they often bring the bull within shooting distance of their rifles. Since the cow moose makes these calls during only two or three weeks of the year, until she has found her mate, they can be used by hunters only at this time.

Unlike the elk and the white-tail, the moose is not a grazing animal. It browses upon the leaves and twigs of trees and bushes, eating the bark and twigs of the birch, spruce, hemlock, alder, willow, aspen, and maple.

The young moose is called a calf. It is born in May, and at first it is a strange-looking animal, with long legs and short body. It is not spotted like the fawn of the elk or the white-tail. It is reddish brown in color until it is about a year old when it takes on the color of the parent moose. Until it is almost a year old, the moose calf stays with the mother.

For a number of years, moose have been protected by the government. Without this protection, they might already have been exterminated.

Animals need wild lands on which to live as they did in former times. They should be saved from thoughtless hunters. You can readily see the importance of game laws to regulate hunting, and of the establishment of wild animal preserves, without which many species would soon be exterminated.

SOME THINGS TO THINK ABOUT

Some of these sentences are true. Some are not true. On a piece of paper, write the number of each sentence. If it is true, write *True* beside the number. If it is not true, write *False*.

1. Bison once lived in large herds in this country.
2. Beavers are again increasing in numbers.
3. Some of our national parks are game preserves.
4. Yellowstone Park is about the size of the State of Rhode Island.
5. Antelope cannot be bred in captivity.
6. The white-tailed deer has been able to hold its own in numbers.
7. About 20,000 elk live in Yellowstone Park.
8. A male white-tailed deer makes a good pet.
9. The moose is the largest of the deer family.
10. Elk feed during the middle of the day.

SOME THINGS TO DO

Find the national parks on the map. Which one is nearest to your town or city?

Explain why we should have game laws.

Compare the white-tailed deer and the moose.

Tell how we should protect the antelope.

Tell how you could recognize an elk.

Obtain a copy of the latest game laws of your state.

CHAPTER XII

OUR VANISHING CHRISTMAS GREENS

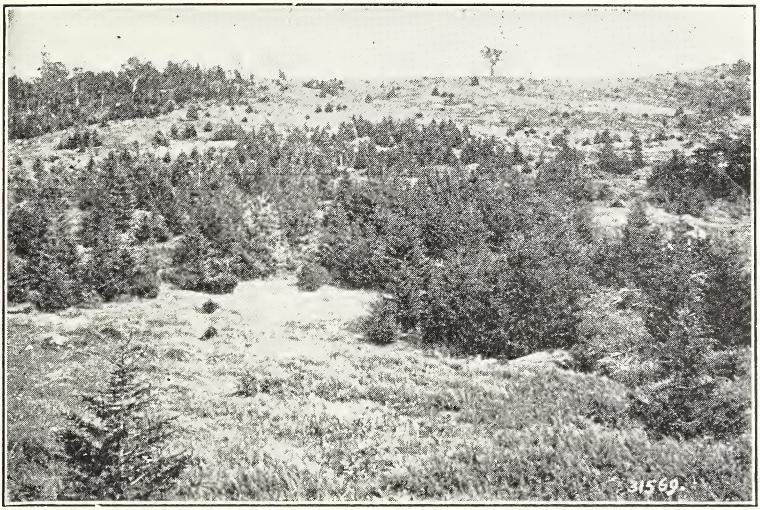
1. What kinds of trees are used for Christmas trees in your community?
2. What is done with them after Christmas?
3. What plants and shrubs are used for wreaths and other Christmas decorations?

The Christmas tree is in many homes the heart of the Christmas celebration. Bright with colored lights and other decorations, it radiates cheer and good will. So many of our earliest recollections of Christmas are centered round the tree that we would not want to give up having one each year.

However, it is true that many valuable small trees are destroyed in the annual Christmas celebration, and each year more people are wondering if the custom is not too destructive and too wasteful.

"Plant Your Own Christmas Tree," is the slogan adopted by many organizations interested in the conservation of trees. Evergreens planted in the dooryard or by the roadsides may be decorated and lighted annually. Such Christmas trees, shedding their light abroad in the community, give it a holiday air, and are no doubt the best solution of the Christmas tree problem.

Of course, there are some people who are not



SMALL SPRUCE TREES SUCH AS THESE ARE VERY GOOD FOR CHRISTMAS TREES.

satisfied to have only an out-of-door Christmas tree, but who wish to have one in their homes. Here is a plan for them. Get a living evergreen tree, roots and all. Plant it in a box with plenty of soil. Set the box in a small tub or something similar that will catch the water that must be supplied to keep the tree growing. Both the box and the tub may be covered with a sheet and bits of cotton or with colored crepe paper to make them fit into the Christmas decorations. When the holiday season is over, plant the evergreen tree where it will continue to grow.

Spruce and fir are the favorite Christmas trees. Hemlock and red cedar will also serve. In the South, small pines, native to the region, are widely used. The spruce and fir trees used for Christmas trees in the East and in the Middle West grow in forests from northern New York to Maine and Canada. In the West native fir and spruce are used. Many of the evergreen forests are overcrowded, and the cutting of a limited number of small trees will often improve the woods. The thinning must not be overdone, however, or the forest will suffer from a lack of young trees.

In Denver, Colorado, the city council a few years ago passed a law requiring every Christmas-tree seller in the city to furnish a $50 license. This reduced the number of sellers and helped the city to enforce the rule that all trees sold must be cut under the supervision of the city or the United States Forest Service.

Nurserymen and others are now growing spruce for Christmas trees. This evergreen grows rapidly under favorable conditions. Seeds are planted each year. When the seedlings are a year old, they are transplanted. Spaced three feet apart in each direction, 5,000 trees will grow on an acre of ground. In from three to seven years they are ready for market. At eighty cents each the trees will yield about $300 a year per acre. Very few crops yield more than this amount.

A few of the towns in this country own their own forests. The town-forest movement has really just started in the United States, but it is a growing movement. An annual crop of Christmas trees will prove a profitable venture for the town that owns a forest.

Photograph from J. Horace McFarland Co.
BRANCHES OF HOLLY ARE OUR FAVORITE CHRISTMAS GREENS.

Christmas Greens

The holly, with its glossy green leaves and its bright red berries, is perhaps the favorite of all Christmas greens, and for this very reason it is in grave danger of vanishing from our woodlands. It grows in the moist woods from Massachusetts to Florida, and west to Texas. Holly trees were planted by George Washington at Mount Vernon, where they are cared for by the Mount Vernon

Photograph by L. W. Brownell.

HOLLY FLOWERS BLOSSOM FROM APRIL TO JUNE.

Association. These trees are now 140 years old, and have reached a height of fifty feet.

Holly trees grow slowly. The wood is very hard and nearly white. The bark is close, and in color is white, or grayish brown. The leaves, as you probably know, are evergreen, thick, waxy, with wavy margin and spiny teeth. The flowers appear from April to June. There are two kinds. Those that bear the pollen-producing stamens grow on one tree in clusters of two to nine to a stalk. The pistillate, or berry-producing flowers, grow on another tree, with usually but one flower to a stalk.

The pistillate flowers develop into the fruit—a bright red berry that remains on the tree until late in the winter. So many of the branches with the berries are gathered each year that few of the seeds are being planted in the natural way.

Holly may be grown in nurseries. A staminate, or stamen-producing tree, and a pistillate, or pistil-bearing tree, should be planted near each other, for the pistils cannot develop into berries unless the pollen from the stamens reaches them.

Winterberry is a *deciduous* (dē-sĭd'ū-ŭs) holly. Deciduous means "falling off at maturity." A deciduous tree loses its leaves each year. Like the holly, winterberry grows in swamps. Its leaves are smooth and sharp-toothed. Winterberry is in demand for its bright red berries, and, like the holly, is becoming rare.

Ground pine, widely used for Christmas wreaths, is being destroyed even more rapidly than holly. Under the very best conditions, it is a plant that increases in number slowly, and usually it is badly injured by picking. It grows in the moist woods with its root-stalk creeping underground, and it has many low-spreading branches. Its stems look much like those of a small hemlock. The ground pine is very beautiful as it grows in the woods.

Laurel is used for Christmas chains. It is an ornamental shrub that grows from two to ten feet high in moist places and on mountain sides from Maine to Florida, often forming dense thickets. It is more abundant in the South. It belongs to a large family of attractive plants, of which the trailing arbutus is perhaps the most beautiful.

The stems and branches of laurel are irregular and tough. The leaves are evergreen, shiny and

Photograph from J. Horace McFarland Co.

THE LEAVES OF THE LAUREL ARE A SMOOTH SHINY DARK GREEN. THE FLOWERS GROW IN CLUSTERS.

dark. The flowers, which are of rose-color, white, or spotted with crimson, grow in large, showy clusters.

Some laurel may be gathered each year if it is taken carefully, without pulling the plant up by the roots, and without injuring the young plants. The young plants, you see, will provide the Christmas greens for the years to come if they are just allowed to grow.

Rhododendron is similar to laurel but grows much larger. It, too, grows in moist, cool places. Its flowers are more showy, and its leaves are larger than are those of the laurel. For this reason, they are not so easily handled for Christmas decorations.

With our holly disappearing, our ground pine being killed out, and our woods being combed for Christmas trees, it is time for us to think of the future. We do not want our Christmas greens to vanish. What is to be done?

We can use living Christmas trees or those that come from forests where they have been cut in the process of thinning out the trees. Christmas trees can be grown for the special purpose and can be planted when Christmas is over.

We can buy living holly grown in greenhouses instead of cut branches. We can refuse to buy ground pine wreaths or insist on having them treated with preservatives so that they will last for several seasons. If we go into the woods for our own greens, we can gather sparingly and carefully, taking care not to injure the young plants.

We can use cultivated plants for at least a part of our Christmas decorations. The Jerusalem cherry, the poinsettia, cyclamen, asparagus ferns, tubbed evergreen trees, and boxwood, serve very well. Narcissus bulbs may be started in October for Christmas blooms.

Surely it is more in keeping with the spirit of Christmas to gather our greens carefully, thinking of the future, than it is to fill our houses with beautiful branches and berries, the use of which means the destruction of some of the most beautiful shrubs and trees in our woodlands.

SOME THINGS TO THINK ABOUT

1. If Christmas trees sell for an average price of eighty cents each, how much money can be made each year, after the first acre of trees is ready for market, by the owner of five acres of spruce trees? The grower planted his trees so that he would have one acre of them ready for the market each year.
2. Explain why a staminate holly tree should be planted near a pistillate one. On which will berries develop?
3. What is a deciduous tree?
4. Describe the ground pine.
5. Explain how an insect, pushing its way into a flower, helps the plant.

SOME THINGS TO DO

If you have a Christmas tree at home or at school, get a live one and keep it watered until you can plant it out-of-doors.

Visit a florist's shop to find out what plants make good Christmas decorations.

Visit the woods to find out what Christmas greens you could gather without injuring the plants. Enjoy the beauty of the others right where they are, and leave them there for others to enjoy.

CHAPTER XIII

THE SUN AND ITS FAMILY

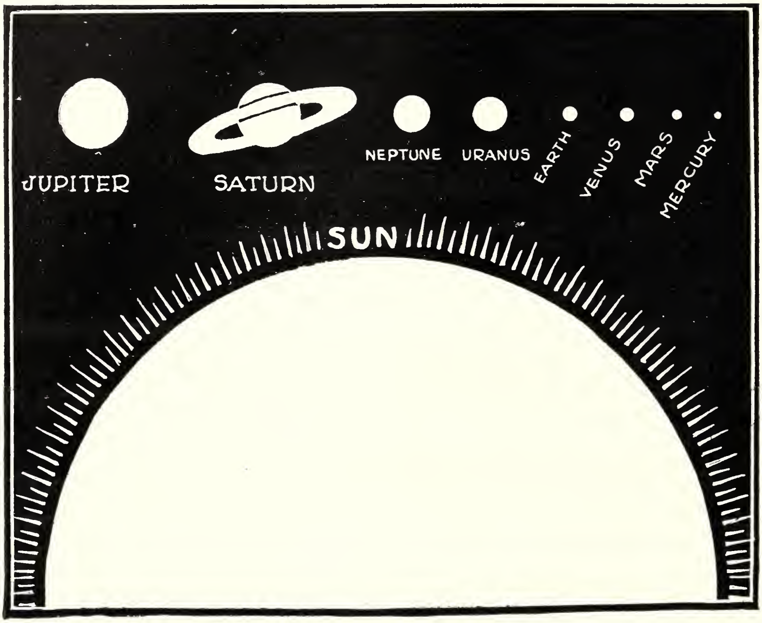
1. How do planets differ from stars?
2. Did you ever see a "shooting star," as a meteor is sometimes called?
3. Did you ever see a comet? Did you ever see pictures of comets, or hear any one tell of having seen one?

If you could take a trip to the sun in a magic airplane, traveling at the rate of 100 miles an hour, it would take 106 years to make the journey. Imagine how far away from us the sun must be!

You undoubtedly think of the earth as being very large. Its diameter, or distance through the center, measured in a straight line, is about 8,000 miles. The earth is indeed a great ball, but compared to the sun, it is not large at all. The diameter of the sun is 110 times as great as the diameter of the earth, and its weight is estimated by scientists to be 300,000 times the weight of the earth.

You probably know that the earth travels around the sun once each year, but have you learned that the earth is but one of a group of planets that revolve about the sun, and that one of them, Jupiter, is 1300 times as large as the earth?

In early times, people looked at the heavenly bodies and wondered what they were. They gave them names and made up stories about them, some



THE SUN IS MANY TIMES LARGER THAN THE LARGEST PLANETS. THIS SHOWS THE SIZES OF THE PLANETS COMPARED TO THAT OF THE SUN.

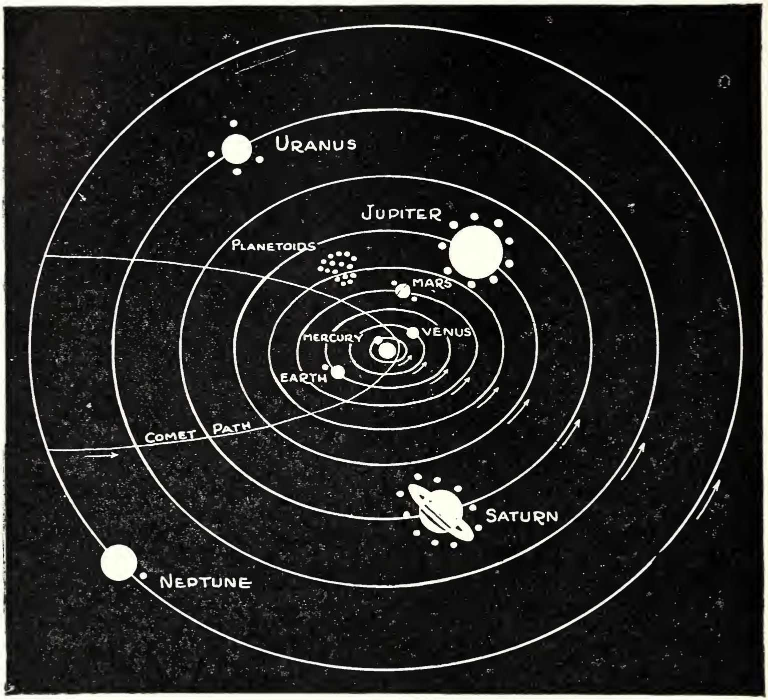
of which you probably know. They are interesting stories, but later, when the telescope was invented, astronomers studied the heavenly bodies and discovered facts about them much more interesting than the stories the ancients invented.

The sun, and the heavenly bodies revolving about it, make up the solar system. Besides the eight planets, there are many, many smaller bodies, known as *planetoids,* that also revolve about the sun. The sun, you see, is the center of the solar system, and it is many, many times larger than the largest of the planets. It is a great mass of white-hot gases that give off a tremendous amount of light and heat. Two of the planets, Mercury and Venus, are nearer to the sun than the earth is. The others —Mars, Jupiter, Saturn, Uranus, and Neptune—are farther away than the earth. Pluto, a new planet discovered in 1930, is farther from the earth than any of the others.

The distance from the earth to the sun varies with the season, but on the average it is 93,000,000 miles. When you think that the magic airplane, traveling at 100 miles an hour, would require 106 years to cover the distance from the earth to the sun, it helps you to realize how very far away the sun is. And yet, compared to the distance from the earth to the nearest star, the distance from the earth to the sun is very short. Each of the stars is really a sun. That is, it is a mass of white-hot gases, giving off light and heat, just as our sun does.

As you look into the sky at night, the planets will probably look exactly like stars. They shine like stars, and they appear to be about the same size as stars. Of course, really, the planets are by no means as large as the stars, but they are so much closer to us that they appear to be about the same size or larger. Stars shine because the tremendously hot gases of which they are made are giving off light. Planets shine because they reflect the light of the sun. It is difficult to distinguish between planets and stars unless you know their position in the sky and their general appearance. This is not hard to learn, however, if you like to study stars.

Venus, the planet most like the earth, is the



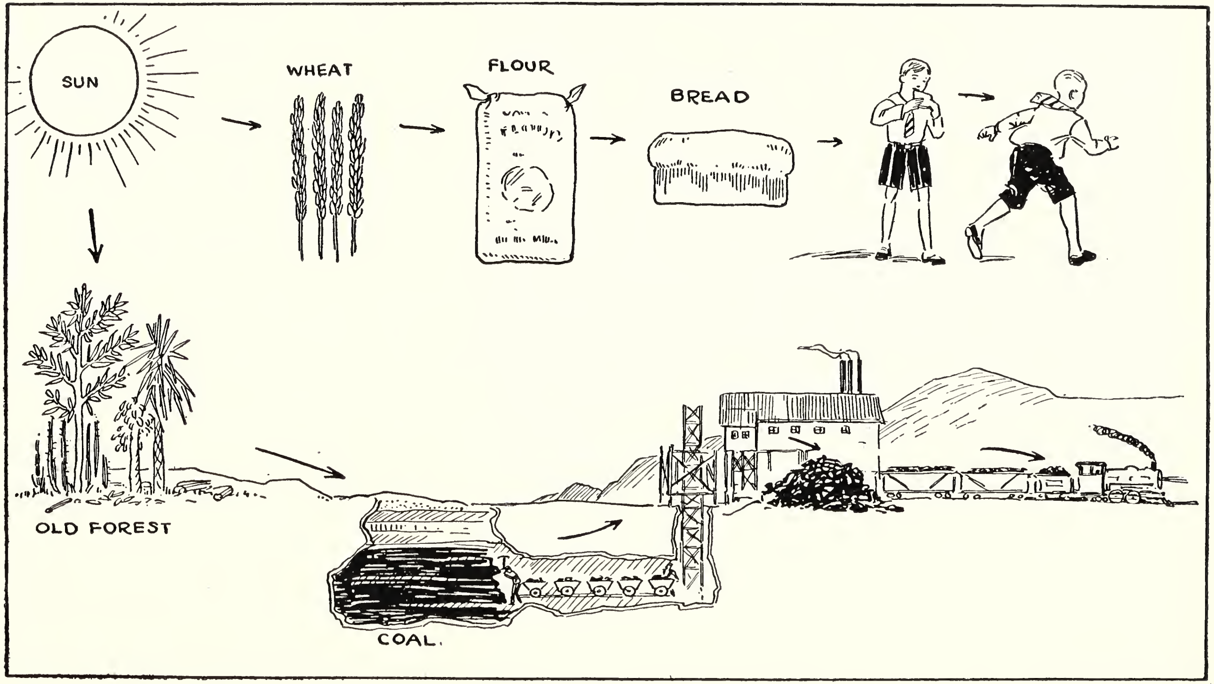
HOW THE PLANETS REVOLVE ABOUT THE SUN.

brightest heavenly body to be seen in the sky at night, except the moon. Of course, it has no light of its own, but it reflects the light of the sun. It appears to shine more brightly than the other planets because it is nearer to us. For about seven months Venus appears in the evening sky in the west. We say, then, that it is the "evening star," although really it is not a star at all. Then it disappears for a time, to reappear in the morning sky in the east.

Remembering that all of the planets are revolving about the sun in orbits or paths which you see represented in the accompanying diagram, can you think why Venus should appear in the west, and then in the east? Perhaps you can discover, too, why it disappears entirely for a time.

You will find it interesting to have someone point out Venus to you in the sky. When you see it, remember that, bright as it is, it has no light of its own, but is merely reflecting the light of the sun. If you could look at the earth from Venus, it would appear to you very much the same as Venus looks from the earth, for the two planets are about the same size; and of course the earth, like Venus, reflects the light of the sun.

The sun, which is the center of our solar system, is by far the largest body in it. Its outer portion is composed of white-hot gases that give off light and heat; its center is possibly liquid. Although it is so far distant from us, the sun indirectly is the source of all of our heat, light, and power. Many plants can grow only in the sunlight, and as they grow, they take energy from the sun's rays and store it in their bodies. Animals, on the other hand, cannot take their energy directly from the sun, but must get it from plants. You may think that coal and gas are also sources of heat and power. The truth is that they are merely storehouses of energy that came originally from the sun. Coal and gas were formed from plants that grew upon the earth thousands of years ago. The energy stored in the coal and gas was drawn from the sun by these plants as they grew. Then, the heat which you feel when you light the gas, or burn a piece of coal, was taken from the



TWO WAYS IN WHICH THE SUN'S ENERGY IS MADE AVAILABLE TO US.

sun's rays centuries ago by a growing plant and stored in its body.

How hot the sun must be to give us so much heat at a distance of 93,000,000 miles! Astronomers tell us that only a very small fraction of the sun's heat reaches the earth. They estimate that the temperature of the sun's surface is something like 12,000 degrees. You can hardly begin to imagine how hot this is, but it may help you to realize it a little if you remember that the temperature of boiling water is only 212 degrees. On the surface of the sun, even such hard materials as iron can exist in the form of gases only.

The earth, as you probably know, travels around the sun once a year. We say that it revolves in its *orbit,* as the path of a planet about the sun is called. The other planets, too, revolve about the sun, but the lengths of time required for their journeys vary greatly, and so do the distances they must travel, as you will see by looking at the diagram given above. Neptune, the planet most distant from the sun, revolves in its orbit only once every 164¾ years. Uranus travels about the sun in 84 years; Jupiter, in 11⅞ years. Pluto revolves in its orbit only once in 300 years.

While the earth is revolving about the sun, it is also whirling round and round, making a complete rotation every twenty-four hours. At the equator an object on the earth's surface is traveling at the rate of 1,000 miles an hour, or more than sixteen miles a minute, with the rotation of the earth, and at the same time the earth and everything on it is traveling in the orbit around the sun at the rate of 66,600 miles per hour, or 1,110 miles a minute. Moreover, astronomers tell us that the entire solar system—the sun and the planets as a group—is traveling through space at a rate of 43,200 miles per hour, or 720 miles a minute. Some of the other planets rotate at rates of speed varying from that of Jupiter, which makes a complete rotation in 9 hours and 55 minutes, to Mercury and Venus, which either do not rotate at all, or turn so slowly that scientists cannot be sure they are rotating.

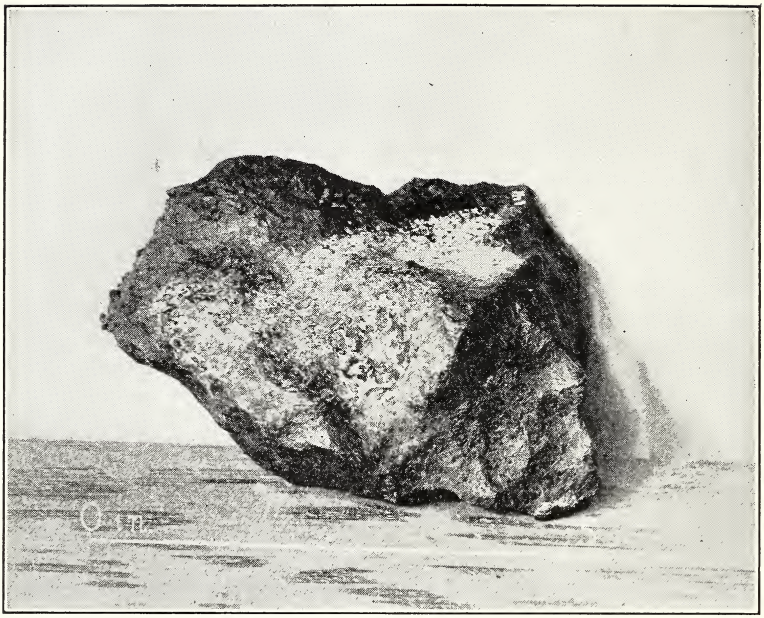
The moon is a small body that revolves about the earth. A heavenly body that revolves about a planet in this way, is called a *satellite* (săt′ĕ-līt). Some of the planets have several satellites. Mars, for example, has two moons, each about thirty miles in diameter. Jupiter has nine, two of which are larger than the planet Mercury. Four of the moons of Jupiter were discovered in 1610 by Galileo with his newly perfected telescope. The moon that revolves about the earth is thought by scientists to have been thrown from the earth in a great explosion, while the earth was still in a molten, or fiery liquid condition. In the next chapter you will learn many interesting things about this beautiful satellite of the earth.

You may some time have heard older people tell of seeing comets. Comets look like stars with long tails. They are really mixtures of burning iron or stone and gases with an exceedingly thin mass of gas streaming out from them. They come from somewhere out in space, travel round the sun at a

Photograph by E. E. Barnard.

COMETS LOOK LIKE STARS WITH LONG TAILS.

speed of more than 300 miles a second, and return again to space. Some of them travel in definite paths and return at stated intervals. There are



HERE IS A SMALL METEORITE, THE PART OF A BURNING METEOR THAT LANDED ON THE EARTH.

people who believe the appearance of a comet foretells terrible calamities, and there are others who fear that a comet may strike the earth. Of course, knowing what a comet is, you can be sure that it has nothing to do with events upon the earth; and as for the danger of a comet striking the earth, this is very unlikely. Twice in the nineteenth century the earth passed right through the tail of a comet with no bad effects.

Meteors (mē′tē-ôrz) are masses of metal, usually for the most part iron, that fall from space into our atmosphere. Their weight varies from a few pounds to several tons. They may have been thrown off from some planet in a volcanic explosion, or they may have been formed by the breaking up or cooling of a comet's head. When they come near enough to the earth for the pull of gravity to draw them, they fall toward the earth, rushing through the atmosphere at a tremendous speed. They become very hot from the friction of the atmosphere, and the small meteors are burned. The large ones sometimes do not entirely burn in their fall and the part that reaches the earth is called a *meteorite* (mē'tē-ŏr-īt'). You must have often seen the flash of light from a meteor—a "shooting star," as it is sometimes called,—although you know, of course, that a meteor is very, very different from a real star.

On a clear night in the Northern Hemisphere 2,000 stars are visible. Mere points of light they appear as we look at them, yet many of them are much larger than our sun. The stars appear small because they are so very far away from us. Even the nearest star is so far distant from the earth that in comparison the sun is near at hand. We need a larger unit than the mile in which to express their distance from us. If we should express it in miles, the number would be so great that we could not begin to comprehend it. For this reason, astronomers have come to use the "light year" as a unit of distance. Light travels at the rate of 186,000 miles each second. Can you imagine how far it would travel in a day, or in a year? The distance light would travel in a year is more than 63,000 times the distance lying between the earth and the sun, and amounts to about 6,000,000,000,000 (six trillion) miles. This is a light year.

The North Star is fifty light years distant from the earth. In other words, the light that reaches your eyes from the North Star left that star more than fifty years ago. Millions of stars, too far distant to be seen with the unaided eye, are visible with the telescope. With its aid, the Milky Way, which appears to the naked eye as a pale-white belt of light stretching across the heavens, is seen to be made up of millions of stars. Each star, like our sun, is a huge globe of white-hot gases giving off light and heat. Because the stars are a great distance from us, astronomers cannot tell which of them have groups of planets, but they believe that many of them do.

SOME THINGS TO THINK ABOUT

Fill in the word or words necessary to complete these sentences correctly.

1. The diameter of the earth it about ..... miles.
2. The diameter of the sun is about ..... times the diameter of the earth.
3. The earth is one of a group of ..... that revolve about the sun.
4. The two planets which are nearer to the sun than the earth are ..... and ......
5. The five planets that are farther from the sun than the earth are ....., ..., ..., ..., and ......
6. The path of a planet around the sun is called its ......
7. Planets shine by light ..... from the sun.
8. The earth revolves in its orbit once each ....., and rotates once each ......

SOME THINGS TO DO

Study an almanac to learn what you can about the sun, the moon, and the planets.

Study the sky at night to see whether you can distinguish any of the planets. If you can find one, notice its position in the sky from night to night.

Perhaps you can get a chart of the sky, and can learn to pick out some of the constellations, as groups of stars are called. You will find it interesting, if you have a book of myths, to read the stories that were invented in ancient times about the different constellations.

CHAPTER XIV

OUR NEAR NEIGHBOR, THE MOON

1. How do you think the earth would look to a person on the moon?
2. Have you ever heard stories about a man in the moon?
3. Is there really a man there?

Since very early times the moon has been an object of mystery. Curious stories have grown up about it. You have likely heard of the man in the moon. Sometimes, if you look carefully, you can see in the moon something that looks a little like a man's face. Then again, you can see something that looks a little like a woman in the moon. This explains how some of the legends started.

There is a Chinese legend of a fairy queen in the moon who sits on a golden throne. The American Indians tell us of a woman who was banished to the moon for continually asking when the world would end. A Buddhist legend tells of a hare that was set in the moon because of its kindness to Buddha. There is a myth, too, that tells how a toad, pursued by a wolf, escaped in a flying leap to the moon, where he may be seen to this very day.

Of course these stories are not true. In early times people had no way of finding out anything about the heavenly bodies, so they invented stories about them. Since then astronomers with their

THIS IS HOW THE MOON APPEARS AT THE FIRST QUARTER. NOTICE THE CRATERS IN ITS SURFACE.

telescopes have discovered facts more fascinating than the legends. For example, before 1609, when Galileo made the first effective telescope, people believed the moon to be a glass case. The telescope showed its surface to be much like that of the earth, with mountains, valleys, and openings that look like huge craters of volcanoes. Find them in the photograph of the moon which you see here.

Even to this day, however, there are people who

THE FULL MOON AS IT APPEARS THROUGH A TELESCOPE.

believe that seeds will grow better if they are planted in certain of the moon's phases—new, full, or old. They think that shingles put on a building when the crescent of the moon points upward will curl. You may have heard that a moon with points turning upward is a sign of dry weather. Many of these curious beliefs are unfounded.

Although the moon appears to be about the same size as the sun, it is really only about one-fourth the size of the earth; and the diameter of the sun, you will no doubt remember, is about 110 times as large as that of the earth. The diameter of the moon is about 2,160 miles; that of the earth is about 8,000 miles; and the sun has a diameter of nearly

864,390 miles. If the moon were as far from us as the sun is, we should not be able to see it at all. The moon, however, is but 238,840 miles from the earth, while the sun is almost 93,000,000 miles distant from us. In the last chapter, you learned that a magic airplane traveling at the rate of 100 miles an hour would require 106 years to make a journey to the sun. How long would it take this magic airplane to reach the moon?

The moon is a satellite, revolving about the earth once every twenty-nine and one-half days, and accompanying the earth on its journey round the sun. If you will watch the moon for several nights, you will observe that it appears to change in shape. Like the planets, the moon has no light of its own, but reflects the light of the sun. Half of the moon is always lighted by the sun. The shape which is visible to us is determined by how much of the lighted half we are able to see.

You can illustrate the moon's phases by holding a ball at arm's length from your body, and turning slowly around in front of a strong light. When the ball is directly between you and the light, the visible portion is dark. As you turn, a crescent-shaped, lighted portion appears. This is like the new moon. Gradually the lighted portion increases to the circular shape of the full moon. Then it decreases, becoming crescent-shaped, and finally disappearing as it again comes between you and the light.

Every twenty-nine and one-half days, the moon completes one revolution about the earth. When it is directly between the earth and the sun, its dark

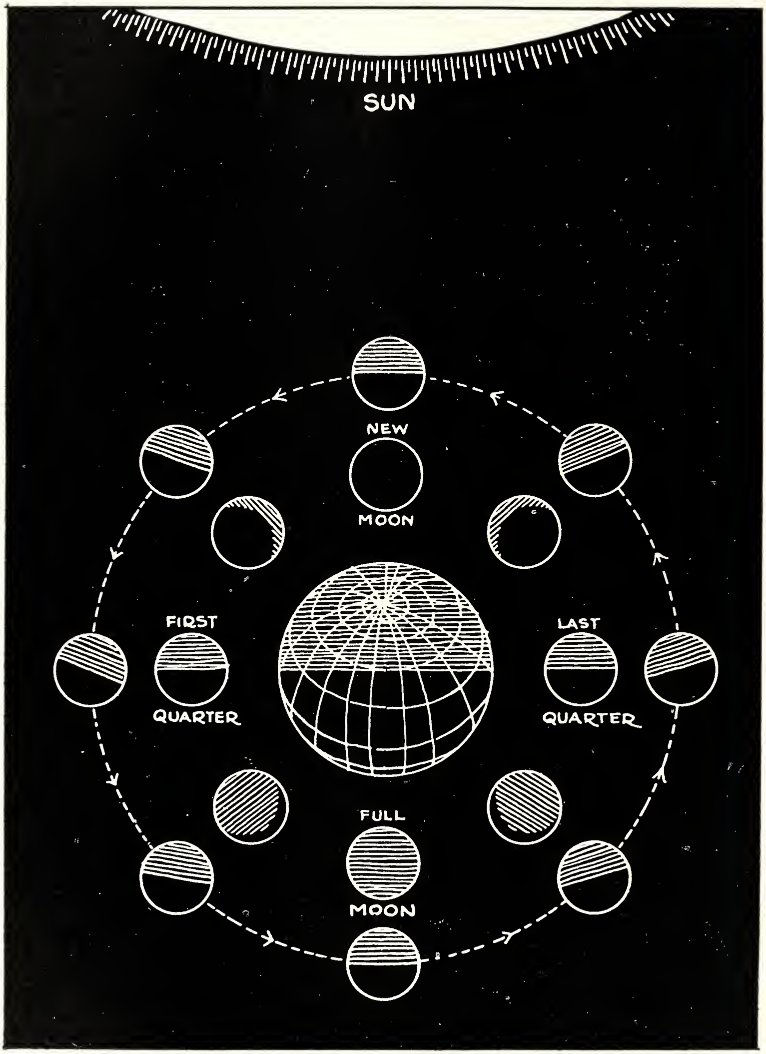
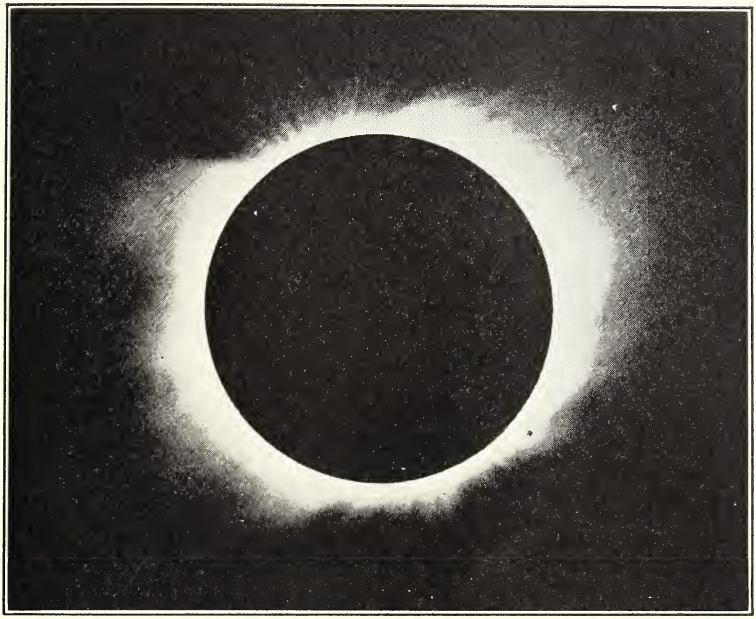


DIAGRAM TO ILLUSTRATE THE PHASES OF THE MOON.

side is toward us, and it is entirely invisible. As it continues to revolve, a tiny crescent of light appears. This is the new moon, which gradually increases in



THIS PHOTOGRAPH WAS TAKEN WHEN THE MOON WAS DIRECTLY BETWEEN THE EARTH AND THE SUN.

size until at first quarter, half the illuminated surface of the moon may be seen. More and more of the lighted surface becomes visible until we have the full moon, which turns its lighted half toward the earth and appears as a great ball of light. As it continues its trip, the lighted portion begins to recede, and we see the half-moon at third quarter, and again the crescent, which disappears as the moon once more reaches a position between the earth and the sun. The accompanying diagram will make this clear.

When the moon passes directly between the earth and the sun, it sometimes shuts off the light of the

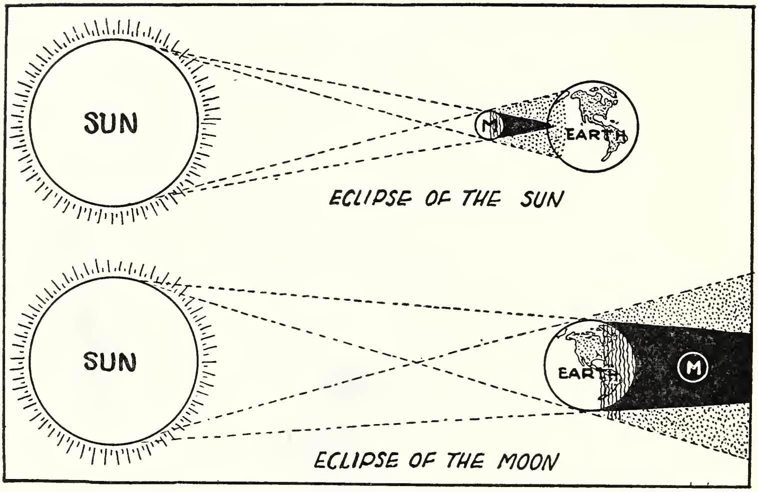


DIAGRAM ILLUSTRATING ECLIPSES OF THE SUN AND MOON

sun from a small part of the earth. This is called an *eclipse* of the sun, or a *solar* eclipse. A solar eclipse never lasts longer than a few minutes, and can only be seen from a small portion of the earth's surface—that portion which is in a *direct* line with the sun and the moon.

There are also *lunar* eclipses, or eclipses of the moon. These are caused by the earth shutting off the light of the sun from the moon, as it passes in a direct line between them. Lunar eclipses are sometimes visible for two hours or longer, and can be seen over wide portions of the earth. Can you tell from the diagram why a lunar eclipse lasts longer than a solar eclipse?

In order to make this clear in your mind, hold a large orange, representing the earth, between a small ball, for the moon, and a bright light, for the sun. This is like the eclipse of the moon. Then hold the ball between the orange and the light. This will throw a shadow upon the orange that will be similar to an eclipse of the sun.

If you have ever lived near the ocean, you know that the level of the water rises and falls regularly. This is called the *tide*. When the water reaches its highest point, it is known as *flood* tide; when it reaches its lowest level, it is known as *ebb* tide. There is usually one high tide and one low tide every twelve hours.

Tides are due to the attraction of the moon. This is one of the most interesting examples of the force of gravity, for it is the gravitation, or pulling power, of the moon, that draws the water of the earth and causes the tides.

SOME THINGS TO THINK ABOUT

Some of these sentences are true. Some are not true. On a piece of paper write the number of each sentence. If it is true, write *True* beside the number. If it is not true, write *False*.

1. When the points of the moon are turned up, we should expect dry weather.
2. The moon's surface is much like the surface of the earth.
3. The moon is really made of glass.
4. The moon is about the same size as the sun.
5. Tides are caused by the attraction of the moon for the water in the ocean.
6. An eclipse of the sun is caused by the moon coming directly between the sun and the earth.

7. The moon influences the weather.
8. The telescope has helped the scientist to discover many facts about the moon.
9. The moon revolves about the earth in its orbit.

SOME THINGS TO DO

Watch for the moon for several nights, and record the time when it rises. In almanacs, and on some calendars, you will find the time given for the new moon, the first quarter, the full moon, and the last quarter. Check these facts by your own observations.

Perform the following experiment, which will help you to understand why the shape of the moon seems to vary. In a dark room at school, or in the evening at home, ask your teacher or your father to place a candle on the table, and imagine that it is the sun. Sit on a chair several feet away from the candle. You will represent the earth. In your hand hold an orange to represent the moon. Turn your back to the candle and hold the orange at full arm's length.

Now, move about one-fourth turn to the left and draw the shape of the lighted part of the orange. Repeat this for every quarter turn until you reach the place from which you started. Do your diagrams agree with those given in this chapter? If they do not, try the experiment again.

CHAPTER XV

THE ELECTRIC BELL

1. How do you ring a door bell?
2. Have you ever examined an electric bell to find out what makes it ring?
3. What have you learned about magnets?

If you were asked to tell what makes an electric bell ring, you might say that it is the electric current. It is true that the current is necessary, but of course the bell itself must be so constructed that the current will cause the hammer to strike the gong. You will find it very interesting to examine an electric bell, or to study the pictures of the different parts shown in this chapter, to discover just how it is that the current causes the bell to ring.

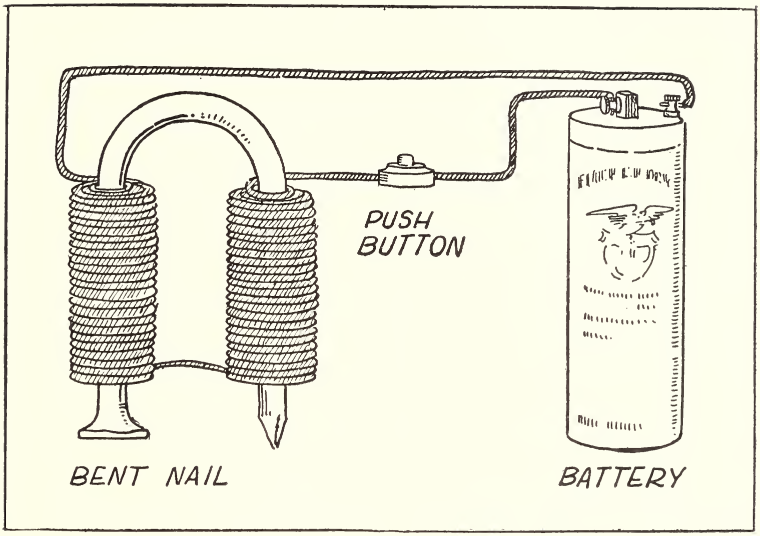
In order to do this you must first learn something about the *electromagnet,* for it is an essential part of the electric bell, and also of many other electric machines. Indeed, the electromagnet is so important a part of the telegraph, the telephone, and the electric generator and motor, that an understanding of its workings is the first step toward the understanding of any of these machines.

About a hundred years ago William Sturgeon made the first electromagnet, winding a thick copper wire about a piece of soft iron that served as a core.

Joseph Henry, a few years later, made a better electromagnet by using more turns of wire, insulated with silk. An insulated wire is one that is covered with some material that will prevent the transfer of electricity from the wire to an object touching the wire. By using a great many turns of this insulated wire, Henry made a magnet that lifted a weight of 450 pounds. The best way to learn what an electromagnet is, and to discover many interesting things about it, is by making a small one for yourself. Take a nail and bend it until it is the shape of the letter U. Wind three layers of No. 24 insulated copper wire on one end of the nail. Then wind the same amount of wire in the opposite direction about the other end. Paste a strip of paper over each coil to hold it in place.

Now connect each end of the wire to the battery. It will be easier to operate if you use a push button switch, as shown in the diagram. This button switch will serve to break the connection. The electric current will go through the coils of the wire and back to the battery again only while you are pressing the button. Your electromagnet is now ready for use.

Turn on the current and use your magnet to pick up nails or pieces of iron. Then turn off the current and watch them drop. If you have read *Book Three* of this series of science readers, you probably remember how the bar magnet could pick up pieces of iron. The electromagnet will do this, too, as long as the current is passing through it. When you break the current by removing your fin-



HOW TO MAKE A HOME-MADE ELECTROMAGNET.

ger from the push button, or in some other way, the electromagnet will drop the iron. It is a magnet, you see, only while the electric current is passing through it. An electromagnet can be made not only to pick up pieces of iron, as a permanent magnet does, but to drop them as well.

Examine the picture of the electric bell. You will see the electromagnet with its coils of insulated wire. Notice also the *armature* (är′mă-tūr). This is a strip of soft iron, so placed that when the electromagnet draws it forward, it causes the hammer to strike the gong. The hammer, you will notice, is attached to one end of the armature.

The armature, being made of iron, is attracted to the electromagnet while the current is on, as it is

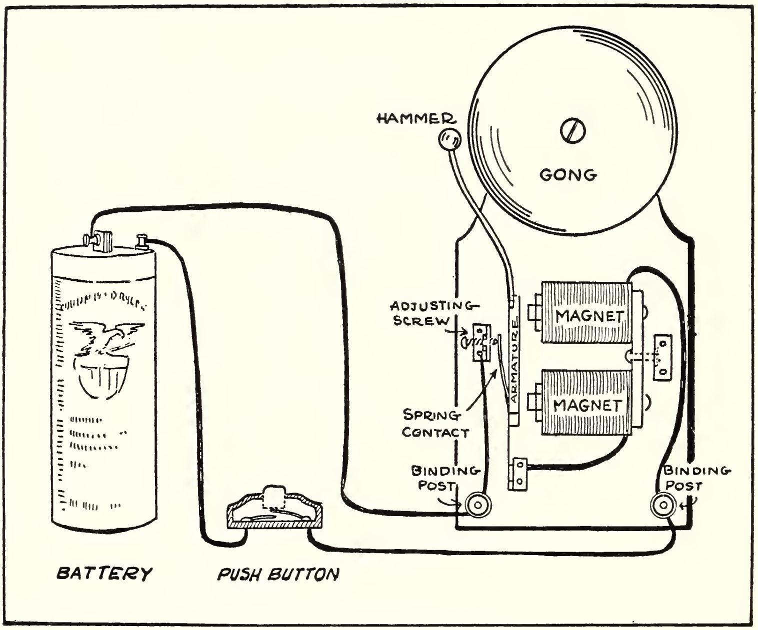


DIAGRAM OF AN ELECTRIC BELL.

when you press the button switch. However, as the armature is drawn to the magnet, the current is broken, not at the switch, but in the bell itself. Study the picture carefully to see if you can discover how this is done.

Notice the spring attached to the armature. In the picture, it touches the adjusting screw. One wire from the battery is attached to the wire that forms one coil of the electromagnet. The wire that forms the other coil of the electromagnet makes a contact with the spring that is attached to the armature. From the spring, the current runs through the adjusting screw to a wire that carries it back to the battery. Can you trace the path of the current in the picture?

When the armature is drawn to the magnet, the spring is pulled away from the adjusting screw, and of course the current is then broken. When the current is broken, you will remember that the armature is no longer attracted to the electromagnet. It is pulled back into place by the spring, which again touches the adjusting screw. This closes the circuit, the electromagnet attracts the armature again, and the process is repeated.

Of course, this whole process, requiring many words for its description, takes place several times in every second. The armature moves back and forth very quickly, causing the hammer to strike the bell rapidly. The ringing will go on until the circuit is broken by taking your finger off the push button switch, or in some other way.

The buzzer, used in homes and offices when the loud ringing of a bell is not needed, is similar to an electric bell. It has an electromagnet and an armature, but it has no hammer and gong. Instead, the armature itself makes the buzzing sound that serves as a signal.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. The electromagnet was invented by ..... about ..... years ago.
2. Joseph Henry, a few years later, ... the electromagnet by using more ......

3. In an electric bell, the electromagnet attracts the ......
4. When the armature touches the ....., the current is cut off.
5. Then a ..... pulls the armature away from the ......
6. The electric current needed to operate a bell is usually obtained from a ....

SOME THINGS TO DO

A toy electromagnet can be made by following the foregoing directions.

Place a door bell in one room and connect it to a push button in another. If it does not work, look for loose connections, and check with the diagram in this chapter to see whether it is correctly wired.

If you have a toy electric train with a bell, trace the path of the electric current to and from the bell.

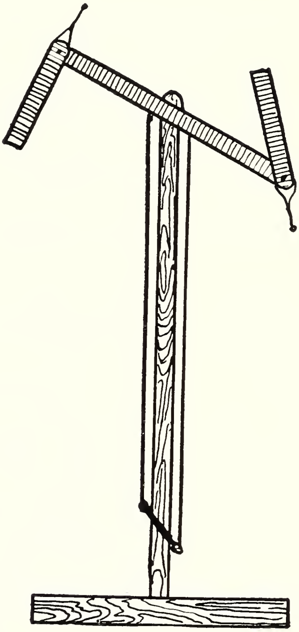
CHAPTER XVI

THE TELEGRAPH AND ATLANTIC CABLE

1. Can you tell an interesting story about message-sending in early times?
2. Have you ever sent a telegram? Tell about it.
3. If you have seen a telegraph instrument, describe it and tell how it is used.

From very early times people have sent messages to each other. The messengers of savage tribes sometimes carried notched sticks to express the message. The Indians, by smoke or drum signals, warned each other of the approach of enemies, or of other dangers. Scottish clans were called to battle by a messenger with a fiery cross. You can find no end of fascinating stories of the interesting ways of message-sending in the early days.

In 1792, Claude Chappe, a Frenchman, invented a message-sending device which was a great improvement over the methods then in use, and which was used by the French government for many years. This device consisted of a pole at the top of which was a horizontal cross beam. At each end of the beam was a movable pointer that could be moved to various positions by a string attached to it. The letters were represented by different positions of pointers, very much like flag-signaling to-day. About a thousand words could be spelled out in an hour by an efficient operator.



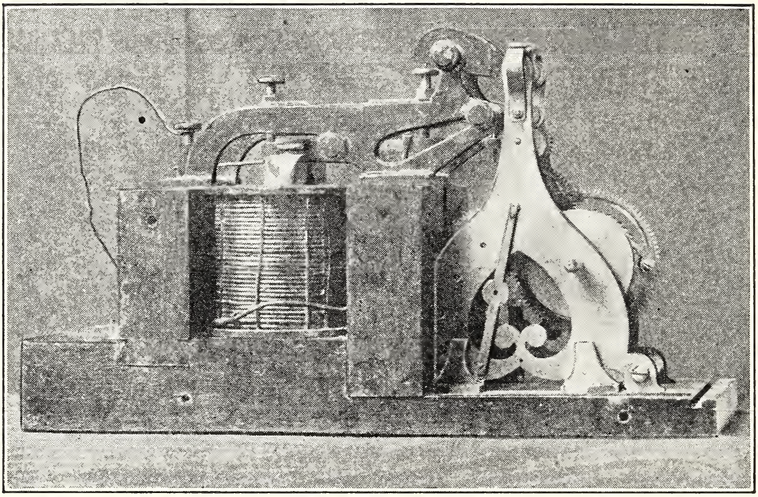
IN THE CHAPPE MESSAGE SENDER, LETTERS WERE REPRESENTED BY DIFFERENT POSITIONS OF THE ARMS.

These simple instruments were placed on towers built on hills about three miles apart. By repeating the signals from tower to tower, messages could be sent long distances. Lights were hung on the pointers, making it possible to use the system by night as well as by day. Along the coast of France and round about Paris, this system extended some 1,400 miles.

Many years before Chappe's invention, however, men had been experimenting with electricity to see whether it could be used for sending messages. In 1819 Oersted of Copenhagen, Denmark, discovered that when a magnetic needle is brought close to a wire through which an electric current is passing, the needle has a tendency to place itself at right angles to the wire. Using this principle, Sir Charles Wheatstone of England, in 1837, invented an electrical telegraph, which consisted of a coil of wire with a needle suspended in it. As the current passed through the coil, the needle was pulled to one side or the other, depending upon the direction of the current.

You will remember that William Sturgeon of England in 1825 made the first electromagnet. From what you have already learned of the electromagnet, you will see that by means of it a signal can be sent as far as a current of electricity will travel over a wire. In 1831 Joseph Henry discovered how to send an electric current a great distance over a wire, and the next year he constructed an electric telegraph in which signals were transmitted by means of an electromagnet. His machine was little more than a toy. Around the inside of his laboratory, he placed two pairs of copper wires, each a mile long. By means of the current passing through these wires, he was able to make an electromagnet tap out signals. This simple instrument was the basis for the invention of a practical and useful telegraph.

To Samuel F. B. Morse, an artist, goes the credit for inventing the telegraph which supplanted other systems and which, with minor changes, is the telegraph in use to-day. While returning from Europe in 1832, he worked the instrument out on paper. The receiving instrument consisted of an electromagnet



THIS IS THE ORIGINAL MORSE RECEIVER USED IN THE WASHINGTON-BALTIMORE LINE.

and an armature, which, as you see in the picture, were arranged to operate much as do the electromagnet and armature in an electric bell. The instrument for sending the message was simply a key which closed and opened the circuit, just as the push button switch permits current to pass through the wires when pushed, and cuts the current off when released. A moving paper tape, which formed a part of the receiving instrument, recorded the opening and closing of the circuit. The signals were known as dots and dashes, the dots representing the closing of the circuit, for an instant only, and the dashes representing a longer contact.

For several years, Morse worked on his device, first alone and then with the assistance of Alfred Vail. Finally, there was a satisfactory working model. The Morse code of dots, dashes, and spaces was also developed. In 1843 Congress granted $30,000 for the construction of a telegraph line between Washington and Baltimore. The first plan was to lay the wires underground, but this attempt failed because of defective insulation. It was Ezra Cornell, the founder of Cornell University, who suggested that the wires be fastened to the limbs of trees, using the necks of bottles for insulation. This plan was followed; the line was completed in 1844, and on May 24, Morse sent over the wire from Washington to Baltimore, the historic message to Vail, "What hath God wrought!" and Vail sent the same message back to him.

It was a great occasion. The usefulness of the telegraph had been demonstrated, but it was not until 1856 that the Western Union Telegraph Company was organized and the development of the system begun in earnest.

In 1858 there came a wonderful improvement in the telegraph. J. B. Stearns invented a device by which a message could be sent and another received over the same wire at the same time. Then Thomas A. Edison discovered a way by which four messages could be sent at one time, two in each direction, over the same wire. At the present time, eight messages can be sent over a single wire, four in each direction.

The Atlantic Cable

As soon as the telegraph was perfected, and while lines were under construction all over the land, scientists began to think of laying insulated wires in the bottom of the sea, making it possible to send messages across the ocean. It seemed as though it would be necessary simply to find the right insulation and get the wire across.

In 1842 Morse laid a cable in the New York harbor. In 1850 England and France were connected by cable. In 1852, F. N. Gisbone, requiring money for his project of connecting New York and Newfoundland, sought the aid of Cyrus W. Field, whose enthusiasm was so aroused that he undertook the still greater task of connecting Europe and North America by a cable line laid across the Atlantic Ocean.

Seven insulated copper wires were wound with tarred hemp, and were placed in a tube of heavy iron wires, as shown in the diagram. After two discouraging and unsuccessful attempts, the cable was finally laid on August 5, 1858. President Buchanan and Queen Victoria sent messages to each other, and there was great rejoicing. But while the event was still being celebrated, the cable failed to work. The voltage of the electric current that had been used was too high, and it had ruined the insulation.

In 1864, after improvements had been made in the cable instruments, Field organized a new company to make another attempt to lay the cable. When the task was two-thirds completed, the wire broke and was lost; finally, in 1866, the work was completed, and since that time cable service between Europe and America has been continuous.

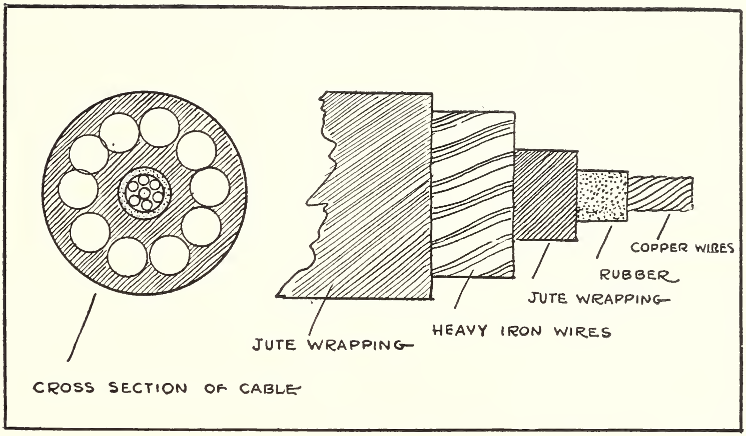
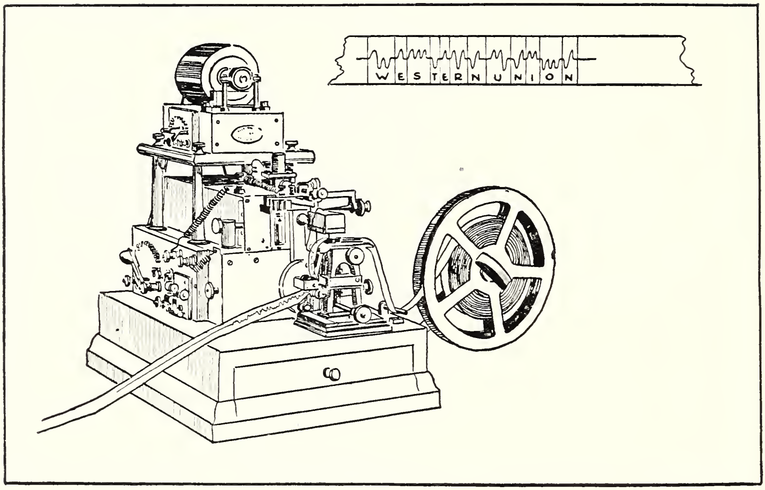


DIAGRAM TO SHOW THE CONSTRUCTION OF THE ATLANTIC CABLE.

The problem of sending messages across the ocean was much more difficult than was the problem of sending them over the land. The distance is great, and the voltage of the current used must be low in order not to destroy the insulation of the wires. The instruments used to send and receive messages must be much more complicated than the telegraph. Messages are received by means of a mirror *galvanometer* (găl-vă-nom′ ĕ-tĕr), an instrument based upon Oersted's discovery about the magnetic needle. In the galvanometer are many turns of insulated copper wire in the form of a hollow coil. In the center of the coil, a needle is suspended. This needle is deflected to right or left, depending upon the strength of the current. The receiver for cable messages is, of course, much more complicated than this description would lead you to suppose; yet the tiny coil and the magnetic needle are essential parts,



A MODERN CABLE-RECORDING INSTRUMENT IS A COMPLICATED MACHINE.

and they indicate the principle upon which the receiving instrument operates. The galvanometer can be operated by an electric current of much lower voltage than can the sounder of a telegraph.

In the picture you see the delicate recording instrument of the cable, with the tape attached. In the upper corner is a portion of the tape, with the heavy black line showing the dots and dashes.

To-day telegraph lines connect not only the great cities, but nearly all of the small cities and towns of the United States. What a great saving of time this means! In less than an hour a message can be sent across the entire continent. Without the telegraph and the cable it would not be possible to carry on the business of the world as it is carried on to-day.

SOME THINGS TO THINK ABOUT

Pick out the correct ending for each sentence:

1. Claude Chappe invented a device for sending messages { by electricity. / by signals from towers. }

2. Sir Charles Wheatstone invented a telegraph that signals by means of { a magnetic needle. / an electromagnet. }

3. Samuel F. B. Morse invented a a telegraph that signals by means of { a magnetic needle. / an electromagnet. }

4. The first telegraph line in this country ran { from Baltimore to Washington. / from New York to Philadelphia. }

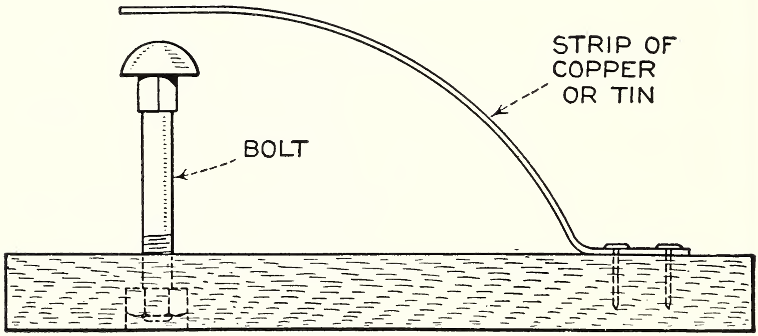
5. The Atlantic cable signals by means of { a magnetic needle. / an electromagnet. }

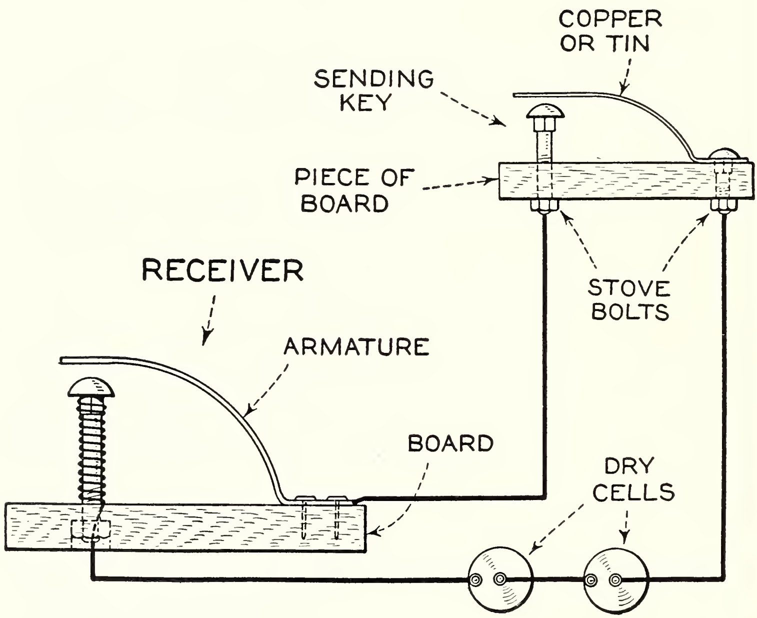
SOME THINGS TO DO

Obtain some blank sheets for sending messages from the nearest telegraph office. On the back of the blanks you will find the different kinds of service described. Read about them and tell some use for each.

If you have a telegraph set in your school, place the instrument with the key for sending messages in the front of the room and the sounder for receiving them in the back of the room. Connect the two instruments with insulated copper wire to a dry cell. The diagram will show you how

RECEIVER BEFORE WIRING





the connection is to be made. Try to find out what happens when the sending key is pressed. What causes the bar on the receiving set to click?

You will be surprised to learn that you can easily make a telegraph set that will work. It will not be difficult, either, to find the materials for it. All that you need for the receiving set is a piece of board four inches by ten inches, a bolt or spike about six inches long, a hundred feet of No. 20 insulated copper wire, a screw, and a piece of thin copper about one inch wide and eight inches long.

Fasten the bolt to the board, as shown in the diagram, and wrap it with the insulated wire, leaving two long ends of wire to connect to the dry cell. This bolt, with the coil of wire about it, is to be your electromagnet. Now bend the copper as shown in the diagram, and screw it to the board. This is the armature. If you do not have the copper, you can substitute a strip cut from an old tin can. Adjust the armature so that there is about one-half inch space between it and the electromagnet. This is your receiving set.

The sending key is still easier to make. You will need a piece of board about four inches by six inches, two stove bolts, and a piece of copper or tin about five inches long and an inch wide. Bore two holes in the board for the stove bolts, and a hole in one end for the copper. Fasten one end of the copper to the board and bend the other end as shown in the diagram.

Place the sending key in the front of the room and the receiving set in the back. Connect them with the dry cell according to the diagram, and your telegraph set is ready for use.

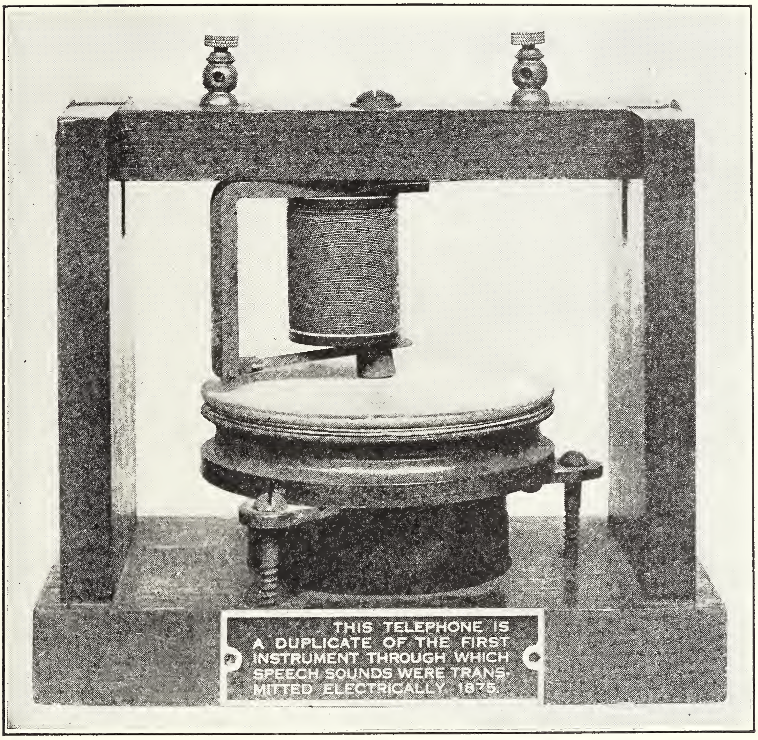
CHAPTER XVII

THE TELEPHONE AND RADIO

1. Have you ever wondered how the telephone works?
2. Have you ever looked inside your radio set?

In the attic of an electrical shop in Boston, on the second day of June, 1875, Alexander Graham Bell worked with his assistant, Thomas A. Watson, to perfect a telegraphic instrument that would send a number of messages over one wire. They were experimenting with metal reeds and were having only fair success. One of Watson's reeds stopped vibrating. He plucked at it, intending to adjust it. Suddenly, Bell rushed in from the room where he had been working with the receiving set. His acute ears had caught the faint melodious twang of the reed Watson had been plucking. The principle of the telephone had occurred to him.

The mechanism of the first telephone was simple. Look at the pictures of a model of Bell's first telephone instrument. It was nothing more than an electromagnet that had a permanent magnet for its core, with a circular piece of soft iron mounted in front of it. Bell used one of these simple instruments for a *transmitter,* or sending device, and another for a *receiver.* No doubt they seem very much like toys to you, and you would not find it difficult to construct similar instruments and to set



Courtesy of the New York Telephone Co.

THIS IS A MODEL OF THE FIRST BELL TELEPHONE.

them up so that you could use them. Let us see how these simple telephones worked.

When you speak, the vibration of your vocal cords sets up waves in the air. When these waves strike the sensitive drum in the ear, the drum vibrates and sound is heard. In the telephone instrument, the sound waves made by the voice caused the soft iron disc to vibrate. Back of the iron disc was the electromagnet with a permanent magnet for its core. You have already learned that the strength of a magnet is changed by moving a piece of iron close to it, and then pulling it away. As the iron disc vibrated, it moved rapidly, first approaching the magnet, and then moving farther away. This vibration caused a change in the strength of the permanent magnet, which in turn changed the strength of the current flowing through the wires of the electromagnet.

Of course, the two telephone instruments were so connected that the electric current made a complete circuit from the battery through the telephone instruments and back to the battery again.

When the strength of the current was changed in the transmitter, this current, flowing to the receiver, changed the strength of the electromagnet there. As the electromagnet in the receiver increased in strength, its attraction for the iron disc increased, and vice versa. Thus, the fluctuating current set up a vibration in the iron disc of the receiver similar to that produced by the sound waves in the disc of the transmitter. This vibration of the iron disc in the receiver set up waves in the air, causing sounds similar to those which started the vibration in the disc of the transmitter.

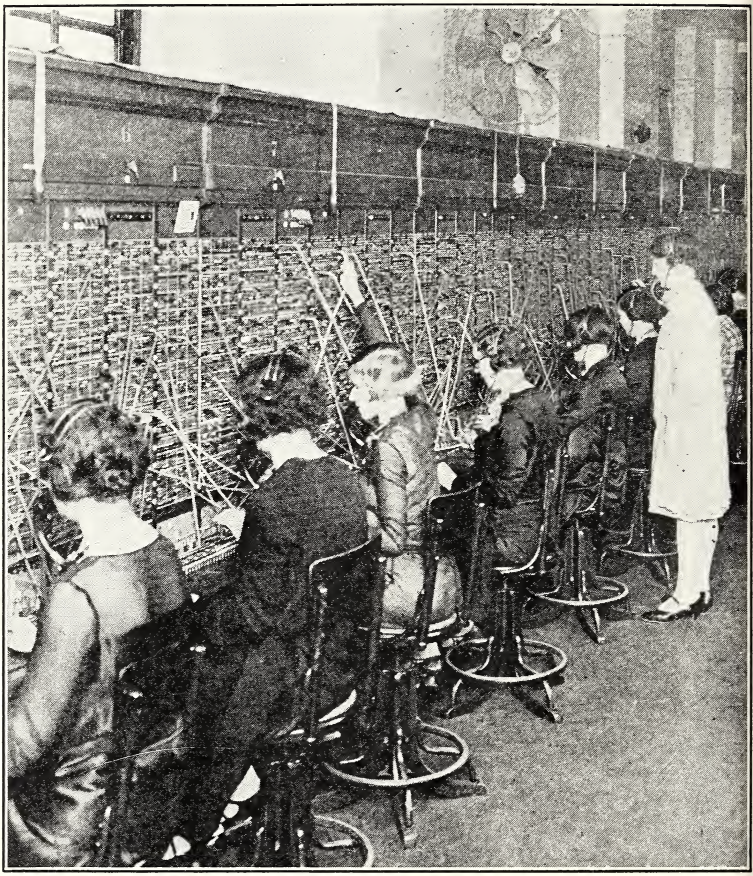
From this, you will see at once that sound waves themselves did not travel over the wires at all. Through the wires flowed an electric current of varying strength, setting up a vibration in the receiving instrument which caused sound waves.

In 1875 people knew much less about electricity than they do to-day. Bell's first telephone instruments were exceedingly simple, but when they were exhibited at the Philadelphia Centennial Exhibition, which was held in 1876, they excited a great deal of wonder. They were described in all the newspapers, and the next year the Bell Telephone Company was organized to put the device into practical use.

The first out-of-door line connected the Williams Electrical Shop, in the attic of which the first telephone was made, with the home of the owner in Somerville. Then two telephones were ordered in Charlestown, and a little later six were lent for use as a burglar-alarm system. For these six telephones the first crude telephone exchange was established. Soon telephones were installed and exchanges were built in New Haven, New York, and Philadelphia, and by the fall of 1877, more than 700 telephones were in use.

The exchange or "central" is an important part of a telephone system. Without it, there would have to be a wire from every telephone instrument to every other one with which it had any connection. It is much simpler to connect each telephone with the exchange.

When you tell the girl at the exchange the number of the telephone with which you wish to be connected, she is able to connect the wire from your telephone with the wire from theirs. This sounds very simple, and it is true that the early switchboard or exchange was a simple device. It worked very well for the few telephones then in use, but as the number of telephones increased, the switchboard became more complicated. Nearly a thousand patents have been taken out in the construction of

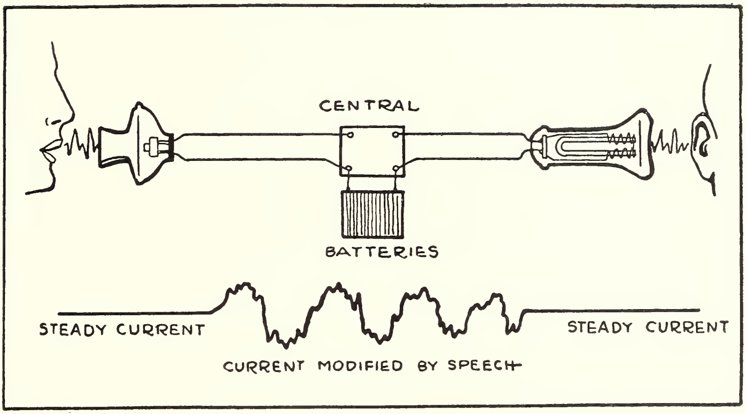


Courtesy of the New York Telephone Co.

THE TELEPHONE EXCHANGE IS THE HEART OF THE MODERN TELEPHONE SYSTEM.

the great switchboard which is in use in the modern telephone exchange.

Moreover, in large cities to-day telephone-exchange girls are being replaced by machines which do their work. There is an automatic system of making a connection which is worked by a dial on



HOW THE TELEPHONE WORKS.

the telephone instrument. This automatic system is being introduced very rapidly.

Just as the present-day switchboard is more complex than the original one, so the telephone instruments in use to-day are more complicated, more effective, and more convenient to use than were Bell's original instruments. However, the same scientific principles are involved in their operation.

As you know, the receiver and the transmitter are no longer alike in construction. When you speak into the mouthpiece of your telephone, the sound waves cause the thin disc to vibrate, just as the disc vibrated in Bell's original instrument. However, in the present-day transmitter, instead of an electromagnet there is just back of the disc a box filled with pulverized graphite, which is really tiny bits of carbon.

Through this box a weak current of electricity is flowing. As the disc vibrates it alternately pushes against the carbon, pressing the little pieces closer together, and releases them again to fall back into a looser position. As the bits of carbon are pressed together, a stronger current flows over the wire, and as they are released the current becomes weaker. Thus, the result is an electric current which fluctuates with the sound waves just as in the original transmitter, but the box of carbon is a more effective way of producing this fluctuating current than was the electromagnet in Bell's original transmitter.

Wireless Communication

The telephone seemed at first almost too wonderful an instrument for people who had not seen it to believe that it really existed. However, the next step in message sending was even more amazing, for scientists next discovered that it was possible to reproduce sounds at distant points without the aid of wires.

As you know, the sound wave does not travel over the telephone wires at all. Through the wire flows an electric current which is able by means of the receiving apparatus to set up sound waves similar to those which caused vibrations in the sending instrument.

You will remember that sound is caused by waves in the air. Sound waves can travel only a limited distance, and they are blocked by solid objects. Scientists have discovered other waves, however, known as wireless or radio waves, which circle the earth, passing through walls and other solid objects and probably continuing out into space. Sound waves travel at the rate of about 1,125 feet per second, the rate varying somewhat with the temperature of the air. Radio waves travel much more rapidly. Their speed is about equal to that of light, or 186,000 miles per second.

When the existence of radio waves was discovered, scientists saw at once the great importance of finding out how sound waves could be changed into radio waves, which could travel so rapidly and so far, and at some distant point be changed back again into sound waves. They knew that this would solve the problem of communication at great distances without the aid of wires.

Like all other great discoveries, wireless communication was not the result of one man's work, but rather of many discoveries made by various scientists over a period of years. It is not possible in this short chapter to tell you the whole story of wireless. Step by step, first one student and then another contributed something to the solution of the problem, until finally in 1896 Guglielmo Marconi, an Italian, invented a wireless telegraph by which he was able to send dots and dashes for some distance by means of wireless waves.

Nor is it possible in the short space which we have here to explain the scientific principles involved in the operation of all the complicated apparatus which is used to send out and to receive wireless messages. However, here is a diagram of the most essential parts of a broadcasting station and of a radio receiving set.

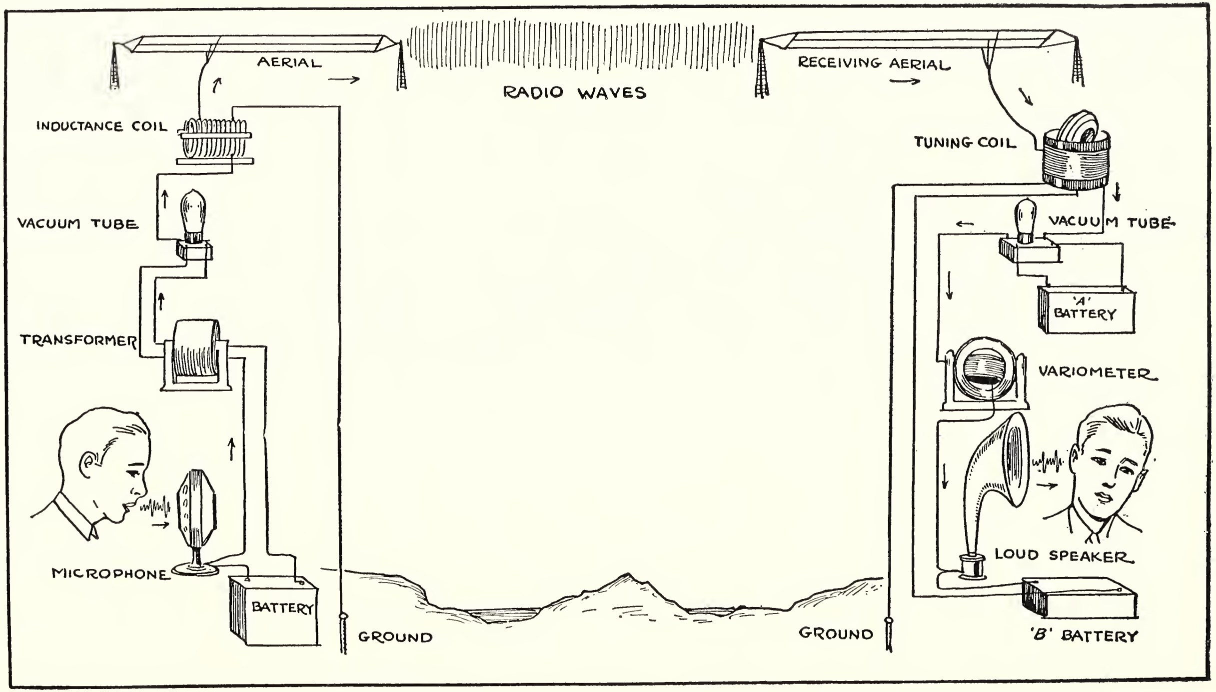


DIAGRAM SHOWING ESSENTIAL PARTS OF RADIO TRANSMITTING AND RECEIVING STATIONS.

Radio waves may be thought of as being somewhat like the waves caused in the water of a pond by throwing a stone into it. The broadcasting station is the stone that starts the waves. In the broadcasting station there is the microphone with parts that vibrate with the sound waves. From it an electric current passes through a wire to the transmitter where the radio waves are set up. The vibrating parts of the microphone cause the electric current to fluctuate at the same rate as its parts are vibrating with the sound waves. On the way from microphone to transmitter, the current passes through a transformer, which gives it a higher voltage, and through a vacuum tube, which speeds up the rate of the fluctuation in the current enormously. Sound waves vary in rate or frequency from 16 to 40,000 per second. Waves of a lower frequency than 16 per second or of a higher frequency than 40,000 produce no effect upon our ears. Radio waves vary from a few thousand to several millions per second.

Radio waves are set up in the transmitter, and are thrown off into space from the antenna after they have been adjusted in frequency and length by the vacuum tube and the inductance coil. There is always a definite relationship between the frequency and the length of radio waves. The shorter the waves, the higher the frequency. The antenna is the group of wires held high in the air by the tall masts which you usually see at broadcasting stations.

The radio waves sent out from the antenna of the broadcasting station are caught by the antenna of the receiving set which is tuned to the same wave length and frequency that is being sent out. A vacuum tube is used in the receiving set to change these radio waves to a lower frequency so that they can be transformed in the loud speaker or the earphones back into the sound waves which you hear when you tune in your radio. The A and B batteries supply the electric current for the vacuum tube and for the loud speaker or the earphones.

No doubt you are wondering just how the vacuum tube works to change the wave frequency, how the inductance coil adjusts the wave length, and how the transformer changes the voltage of an electric current. Before you can understand these radio mysteries, however, you will have to know more about electricity than you do now, and you will learn this as you continue your study of science. If you do not want to wait to find out more about how the various parts of your radio set work, you can read *The Book of Electricity,* by A. F. Collins, which tells you many interesting things about electricity, and *The Book of the Wireless Telephone and Telegraph,* by the same author, which explains in detail the mechanism of sending and receiving wireless messages.

SOME THINGS TO THINK ABOUT

Here are ten beginnings for sentences and fifteen endings. On a piece of paper write the number of each beginning, and opposite the number write the correct ending.

If more than one ending is correct for any beginning, write them both.

1. The telephone wire	1. was invented by Marconi.
	2. sends out radio waves.
2. Sound waves	3. causes the disk in the telephone transmitter to vibrate.
3. The telephone	4. intercepts radio waves.
	5. travels along the telephone wires.
4. The wireless telegraph	6. was invented by Alexander Graham Bell.
	7. supplies the electric current.
5. The loud speaker	8. was produced by an electromagnet with a permanent magnet for its core.
6. The vibration of the vocal cords	9. travel faster than sound waves.
7. In Bell's original instrument, the fluctuating electric currents	10. was produced by a box of pulverized graphite.
	11. transforms radio waves into sound waves.
8. Radio waves	12. carries the electric current.
	13. transforms sound waves into radio waves.
9. The antenna at the broadcasting station	14. are caused by vibration of molecules of air.
10. The antenna at the receiving station	15. travel more slowly than sound waves.

SOME THINGS TO DO

Examine a telephone transmitter and find the parts mentioned in the chapter. Remove the cap that holds the disk to the receiver, and look at the magnet and coil. Always hold the receiver hook down if you experiment with an instrument that is connected.

Make two telephone instruments similar to Bell's original instruments. Connect them and see if you can make them work.

Make a diagram to show how six houses could be connected by telephone with and without a central switchboard.

Examine a radio set to see the parts mentioned in this chapter. You may be able to construct a simple set for yourself.

CHAPTER XVIII

LOCOMOTIVES AND TRANSPORTATION

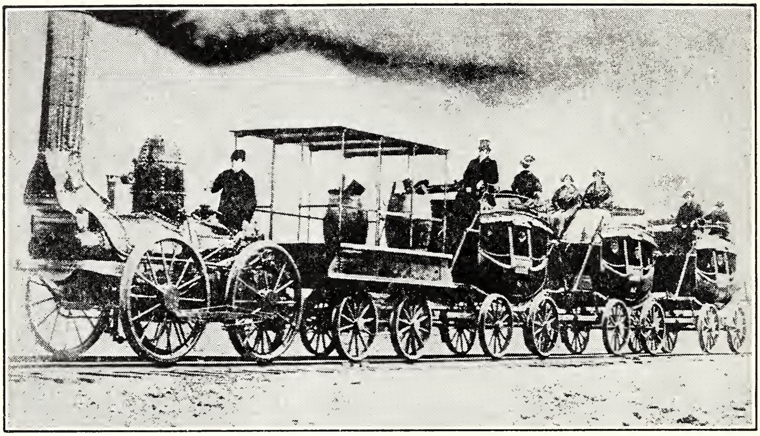
1. Have you ever played with a toy electric train?
2. What furnishes the power to make it run?
3. What furnishes the power that enables the great engines on the railroad to pull their heavy loads?

Way back about 1850 there was a song that was sung everywhere. It was called: "Don't You Find It Pleasant Riding on a Rail?" It mentioned, among other things, "dashing through the forests at fifteen miles an hour!" and it celebrated the exploits of the first railway trains.

When you look at a picture of the first passenger locomotive built in America, you will not be surprised to learn that a speed of fifteen miles an hour was considered really dangerous, for this first locomotive looks more like a toy engine than a real one, and a very old-fashioned one at that. Compare the picture of the *DeWitt Clinton,* as this first locomotive was called, with the picture of the modern locomotive. Doesn't this help you to understand the tremendous improvements that have been made in modes of travel?

Steam Locomotives

Like the first telephone, the first locomotive was the result of the work of several persons. Since

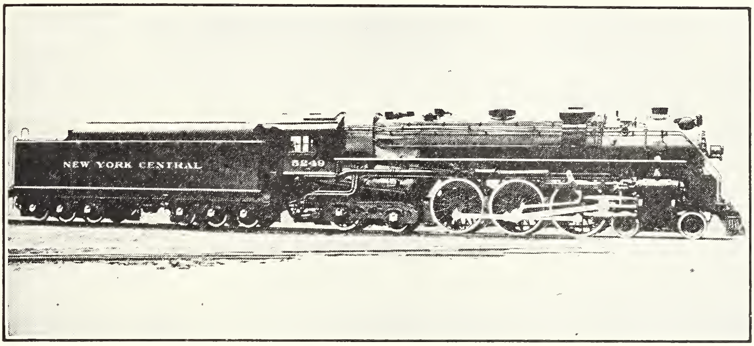


Courtesy of New York Central Lines.

THE DE WITT CLINTON WAS THE FIRST PASSENGER ENGINE BUILT IN AMERICA.

very early times men have known of the power of steam and have used it to help them in their work. Between 1765 and 1776, however, James Watt, a maker of mathematical instruments in Scotland, made such great improvements upon a steam engine that was brought to his shop for repair, that he has come to be known as the inventor of the steam engine.

Let us see how this old engine worked, and what the improvements were. The engine that was brought into James Watt's shop for repair consisted of a boiler, where steam was generated, and of a cylinder fitted with a sliding piston. The steam was admitted to the cylinder at one end, forcing the piston head to the other end. Then a valve was turned that released a spray of cold water into the cylinder. This valve was turned by hand. The



Courtesy of New York Central Lines.

MODERN LOCOMOTIVES HAVE GREAT POWER AND SPEED.

cold water condensed the steam and created a vacuum in the cylinder. The pressure of the air filling the vacuum forced the piston head back to its original position. Then the valve was closed and the steam pushed the piston forward once more; the valve was opened, and the piston was forced back. So the process went on, producing a jerky back-and-forth motion of the piston head.

James Watt made several improvements upon this engine. The most important was a device to admit the steam first at one end of the cylinder and then at the other, thus moving the piston by steam pressure alone. In principle this engine was exactly like the ones in use in the great locomotives of to-day.

Not long after Watt made his improvements in the steam engine, someone found a way to make the moving piston turn the wheels of a locomotive, which in turn could pull other vehicles. During several following years, various experimental locomotives were made. In 1802 a real steam locomotive was built and was actually used to haul a wagon loaded with passengers through the streets of London.

Then came the work of George Stephenson, who built the *Blücher*—a locomotive that could haul thirty tons at four miles an hour up a grade of one foot to every 450 feet, and the *Rocket,* which could haul a load of thirty-six passengers and thirteen tons of freight at a speed of thirty miles an hour. In England the Stockton and Darlington Railway and the London and Manchester Railway were built.

You can imagine that in the United States where the roads were poor and the distances great, people followed Stephenson's experiments with a great deal of interest. From 1829, when the first railroad was used in this country, steam transportation developed rapidly in the United States. In 1849 a railroad from New York to Boston was completed. The year 1869 marked the completion of a transcontinental railroad connecting the Atlantic and the Pacific coasts. To-day there are in the United States more than a quarter of a million miles of railroad.

Look at the diagram of the working parts of the locomotive. There is the firebox and the boiler in which steam is generated. From the heat produced by the fuel in the firebox, the water in the boiler is converted into steam. Then there are the cylinders, where the steam is used to move the pistons back and forth; and there are the great driving wheels of the locomotive, the turning of which enables it

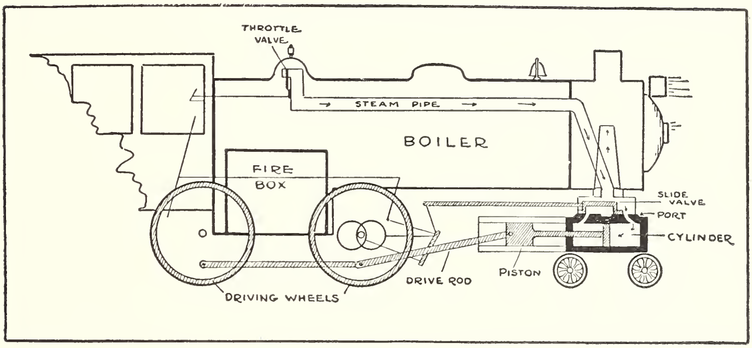
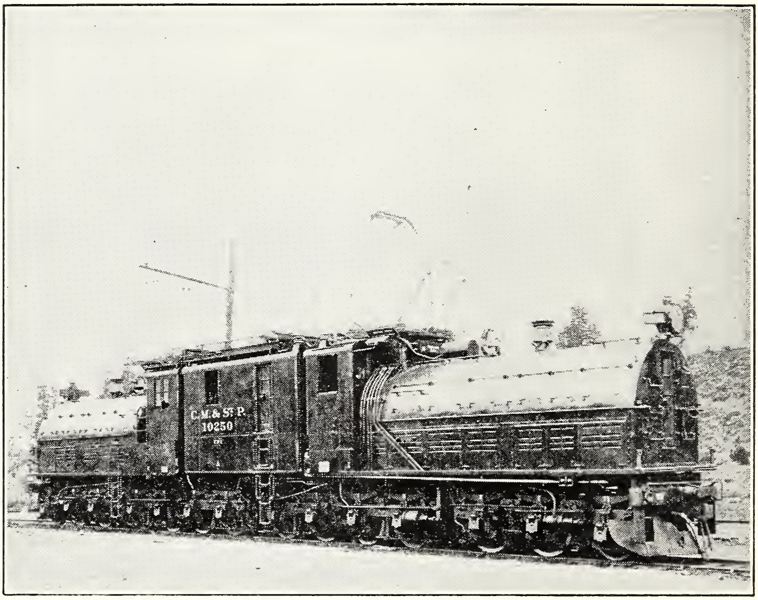


DIAGRAM SHOWING MAIN WORKING PARTS OF A LOCOMOTIVE.

to move and to pull its heavy loads. The firebox and the boiler produce the steam, and all the other parts are used to change the energy of the steam into the motion of the driving wheels.

From the boiler the steam enters the steam chest, from which there are two openings into the cylinder. These openings are called ports. Steam enters the cylinder from one of these openings, pushes the piston to the other end, and passes out of the second port into the exhaust. Over these openings is a slide valve that automatically reverses this process, allowing the steam to enter the second port and pass out through the first, and thus pushing the piston back to its first position. You can see in the diagram how this works.

By means of heavy driving rods, the piston rods are connected to the great driving wheels of the locomotive, so that the movement of the pistons back and forth moves the driving rods, and these, in turn, move the wheels. Study the diagram to see how this could be. You will find it interesting, too,



Courtesy of Chicago, Milwaukee and St. Paul R. R.
ELECTRIC LOCOMOTIVES ARE BEING USED MORE AND MORE FOR DRAWING OUR TRAINS.

to look carefully at the next locomotive you see moving slowly, for on it you will see the driving rods turning the driving wheels. In the early locomotives but one pair of driving wheels were used; now two or three pairs are common. They are so joined that they turn together.

Of course a locomotive has many other parts. There is a safety valve, which allows the steam to escape from the boiler when it reaches a certain pressure. Otherwise there would be danger of the pressure becoming too great and bursting the boiler. There is the throttle, by which the engineer regulates the amount of steam that goes to the cylinders and so controls the speed of the locomotive. Later, you will want to know more of all of these interesting parts.

Have you ever seen an electric locomotive? Here is a picture of one which has the pulling strength of about 4,000 horses. It is one of the largest electric locomotives in the world. It is 94 feet long, and weighs 715,000 pounds.

The electric locomotive has no firebox and no boiler. Instead of getting its power from steam, it gets it from electricity, and the current is supplied either from an overhead wire or from a third rail. In cities, electric locomotives have been used for some time, because they are not so noisy as steam locomotives, and because they do not give off smoke. Several of the railroads in the western part of the country have been electrified, and some railways in other parts of the country are now being electrified.

SOME THINGS TO THINK ABOUT

Here are some beginnings of sentences. Below are some endings. Put them together so that all the statements are true.

1. James Watt is known as
2. Steam is the means of
3. George Stephenson was
4. Steam is generated
5. Piston rods transfer the energy
6. The throttle operated by the engineer

1. the builder of the *Rocket,* one of the first locomotives.
2. moving the piston rod back and forth.

3. in the boiler from heat produced in the firebox.
4. the inventor of the steam engine.
5. turning the wheels of the locomotive.
6. to the driving wheels by means of the driving rods.
7. by means of the safety valve.
8. controls the amount of steam that goes to the cylinders.

SOME THINGS TO DO

Draw a diagram of the working parts of a locomotive, and explain how the steam makes the driving wheels turn.

Look carefully at the next slowly moving locomotive you see. Explain how the driving rods, which move back and forth, turn the wheels round and round.

If you have an electric toy train, bring it to school. Find out from the engineer in the building whether the voltage of the current is such that you can operate your train in the schoolroom. If it is, connect the train. Tell how the electric current reaches the working parts of the train. If you have signals or lights, tell how the current reaches them.

CHAPTER XIX

THE WORK OF THE WEATHER BUREAU

1. Have you ever made plans which you could not carry out on account of the weather?
2. Have you ever used the weather forecast in the paper to help you in making plans?
3. In what way is it of value to fruit-growers to have a forecast of weather conditions? to shipping companies? to railroad companies?

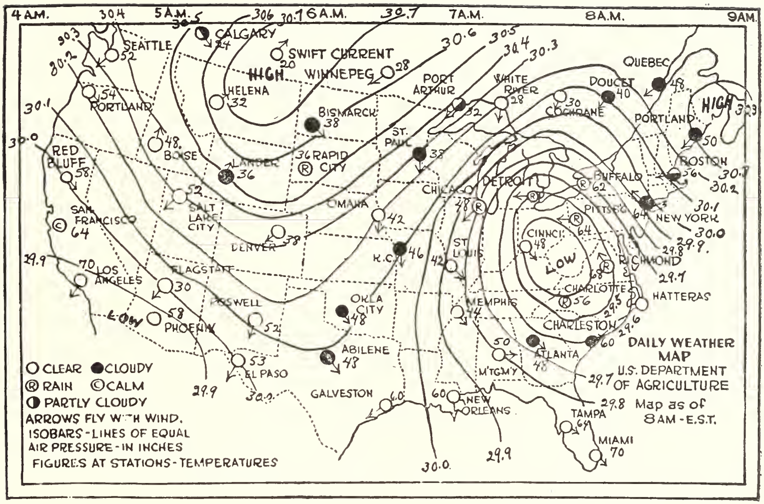
Did you ever think of what an important part the weather plays in our daily lives, and how useful it often is to know what kind of weather to expect the next day? If you are planning a picnic or a coasting party, one of the first steps is to look at the weather forecast in the paper. If rain is predicted, you will probably plan something that you can do indoors instead.

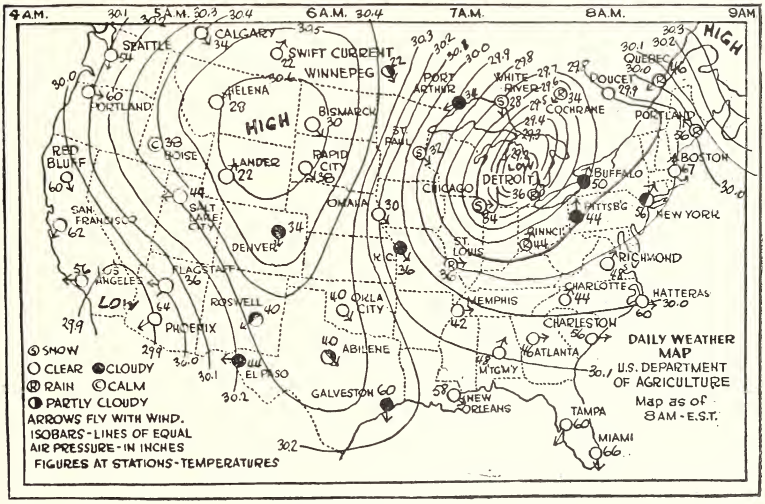
It is often very important to be able to predict the weather. Fruit-growers who know of a coming frost can protect their blossoming trees by placing heaters in the orchards, or by making smudges—smoldering fires that produce protective clouds of smoke. People who live along the banks of rivers that sometimes overflow can remove their property to a safe place if they are warned in the weather forecast of heavy rains which are likely to cause a flood. Shipping companies, when warned of approaching storms, often change the sailing dates of their ships or alter their courses so as to avoid the bad weather. Something like $30,000,000 worth of property is saved each year by warnings issued about the weather.

Perhaps you are wondering just who makes these weather predictions, and how it is done. It is the work of the Weather Bureau of the United States Department of Agriculture, from which daily weather reports and forecasts are sent out by radio and telegraph to be printed in the newspapers, and otherwise distributed to the people who are interested in the weather. The main office of the Bureau is at Washington, D. C., but more than 3,000 observers, scattered throughout the country, assist in the work of the Bureau.

Daily, at eight o'clock in the morning, and again at eight o'clock in the evening, Eastern Standard Time, observations of weather conditions are telegraphed to the Bureau from more than 200 stations located in various parts of the United States, Canada, Alaska, and the West Indies. Each of these stations reports the facts about the temperature, air pressure, wind, clouds, and rain or snow in its locality.

From their reports the daily weather map is made. You will be interested in examining these maps, two of which you will find, one on the opposite page. Study it carefully, with the printing that is below it, to see how much you can find out for yourself about weather conditions in the different parts of the country on the day for which the map was





Courtesy of the "New York Evening Post."

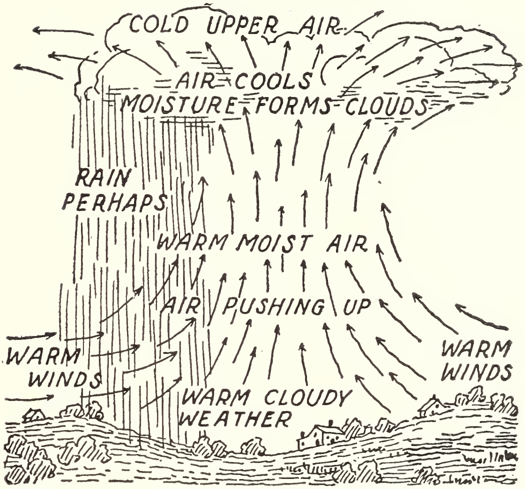
WEATHER MAPS ENABLE US TO TELL WHAT WEATHER IS IN STORE FOR US.

made. The solid lines show the air pressure. The figures beside the names of the stations show the temperature.

Notice how the solid curved lines surround areas that are marked "High" or "Low." These words, "High" and "Low," refer to the air pressure within the area. You will remember that the amount of air pressure is one of the facts reported to the Bureau by the weather observers. They discover the amount of the pressure in their various localities by means of the *barometer* (bă-rŏm′ĕter). There are various kinds of barometers, all of which are intended to measure the air pressure, which is constantly changing.

Barometer-readings are reported, not as you might think, in terms of the air pressure per square inch, but rather in terms of the height of the mercury in the tube of the barometer. A reading of thirty indicates that the mercury stands thirty inches high in the tube, and indicates an air pressure of fifteen pounds to the square inch. From this you will see that it is necessary to divide the barometer reading by two in order to discover the air pressure per square inch.

An area of low pressure on the weather map means that, within that area, the barometer readings were lower than were the readings in the surrounding territory. In other words, the air was not pressing very heavily upon the earth at that point. Let us see why. In an area of low pressure, the temperature is higher than it is in the surrounding country—that is, it is warmer than in the places

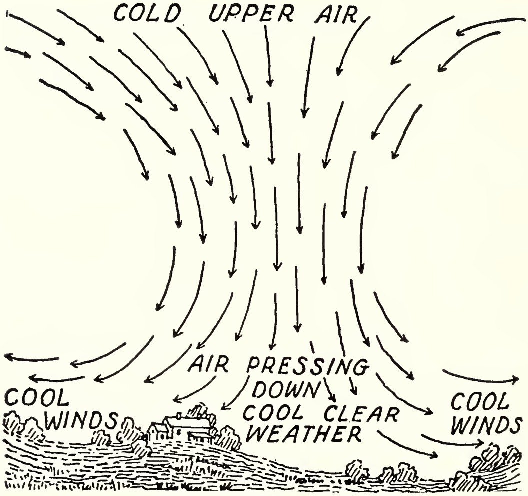


WHAT USUALLY HAPPENS IN A LOW-PRESSURE AREA.

around here. As you know, warm air rises, and of course you can readily see that rising air would not press very hard upon the earth.

Let us see what happens as the air rises. You can see how the air in a neighboring high-pressure area would tend to push into the low-pressure area from all sides. From all directions air is moving toward the area of low pressure, and, when it reaches there, it is being warmed. As it becomes warmer than the air in the surrounding country, it expands and rises. Then it cools, and the moisture in it condenses to form clouds and snow.

The warm air continues to rise and cool until finally the downward pressure of the colder air above is greater than the upward pressure of the warmer air below. Then the colder air descends to the earth. Air pressure is low in an area where



WHAT HAPPENS IN A HIGH-PRESSURE AREA.

air is rising; it is high in an area where the air is coming down.

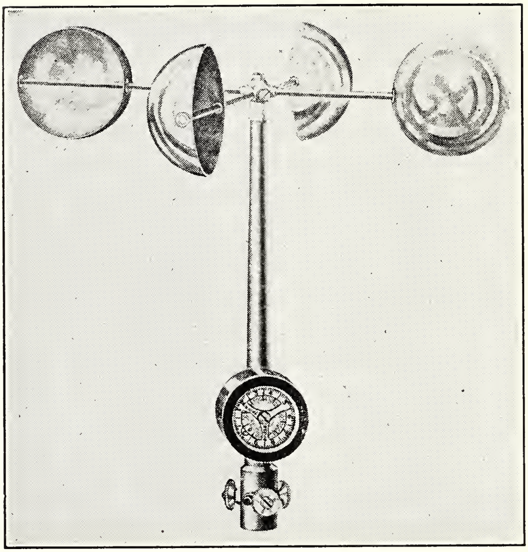
Air pressure is one of the most important facts to know in predicting the weather. In an area of low pressure, you can expect rain or snow followed by cooler weather and high air pressure. In an area of high pressure you may expect clear weather, for there the cooler air is descending and becoming heated. As you know, moisture in air condenses as the air cools—not as it becomes warmer. So, as the cold air becomes warmer you will not expect the moisture in it to condense and fall as rain or snow.

Of course, as you no doubt noticed, the weather map shows many facts about the weather in addition to the air pressure. The tiny arrows on the map point in the direction toward which the wind is blowing. Below the map you will find an explanation of the various kinds of circles that appear on the arrows. The paths of storms are shown by dotted lines with arrows.

You may wonder how, even with all the facts about the weather at hand, the forecasters at the Weather Bureau are able to predict what the weather conditions for the next day will be. If you were to examine the daily weather map each day over a period of weeks, you would discover some interesting things. For example, you would notice that areas of low pressure follow each other across the country. Since you have already learned that an area of low pressure, after a storm, becomes an area of high pressure, you know that the areas of high pressure must follow right along after the "lows."

These areas of low pressure are usually formed in the western part of the country, and they move across to the east with the prevailing winds at the rate of several hundred miles a day, the speed varying with the season according to the speed of the wind. Of course, the weather observers have reported the speed of the wind, which they have measured with an instrument known as the *anemometer* (ăn′ĕ-mŏm′ĕ-ter). The observers measure the speed of the wind, not only on the surface of the earth, but at various distances above the surface, sending the instrument up in a box kite.

Knowing the location of the areas of low pressure and the speed of the winds in various sections, the weather forecasters can be pretty certain where the low pressure area will be the next day. They know, too, that storms are pretty sure to occur in the



AN ANEMOMETER MEASURES THE SPEED OF THE WIND

areas of low pressure, and that the storms will be followed by high air pressure and clear weather. Of course, the "low" may not move just as they expected it to move. Then the forecast will not be correct, but it has been estimated that the weather forecasts are correct about six times out of seven.

In the cotton and grain-growing sections a special telegraphic report of the weather conditions is sent out to the farmers. In the cattle regions, bulletins are published at several central points, making it possible to move the stock to places where there is enough food and water. In the fruit-growing districts, warnings of cold waves are most important. The Weather Bureau sends out warnings of frost in the fruit districts of Florida, California, Washington, Oregon, Utah, and Colorado, so that the growers may take steps to prevent their fruit from freezing. During one cold wave, it is estimated that more than $14,000,000 worth of fruit was saved by protecting it in this way.

The railway companies make use of weather forecasts in caring for shipments that are likely to freeze or spoil. They put ice, or heat, in the cars as it is needed, or they may hold their shipments for a few days until the danger is past.

Another service of the Weather Bureau is to give the details of flying conditions so that flyers may know of wind and storm conditions at various altitudes and other information of importance for those who intend to fly long distances.

It would be difficult to mention all of the many ways in which the Weather Bureau offers service to the people of the country. When you recall that it is estimated that the weather forecasts make it possible to save more than $30,000,000 worth of property which might otherwise be lost, in one year, you can readily believe that the Weather Bureau is rendering a great service in the field of conservation.

SOME THINGS TO THINK ABOUT

Some of these sentences are true. Some are not true. On a piece of paper write the number of each sentence. If it is true, write *True* beside the number. If it is not true, write *False*.

1. Weather observations are made daily at 8 A.M. and 8 P.M., Eastern Standard Time.

2. A low reading of the barometer usually indicates the approach of a storm.
3. The anemometer is used to determine the temperature.
4. The barometer measures the air pressure.
5. Frost warnings are never sent out by the Weather Bureau.
6. The daily weather map indicates the air pressure, the temperature, and the direction of the wind.
7. The weather map also shows how fast the wind is blowing in various places.
8. The weather map is made up from facts obtained from about two hundred different stations.
9. Areas of low pressure travel across the country from east to west.
10. An area of low pressure follows a storm.

SOME THINGS TO DO

Read the weather forecast in the daily paper each day for a week. Make a record of the forecasts, and compare them with actual weather conditions.

If your school does not receive a weather map each day, some pupil may write to the Weather Bureau, Washington, D.C., requesting several maps and asking whether a daily weather map can be sent regularly to the school.

Place a thermometer outside your window and record the temperature twice daily, at regular hours. How does your record compare with the reports in the daily paper?

CHAPTER XX

HOUSES FOR RENT

1. Did you ever build a birdhouse? If so, describe it.
2. Where did you hang it?
3. What kind of birds made their home in your birdhouse?

If you were to build a house for rent, you would want to plan it to please tenants who would probably pay the rent. Many kinds of birds are sure to pay high rents for houses that please them. Some birds offer valuable services in the destruction of the pests that injure the trees and eat the crops. Others keep the fields clean by eating the seeds of weeds.

In planning a birdhouse, the first step is to decide what kind of bird you wish to attract. When you have chosen the kind of bird you would like to have live in your house, a study of its nesting habits will help you to decide what kind of a house will probably please it. The robin, which naturally places its nest in a tree crotch, will use a nesting platform open on one side or more, or a mere shelf if it is provided. On the other hand, the woodpecker, which is a hole-nesting bird, prefers a house that resembles a hole in a tree or post. Wrens will nest in almost any sort of cavity, but they seem to prefer small houses with perches. Purple martins prefer to live in colonies. They like a house in the open, with many apartments. A house on a pole will suit them very well.

It is well, too, when you plan your house, to give some thought to keeping out undesirable tenants—the English sparrows, for instance, that pay little or no rent. Boxes for wrens and chickadees may be made with entrances less than one and one-quarter inches in diameter, which is too small for the English sparrow to enter.

A good time for birdhouse-building is in the late winter or the early spring, for, of course, the houses should be all ready on the birds' moving day, when the prospective tenants are looking for homes.

Wood is by all means the best building material. Select an easily workable kind—cypress, pine, or yellow poplar will do very well. If you wish to construct a rustic house, you may be able to get rough slabs with the bark right on them—sawmill waste, these pieces are called—which are very inexpensive and very satisfactory.

Here are some diagrams from the United States Department of Agriculture Farmers' Bulletin No. 1456, *Homes for Birds,* which show clearly the different types of houses that may be built. Study them carefully.

A birdhouse should offer as much protection from storms as possible. A slanting roof will shed rain most easily, and a strip of metal or roofing paper along the ridge will help to make the house with the slanting roof waterproof. Flat roofs should be heavily painted or covered with waterproof material. On the average house the roof should over-

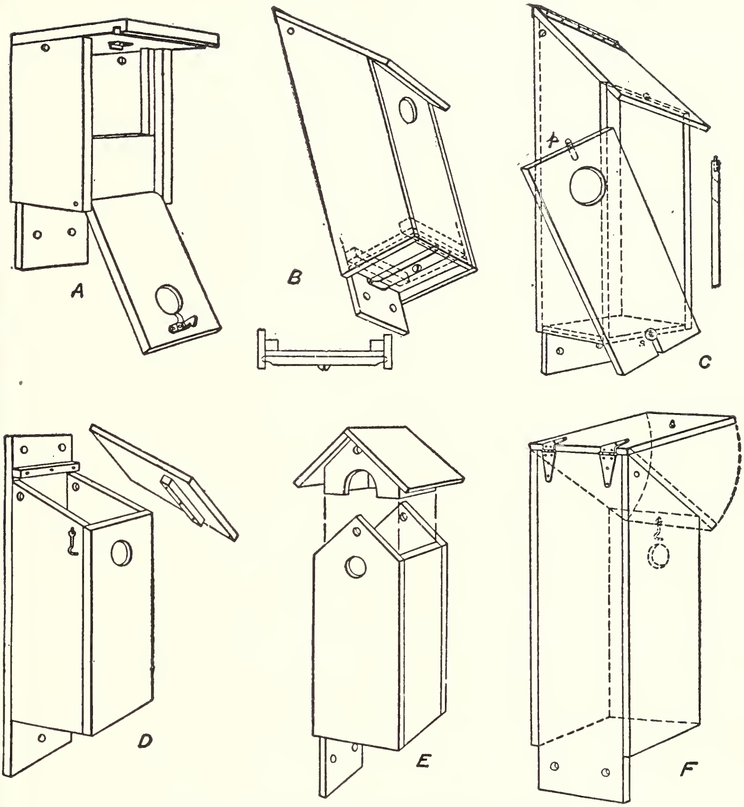


FIG. 1. ACCESSIBLE NEST BOXES.

A, Hinged front held up by a catch; *B,* removable bottom, released by the slight turn of a cleat; *C,* swinging front, held in place by the pin *p* and by tightening the screw *s; D* and *E,* removable tops; *F,* hinged top.

hang two or three inches to protect the entrance hole from rain and snow. It is well, too, to cut a groove across the underside of the overhanging part of the roof to prevent the water from draining back into the house.

Even when all possible methods are used to make the birdhouse waterproof, some water is apt to get in. For this reason, a few small holes should be drilled in the bottom, so that any water which does get into the house can drain out. In climates where there is much freezing weather in the winters, it is well to allow the sides of the house to extend down below the bottom to prevent water from getting into the cracks, then freezing and wedging the sides and bottom of the house apart.

The small entrances to birdhouses are hardly sufficient for ventilation. One or two small holes drilled through the walls near the top of the single-room birdhouse will allow the air to circulate through the box. In martin houses the entrances are so low that the drilling of extra holes is apt to produce drafts. Because of this, it is best to drill only one ventilating hole near the top of the martin box, or else none at all.

Single-room birdhouses are simple in construction, but before you start to build one, you should make some sketches and a definite plan with dimensions. Here is a table which also came from Farmers' Bulletin No. 1456, *Homes for Birds,* and which gives you the dimensions recommended for houses for the various kinds of birds, and which also tells you how far above the ground the boxes should be placed.

This same valuable bulletin, *Homes for Birds,* tells of the house preferences of the various kinds of common birds which have been known to nest in houses. When you have found out what type of

Dimensions of Nesting Boxes for Various Species of Regular Box-Inhabiting Birds and the Height at Which They Should Be Placed above the Ground

Species	Size of Floor	Height of box	Entrance above floor	Diameter of entrance	Height above ground
	Inches	*Inches*	*Inches*	*Inches*	*Feet*
Bluebirds	5× 5	8	6	1½	5–10
Robin	6× 8	8	(1)	(1)	6–15
Chickadees	4× 4	8–10	6– 8	1⅛	6–15
Titmice	4× 4	8–10	6– 8	1¼	6–15
Nuthatches	4× 4	8–10	6– 8	1¼	12–20
House wren	4× 4	6– 8	1– 6	⅞	6–10
Bewick wren	4× 4	6– 8	1– 6	1	6–10
Carolina wren	4× 4	6– 8	1– 6	1⅛	6–10
Violet-green swallow	5× 5	6	1– 5	1½	10–15
Tree swallow	5× 5	6	1– 5	1½	10–15
Barn swallow	6× 6	6	(1)	(1)	8–12
Purple martin	6× 6	6	1	2½	15–20
Song sparrow	6× 6	6	(2)	(2)	1– 3
House finch	6× 6	6	4	2	8–12
Starling	6× 6	16–18	14–16	2	10–25
Phoebe	6× 6	6	(1)	(1)	8–12
Crested flycatcher	6× 6	8–10	6– 8	2	8–20
Flicker	7× 7	16–18	14–16	2½	6–20
Golden-front woodpecker	6× 6	12–15	9–12	2	12–20
Red-headed woodpecker	6× 6	12–15	9–12	2	12–20
Downy woodpecker	4× 4	8–10		1¼	6–20
Hairy woodpecker	6× 6	12–15	9–12	1½	12–20
Screech owl	8× 8	12–15	9–12	3	10–30
Saw-whet owl	6× 6	10–12	8–10	2½	12–20
Barn owl	10×18	15–18	4	6	12–18
Sparrow hawk	8× 8	12–15	9–12	3	10–30
Wood duck	10×18	10–15	3	6	4–20

[1] One or more sides open. [2] All sides open.

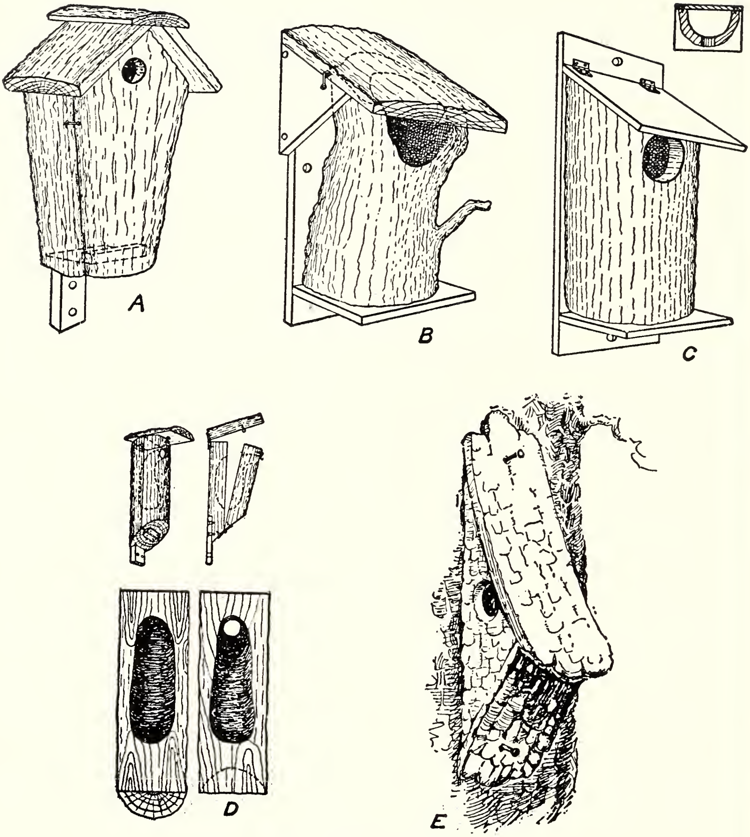


FIG. 2. RUSTIC BOXES.

A has a removable front; *B,* at top held by two hooks; and *C* a single hinged top. In *D* there is a removable top which releases the front half of the cavity in the manner pictured. The principle embodied in *B* can be applied to the type shown in *E,* made of rough slabs.

house your prospective tenant prefers, you can look in the table to find the dimensions, and begin at once to make your sketches and plans.

There are many species of birds which will live in

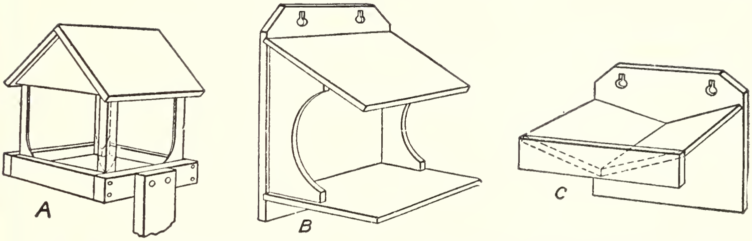


FIG. 3. NEST BRACKETS AND SHELVES FOR ROBINS AND PHŒBES.

any of the types of houses suggested in Figures 1 and 2. Among them are the bluebirds, tree swallows, violet-green swallows, house finches, European starlings, screech owls, barn owls, flickers, and wood ducks. Red-headed, downy, and hairy woodpeckers, and crested flycatchers prefer rustic houses, which resemble their natural nesting places more closely. Sometimes, however, these birds will live in such houses as those suggested in Figure 1, if they are covered with bark.

Robins, catbirds, brown thrashers, phœbes, barn swallows, and song sparrows prefer nesting shelves of the types shown in Figure 3, made of rustic slabs or weathered lumber, or painted dull colors. Any of the three types shown are satisfactory for robins, catbirds, or brown thrashers. The phœbes prefer types *A* and *B;* barn swallows like types *B* and *C,* while the song sparrows prefer type *A*. Barn swallows like to nest in colonies, and for this reason long shelves on brackets are very satisfactory to them.

Three types of houses suitable for wrens are pictured in Figure 4. Almost any kind of cavity will

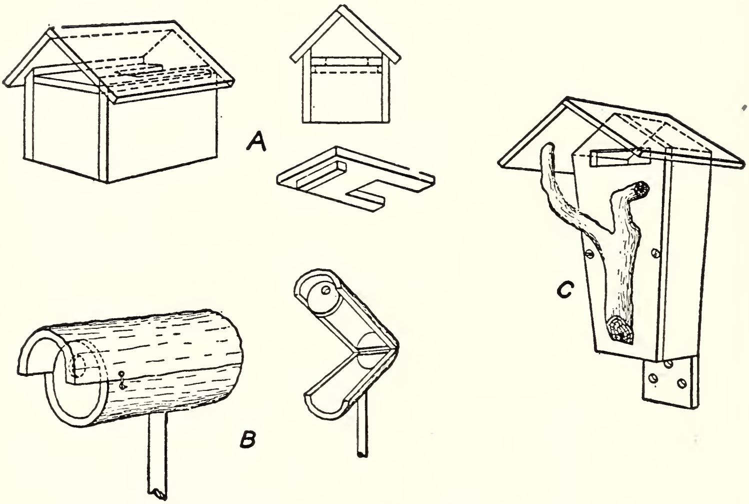


FIG. 4. NEST BOXES FOR WRENS.

satisfy these little birds, but a small house such as *A* or *C* in Figure 4, with a horizontal slot for an entrance, is best. The slot entrance is an advantage because it permits the bird to carry in the nesting material more readily. Wrens seem to like houses built of finished lumber as well as those of the rustic type.

Purple martins, you will remember, like to nest in colonies. In Figures 5 and 6 you will see a martin house which is sectional. You can start with a one-story house of eight rooms, and add other stories of the same dimensions as the colony grows. As you see, the house is held together by hooks and screw eyes, and so will come apart readily for cleaning.

Before you select a site for your birdhouse, it is best to study the habits of the kind of bird you wish as a tenant. You can then place the house in a

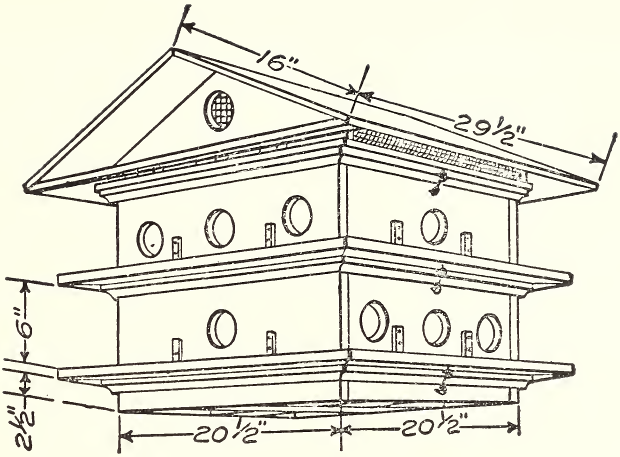


FIG. 5. MARTIN HOUSE.

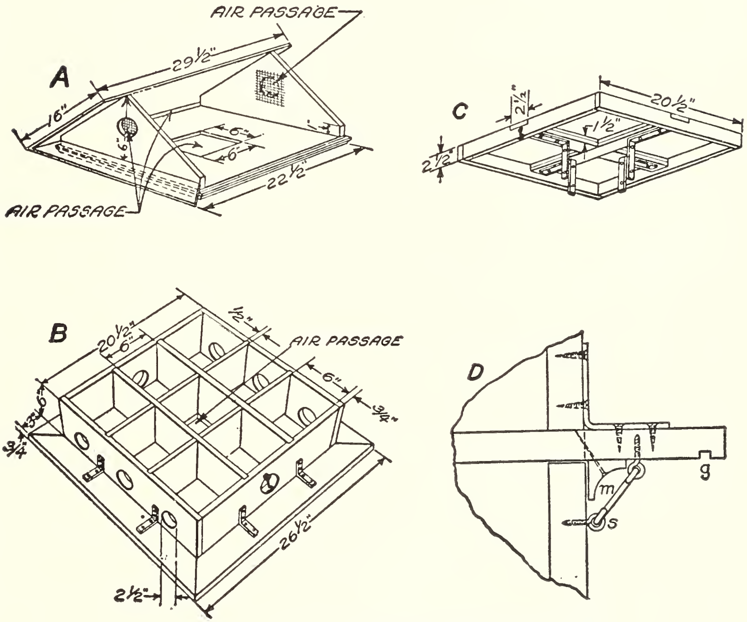


FIG. 6. DETAILS FOR MARTIN HOUSE.

location that resembles the natural nesting places of the species. Bluebirds like orchards. Their bird-houses may be placed in the trees or on the fences that surround the orchard. Barn swallows like a nesting shelf placed under the protecting eaves of buildings. Song sparrows build their nests in thickets, and so, of course, a thicket must be chosen as a location for their nesting shelves. On the other hand, the purple martins prefer that their house be located on a pole right out in the open.

So varied are the preferences of the different birds that it is really necessary for you to select your prospective tenant and study its habits before selecting the site for your house, keeping in mind, however, that you are to place the house at the height above the ground recommended in the table.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. The birdhouses in Figure 1 are suitable for ...., ..., ..., ..., ..., or ......
2. The rustic houses shown in Figure 2 are better suited to ....., ..., and ......
3. ....., ..., ..., ... and ..... prefer nesting shelves such as are shown in Figure 3.
4. Houses suitable for ..... are shown in Figure 4.
5. The entrance to a house for starlings should be ..... inches in diameter and should be placed from ..... to ..... above the floor of the house.
6. The floor of the cavity in a house for the phœbe should be ..... inches square.

7. A bluebird's house should be placed from ..... to ..... feet above the ground.
8. The depth of the cavity in a house for a robin should be ..... inches.

SOME THINGS TO DO

Select a bird that nests in your community, and plan a house for it. Select a type of house which is suitable for that species and which you can build. Study the table to find out what dimensions the house should be. Make sketches showing each part and stating the dimensions. Make sure that you have planned the house so that the floor is of the right size, and so that the house is of the depth suggested in the table. Make sure that you have planned an entrance of the diameter mentioned in the table, and that you have planned to place the entrance the suggested distance above the floor of the house.

When your plans are complete, build your birdhouse so that you will have it ready when the birds are looking for homes.

Find out all that you can about the nesting habits of the bird for which you are preparing a house, and select a suitable site for the house.

CHAPTER XXI

SPRING MIGRATION

1. What birds from your community went south to spend the winter?
2. When can you expect these birds to return?
3. What birds came from the north to spend the winter in your neighborhood?
4. When can you expect these birds to leave?

In late February or early March wild geese in flying wedges wing their way steadily and rapidly to the north, honking as they go. At about the same time the bluebirds and the robins arrive in scattered companies or "loose flocks." Their soft "turwee, turwee" fills the air. Often coming before the snow has left the ground, these hardy travelers are among the first signs of spring.

Not far behind them are the red-winged blackbirds, the flickers, the meadow larks, and the grackles. The phœbe, cowbird, Wilson snipe, killdeer, and mourning dove, too, are among the early arrivals.

In April we may expect the towhee or chewink, the spotted sandpiper, brown thrasher, chipping sparrow, vesper sparrow, white-throated sparrow, fox sparrow, field sparrow, ruby-crowned kinglet, yellow-bellied sapsucker, purple martin, and the hermit thrush.

Courtesy of the American Museum of Natural History.
DUCKS ARE AMONG THE FIRST BIRDS TO FLY NORTHWARD IN THE SPRING.

In May, or later, we may look for the return of the kingbird, the crested flycatcher, wood peewee, wood thrush, red-headed woodpecker, orchard oriole, Maryland yellow-throat, yellow-billed cuckoo, indigo bunting, rose-breasted grosbeak, and yellow-breasted chat.

The warblers bring up the rear of the great army of bird travelers. These small birds are numerous, beautiful, and useful. The yellow warbler, the worm-eating warbler, and the black-and-white warbler scatter over a wide area to build their nests and raise their young. The warblers are great travelers, wintering in the tropics and spending their summers in the pine forests of the far north.

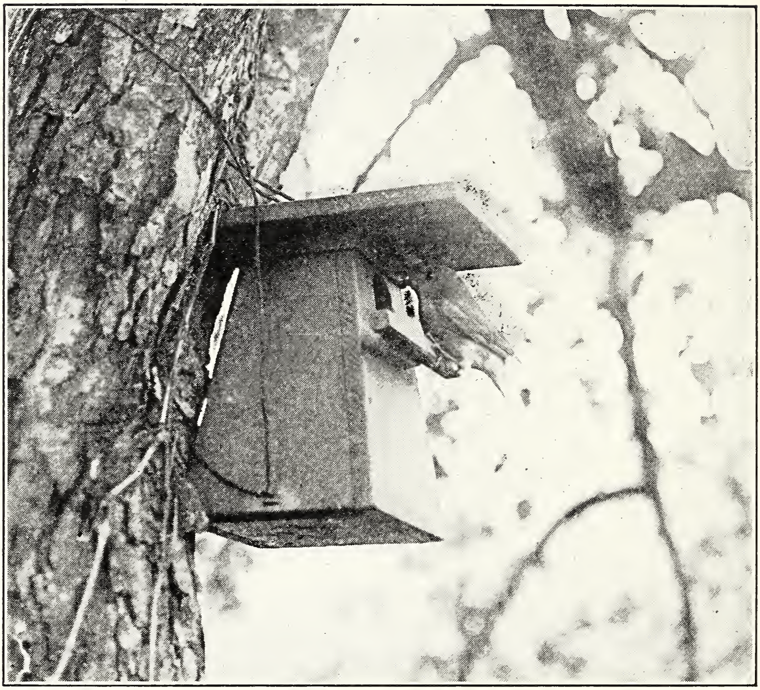
You will find it interesting to keep a bird calendar, listing the migrants that pass through on their northern journey, as well as the time of arrival of the various summer visitants in your community. There are some excellent bird guides that will help you to identify the different birds. No doubt you will find one in your school library.

With your guide and your notebook at hand, you will find it great fun to sit in some quiet spot and watch the birds during the migration season. You will find it interesting, too, to keep your bird calendar from year to year. If you do this, you will be amazed to discover how regular bird travelers are in their schedules. Almost on the same day of the month they arrive, year after year. So regular are they that the Indians named their seasons after the birds that returned at that time. When you consider the great distances some birds travel, their prompt arrival seems still more remarkable.

If you keep your bird calendar over a period of years, you can make a time-table of the arrival and departure of the migratory birds in your community. You will find that the early arrivals—those that come in February and March, for instance—are much less prompt than are the later ones. This is because the March weather is so uncertain. Although the exact time of a bird's arrival depends somewhat upon the weather conditions, it is not the weather that causes them to start on their return journey. The bird in its winter home in the tropics

Photograph by L. W. Brownell.
ROBINS ARRIVE EARLY IN THE SPRING AND BUILD THEIR NESTS.

cannot possibly know anything of the weather in the community where it nests. However, its northward journey may be delayed by bad weather or hastened by unusually good weather.



Photograph by Frank M. Chapman.
A BLUEBIRD FINDS A NESTING BOX ALL READY FOR A HOME.

Why do birds travel? Many students of bird life believe that bird migration began back in the great Glacial Period, when most of our land was covered with ice. Great changes in climate occurred then, and perhaps the birds were forced to journey southward or to perish in the cold; but with the melting of the ice sheet, they returned again to their native lands.

So each autumn, before the approach of snow and ice, a vast army of birds leave their native lands for the warmer south; but with the return of spring and the nesting season, they go back to the homes of their ancestors to lay their eggs and raise their young. All birds nest in their northern homes. Dr. Frank M. Chapman believes the homing instinct that sends the birds on their long journeys to their nesting places is very like the instinct which leads the salmon up the river to spawn, to deposit their eggs, or the seals to their rookeries or breeding places.

"How do birds find their way? What is the bird's compass?" asks Dr. Chapman. Sight, smell, touch, or taste can help them very little, and their hearing can do nothing more than enable them to hear the calls of other birds, and so keep the flock together; and so Dr. Chapman concludes that the birds must have a sixth sense, which he calls a sense of direction.

Sometime you will want to read all of his book *The Travels of Birds*. In it he tells some fascinating stories of pigeons, carried far out to sea in steamers, and, when released, flew back to their homes. He tells, too, of terns which found their way home over hundreds of miles of water unmarked by land of any description.

You have already learned that the majority of the insect-eating birds are migratory, so you know how important it is that bird travelers be protected as much as possible. You have learned of some of the steps the national government has taken to conserve bird life. There is the Federal Migratory Bird Law that forbids the shooting of bird migrants in the spring, and that permits shooting them only during a limited and specified time in the fall. Then, too, the Congress of the United States has appropriated $8,000,000 to be spent within the next ten years in the conservation of bird life. Much of the money will be used to establish bird sanctuaries along the main migration highways.

Perhaps you and your classmates have already planned to help in the protection of the birds by creating a bird sanctuary such as you read about in Chapter IX; and you may already be working on a birdhouse that will provide a home for some bird which nests in your community. The birds are the natural guardians of field and forest. They are worthy of protection.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. List five birds which arrive in your neighborhood early in the spring. Find out, if you can, when these birds leave in the autumn.
2. List five birds which arrive in May or later. When do they leave in the autumn?
3. Birds which migrate make their nests in their ..... homes.
4. Dr. Chapman believes that birds have a sixth sense ..... which is a sense of .....
5. The United States Government is helping to ..... bird life.

SOME THINGS TO DO

Sit down in some quiet spot frequented by the birds and watch them. Make simple notes of what you see.

Keep a bird calendar in your classroom. If you begin it in February, you may be able to make a complete record of the arrivals of the various species of summer visitants in your neighborhood. Some such form as this may be used:

Name of Bird	Date Seen	Where Seen	Name of Person Reporting

The following bird game will help you to learn the names of the different kinds of birds: Give each child a bird picture. He writes a simple description of it. Then he says to the class: "I am thinking of a bird. It looks like this." Then he describes his bird to the class. The other children guess the bird's name.

Learn something of the life of John J. Audubon, who was a great lover of birds. Perhaps you will wish to organize a chapter of the Junior Audubon Society, which is a national bird club. If so, write to The National Association of Audubon Societies, 1947 Broadway, New York City, for information as to how it may be done.

CHAPTER XXII

ARE BIRDS WORTH WHILE?

1. Have you ever seen a bird catch an insect on the wing?
2. What seed-eating birds nest in your community?
3. Of what use is a vulture or a gull?

On a fence, a telegraph wire, or the dead limb of a tree, the kingbird perches and waits for an insect to fly by. Then, darting after it, the little gray bird swallows its prey and returns to the same perch, or to one near-by, to watch for another wasp, fly, or beetle to pass that way.

The kingbird is smaller than a robin. Its upper parts are dark gray. Its under parts are of white, washed with gray on throat and breast. A bright orange-red crown adorns the head of the adult bird, but this crest is seldom seen because the kingbird sits upright in perching. The bright crown may have suggested the name, kingbird; or perhaps the name may have come from the fact that the kingbird dominates birds much larger than itself.

At the approach of a hawk, an owl, or a crow, it utters a sharp cry, *pi-tink, pi-tink,* and sallies forth to battle. Its broad tail serves as a rudder, helping it to turn quickly and to dodge so easily that it is safe to pursue and harass the larger birds.

Kingbirds do not harm little birds. Indeed, small birds are much safer near the kingbird's nest for

Courtesy of American Museum of Natural History.
A KINGBIRD IS A GOOD INSECT-CATCHER.

it drives away crows and hawks. For the same reason, the kingbird is a friend to the poultry-raiser. It is useful, also, to the bee-keeper. It eats a few bees, it is true, but it also devours large numbers of robber flies that prey upon honeybees.

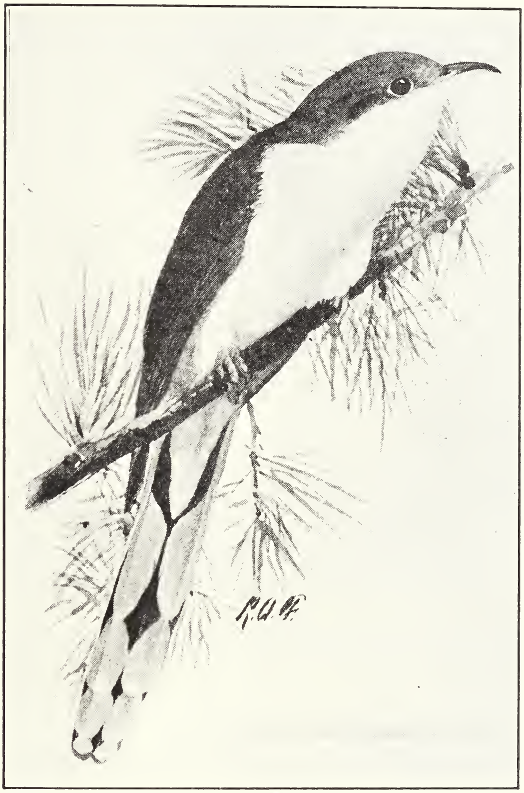
Photograph by L. W. Brownell.

KINGBIRD EGGS ARE WHITE SPECKED WITH BROWN.

Kingbirds are widely distributed and easily recognized. They nest throughout the United States east of the Rocky Mountains, from northern Florida to Canada, wintering in South America. They usually reach Florida some time in March. Those that go farther north reach their summer homes some time in April.

The kingbird's nest is well built of dead weed stalks, string, and plant fibers and is lined with softer materials. It is placed near the end of a branch, from four to thirty feet from the ground. The eggs, usually four in number, are laid in May. They are white with brown spots. The young birds differ little from the parents except that they lack the orange crown.

Another valuable insect-eater is the cuckoo. Mod-



From a drawing by L. A. Fuertes.
ANOTHER VALUABLE INSECT-EATING BIRD IS THE YELLOW-BILLED CUCKOO.

est and retiring, it spends its life among the thick leaves of the trees, looking for caterpillars. One student of bird life declares that it eats so many "woolly" caterpillars that its stomach is lined with the spines from their bodies.

You will remember that many kinds of caterpillars do great harm to the trees by feeding upon

Photograph by L. W. Brownell.
THE CUCKOO MAKES ITS NEST OF TWIGS AND LAYS THREE TO SIX GREENISH BLUE EGGS IN IT.

their leaves. The cuckoo devours many of these pests.

The cuckoo is more often heard than seen. In damp and cloudy weather its call, *kuk-kuk, kuk-kuk,* is very frequent, and for this reason some people believe that it foretells rain. Sometimes it is called the rain crow.

The yellow-billed cuckoo is a long, slender bird, sometimes reaching a length of twelve inches, of which more than half is tail. This long tail is black, broadly tipped with white. The upper parts of the bird are white. The bill is blackish with lower part of rich yellow.

The nest, a loose platform of twigs, is built on a horizontal branch, usually about fifteen feet from

Photograph by L. W. Brownell.

SEEDS OF UNWANTED PLANTS ARE THE PRINCIPAL FOOD OF THE FIELD SPARROW.

the ground. From three to six eggs of greenish blue are laid in May.

The yellow-billed cuckoo is a summer resident in the middle and northeastern states. In September it migrates to tropical America, returning to the United States in early May.

The kingbird and the cuckoo are but two of the many varieties of insect-eating birds. There are the phœbes, the woodpeckers, the orioles, the meadow-larks, and perhaps you can name many others that live in your neighborhood or pass through it on their migrations.

Seed-eating birds are useful, also, for they eat the weed seeds in fields and woodland, thus keeping down these unwanted plants. The field sparrow and the junco, which is also a member of the sparrow family, are two of the many species of seed-eating birds.

The field sparrow is one of the smallest members of the sparrow family. It somewhat resembles the chipping sparrow. Its upper parts are grayish brown streaked with black and brownish red. The female is a little duller in color than the male, and the young are somewhat more streaked than are the adult birds. The song is a clear whistled trill which is heard in the fields of the northern states from April to mid-October.

As the field sparrows leave, or even before, the juncos arrive to spend the winter. They are winter visitants in almost every state, nesting in Canada and Alaska. Sometimes they are called snow-birds, and it is an excellent name for them, for how many times we see them on the ground in the snow!

The junco is about the size of the English sparrow, but it has a longer tail. Its upper parts and breast are a grayish slate color. Its under parts are white, and the outer tail feathers show white when it flies. The female is duller in color than the male and has a little more brown in her feathers.

The junco sings very little during the winter, but when spring comes, its cheery trill is heard in sunlit corners of the woods. In early May it migrates north to Canada or Alaska to nest and rear its young, returning again in the autumn.

Photograph by Paul Griswold Howes.
ANOTHER USEFUL BIRD IS THE VULTURE. THIS IS A YOUNG BIRD.

During the winter when the snow covers the weed seeds, juncos visit the feeding stations in large numbers. Perhaps we do not fully realize that mid-winter is a hard time for birds, and that then, if ever, additional food is welcome.

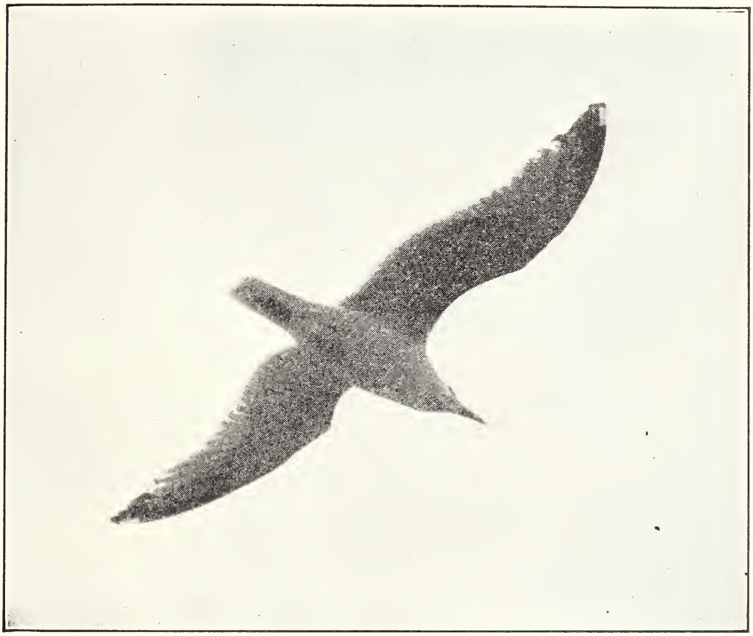
Vultures, or buzzards, as they are often called, are birds that eat dead animals. Perhaps you have seen them by the roadside eating rabbits or other small animals that have been killed by automobiles. When a dead cow, horse, deer, or other large animal is found, the vultures from all near-by districts gather for a great feast. They quickly devour the body, which would otherwise become very offensive.

Circling in the sky with wings hardly moving for hours at a time, the turkey vulture is one of the most graceful of our soaring birds. It has feathers of blackish brown, glossed with purple when fresh, rusty and soiled when old, and it looks somewhat like a turkey. The reddish skin of the head and neck is bare, permitting it to eat without soiling its feathers.

Turkey vultures build no nests. In May two whitish eggs blotched with black, brown and gray are placed on the ground among rocks, or in a hollow log. They are well hidden, for the blotches give them so nearly the appearance of the rocks that it is very hard to see them.

As the turkey vultures clean the land, so the gulls cleanse the waters and the beaches, feeding upon refuse which they find floating down the rivers, upon bits of food left on the beaches by careless campers, upon garbage from the great cities which has been dumped into the water, and upon food thrown overboard from ships. The herring gull, or sea gull, as it is often called, is a large white bird with pearl-gray back and wings. The tip of the wing is black with white spots. Its webbed feet are pale pink. It builds a nest of seaweed, or similar material, on the ground, and lays two or three eggs in it in May.

Are birds worth while? The flycatcher family, of which the kingbird is a member, sweeps the sky for insects in its own peculiar way. The yellow-billed cuckoo eats the woolly caterpillars from the orchard and shade trees, while the black-billed



Photograph by H. Armstrong Roberts.

GULLS CLEANSE THE WATERS AND BEACHES

cuckoo destroys the pests on the young saplings of the lowlands, and in the alder trees along the streams.

Juncos and other sparrows feed on weed seeds and thus serve the farmer and the gardener. Vultures, soaring with outstretched wings over hills and valleys, are ever searching for dead animals to devour, thus ridding us of decaying flesh which would in time become very offensive. Gulls fly over lakes and streams eating dead fish and other wastes from the water and the shore.

These are but a few of the many species of valuable birds. There are countless others. In fact, there are so many kinds of useful birds that it is well to think of a bird as useful unless you are positively certain that you know that it is really harmful.

> Think of your woods and orchards without birds!
> They are the winged wardens of your farms,
> Who from the cornfields drive the insidious foe,
> And from your harvests keep a hundred harms.
>
> From Longfellow's *The Birds of Killingworth*

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. The ..... is sometimes called a rain crow.
2. The kingbird and the cuckoo are ..... eating birds.
3. The field sparrow and the junco are ..... eating birds.
4. These birds are useful because they eat the seeds of .....
5. The ..... is sometimes called a snowbird.
6. Vultures eat ..... animals.
7. The eggs of the turkey vulture look like ......
8. ..... feed upon the refuse from the lakes and the streams.

SOME THINGS TO DO

Observe the birds of your community to find out what they eat. You will need a bird guide to help you identify the different kinds. Perhaps you can find one in your school library. *What Bird Is That?* by Frank M. Chapman, is a very good guide. Record your observations in your notebook, listing the name of the bird and then the food which you saw it eat.

If possible, visit a museum and look at the birds there to see how each bird's body is adapted to getting the food upon which it lives.

CHAPTER XXIII

FOREST TREES OF GRACE AND BEAUTY

1. Have you ever seen a birch tree?
2. Can you name some trees upon which the blossoms appear before the leaves in the spring?
3. What kinds of trees are planted on lawns and in the parks of your community?

The Birches

Straight and tall in the forests of northern United States and Canada stands the "Queen of the North Woods," the paper birch.

It is the largest of the fifteen species of birches that are native to North America. Stately and graceful, with trunks of chalky or creamy white, these paper birches grow sometimes to a height of eighty feet. Artists have pictured them and poets have written of them, but to appreciate their beauty fully we must see them growing. Against a dark background of river, lake, or some other forest trees, their white trunks glisten, and the larger trees stand out like white giants in the dim distance of the dark wood. The young trees, too, slenderly erect in the border of the forest, make a striking picture.

The young twigs are stout, hairy, and dark in color, but after several years they become white like the trunk. The leaf buds are sharp pointed, dark

Photograph by Publisher's Photo Service.

THE PAPER BIRCH IS ONE OF OUR MOST GRACEFUL TREES.

chestnut brown in color. The leaves, which usually appear some time in April, are simple and alternate, two or three inches long, finely toothed on the margin, sharply pointed at the end. In color they are a dull green. The upper side of the leaf is smooth, but the under side is hairy.

Sometimes the flowers appear before the leaves; sometimes they appear at the same time. The flowers grow in catkins or long hanging bunches. Each catkin has a central stalk along which grows a great number of flowers. The flowers themselves are so small that we must use a magnifying glass to see what they are really like. There are two kinds of catkins on the paper birch. One kind bears the stamens covered with pollen. The other bears the pistils—little forked red threads that end in a swelling at the lower end. The pollen is carried by the wind, or by insects, to these pistils. At the bottom of the pistil is the ovary, where the seeds develop.

The small seeds have wings and are carried away from the mother tree by the wind. Because of this, the young trees often grow up at some distance from the mother tree. Some of the seeds fall in uncrowded places, giving the young tree a much better chance to develop than it would have if all the seeds fell right down at the foot of the tree on which they grew.

The paper birch is often called the white birch or the canoe birch. The Indians and the early settlers used its bark to make their canoes. Just below the lowest branches, and just above the roots, they cut through the bark around the tree. Then, slitting it from top to bottom, they clipped it off the tree trunk. The bark of the paper birch will also peel off in layers that look like sheets of paper.

Courtesy of U. S. Forest Service.

THE FLOWERS OF THE BIRCH GROW IN CATKINS.

Perhaps sometime you have been in the North Woods and have stripped off pieces of birch-bark upon which to write notes to your friends.

Have you ever noticed the little oblong marks on the bark of trees? In many trees these marks occur only on the branches, but in the birch they are found on the trunk as well. They are called *lenticels* (lĕn′tĭ-sĕls). Through them the air can reach the living inner part of the bark, and the water vapor can escape from the tree.

The wood of the paper birch is valuable for its light color and for its softness. Because it is so soft it can be worked easily, and it is used for spoons, ladles, bowls, spools, and toys. Charcoal made from it is burned in forges, and soot made from birchwood is used in the making of printers' ink. Birchwood is also used for paper pulp and for fuel in sections where it is abundant.

The popular names of many varieties of birches describe the species. There is the black birch, which is also known as the cherry or sweet birch. It has bark of chestnut brown, much darker than that of any other species. From the tender bark of its young twigs, pleasingly sweet to the taste, comes much of what is called the oil of wintergreen. In appearance the black birch resembles the cherry tree. Its wood, marketed under the name of "birch," is widely used for furniture and woodwork, and is often stained to imitate cherry or mahogany.

There is the yellow birch, with its ragged yellow or yellow-gray bark, abundant in the forests of northern New England, particularly in the damp lowlands. Because of its abundance it is used for fuel, lumber, and paper pulp, as well as for the making of furniture. Its loose bark is a great help to campers in starting their fires, as it burns very readily.

The red birch, a picturesque tree that grows singly or in small clumps along river banks, is also known as the river birch. Its dark red leaves and ragged red bark are most often seen against a background of glistening water. It is found in large numbers along the banks of the Merrimack River in southern New Hampshire and Massachusetts. It extends southward along the Atlantic Coast to Florida, and westward along the Gulf of Mexico to Texas.

The gray birch, also called the small white birch, the poplar birch, and the Oldfield birch, has close white bark with heavy black markings. Although it lacks the freedom from knots which makes the paper birch so dazzlingly white in the sunlight, the gray birch is delicately graceful in leaf and branch. Its glossy leaves on their slender stems shift in the slightest breeze, shimmering in the sunlight.

The Flowering Dogwood

From Massachusetts to Michigan and south to Florida and Texas, grows the flowering dogwood. Through the woods in springtime it scatters the white glory of its flowers; and in the autumn, the fruit, a scarlet egg-shaped berry growing in groups of two to five on stout stalks, are no less beautiful.

This tree commonly grows in rich woodlands under the shelter of other trees. In the north it is often a shrub, but in the south it sometimes reaches a height of forty feet, with a trunk eighteen inches in diameter.

Whatever its size, the flowering dogwood is a tree of rare beauty. The blossoms, which appear on the ends of upturned twigs either before or with

Courtesy of U. S. Forest Service.

THE FLOWERING DOGWOOD IS A TREE OF RARE BEAUTY.

the unfolding leaves, have four large white petals —really leaflets, or bracts—growing round the true flowers of greenish yellow.

These white bracts attract insects that carry the pollen from blossom to blossom, and from tree to tree. After a time the bracts drop off and the fruit develops, reaching its full size late in the summer and remaining on the tree until autumn, and sometimes until late in the winter.

The leaves of the flowering dogwood are about three to five inches long. They are simple, with unnotched edges and indented whitish ribs, which give the edge a wavy appearance. The bark of the younger twigs is grayish in color. On the older stems it is reddish brown to black, broken up into

Photograph by L. W. Brownell.

DOGWOOD LEAVES HAVE INDENTED RIBS THAT GIVE THEM A WAVY APPEARANCE.

scaly blocks which give it an "alligator bark" appearance.

The wood, valuable for its hardness, is widely used for tool handles. It has a fine, firm texture, and is brown in color. The bitter bark was once believed to be vaulable as medicine. From the bark of the roots the Indians used to obtain a scarlet dye which they prized highly.

The Red Bud

The red bud, with its clusters of pink blossoms on bare, brown branches, lends a touch of striking beauty to southern forests in the early spring. It is oftentimes called the Judas tree because of an

Photograph by L. W. Brownell.

THE PINK RED-BUD FLOWERS APPEAR BEFORE THE LEAVES.

old legend that it was upon such a tree Judas hanged himself after he had betrayed Christ. The story goes that the blossoms have been red with shame since that day.

Photograph from J. Horace McFarland Co.

RED-BUD SEEDS GROW IN PODS OF LIGHT ROSE COLOR.

It is a tree of the underwoods, growing usually in the shade of other trees, but it is found also in abandoned fields. Indeed, it thrives even better in the sun than it does in the shade.

Red-bud blossoms, which appear before the leaves, grow in clusters of six or eight flowers, which are like those of the pea or bean in shape. The tree belongs to the great plant family called the *legumes* (lĕg′ūm), to which the pea and bean also belong. Its seeds grow in pods of light-rose color, which stay on the tree all through the autumn, breaking open early in the winter. Each pod has in it about a dozen brown seeds.

The red bud seldom grows to a height of more than fifteen or twenty feet. The trunk is short and usually not more than six inches in diameter. The branches are rather upright. The crown is broad and shallow. It is native to the forests of the southern states, but when planted it thrives also in the northern states, where it is widely used for ornamental planting, especially on lawns under tall trees with high branches.

In the springtime people often go to the woods and gather armloads of branches of dogwood and red bud. They are indeed beautiful, but if the branches are broken, the trees suffer. The best plan is to enjoy the blossoms right in the woods where they grow and leave them there for others to enjoy.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. The flowers of the paper birch grow in ......
2. The seeds of the paper birch have ......
3. The wood of the flowering dogwood is used for ......
4. The red bud tree belongs to the ..... family.
5. Its seeds grow in .....

SOME THINGS TO DO

In your notebook make a drawing of a paper birch.

Write the names of the different kinds of birch trees. Opposite each name write a characteristic of the tree.

Perhaps there are other trees in your neighborhood as beautiful as the dogwood, the red bud, or the birches. Describe them or draw them in your notebook.

Make a scrapbook of pictures of beautiful trees.

CHAPTER XXIV

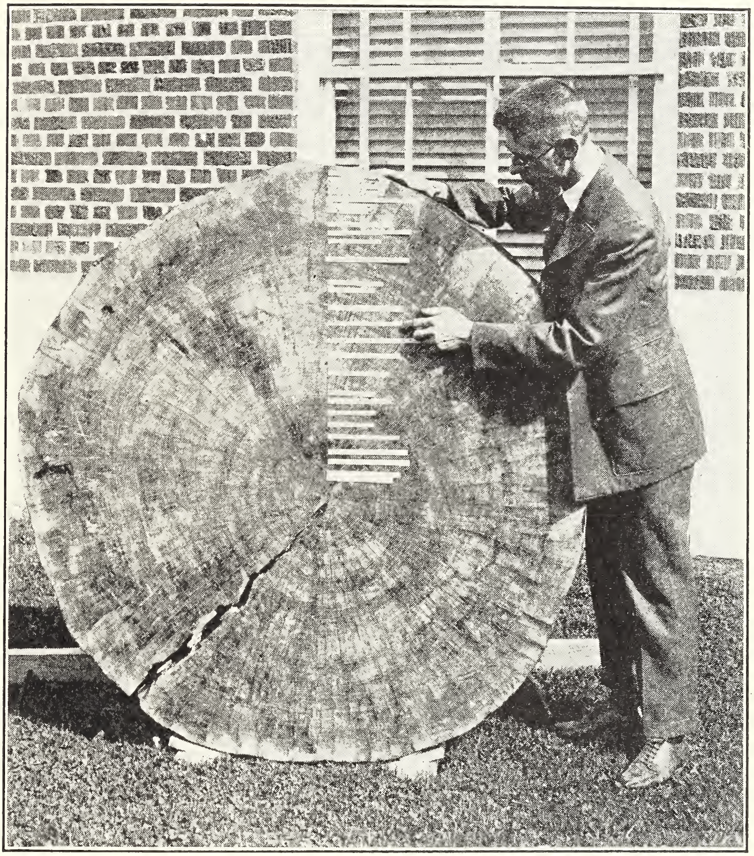
HOW TREES GROW

1. From what is maple syrup made?
2. How can you find out the age of a tree?
3. Can you tell by looking at a tree whether or not it is growing?

What a wonderful thing a tree is! White oaks, growing from tiny acorns, in 100 years tower seventy or eighty feet tall. Many of them live to be 250 or 300 years old. White pines and hemlocks stand for centuries. When a tree is cut down, its age may be told by counting the rings in a cross section of the trunk. The age of a living tree can be estimated by comparing its size with that of another tree of the same species that has grown under similar conditions.

There is at Tule, in Mexico, a great cypress tree which is thought to be 5,000 or 6,000 years old. In the Giant Forest Grove of California there is a sequoia tree, the *General Sherman,* that is estimated to be at least 4,000 years old. There are trees now living that had their beginnings long before the birth of Christ. Indeed, some of them had probably grown quite tall when the Pharaohs ruled in Egypt.

What an interesting thing it is that a great tree, with its roots, trunk, branches, and leaves, can develop from a tiny seed.

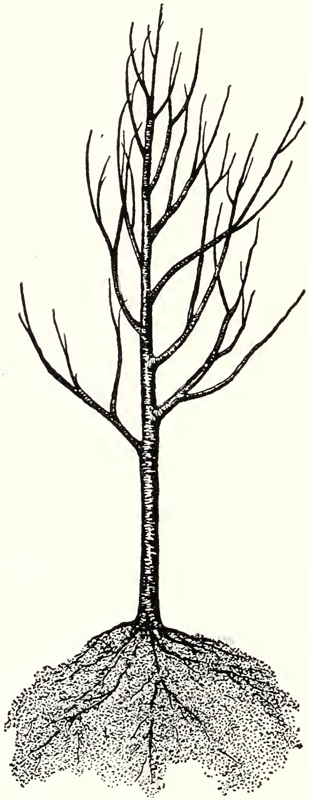


Courtesy of U. S. Forest Service.

THIS IS A SECTION OF A WESTERN PINE 670 YEARS OLD.

The man is pointing to the ring that grew in 1565 when St. Augustine was founded. This tree was eleven years old when Marco Polo traveled in the Far East in 1271. Think of the other great events that have occurred during its life.

If you can find an uprooted tree, it will be very interesting to examine the root system. The roots hold the tree fast in the ground, help it to stand in



THE ROOTS BRANCH BELOW GROUND IN A FLATTER MASS THAN THE BRANCHES.

the face of storms, and take in the tree food from the ground. The fine hairy rootlets that branch from the large root absorb food in liquid form from the soil. In much the same way that the tree branches aboveground, the roots branch underground, arranging themselves, however, in a flatter and denser mass than the branches.

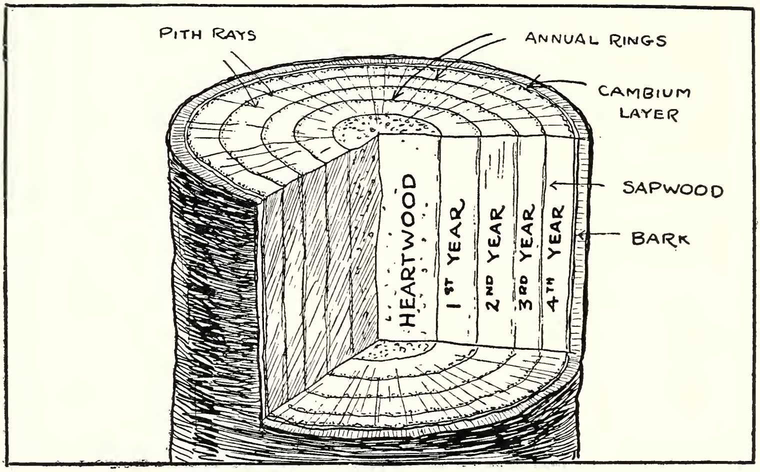
Roots of trees have a way of growing toward moist places. The roots of poplar trees are especially long, and in towns they grow toward the sewers. Many towns have laws forbidding people to grow poplar trees because they are so apt to clog the sewers.

The trunk of the tree is a channel through which the water and food, absorbed by the rootlets, flows upward to the leaves. Examine a cross section of a tree trunk. On the outside is the outer bark, a protective covering. On some trees, such as the oaks, this bark becomes very thick and corky. Next to it is the cambium layer, sometimes called the inner bark. It is a thin-walled tissue lying between the bark and the wood. This thin tissue is exceedingly important in the life of the tree for it is the living and growing part of the trunk. On the outside it builds a layer of bark, and on the inside a layer of wood.

Just inside the cambium is the sapwood, which is made up of the more recent rings of growth. Its cells are filled with sap, as the water and food absorbed by the rootlets are called. This sap moves up in a mysterious way, flowing from the rootlets through the trunk and branches into the stems and veins of the leaves and back again.

In the center of the trunk is the heartwood, darker in color than the sapwood, because it contains no sap. It gives strength to the tree and holds it upright.

The branches and twigs that spread out from the trunk are similar to it and do the same work. Through them the sap is carried to the leaves.



TRUNK OF TREE CUT AWAY TO SHOW ITS STRUCTURE.

With sunshine for power, and with raw materials from the air and from the sap, the leaves of the tree manufacture starch. The leaves are held out into the sunlight by the branches. Through their stems and veins runs the sap, bringing the food which has been drawn from the soil by the rootlets. Through the pores of the leaves carbon dioxide is absorbed from the air. You probably know that we breathe oxygen into our bodies and breathe out carbon dioxide. Plants with green leaves take in carbon dioxide and give out oxygen. Carbon dioxide, you see, is a combination of carbon and oxygen, and the plant uses the carbon in making starch.

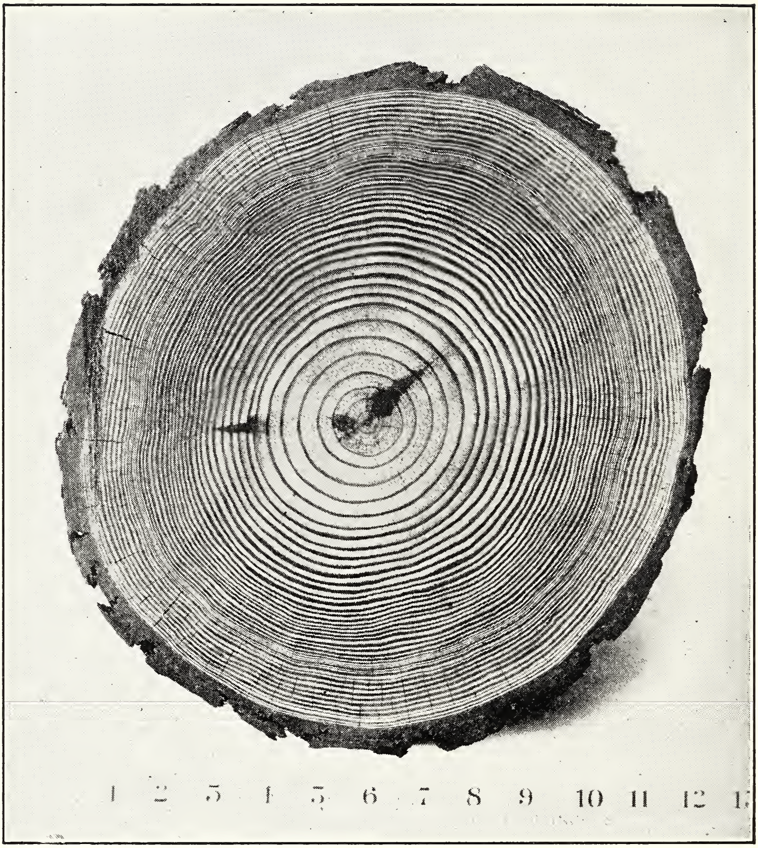
The green coloring matter in the leaf is *chlorophyll* (klō′rō-fĭl). Without it, the leaf could not make starch. You learned in Chapter IV some plants that had no chlorophyll in their leaves. How did these plants get their food? Green leaves are the greatest food factories in the world. Without them all of the animals, including man, would probably starve. Animals have no way of making their food from air, water, and sunshine, as the green plants have.

The starch made in the leaves of the tree by light of the daytime sun, is at night changed into sugar, which is dissolved in the sap and carried to all parts of the tree. Some of the sugar is changed into wood. Some of it is changed back into starch and is stored away in the seeds and the fruit of the tree.

Mrs. Comstock, a great nature student, says in her *Handbook of Nature Study:* "It has been estimated that on a mature maple of vigorous growth there is exposed to the sun nearly a half acre of leaf surface. Our tree appears to us in a new phase when we think of it as a starch factory covering half an acre."

Trees have periods of rapid growth. Select trees near your school, or near your home, and watch them grow. Perhaps you can find out at what time of the year they grow most rapidly, and also whether they grow during the day or during the night. Everybody knows that trees grow, but few people know when they grow or how.

In the temperate zone most of the native trees grow in height during less than forty days in the spring and early summer. By careful watching you will observe that some trees begin to grow early in the spring and complete their growth by the middle of May. The wild black cherry and the buck-



Courtesy of U. S. Forest Service.

ANNUAL RINGS OF GROWTH ARE NOT ALWAYS OF THE SAME THICKNESS.

eye are two trees that do this. The chestnut oak begins to grow about the middle of April. The tulip tree begins to grow the latter part of April. The growing period of the Norway spruce does not begin until May. Some trees have two growing periods. Watch for this when you make your observations. Usually you will find that trees grow about twice as much at night as during the day. Can you think why this is true?

Just how do trees grow? At the tips of the twigs and at the tips of the rootlets the new growth will be found. Up a little higher, down a little deeper, out a little farther, a tree pushes itself each year. Each year the cambium layer in trunk and branches builds a new layer of sapwood. During a good growing season the layers of growth may be a little thicker than during a poor growing season. If you have had a chance to examine a cross section of the trunk of a tree, you have probably noticed that the annual rings of growth are not all of the same thickness. Why is this?

The annual growth of a tree is usually completed by midsummer. Then, in all trees except the evergreen, the chlorophyll is withdrawn from the leaves and stored in the woody part of the tree. The brilliant colors of the autumn leaves are not caused by frost, as so many people think. The green coloring matter has been withdrawn, and the leaf has in it only material the tree can no longer use. This material is often brightly colored. As the chlorophyll is being stored away, a thin, corky layer is developing between the leaf stem and the twig. When this layer is completed, the leaf drops in the wind or of its own weight.

Sometimes the fruit does not ripen until after the leaves have fallen. Often it remains on the tree until late in the winter. Perhaps you have seen the buttonballs of the sycamore swaying gracefully in the cold winter winds, scattering their seeds all winter.

John B. Tabb has written a poem about the flow of the sap, which is so essential to the growth of the tree. The first verse reads:

> This is the way the sap-river flows
> From the root to the top of the tree
> Silent and dark
> Under the bark
> Working a wonderful plan
> That the leaves never know
> And the branches that grow
> On the brink of the tide never see.

Surely the growth of a great tree is according to a "wonderful plan." The tiny seed pushes out roots below ground and leaves upward into the light. The roots draw water from the ground and send it up to the leaves. The leaves, drawing carbon dioxide from the air, manufacture starch, which is later changed into the wood of the tree. Roots, trunk, branches, leaves—each has its special part to play in the life of the tree.

SOME THINGS TO THINK ABOUT

1. Mention two ways in which roots are useful to trees.
2. Mention two ways in which the trunk is useful to the tree.
3. Explain the work of the green leaves.
4. Name some plants that have no chlorophyll in their leaves, and tell how these plants get their food.

SOME THINGS TO DO

Find a cross section of a tree trunk and count the annual rings of growth. Record the number in your notebook, making a note also of the kind of tree and the diameter of the trunk.

Compare your record with those of your classmates to see what you can discover about the rates of growth of different species of trees.

Cover several leaves of a tree with thick cardboard for about a week. Then look to see what has happened.

Observe the different trees of your neighborhood to discover when they grow. Make a list of the different species with the dates of their growing periods. *Example:* Sweet buckeye—April 5 to May 10.

Look in an encyclopedia to find out where cork comes from.

Select a tree for special study. Learn to identify it by its leaves, its seeds, or its bark. Find out when it grows. Observe, also, when its leaves appear in the spring and when they begin to fall.

CHAPTER XXV

FRIENDS AND ENEMIES OF THE FOREST

1. Have you ever seen a forest fire? Have you ever read stories about forest fires?
2. Have you ever seen caterpillars eating the leaves of a tree, or boring into its trunk?
3. What kinds of insects attack the trees of your neighborhood?

When the early settlers came to America, they found the land covered with immense forests. One of their first problems was to clear enough land to raise food, so they cut out great areas of trees. As the population increased, people moved westward, spreading over the vast prairies and treeless plains they found. It was not necessary to clear land for farming there, but the demand for wood and lumber for building and fuel increased so rapidly that tree-cutting in other parts of the land continued at an amazing rate. Great forests were utterly destroyed. No one thought, in those days, of saving the young trees for future growth. There seemed to be an unlimited supply of forested land.

There were, in fact, some 822,000,000 acres of forests in this country when the first white settlers came. To-day there are but 138,000,000 acres of untouched forest, and 150,000,000 acres of second growth of commercial value. With the increasing

Courtesy of U. S. Forest Service.

THE TREES HAVE ALL BEEN CUT AND NO SECOND GROWTH PERMITTED TO STAND.

population and the decreasing acreage of forests, it has become necessary for us to give some thought to the forests of the future. Trees are still being recklessly and wastefully cut, however. In many places the young trees are not being saved, even upon land that is utterly worthless for anything but tree-growing.

From the time a forest tree crashes down and the finished product of manufactured wood is delivered, two-thirds of a tree is often wasted. In the first place, it is often cut too far above the ground. Branches and top are sawed off and abandoned. Valuable material that could be used for firewood, pulp, and small lumber is wasted, because it is too expensive to haul it out of the forest. At the mill the sawing is wastefully done. Slabs are burned to get them out of the way. When the lumber is finally shipped to the buyer, he saws it to fit his particular needs, wasting the small pieces. Even when the finished product is made, fire and decay attack it unnecessarily because proper precautions are not taken for its preservation.

These wasteful methods have been employed because logging and lumbering companies could make more money in this way. To-day, however, lumbermen, manufacturers, and foresters are turning their attention to losses from wasteful methods. There have been great national conferences on wood utilization. Preserving timber, the use of scraps, and more careful choice of grades and sizes of lumber are among the subjects discussed.

It is not only the rapid cutting of trees, however, that is destroying our forests. We use 23,000,000,000 cubic feet of wood a year. Forest fires and insects destroy about 2,000,000,000 feet.

A forest fire is a terrible thing. With a roaring crackle, sheets of fire run to the tops of tall trees and flames lick up the leaves and dead branches on the ground. The air is dull with smoke and hot as the breath from an oven. Animals of the forest run ahead of the flames in a wild frenzy.

After such a fire the forest is indeed a sad sight. Charred stumps remain to attract insects and fungus growths. The ground is bare and dries out quickly. The fertile top soil is burned away. The poor soil

Courtesy of U. S. Forest Service.

A FOREST FIRE IS A TERRIBLE THING.

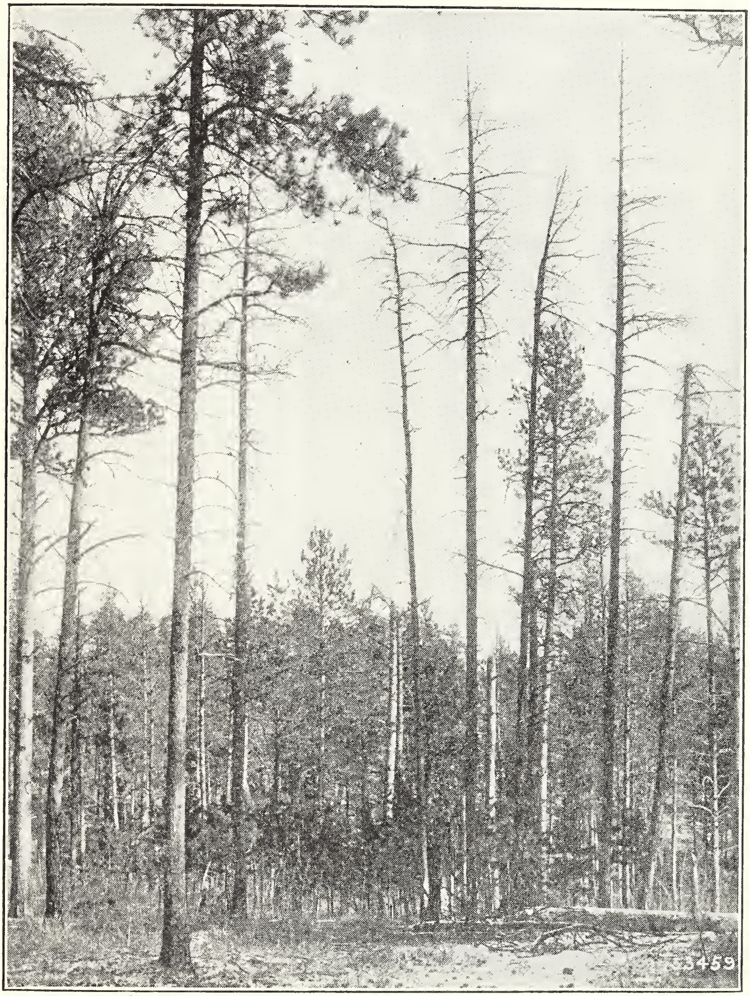
that is left is easily washed away by the rainfall. Springs and streams no longer flow down the valleys. It is said that in the history of this country

Courtesy of U. S. Forest Service.

CHARRED STUMPS LEFT BY A FIRE ATTRACT INSECTS AND FUNGUS GROWTH.

more timber has been destroyed by fire than has been put to use, and some men who have studied the problem believe that insects have killed even more trees than the forest fires have destroyed.

There are 200,000 kinds of tree-attacking insects. They destroy thousands of acres of valuable timber each year. During the month of May you will find tree after tree stripped of the green part of its leaves by cankerworms. You have already learned of the injury done to trees by the tussock and gypsy moths and by the elm-tree beetles. Bark beetles have destroyed large numbers of spruce in the Adirondacks. The pine beetle has attacked the forests



Courtesy of U. S. Forest Service.

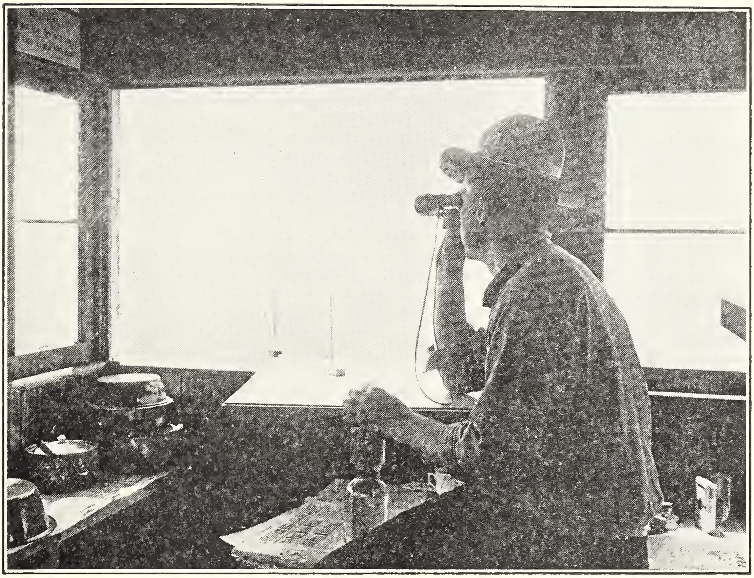
BEETLES DESTROYED THESE YELLOW PINE TREES.

of the Rocky Mountains and the Far West. Some insects bore through the bark into the sapwood and eat it. Others get into the heartwood and weaken the tree. Pine beetles lay their eggs on the bark of pine trees. The grubs, when hatched, work their way under the outer bark to the cambium layer and the sapwood, where they cut off the flow of sap and injure the tree.

Chestnut trees, once so plentiful in the eastern part of our country, have been destroyed by chestnut blight, which is caused by a fungus growth on the tree. The fungus was accidentally brought into this country from China, and its deadly work is one of the saddest of tree stories. There seems to be no way of checking the disease. The white pine blister rust, brought over from Europe with imported nursery stock, is destroying many of our best white pine forests. The mistletoe is injurying many of the fine forest trees of the south.

Field mice, gophers, and rabbits eat the bark of young trees, often injurying them enough to kill them. Heavy snowstorms sometimes load trees with a burden too heavy to carry, and they are broken by the weight. Lightning may do serious damage in a forest, killing trees and starting forest fires. Windstorms break and uproot the trees; cattle and sheep, grazing over forested areas, trample and destroy the young saplings.

One afternoon, in a forest in Center County, Pennsylvania, a warbler was seen to eat thirty cankerworms, one right after the other. Many of our familiar birds are insect-eaters, while the owls and the hawks eat mice, rabbits, and other small animals that injure trees. So useful are the birds in destroying the enemies of the forest that their protection is



Courtesy of U. S. Forest Service.
THE FOREST SERVICE AND MANY INDIVIDUAL STATES HAVE RANGERS TO WATCH FOR FOREST FIRES AND CARE FOR THE FORESTS.

an important step in forest conservation. Thus, when you build birdhouses and feeding stations, or establish bird sanctuaries, you are protecting the forests as well as the birds.

The United States Government is taking a hand in the conservation of our forests. There are in this country about 150 national forests under the management of the United States Forest Service. Foresters and rangers are employed to care for these forests. From their lookout towers the rangers watch for fires. They see that campers and tourists put out their campfires. When they discover a forest fire, they organize fire-fighters to put it out. Many state governments, too, have forestry departments, and maintain state forests, employing foresters and rangers to care for them.

You will be interested in the following rules and regulations prepared by the Department of Forests and Waters of the State of Pennsylvania.[1]

1. The State forests are for the use and benefit of all the citizens. Forest officers are instructed to coöperate with and assist all persons in the legitimate enjoyment of them.

2. To provide for the proper use and protection of the forests, no standing young or old trees shall be cut, shot at, barked, or otherwise damaged or destroyed, except as may be necessary for proper utilization of the forests, and with the approval of a forest officer, secured in advance.

3. Since uncontrolled grazing by horses, sheep, cattle, or hogs, is injurious to young trees, it is prohibited except by special permission.

4. No permit is required to camp overnight, but to insure the protection of forests against abuse, a permit is necessary to camp for a period of two days or longer.

5. For the protection of public health, springs and streams must not be polluted.

6. If the needs of the State for timber are to be met, forest fires must be prevented. No camp fires are permitted, unless proper precautions are taken to prevent their spreading to the forest.

7. All camp fires must be put out completely, immediately after use.

8. Persons suspected of starting forest fires, intentionally or unintentionally, will be prosecuted.

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[1] State forest rules from *In Penn's Woods*, Bulletin 31, 1928, Commonwealth of Pennsylvania, Department of Forests and Waters, Harrisburg, Pennsylvania.

9. The placing of advertisements in the State forests is not permitted.

10. For the protection of those who will camp in the forests hereafter, all wastepaper, empty cans, and other refuse must be buried or otherwise disposed of by those who bring them into the forest.

11. For the protection of wild life, strict observance of the game and fish laws by campers will be required.

12. For the preservation of flowers, the gathering of flowers of woody species is prohibited, except on permission of a forest officer.

13. For the preservation of fish life, and the comfort and consideration of campers, the use of motor-driven boats on lakes, ponds, and dams within the State forests is prohibited.

Seven Tested Rules for Preventing Forest Fires

1. Care—Be as careful with fire in the woods as you are with fire in your own home.

2. Matches—Be sure your match is out. Put it in your pocket or break it in two before throwing it away. Make this a habit.

3. Tobacco—Throw pipe ashes, and cigar or cigarette stubs, in the dust of the road, and stamp or pinch out the fire before leaving them. Do not throw them into brush, leaves, or needles.

4. Location of Camp—Select a spot as free as possible from inflammable material, sheltered from the wind, and near accessible water.

5. Camp Fires—Never build a camp fire against a tree or log, in leaf mold, or in rotten wood. Build all fires away from overhanging branches and on an earth or rock foundation. Dig out all rotten wood or leaf mold from

the fire pit, and scrape away all inflammable material within a radius of three to five feet. Make sure the fire cannot spread on, or under the ground, or up the moss or bark of a tree while you are in camp, and that it is going to be easy to put out when you are ready to leave camp.

6. Leaving Camp—Never leave a camp fire, even for a short time, without completely extinguishing every spark with water or earth free from moss and leaf mold. Do not throw charred cross-logs to one side, where a smoldering spark might catch. It is well to soak thoroughly all embers and charred pieces of wood, and then cover them with earth. Feel around the outer edge of the fire pit to make sure no fire is smoldering in charred roots or leaf mold. Hundreds of fires blaze up again and escape each year, after campers have thought they were extinguished.

7. Put the Fire Out—If you discover a forest fire, put it out. If you need help, notify the nearest forest-fire warden. A telephone central operator will connect you with him.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. When the early settlers came to America there were about ..... million acres of forests. Now there are but ..... millions of acres of untouched forests, and .....acres of second growth.
2. The people of the United States use about ..... cubic feet of wood each year. Forest fires and insects destroy about ..... cubic feet.
3. Insects destroy trees by eating their ....., by boring through the bark into the ..... and eating it, or by getting into the ..... and weakening the tree.

4. Birds are friends of the forests. They eat the ..... which attack the trees.
5. There are about ..... national forests.
6. Forestry departments often plant the seeds of forest trees in ..... When the seedlings are two or three years old, they are transplanted to the ......

SOME THINGS TO DO

Make a list of the enemies of the forest.

Name birds that are friends of the forest.

Find out whether you have a state department of forestry in your state.

If your state owns any forests, find out from your state government where they are. Perhaps you can also get a list of the rules and regulations for the protection and use of the state forests.

Does your state maintain a nursery for growing seedlings? Upon what conditions will your state supply seedlings to an individual for planting?

Perhaps you can plant some trees at your school or near your home. The time for planting trees differs in different parts of the United States. If you have a state department of forestry, they will tell you when the best time for planting is in your community. Arbor Day is a good time to plant trees, for it always occurs during the best tree-planting season.

Ask at your library for books about trees. Here are a few that are sure to interest you, if you can find them:

Field Book of American Trees and Shrubs, F. Schuyler Mathews, G. P. Putnam's Sons.

A Primer of Forestry (*Parts I and II*), Gifford Pinchot, Superintendent of Documents, Washington, D. C.

The School Book of Forestry, C. L. Pack, The American Tree Association, Washington, D. C.

CHAPTER XXVI

WHAT ARE OUR FORESTS WORTH?

1. Of the various articles you use nearly every day, which are altogether, or in part, forest products?
2. Can you think of any useful things obtained from the forests, excepting wood?
3. How do the forests help to conserve bird life?

From the original forest wealth of the country we have hewed our homes and built our industries. Think, for a moment, of what a great part the trees have played in the development of our industries. Wood has been used not only for homes, churches, and schools, but also for railroad ties and telegraph poles, for farm implements, and for the equipment of mines, of manufacturing plants, and of many other industries.

Lumber, fuel wood, paper pulp—these, perhaps, come first to our minds when we think of what the forests mean to us. It is indeed hard to imagine how we would live without wood and wood products. It is estimated that we use in this country, in one form or another, about 23,000,000,000 cubic feet of wood each year. This means that we use annually the wood from about 250,000,000 trees. These trees would cover an area of 18,500 square miles, which is an area equal to Massachusetts, Connecticut, and New Jersey. Newsprint paper, you know, is made

Courtesy of the Canadian Department of Immigration and Colonization.

WOOD HAS MANY USES. THESE TREES ARE TO BE MADE INTO PAPER PULP.

of wood pulp. For the paper used in one Sunday edition of a large city newspaper it is estimated that sixteen acres of spruce trees are required. However, important as wood and its products are in our daily lives, they are only one of the many gifts of the forests.

Forests prevent floods. Through the thick, leafy branches of the trees, rain strikes the earth gently. Much of it is absorbed by the soil and decayed leaves or leaf mold, which acts like a sponge, holding many times its weight in water. The overflow runs quietly to the streams instead of rushing down and carrying the earth with it, as it would if there were no trees there. The rootlets of trees, with their millions of tiny fingers, hold the particles of soil firmly in place, keeping them from being washed away by the rain. Snowbanks in the forest, too, melt slowly, and do not play the part in causing floods that they do in unforested country where they are more quickly melted by the warm rays of the sun. The surest way to decrease the danger from floods is to plant forests on the watersheds of streams.

Some of the water that sinks into the ground in the forests forms springs. In times of heavy rain, the soil cannot absorb all of the water, and some of it flows away in streams. These streams are much clearer and purer than are the streams in unforested land. Where streams run down treeless slopes, they are apt to be muddy, for they carry so much soil with them. The roots of trees, you know, hold the soil fast and act as a filter for the water in the forest streams.

Courtesy of U. S. Forest Service.
WHERE THERE ARE NO TREE ROOTS TO HOLD THE SOIL, THE LAND IS EASILY WASHED AWAY.

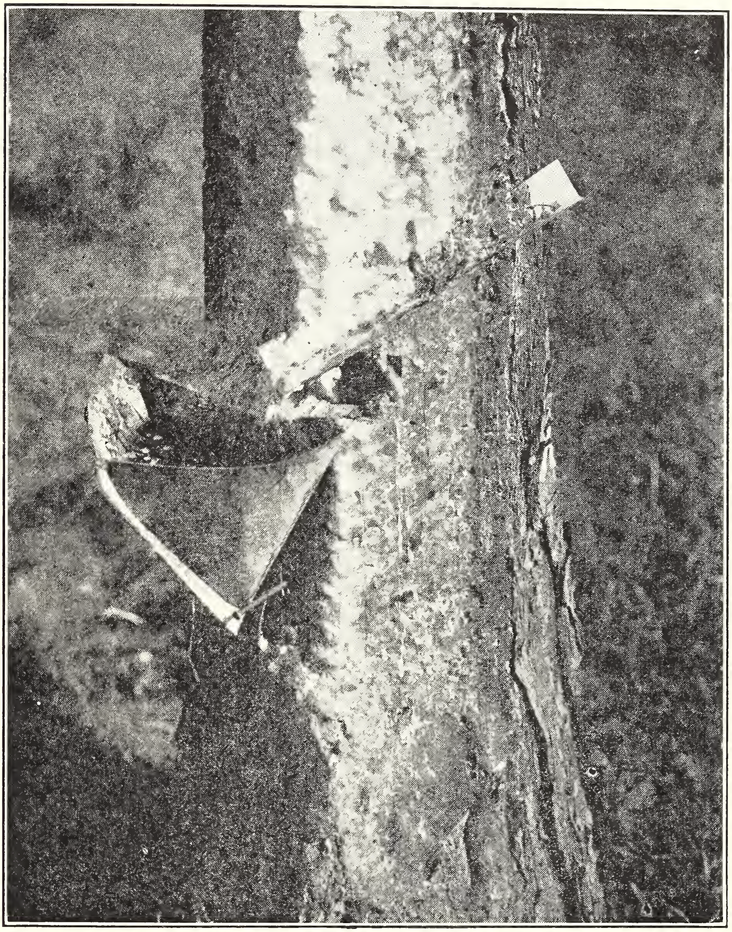
From forest springs, lakes, and streams, many large cities get their water supplies. New York City goes far out into the forests of the Catskill Mountains for its water, diverting mountain streams into great reservoirs, and carrying the water many miles through tunnels under mountains and rivers to the homes in the great city. Other cities, too, bring their water long distances from forest springs, lakes, and streams.

The streams of the forest are valuable, also, for power. Sometimes they cut deep gorges, across which dams are built. The dams prevent floods and make it possible to use the water stored up to run dynamos for making electricity, which is sent for miles over wires to farms and cities.

It is hard to overestimate the influence of trees upon the surface of the country and upon the water courses. Many thousands of acres in China are barren wastes because they are forestless. The hills have eroded, or washed away, and the soil has been carried out by the rains.

You have learned how trees grow. You know that their green leaves store away the energy they draw from the sun's rays. You have learned that they absorb carbon dioxide from the air, breaking it up into the carbon and oxygen of which it is composed. Some of the carbon is combined with other materials to form the body of the tree. You have learned to how many uses the body of the tree can be put, but have you ever thought of the value of the service which the tree performs in clearing the air of carbon dioxide and filling it with oxygen for us to breathe? All green plants help in this work of supplying us with oxygen, but a great tree, with its half-acre or more of leaf surface, can do more than hundreds of smaller plants.

Have you ever thought of the forest products that are not wood? From the southern pine forests come pitch, tar, turpentine, and resin. Turpentine and resin are made from the sap of the long-leaf pine. The bark of the tree is scarred, and the sap which drips out through the opening is collected in holes or boxes. It forms a thick gum which is scooped



Photograph from Publisher's Photo Service.
FROM THE SOUTHERN PINE TREES WE GET RESIN.

out and sent to the distillery. There it is heated. The turpentine passes off as a vapor that is condensed into a liquid. The resin is the product that remains. Turpentine and resin are valuable in shipbuilding and in making paints and varnishes.

Photograph by Ewing Galloway, N. Y.

FROM THE MAPLES IN OUR NORTHERN FORESTS WE OBTAIN MAPLE SUGAR.

In much the same way maple sugar is made from the sap of the maple tree. In the spring, when the sap begins to flow just after the first thaw, holes are bored into the trees and tubes are driven into them. Sap oozes into the tubes and drips into the buckets that are hung just below. The sap is collected and boiled to make syrup and sugar.

Have you ever camped in a forest? It is a delightful experience. The pleasant silence is broken by strange new sounds. There is a great variety of plant and animal life in the woodlands. Did you ever think how dependent upon each other are plants and animals? The birds that depend upon the trees for nesting places, protect the forests by destroying many of the insects that injure the trees. This is but one example. You can think of many others. Forests are natural sanctuaries. There wild animals can find homes and raise their young. Without the woodlands, these wild creatures would soon disappear.

Forests beautify the landscape. Trees cover mountainsides that would otherwise be bare and unattractive. We enjoy their beauty while they perform their useful tasks of purifying and regulating our water courses, holding our soil in its place, and preventing it from being washed away by the rain, filling the air with oxygen, and storing up valuable energy and building material for future generations of trees. The forests are among our greatest national resources. Trees must be cut to supply us with wood, of course, but if some tree-planting is done each year, and if only the large trees are cut and the young ones protected, there will be a continuous supply of lumber. As someone has well said, "Our forests should be farmed, not mined." What does this mean?

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. Forests purify the ..... water supply and prevent floods.
2. The rootlets of trees hold the ..... in place.
3. Green leaves absorb ..... from the air.

4. They break it up into .... and ......
5. We use the ..... from the air in our bodies, and breathe out ......

SOME THINGS TO DO

Make a list of twenty useful articles made of wood.

Make a list of forest products that are not wood.

Take a trip to the woods and keep a record of what you find there to enjoy.

Observe the hillsides that are treeless, and compare the soil with that on forested hillsides.

CHAPTER XXVII

WAYS OF GROWING TREES

1. What is the date of Arbor Day in your state?
2. Have you ever planted a tree?
3. Did you ever notice the young trees that spring up under the mother tree in the woods? What happens to them?

Now that you know how useful trees are, you will no doubt want to plant a tree, and to watch it grow. Let us see first how trees get their start in the forest—for you know, of course, that thousands of trees grow naturally in the forest, to every one that is planted by man.

All trees produce seeds, which are scattered about in various ways. Light seeds, like those of the elm, are carried by the wind. Some seeds, like those of the poplar, the maple, the box elder, the birch, and the pines, have wings that help them to fly in the wind. Sycamore seed balls stay on the trees until spring, when they burst, and the seeds are scattered by wind and water. Nuts and acorns are too heavy to be carried by the wind, but they are oftentimes carried by animals that store them away to use as food, and then frequently forget or neglect them; thus giving the seed a chance to grow.

If you want to grow a tree, it will hardly be necessary for you to begin by planting a seed unless

Courtesy of U. S. Forest Service.
ALL TREES PRODUCE SEEDS. THESE ARE THE SEEDS OF THE ELM, FIR, PINE, BOX ELDER AND BASSWOOD.

you wish to raise a nut tree. You will remember that, in an earlier chapter you learned that nut trees are very difficult to transplant. If you attempted to dig up a little nut tree to plant again as your own, the tree would very likely die. Thus, the easiest way to grow them is to plant the seeds. However, other forest trees may be transplanted without difficulty, and you will undoubtedly be able to get a small tree either from the woods or from a nursery.

Courtesy of U. S. Forest Service.
THE FOREST SERVICE GROWS SEEDLING TREES THAT CAN BE TRANSPLANTED LATER TO A PERMANENT PLACE.

You see, in spite of the excellent ways in which seeds are prepared for traveling, many of them drop right at the foot of the mother tree. There many young trees spring up, so you will have no difficulty in finding a young tree growing in the woods in a spot where it could not possibly develop properly. It may be right under the mother tree, or it may be where two or three seeds have fallen near together.

Foresters working for the United States Forest Service or for some of the state departments often gather seeds for planting in nurseries. There are individuals, too, who make a business of gathering seeds for planting. After a year or two in the nurseries, seedlings are transplanted to the places where the trees are wanted. Some state forestry departments maintain their own nurseries and will supply seedlings free of charge, or at a very small cost, to individuals who will plant them in suitable places for windbreaks or for forests on land which would otherwise be idle. Perhaps you can get a young tree to plant from your state nursery.

The season for transplanting trees varies in the different sections of the country. North of the 37th parallel, the best season is in the spring when the frost is out of the ground but before the budding begins. South of this line, transplanting may be done in the fall. Arbor Day is observed on different dates in the various states, but it always occurs during the best season for transplanting trees. Therefore, if you plant your tree on Arbor Day, or thereabout, you are almost sure to have chosen a good time for doing it.

When a tree is dug up for replanting, whether from a nursery or from the woods, enough soil should be taken with the roots to prevent disturbing the root structure any more than is absolutely necessary. The root system of even a small tree is larger than you would suspect, and even when you have taken quite a bit of soil, some of the roots will be left in the ground. If the tree is not an evergreen one, enough branches should be trimmed off to make up for the loss of roots. You see, it is very important that the roots of a tree be able to supply enough moisture for the branches. Therefore, when the roots are disturbed and some of them lost, the

Photograph from J. Horace McFarland Co.
NURSERIES GROW LARGER SHADE AND FRUIT TREES.

amount of moisture needed by the branches should be reduced by cutting off some of the branches.

Trees should be planted in well worked, enriched soil. The holes should be considerably larger than the roots of the trees can occupy, and the soil in the bottom of the holes should be broken up to the depth of the spade blade. It is well to dig the hole at least two feet deep, and to fill it with soft, freshly dug topsoil up to the point where the roots of the tree should be. The depth of the roots will depend upon the size of the seedling, of course. It is a good plan to plant the tree an inch deeper than it grew originally.

On the layer of topsoil spread out the roots of the tree so that none of them will be in a cramped position. Cover with two or three inches of fine topsoil, pressed firmly around the roots. Water lightly, and when the water soaks in, fill the hole with soil, leaving the surface loose and a little higher than the surrounding soil. It is a good thing to protect the young tree with some sort of guard.

If you want to raise a fruit tree instead of a forest tree, there are some other steps which you must take. An apple seed will produce an apple tree, but the young tree will not bear fruit like the apple from which the seed came. Instead, it will bear wild apples, small and sour. So you see, in raising an apple tree, it makes very little difference what sort of apple you take the seed from, for the tree that develops will be a wild apple tree, regardless of the variety of apple from which the seed came.

It is by the process of grafting that you can force your tree to produce the sort of fruit you want. Let us see first how the seedling is grown, and then how the grafting is done. To raise the seedling, you will have to select your seed, keep it in a cool place during the winter, and plant it in the spring. You will want your tree to grow as straight and as tall as possible during its first year, so you must plant the seed in rich, well-worked soil, keep it well watered, and protect the young tree carefully from animals that might break it down or eat it.

Before the ground freezes, dig up the young tree with a good deal of soil around it and plant it in a cool, damp place, where the ground will not freeze. Sometime during the winter, decide what sort of apple you want the young tree to produce, and select a twig from that kind of tree to graft on to your seedling. In size, the twig should be about the same as the young tree is at the point where you wish to make the joining.

This joining may be made at any point, but since that part of the tree that grows above the graft will be the variety of tree represented by the twig, it will be advisable to graft low, perhaps even to the root itself.

There are a number of ways of joining. The tongue graft is shown in the picture. Notice the first drawing. This shows how the seedling should be cut off for the grafting. You will see that it should be cut on a slant and not straight across, as you might imagine.

To make a successful graft, the cambium of the twig must exactly join the cambium of the young tree. Thus, you see how important it is that you select a twig of the same size as your tree. Notice in the picture how the twig is cut, and how twig and tree are fitted together. After they have been carefully fitted, they are bound together with cotton yarn coated with grafting wax, which is made of equal parts of tallow, beeswax, and linseed oil. Smear the wax thoroughly over the whole joint, making sure that it is airtight.

Grafting should not be done during the growing season, but in the winter when both twig and tree are dormant. After the graft is made, the tree should be set away until spring, when it may be transplanted into loose, rich soil. The fruit tree, like the forest

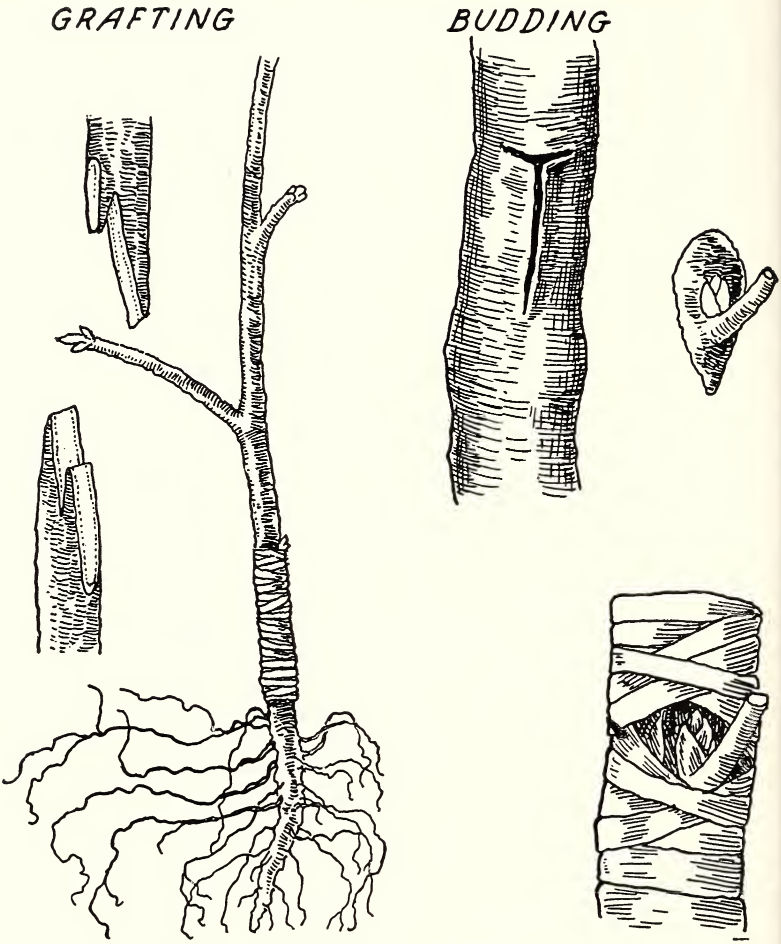


DIAGRAM SHOWING THE PRINCIPAL STEPS IN GRAFTING AND BUDDING.

tree, should be transplanted into a deep hole partly filled with topsoil so that the roots will have a good chance to get a start.

Grafting is generally used for pear, cherry, and orange trees, as well as for apple trees. If, however, you wish to raise a plum or a peach tree, you will use the process of budding, instead of grafting, to make it produce the variety of fruit you wish. Occasionally budding is also used for apples, pears, cherries, and oranges.

In the picture you will see the various steps of the budding process illustrated. It is done during the summer or fall months, when the seedling is about a year old, right in the field where the tree is growing. The first step is to select a year-old twig from a tree producing the variety of fruit which is wanted. When the twig is cut, wrap it in clean, moist cloth, until you are ready to use it. Then cut the bud from the twig.

Then make a cross and an up-and-down cut in the seedling, such as you see in the diagram. Pull the bark back carefully. Now, insert the bud and fold the bark back, wrapping it with raffia or yarn. As soon as the bud and the seedling have grown together, remove the wrappings to prevent them from cutting the bark, and cut the tree back very close to the bud, so as to force nourishment into the bud.

As the tree grows, some pruning will be needed to make it the desired shape, or perhaps to get it to bear more fruit instead of growing larger in size. There is not space in this chapter to tell you how this pruning should be done, but perhaps you can find some one in your neghborhood who raises fruit trees, and who will tell you about pruning, or who may even let you watch the work being done.

SOME THINGS TO THINK ABOUT

Fill in the word or words to complete these sentences correctly.

1. Tree seeds are carried by . . . . ., ..., and . . . . .
2. North of the . . . . . parallel, trees should be transplanted in the spring.
3. A tree should be transplanted an inch . . . . . than it was originally.
4. An apple seed will develop into a . . . . . apple tree.
5. In order to produce a cultivated variety of apples, you must . . . . . a twig of a cultivated apple tree on to the seedling.
6. To produce cultivated varieties of pears and peaches, a process known as . . . . . is used.

SOME THINGS TO DO

Plan a program for Arbor Day that will include the planting of one or more trees where they will be of value. If Arbor Day is over for this school year, make plans to carry out your program next year.

You will find it interesting, also, to plant some fruit seeds, and to experiment with grafting and budding.

Make a study of the seeds of various kinds of trees to see how they are fitted to travel. If you are studying this chapter in the spring, you will have to wait until the seeds have developed, or make your study from pictures.

CHAPTER XXVIII

THE TYPHOID FLY

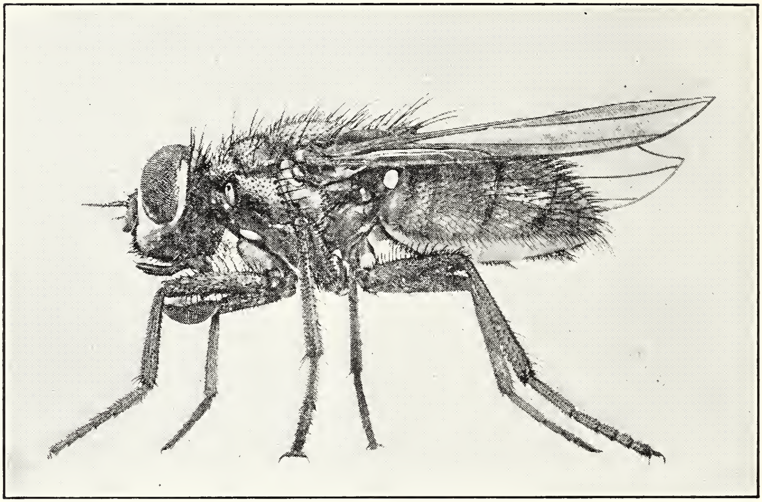
1. Why do we dislike having flies in our homes?
2. What do flies eat?
3. What can we do to reduce the number of flies?

The house fly, like the mosquito, is an insect pest. Indeed, it is far more dangerous than the common mosquito, for it is a disease-carrier.

You have probably heard it said that some diseases are caused by germs. These germs may be *bacteria* (băk-tē′rĭ-ă), which are very tiny plants; or they may be *protozoans* (prō′tō-zō′ans), which are little animals. Can you imagine plants and animals so tiny that dozens of them can live on the head of a pin? Not all bacteria and protozoans are harmful, but some of them are. Typhoid fever, for instance, is caused by bacteria that may be carried by the common house fly.

If you will examine the body of a house fly or look at a picture of one, you will readily see how it might carry germs, for its body is covered with hairs. Scientists have estimated that as many as 1,250,000 bacteria may be found on a single fly.

You will no doubt remember that the antennas of the mosquito are organs of hearing. Those of the fly are organs of smell. Flies have a keen sense of smell which guides them to their food. They



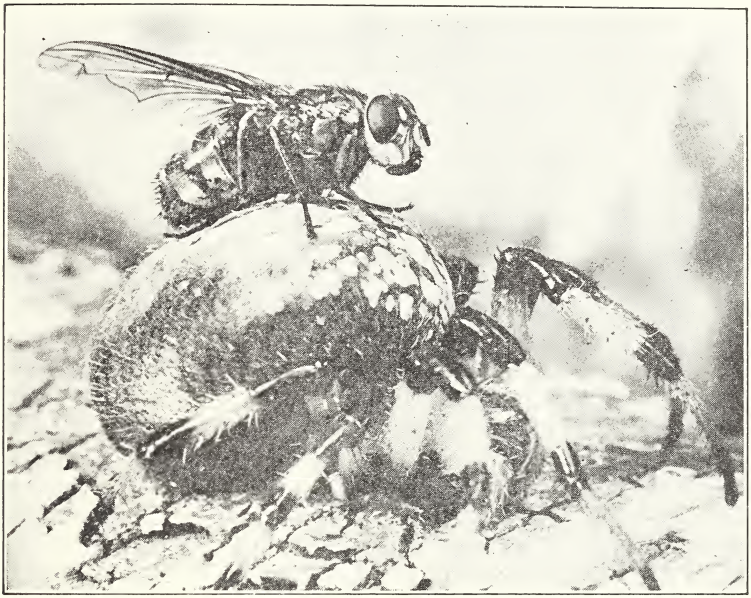
Courtesy of American Museum of Natural History.

THIS IS HOW A FLY WOULD LOOK THROUGH A POWERFUL MAGNIFYING GLASS.

are attracted by the smell of garbage and of the stable, as well as by the food that is being prepared for us to eat. Thus the fly that lights upon food in the kitchen may have just eaten from a garbage pail in the alley, if some careless person has left one uncovered.

With its tube-like mouth, or *proboscis* (prō-bŏs′ĭs), as it is called, milk and other liquids can be sucked up directly, but solids must be changed into a liquid form before they can be eaten. When the fly attempts to eat a solid, it pours out saliva upon it, and changes a part of it to liquid, which it is able to suck up with its proboscis.

Now, the fly carries disease germs on the inside of its body, as well as on the outside. When it feeds on germ-laden food, as it frequently does, the germs



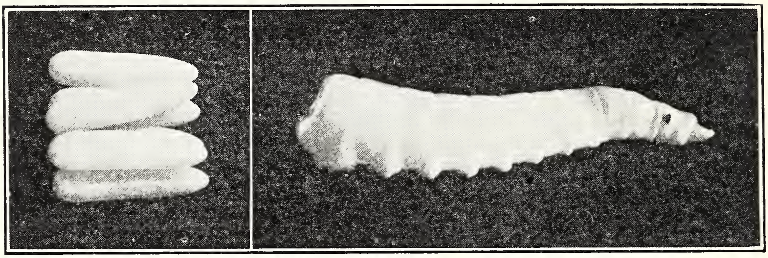
Photograph by Lynwood M. Chace.

THIS FLY HAS LIGHTED ON THE BODY OF A LARGE SPIDER.

often live in its mouth and stomach until they are passed out with the saliva; or sometimes they are deposited in the flyspeck that is left on the window-pane or the wall.

There is no doubt that we should make war on house flies and destroy as many of them as we can. Therefore, let us learn how they live and breed.

Flies are most numerous in summer. When the weather gets cold, many of them die. However, a few may be seen flying about in warm houses. Others crawl away in cracks and live there for the winter. Like the frog, the snake, and the bear, flies do so little during the winter months, that they need not even search for food.



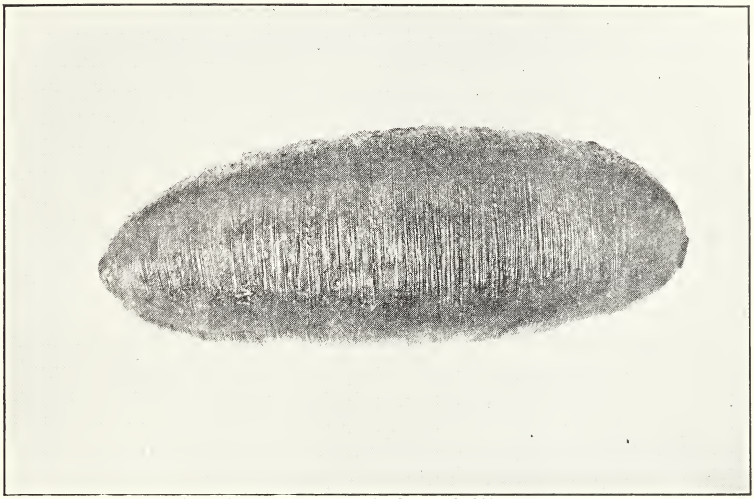
THE EGGS AND LARVA OF THE HOUSE FLY MUCH MAGNIFIED.

In the spring, they come out from hiding and hunt a place in which to lay their eggs. They choose a spot in which there will be food for the young larvas when they are hatched. In horse manure, decaying fruits, vegetables, and garbage, the female fly lays from 120 to 150 eggs at a time, and she often lays four times in a season. This means that one female may lay as many as 600 eggs in one summer.

About eight to twelve hours after the eggs are laid, the young larvas are hatched. They are sometimes called maggots. They are very active, and begin at once to burrow into the material on which the egg was laid.

They soon outgrow their skins and shed them for new ones. Do you remember other insect larvas that do this? Maggots shed two skins before they reach their full size of about half an inch in length.

When they are full grown they crawl away in the soil and change to the pupa stage. The skin shrinks and becomes a brownish covering, which is known as a *puparium* (pū-pā′rĭ-ŭm). Within the puparium, in about four or five days, the pupa becomes a fly that breaks the covering and comes out. It



Photograph from American Museum of Natural History.

THE ADULT FLY COMES OUT OF THE PUPARIUM.

is an adult, and never grows any larger than it is when it first comes out. Although some house flies may be a little smaller than others, because they have not had the proper food, they are usually all about the same size. The tiny flies that are sometimes seen about the house belong to a different group.

In about a week after they have left the pupariums, female house flies are ready to begin laying eggs. From the few flies that live through the winter, come all of the summer's flies. From the eggs laid by a single female and her descendants, it has been estimated that several million flies can develop in the course of a summer. Thus, you can see the importance of killing these first flies before they have had a chance to lay their eggs.

It is also important to destroy their breeding places. In the country, flies breed in manure heaps in great numbers. Scientists have estimated that a pound of manure may contain 1,200 or more maggots. From this, you can see what an enormous number of maggots could breed in a large manure heap. In order to prevent this, manure may be placed in covered pits, or it may be spread so frequently that the maggots do not get a chance to develop. When the manure is spread out on the fields, it dries quickly and the maggots and eggs are killed. If manure must be kept in uncovered heaps, borax may be added to kill the maggots.

In the city, flies may breed in the garbage unless it is kept in cans with tight covers. In fact, they are likely to breed in almost any kind of plant or animal matter; thus, it is easy to understand the importance of keeping waste material in tightly covered cans, and of having it taken away at least several times a week during the summer.

Until we can destroy all of the breeding places of the flies, it will be necessary to kill the adult flies after they hatch. Fly-traps can be bought or made at a small cost. We can use a fly-swatter to kill the few flies that come into our houses. Sticky flypaper can be used in most meat markets, bakeshops and stores, to catch the flies that come in from day to day. Poisonous flypapers should be kept out of the reach of small children.

Because the house fly carries germs in and on its body, it should be kept away from the sick, especially from those ill with contagious diseases.

Photograph from American Museum of Natural History.
THIS SHOWS THE BACTERIAL GROWTH THAT CAME FROM THE TRACKS OF A HOUSE FLY IN A DISK.

Every fly that strays into a sick room should be killed.

Decaying material should never be allowed to accumulate on or near your premises. All refuse should be disposed of. If you do not live where regular collections are made, you can bury your garbage or burn it.

Food, whether in the house or in the store, should never be exposed to the flies. If there are flies about, windows and doors should be screened, especially in the kitchen and dining room.

Wherever there are flies, you may be sure that their breeding place is at no great distance. Search for it and destroy it.

SOME THINGS TO THINK ABOUT

Pick out the correct ending for each of the following sentences:

1. The antennas of the house fly are { organs of hearing. / organs of smell. }
2. In winter, flies { go to the Southern States. / live in the cracks of our houses. }
3. One female house fly lays in one season { about 600 eggs. / about 120 eggs. }
4. The larvas of the house fly are called { caterpillars. / maggots. }
5. The house fly { is a dangerous enemy. / is a useful insect. }
6. The best way to fight flies is { to swat them. / to destroy their breeding places. }
7. The best time to swat the fly is { in the early spring. / in the late summer. }
8. Bacteria are { tiny plants. / small animals. }
9. Typhoid fever is caused by { protozoans that may be carried by mosquitoes. / bacteria that may be carried by flies. }

SOME THINGS TO DO

Watch a house fly feed on a lump of sugar. Examine the tongue with a hand lens.

Look at a house fly with a hand lens or a reading glass, to see the hairs on the body. Often you will see pieces of filth sticking to these hairs.

Make a flytrap. Several kinds are suggested in Farmers' Bulletin 734, *Flytraps and Their Operation.*

See how many flies you can catch in your trap in ten minutes.

CHAPTER XXIX

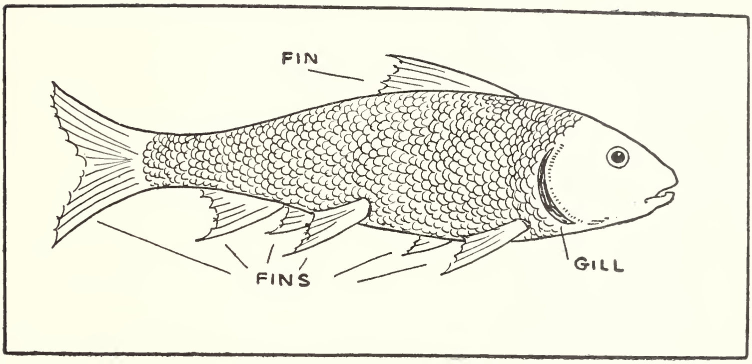
SOME COMMON FISHES

1. Have you ever gone fishing?
2. What kinds of fish did you catch?
3. Are there any laws to govern fishing in your state?

Have you ever thought of the ways in which the body of a fish is adapted to live in the water?

Narrow from side to side and pointed in front, the fish cuts the water easily as it glides forward. The tail, with its long, spiny fin, acts as a propeller, forcing the body forward by pushing against the water, first on one side, and then on the other. Usually the fish has seven fins, all of which help in steering and balancing the body. A fish does not breathe through a nose, as land animals do, but through gills that are placed under bony plates on the sides of its head. The air a fish breathes must be dissolved in water, because the gills cannot take oxygen from the air. That is why a fish gasps and dies when it is taken away from water. Thin oval scales, overlapping like the shingles on a house, protect the fish from its enemies, just as the armor of the knights of old protected them. In fact, some suits of armor were patterned upon the scales of the fish.

There are thousands of kinds of fishes. It will be impossible for you to learn about all of them,



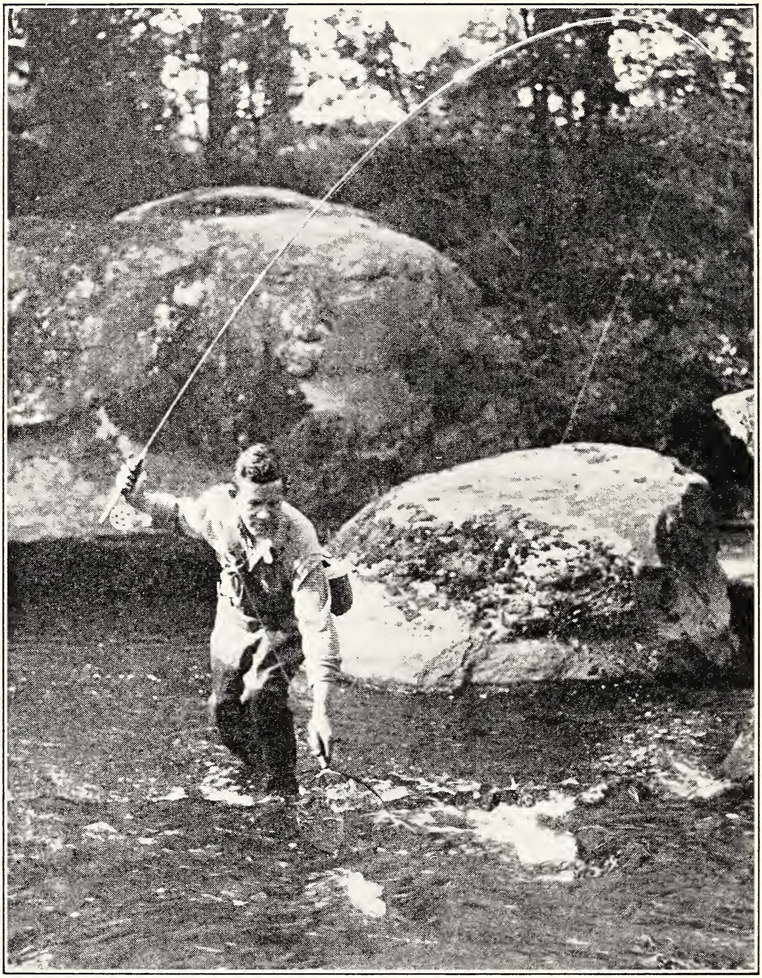
STRUCTURE OF A FISH.

but you will want to know a few of the most common kinds—those found in our lakes and streams or in the markets.

The Brook Trout

Brook trout are native to the clear, cool streams of the Appalachians, and they have been introduced into the streams of the Rocky Mountains. Fishermen will often travel hundreds of miles for one day of trout-fishing; and truly it is great sport, for the trout is a wary fish and is not easily caught.

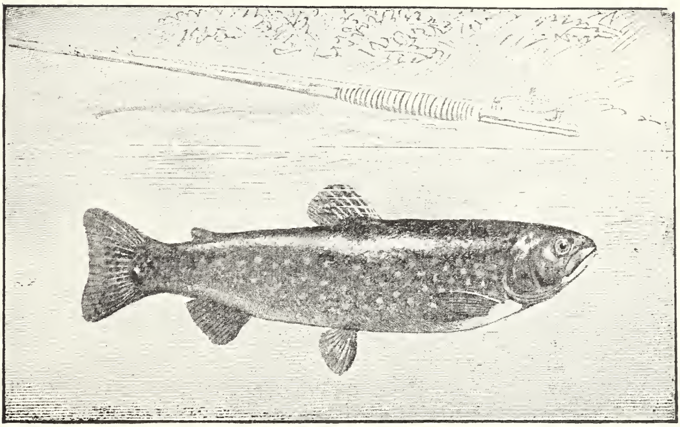
Near the bank, or near a fallen log in the water, trout hide and watch for insects. When a fly or a waterbug comes within reach, they dart after it, leaping clear out of the water. The trout fisherman finds the pools where the trout are hiding, and approaches them by wading upstream in the water, coming very quietly so as not to warn the fish of his approach. Live flies are his best bait. With a long



Photograph by H. Armstrong Roberts.

WITH HIS ROD AND NET THE TROUT FISHERMAN PLAYS HIS CATCH.

line and a reel, he casts the bait out and reels it in very quickly, in order to make it seem real to the suspicious trout.



TROUT LIVE IN THE COOL MOUNTAIN STREAMS.

In the smaller creeks brook trout are usually about six to eight inches in length; but in the larger streams where food is plentiful, they may reach a length of eighteen inches.

In the autumn, trout go far up the small creeks to lay their eggs. Fish eggs are called spawn, and laying them is known as spawning. The trout deposits its eggs in shallow water with a gravel bottom, where they remain until they hatch in the spring. Young trout lay from 150 to 250 eggs, while the older ones lay from 500 to 2,000 in a season.

Large-Mouth Black Bass

The large-mouth black bass, widely distributed in the bays and small lakes from Canada to Florida and Texas, is one of our best game fishes. You may know it by some other name, for it has many.

It is called the straw bass, green bass, lake bass, marsh bass, moss bass, or green trout. It prefers shallow, warm, sluggish water with a muddy bottom.

When caught, a large-mouth bass puts up a game fight. They vary greatly in size. Usually a two- or three-pound bass is considered a large one, although in the northern states they have been known to weigh five pounds and to measure more than eighteen inches in length. In the southern states, where the water remains at a more even temperature and where food is plentiful, they grow much larger.

In coloring, bass are usually dull olive green, lighter on the sides and greenish or silvery below. The body is covered with a plain, dull pattern. Bass taken from the waters in different parts of the country vary in color. Some are lighter than others, and there is a considerable difference in the arrangement of colors. Some fish are more spotted than others. Scientists know no reason for this difference.

Because the flesh of the bass is excellent for food, the United States Bureau of Fisheries, at Washington, D. C., sends out each year thousands of young bass to be placed in streams. In 1928, more than 1,634,800 bass one inch long, called fingerlings, were distributed for this purpose. These tiny fish are placed in waters from which large numbers of bass have been taken, or in streams where bass have never been found.

THE LARGE-MOUTH BASS (above) AND SMALL-MOUTH BASS (below) ARE COMMON IN BAYS AND LAKES.

The Yellow Perch

Unlike the large-mouth bass, the yellow perch is not a good fighter. It can easily be taken by boys and girls with a hook and line. Persons who do not care to try for trout or bass will enjoy fishing for the yellow perch. Nearly any bait can be used. It will bite at angle worms, minnows, pieces of fish, or grasshoppers.

The yellow perch is found chiefly in the lakes of northeastern United States, although it also lives in the ponds and streams of that section of the country.

A full-grown perch will measure seven to fourteen inches in length, and will weigh from one-half to three pounds. It is reported, however, that a yellow perch weighing four and one-half pounds was caught in Delaware Bay.

Although not a large fish, the yellow perch is considered excellent for food, and is a common fish in the markets of the cities along the Great Lakes. Because of the food value of perch, eggs, fingerlings, and young perch called fry, are placed each year by the United States Bureau of Fisheries in lakes and streams where they will grow. In 1928, there were 175,825,000 fry, and 1,569,200 fingerlings distributed for this purpose.

Fish caught for recreation are known as game fish. If they were not protected by law, they would soon disappear from the waters. Each state has its fishing laws, which fix for fishing the time of "open season," or the time during which fishing is

THE YELLOW PERCH (below) AND WHITE PERCH (above) ARE SMALL FISH OFTEN CAUGHT BY BOYS AND GIRLS.

permitted. State laws also regulate the number of fish of each kind that may be taken at one time, and the smallest-size fish of each kind that may be kept. Fish smaller than this must be thrown back into the water. Licenses are usually required for fishing, and game wardens are employed to see that the laws are obeyed. Explain the reason for such laws as these.

Millions of pounds of fish are used each year in the United States for food. Fishing is an important industry. The United States Bureau of Fisheries helps to keep up the supply of fish in lakes and streams by maintaining fish hatcheries and by sending out each year millions of eggs and fingerlings.

SOME THINGS TO THINK ABOUT

Some of the following sentences are true. Some are not true. On a piece of paper write the number of each sentence. If it is true, write *True* beside the number. If it is not true, write *False.*

1. The body of a fish is propelled through the water by its tail.
2. A brook trout is very easily caught.
3. A fish gets oxygen from the water.
4. The brook trout lays its eggs in the autumn.
5. The large-mouth bass is a good game fish.
6. The United States Department of Fisheries helps to maintain the supply of fish in lakes and streams.
7. Yellow perch often weigh ten pounds.
8. The yellow perch is valuable for food.
9. Fishing is an important industry in this country.
10. Fish eggs and small fish are placed in lakes and streams each year by the United States Department of Fisheries.

SOME THINGS TO DO

Watch a fish in an aquarium and notice how its body is fitted for life in the water. Notice how it swims. Look at the gill coverings, as the bony plates on the sides of the head are called. Notice how they move in and out. Can you tell the reason for this?

Examine fish scales under a magnifying glass or a microscope.

Make a list of the kinds of fish sold in the markets of your neighborhood, and find out where they are caught.

Find out what kinds of fish are caught in the lakes and streams of your neighborhood. Find out what laws have been made to govern fishing in your state, and tell the reasons for the different regulations.

CHAPTER XXX

PROTECTING OUR WILD FLOWERS

1. Do you know where to go to find wild flowers growing?
2. What wild flowers grow in your neighborhood?
3. Are they more beautiful as they grow in the woods or after they are picked?

On a pleasant Sunday afternoon in the early spring, many people go to the woods to gather wild flowers. They pick whatever blossoms they find, as many as they can carry. At the end of the ramble, however, when they return home, they are usually disappointed. The flowers are wilted and will probably last one or two days, whereas near the brook in the woods, they might have lived for weeks. Bloodroot, anemone, spring beauty, dog-toothed violet—these and many others—are becoming scarcer each year because so many of them are destroyed.

Flowers that might have been enjoyed by hundreds of people are thoughtlessly gathered and destroyed by one person. Left in the woods, they would produce seeds from which more plants would grow. When they are gathered carelessly, even the plants upon which they grow are often destroyed.

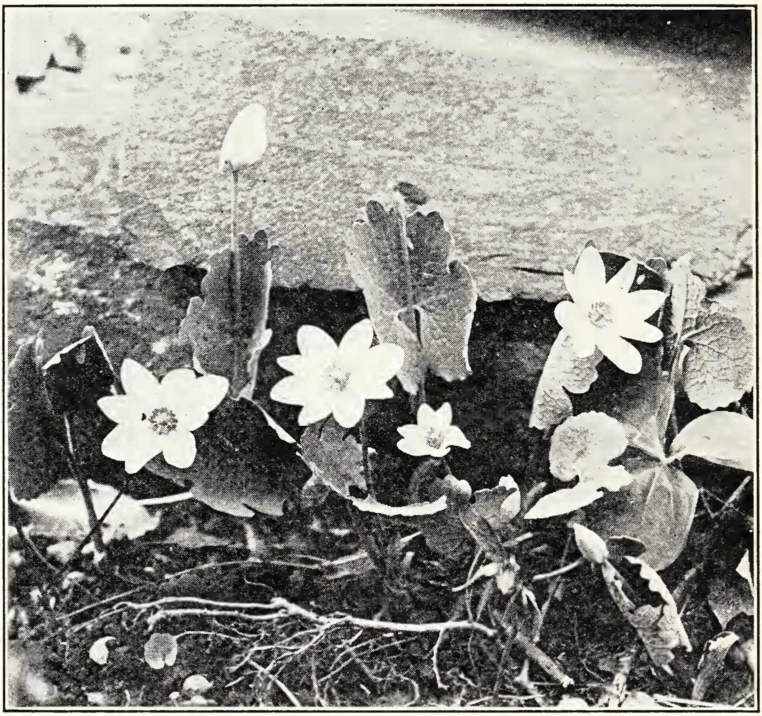
Let us learn to enjoy and leave wild flowers in the woods and fields where they grow, for they are most beautiful there. Let us learn which of them we may pick freely, which may be picked sparingly, and

SPRING BEAUTY IS A FAVORITE AMONG WILD FLOWERS.

which are becoming so rare that they should never be picked at all.

The spring beauty is always a favorite among wild flowers. It is very pleasant to come upon it in the woods in the early springtime. The five-petaled flowers are delicate pink or white with deep pink veins. Each stem bears several blossoms. Growing in colonies, they brighten the woods floor; yet when picked, they are not particularly beautiful.

Wood anemones, or windflowers—frail white or delicate pink flowers growing about nine inches tall—appear in colonies, usually near the edges of the woods, about the same time as the spring beauties. Their leaves are wedge-shaped. The Chinese have long called the anemone the "death" flower, and they plant it on graves. The Romans believed that the



Photograph by Verne Morton.
BLOODROOTS WITH THEIR YELLOW CENTERS AND WHITE BLOSSOMS GROW IN SHADY PLACES.

plant had a mysterious charm that would keep off fever. They wore it for good luck, as some people to-day wear the four-leaf clover. Anemones wilt so quickly that there is little pleasure in gathering them.

The lovely white blossoms of the bloodroot, with their golden-yellow centers, are found not only in the woods but on river banks and in moist pastures. The broad leaf circles the flower stem in a characteristic manner. Even in the woods, the flowers last but a day, and when picked, they are perhaps the most short-lived of any of the wild flowers.

In the early spring, the golden-yellow blossoms of the marsh marigold dot the low, wet meadows. The leaves are glossy green, and are almost heart-shaped. The flowers look like buttercups.

The blossoms are often sold in the streets as cowslips, and the leaves are sometimes eaten as a vegetable. Since this plant grows only in low, wet places, the draining of marshes and meadows destroys many of them.

In the early days in this country, wild flowers were very plentiful. People could gather as many as they wished, and there were plenty left. As the trees were cut and cities grew up, the wild flowers were crowded out. In certain sections of the country many species, once common, have now disappeared entirely.

The Wild Flower Preservation Society was organized to protect the wild flowers. They have divided the different kinds into three general groups. In the first group they have placed those that should not be picked at all within twenty-five miles of any large town or tourist point, and then only sparingly:

aconite	bird's-foot violet	columbine
anemone	buck bean	clintonia
azalea	bluebell	cardinal flower
arethusa	clematis	Christmas berry
bird-on-the-wing	climbing fern	

Chimaphila
dogwood
dog-tooth violet
Elliottia
Fritillaria
gentian
holly
Indian pipe
Indian paint brush
lilies (all)
lady's-slipper
lobelia
lungwort
larkspur
lupine (eastern)
mariposa lily
marsh marigold
mountain laurel
maidenhair fern
mission bells
phlox
pipsissewa
pitcher plant
pasque flower
pride of California
pogonia
redbud
rhodora
rhododendron
rose pink
saxifrage
Shortia
snow plant
shooting star
spring beauty
spotted wintergreen
swamp pink
trailing arbutus
twin flower
toothwort
trillium
toadflax
walking fern

In the second group are those that may be picked sparingly if the roots are not disturbed, and if plenty are left to go to seed:

bloodroot
blue-flag
butter and eggs
brodiæa
bush poppy
beardtongue
blue-eyed grass
crane's-bill
dayflower
dogwood
fuchsia
godetia
perennial lupines (western)
hibiscus
madrone
mallow
monkey flower
milkwort
pink
phacelia
rose
snowberry
sage
snow-on-the mountain
violets (entire-leaved)
valerian

In the third group are those that may be picked freely, with little or no danger of extermination:

aster
agrimony
arrow-leaf
black-eyed Susan
buttercups
blueweed
bluets
boneset
blazing star
bouncing Bet
bush clover
beggarweed
chicory
celandine
cinquefoil
coneflower
clover
coffee weed
Canary Island tea
creamcups
cow parsnip
daisy
dandelion
dogbane
dyeweed
everlasting
evening primrose
foxglove
fireweed
goldenstar
ground ivy
ground cherry
goldenrod
goldenglow
heal-all
hardhack
hound's-tongue
henbit
ironweed
Indian lettuce
Japanese honeysuckle
lilac (wild)
lupine (western annual)
milkweed
morning-glory
mustard
mullein
nemophila
poppy
poppy (California)
pickerel weed
pokeweed
Queen Anne's lace
red maids
speedwell
stonecrop
smartweed
sneezeweed
sunflower (wild)
St.-John's-wort
thistle
tidy tips
vervain
water hyacinth
yarrow

There are, of course, exceptions to these groupings in different sections of the country. For example, in New England, dogwood goes in Group 1, while in the Middle Atlantic States, it belongs in Group 2. Mountain laurel is in Group 1 in New England, and in Group 3 from Maryland south.

In this short chapter there is not space to give you pictures and descriptions of all the different wild flowers. No doubt you know the names of many of the wild flowers that grow in your neighborhood. With a good flower guide, you will be able to find the names of the others. You can check those you find with the groups given here, to find out in which class each kind common to your neighborhood belongs.

Perhaps you would like to organize a Junior Chapter of the Wild Flower Preservation Society. You can find out how to do so by writing to the national headquarters, at 3740 Oliver Street, Washington, D. C.

SOME THINGS TO THINK ABOUT

Some of the following sentences are true. Some are not true. On a piece of paper write the number of each sentence. If it is true, write *Yes* beside the number. If it is not true, write *No.*

1. All wild flowers are plentiful.
2. The Chinese call the spring beauty the "death" flower.
3. According to the Wild Flower Preservation Society the following flowers may be picked freely:

lilies	columbines
spring beauties	rhododendrons
anemones	pogonias

4. The following wild flowers may be picked sparingly without disturbing the roots:

roses	violets
sage	bloodroot
dogwood	pinks

5. The following wild flowers may be picked freely:

asters	cinquefoils
buttercups	chicory
daisies	morning-glories

6. All wild flowers grow everywhere.

SOME THINGS TO DO

List the names of the wild flowers of your neighborhood in three classes: (1) Those that should not be picked at all; (2) Those that may be picked sparingly if the roots are not disturbed, and if plenty are left to go to seed; (3) Those that may be picked freely. Consult the lists of the Wild Flower Preservation Society, and make any changes you think your neighborhood calls for. If you find flowers that are not on the lists of the society, discuss them in class to decide in which group they should be placed.

You can make a very interesting notebook with drawings and descriptions of your neighborhood wild flowers.

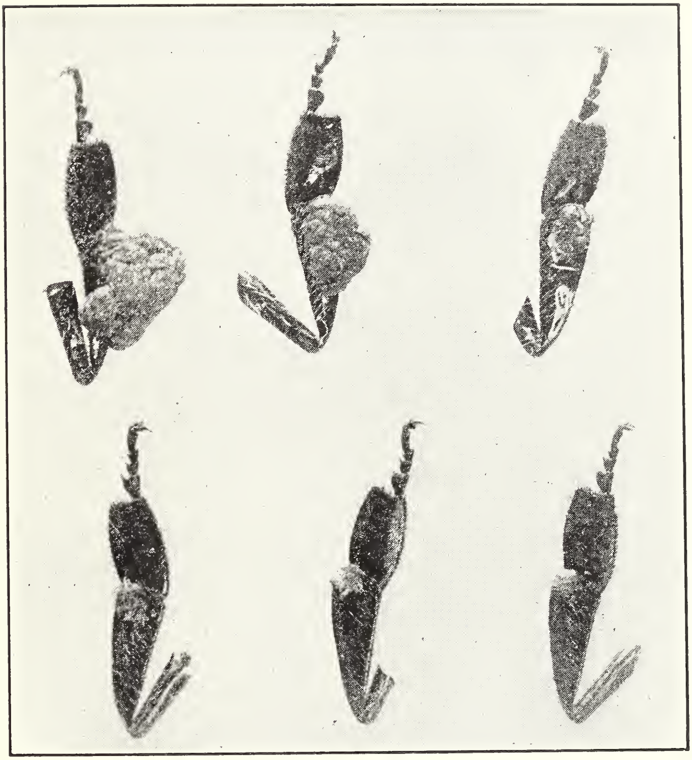
CHAPTER XXXI

FLOWERS AND INSECTS AS PARTNERS

1. Have you ever watched a honeybee on a flower?
2. Do you know how bees carry pollen?
3. Do the bees help or harm the plant by visiting the blossom? How?

Bees go from blossom to blossom gathering nectar and pollen. They have little baskets on their hind pair of legs in which they carry the pollen to their hives. Perhaps you have seen the little workers with their baskets full. They appear to have two balls of golden dust on their legs.

If you examine a bee under a magnifying glass, you find that its whole body is covered with hairs. As it goes from flower to flower, some of the pollen naturally sticks to these hairs and is carried from one plant to the next. You have already learned how important it is, in the lives of some of the plants, that the pollen from the stamens fall upon the pistils of the flower, for unless this happens, seeds will not grow. Sometimes both stamens and pistils are in one flower, and are so arranged that the pollen can hardly fail to fall from the stamens upon the pistils. Sometimes stamens and pistils are in different flowers on the same plant; and in some kinds, stamens and pistils are found on different plants. Pollen may be carried by the wind, but in some plants it is often too heavy and moist to be



THESE MUCH MAGNIFIED LEGS OF BEES SHOW THE HAIRS TO WHICH THE POLLEN CLINGS. NOTICE THE BALLS OF POLLEN ON THE LEGS.

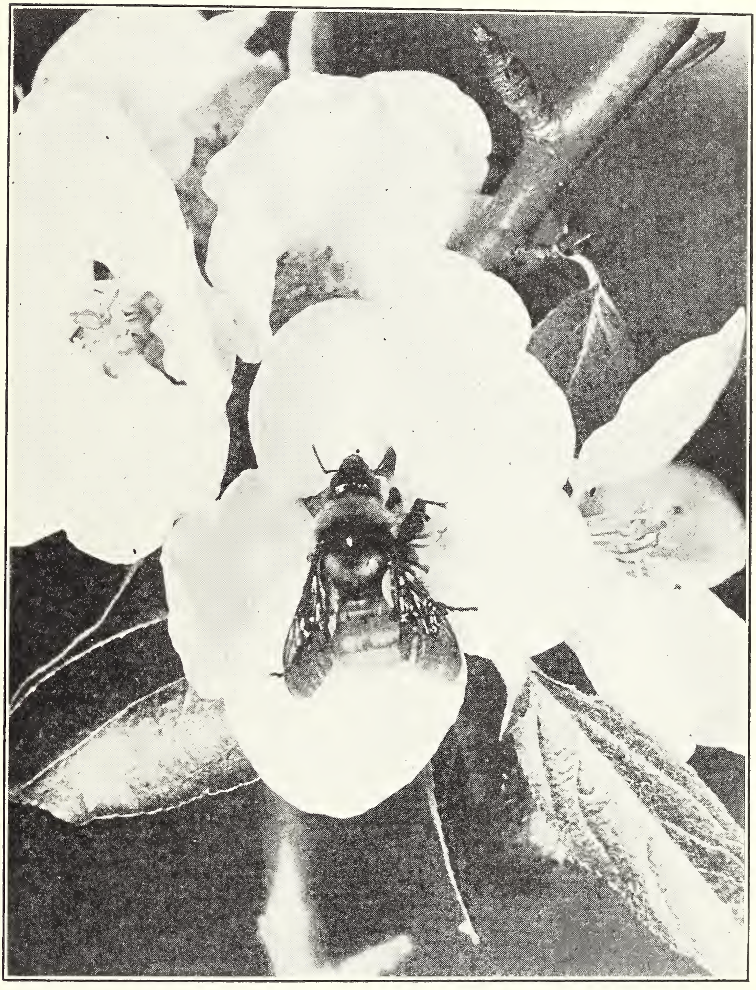
carried far. For such plants, the bee, in gathering its food, does a very valuable service.

When the people in the northwestern states learned that apple trees would grow there, they planted a great many apple orchards. They were soon to be disappointed, for although the trees produced many blossoms, very few apples developed. On apple trees both stamens and pistils are found in each blossom. Look at the picture of an apple blossom. You see at once that the pollen from the stamens can hardly fail to fall upon the pistils of the flower.

However, the strange fact is that for good apples to develop on many apple trees, the pollen from another kind of apple tree must fall upon the pistils. For instance, in order to produce Jonathan apples, the pollen from another kind, such as the Ben Davis apple, is needed. Thus the people of the northwestern states learned that two things are necessary in order to raise good apples. In the first place, the orchards must contain the right combination of different trees; and in the second place, bees are needed to carry the pollen from one kind of tree to the other.

Scientists have studied this matter of pollination in fruit trees—that is, the transfer of pollen from the stamens to the pistils,—by carrying on a number of experiments. Similar experiments have been carried on in a number of different states, with almost the same results. In *Bulletin* No. 163 of the State Agricultural Station of the State College of Washington, one series of tests is described.

Tents were used to cover the trees. Under one tent a Jonathan apple tree and a stand of bees were placed. Another Jonathan tree in the same orchard was covered with a tent under which there were no bees. The tents were so constructed that it was practically impossible for the pollen from another tree to get to the blossoms of the trees that they covered. The test results show no advantage in



Photograph by Lynwood M. Chace.

HERE IS A BEE AT WORK ON AN APPLE BLOSSOM.

having the bees inclosed with the tree. The tree covered with the tent without bees produced 61 apples. The tree covered with the tent with a stand of bees produced 57 apples, while a tree of the same kind in the open orchard produced 100 apples. What was the reason for these results?

In a bulletin of the New Jersey Agricultural Experiment Station, an experiment is described in which two trees—a Jonathan apple tree and a Wealthy apple tree—were covered by a single wire-screen cage, together with a hive of bees, during the blooming period. Trees of the same kind and in the same orchard were covered during the blooming period by a cage under which there were no bees. The conditions of both experiments were the same, with the exception of the bees. The results are shown in the following table, which is taken from the article in *Bulletin* No. 434 of the New Jersey Agricultural Experiment Stations, "Relation of the Honeybee to Fruit Pollination in New Jersey," by Ray Hutson:

Blossoms Setting Fruit on Apple Trees With Bees and Without Bees

Trees	With Bees			Without Bees		
	Total Blossoms	Fruit Set		Total Blossoms	Fruit Set	
		Number	Per cent		Number	Per cent
Wealthy....	3,475	591	17	3,675	148	4.02
Jonathan...	2,758	238	8.4	1,985	16	0.80

In all the experiments reported, the fruit trees tested have shown an increased yield when insects work freely among the blossoms. Honeybees and bumblebees seem to be the most dependable means of carrying pollen from tree to tree. It is a common practice in these days for fruit-growers to place hives of bees among the trees. About one hive to the acre seems to be advisable.

But it is not the fruit trees only that profit by the work of pollen-carrying insects. For instance, there would be few cranberries without the aid of insects. The New Jersey Agricultural Station performed some experiments with honeybees in the cranberry marshes. The scientists covered two equal areas of blossoming cranberry plants with wire cages. Inside one of the cages, they placed a hive of bees, while the bees were kept away from the plants in the other cage. The areas were side by side, and the conditions were similar in the two tests, with the exception of the bees. The results were determined by counting the number of blossoms and the number of berries in each area. In the cage with the bees, from the 2,385 blossoms found on the plants, 1,335 berries developed. In the cage without the bees, there were 2,184 blossoms, and only 185 berries were formed.

From these experiments you can see that bees are indeed useful creatures, not only for the honey they produce, but for their services in carrying pollen from one flower to another. The next time you see one of these small workers with the golden balls of pollen on its legs, you will know that it is paying well for its winter's food by its useful services in pollen-carrying.

SOME THINGS TO THINK ABOUT

Some of these sentences are true. Some are not true. On a piece of paper write the number of each sentence. If it is true, write *True* beside its number. If it is not true, write *False.*

1. Bees carry pollen in little baskets on their legs.
2. Bees carry pollen on their bodies.
3. Apples will not form unless pollen reaches the pistils of the blossoms.
4. The pistils develop best when pollen from the stamens of the same flower reaches them.
5. When bees are kept away from apple orchards, they produce a large crop of apples.
6. Scientists have studied pollination of fruit blossoms.
7. Each apple blossom has both stamens and pistils.
8. The wind carries a great deal of pollen from one apple tree to another.
9. Insects help to increase the cranberry crop.

SOME THINGS TO DO

Find a fruit tree in blossom and observe the bees at work.
How many bees visit one flower in ten minutes?
Look for bees with pollen in their baskets.
Examine the body of a bee under a magnifying glass.

CHAPTER XXXII

A REVIEW

1. What have you learned from this book that will help you to make your community a better place in which to live?
2. What does conservation mean?
3. What are some of our natural resources that should be conserved?

Conservation, you remember, has a double meaning. Sometimes it means to save or to preserve. Sometimes it means to use wisely.

In this book you have learned of plants and animals that should be protected so that there will be some of them left for future generations. This does not always mean that none of them may be used. It may mean only that we must take care not to use so many as to endanger the future supply. Birds; trees; such wild animals as the beaver, elk, antelope, deer, and moose; fishes; some insects; and many of the wild flowers, must be protected if we want any for the future.

You have learned what a great natural resource our forests are. You have learned, also, of how trees grow, and of the friends and enemies of the forest. You know how important it is that we protect the trees from their enemies, and that the trees we use be cut without destroying the young ones, which are to become the forests of the future.

It is important, too, that trees be planted to take the place of those that are used or destroyed by their enemies—fire, insects, and disease. Probably you have helped in a small way by planting a few trees.

You have learned, also, of some useful insects that help in carrying pollen from one flower to another. Because of the help they are in cross-pollination, that is, in pollination from one tree to another, the bees are worth our protection. There are, however, other species of insects that are harmful, and that should therefore be destroyed. The typhoid fly, and some varieties of mosquitoes, are disease-carriers. Some kinds of beetles, and the larvas of certain moths, injure our trees. The clothes moths attack our clothes. Ants destroy our food. The conservation of our health, our trees, our clothes, and our foods demands that we wage war on these insect pests.

Almost every kind of common bird is useful. Some destroy harmful insects; others eat the seeds of weeds and thus help to conserve our crops. The conservation of bird life is so important that the national government has passed laws for the protection of migrating birds, and has created bird sanctuaries, that is, places of refuge, where they may rest on their journeys, safe from harm. Perhaps you have helped in the conservation of bird life by creating a bird sanctuary or by building birdhouses.

Science plays a tremendous part in modern life. Scientists have found numerous ways of using electricity that add greatly to our comfort and convenience. Without their work, we might not have the excellent means of communication and transportation that we have to-day. Think what life would be like without the locomotive, the telegraph, telephone or radio. Scientists have studied weather conditions and now they are able to forecast the weather. The United States Weather Bureau, by sending daily weather forecasts, prevents the destruction of property, and sometimes of human life.

Perhaps you were surprised to learn that all energy comes from the sun, and that plants are able to draw energy from the sun's rays, storing it in their bodies. It seems strange that the heat that comes from a burning piece of coal or wood was stored in the body of a living plant some centuries ago, and that the energy that you get from your food, also comes from the body of a plant. Animals do not have the power to take energy directly from the sun's rays, as plants do. They must get their energy from a plant or from some other animal that got it from a plant.

The study of science is somewhat like solving a mystery. As each new point is understood, dozens of fresh clews are found to call for attention. If you continue your study of science in high school and college, you will learn many of the facts that scientists have discovered, and these facts will help you to understand things that are not quite clear to you now; for instance, how certain parts of your radio work. You will learn, also, about many problems that have not yet been solved. Perhaps, when you grow up, you will want to work on some of these unsolved problems.

SUGGESTIONS TO TEACHERS

General

1. The theme of this book is conservation. It should be presented in such a way as to emphasize the many problems of modern life that are problems of conservation.

2. First-hand observation of each subject in its natural surroundings, and preliminary discussion based more or less upon the introductory questions of each chapter, are essential to securing the best values from the reading of this book.

3. No teacher need hesitate to take her class outdoors for study because of limitations of her own knowledge. Begin very simply, with only the most familiar objects, and a very limited number of them.

4. The following correlations are suggested, in so far as they fit the ability of the group, and are appropriate to the subject—oral and written expression, drawing, painting, songs, stories, poems, dramatization, games, scrapbooks, and collections.

Chapter I

Encourage pupils to make individual observations and report them to the class. It is important that the theme of the book be emphasized in connection with the first chapters.

Chapter II

The stages in the development of the mosquito—eggs, larvas, pupa and adult—are essential for this chapter. The teacher can obtain the specimens by collecting during the summer and autumn or by having the school purchase prepared material from supply houses.

Chapter III

A collection of common household insects should be available to supplement the specimens brought in by the pupils. Frequently, such collections are in the school or city museum.

Chapter IV

Specimens of dodder, Indian pipes, and mistletoe, if available, may be brought to the classroom and studied. If specimens cannot readily be obtained, photographs and drawings will aid in the understanding of these plants.

The action of pitcher plants and sundews can best be learned through observation of actual specimens. Blackboard sketches may be necessary to illustrate how these interesting plants catch insects.

Chapter V

Preparation of an exhibit of the different kinds of nuts that may be available in your neighborhood will aid in the teaching of this chapter. Samples of walnut wood may be obtained from the lumber yard and exhibited. Children should be encouraged to plant walnuts.

Chapter VI

Write to the U. S. Department of Agriculture for a list of available bulletins on insects.

In some states the Experiment Station and the State University will send bulletins, if requested, on this topic.

Encourage children to make a collection of insects of the trees from the school museum. Require all specimens to be labeled.

Chapter VII

Birds in this chapter are readily observable in the country, and city children are sure to see and hear one or more of them on any trip to open country. Excellent illustrative material is at hand through *Bird Lore*, The Audubon Society, charts, etc. Far better than any of these, however, is the mental picture the child gets on seeing and hearing the bird in its natural home surroundings, performing its natural activities. Such results are abundantly worth the effort of taking children into the country or of helping children in the country to see the birds about them.

Chapter VIII

It is difficult to obtain live specimens of owls and to keep them in captivity. It is probably desirable, therefore, to use mounted specimens if these are available.

Chapter IX

Become familiar with local bird sanctuaries and encourage pupils to investigate the means of protecting birds in your community.

Chapter X

Bring to the attention of the pupils the characteristics of the reptile group and emphasize the fact that turtles, lizards, crocodiles, and alligators are also reptiles. This chapter will serve as an excellent opportunity to help pupils abandon their superstitions about snakes. Attempt to have pupils avoid needless fears of snakes but teach them to guard against bite by poisonous reptiles.

Chapter XI

Make use of pictures and lantern slides to show the characteristics and habits of the animals mentioned in this chapter. Good lantern slides may be obtained from one of the regular dealers and from the U. S. Department of Agriculture.

Chapter XII

Suggestions for conservation may be obtained from the Wild Flower Preservation Society, Washington, D. C.

Chapter XIII

Good star maps should be available for both pupils' and teacher's use. The following have been found satisfactory:

S. G. Barton and Wm. H. Barton, *A Guide to the Constellations* (McGraw-Hill Book Company, 1928).

The Book of Knowledge, Volume IX, pp. 3033-40 (The Grolier Society, N. Y.).

Persing, Ellis C., Set No. 1, No. 6874, *Pocket Planetarium* (Wm. M. Welch Mfg. Co., Chicago).

Star and Planet Finder (*Scientific American*, N. Y.).

Chapter XIV

This topic offers another opportunity to help pupils abandon superstitions about the moon and enjoy it as one of the heavenly bodies.

Chapter XV

It is essential that material called for in this chapter be provided for the construction and experimental work. It is frequently more convenient to order your material from the catalogue of one of the supply houses than to spend hours shopping in the stores. All of these materials are provided for in Set No. 1, Welch Mfg. Co.

Chapter XVI

Pupils are usually willing to buy the materials needed to construct a simple telegraph set. If practical, arrange to take your class to the telegraph office and see the operations necessary in sending a message.

Chapter XVII

A trip to the telephone exchange will help students understand the operation of the telephone system. The equipment for the science room should include a telephone transmitter and receiver for demonstration purposes.

Chapter XVIII

The science equipment should include a steam engine and boiler for demonstrations before the class and a steam engine model, locomotive type. Both of these are a part of Set No. 1, Welch Mfg. Co. If these models are not available, make use of charts, pictures and lantern slides.

Educational Chart No. 12 (published by *Railway Locomotive and Engineering*, N. Y.) has all the parts of a locomotive labeled.

Chapter XIX

Guide pupils in the use and interpretation of the data in your daily paper concerning the weather conditions.

Chapter XXI

Keep in the classroom a bird calendar. Organize a Junior Audubon Society with regular meetings, and programs arranged by the members. Field trips during bird migration are always full of interest. Secure from your state department copies of migratory bird laws. Copies should also be obtained from the U. S. Department of Agriculture, Washington, D. C. Correlate geography lessons with the routes of migratory birds.

Chapter XXII

Collect from papers and magazines articles dealing with the value of birds. Have these read at meetings of the Junior Audubon Society. Comstock's Field and Camp notebooks have excellent suggestions for bird study. Write for samples to Slingerland-Comstock Co., Ithaca, N. Y.

Chapters XXIII, XXIV, XXV, XXVI, XXVII

By a series of pretests find out how many trees your pupils can identify. It may be necessary to spend some time learning the names of the common trees before the problems of conservation can be appreciated.

Gather seeds of trees and plant them in flower pots in your school. Your pupils will be delighted to watch them grow. Hemlock seeds, acorns of oaks and others that can easily be obtained should be used for this purpose.

Specimens of wood can be obtained from the National Lumber Manufacturers' Association, Washington, D. C., for a reasonable sum.

Plan an assembly program with your pupils on some phase of conservation that summarizes the essentials you have taken up with them. This makes a worth-while activity if pupils are allowed to organize the program.

Have pupils make maps locating the nearest forest areas, including state or national forest reserves and forest nurseries.

Forest tree seedlings may be secured from your state forest department for planting as a demonstration for educational purposes.

The U. S. Department of Agriculture, Forest Service, has pictures and other exhibits for school use.

A trip to a forest would be well worth while. Members of the class might be able to report actual experiences in a forest.

Chapter XXVIII

Charts, pictures, and lantern slides should be used to learn the important structure and habits of the house fly. Write to the U. S. Dept. of Agriculture, Washington, D. C., for Farmer's Bulletin 734, *Fly Traps and Their Operation.* Other bulletins may be obtained from the same source.

Chapter XXIX

Fish markets in the city make it possible for the teacher to give her class opportunity to study fishes at first hand. Arrange with the men at the market for a definite time so that they can show the class the greatest number of fishes.

Chapter XXX

A trip to a near-by woods to look for wild flowers is the best preparation for this lesson. Other trips taken by the class or independently should follow the reading. The teacher should write or have one of the students write to the Wild Flower Preservation Society, Washington. D. C., for posters and circulars on the protection of our wild flowers. Lantern slides and films may also be obtained from the same source.

Chapter XXXI

Obtain a small branch of a fruit tree with blossoms. It is not necessary to ask each child to bring in flowers as that might lead to the destruction of fruit trees. Allow the pupils to see the essential parts of a flower. Show the shapes of pollen with a hand lens or a compound microscope.

If the trip cannot be taken in the field, at least one bee should be brought in for observation. Demonstration hives with glass sides can be obtained for schoolroom use from A. I. Root Company, Medina, Ohio.

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