ELEMENTARY SCIENCE BY GRADES

Book Five

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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 FIVE

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

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

and 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 Five,* has been designed for use following *Book Four* 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 and 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, certain insects, the earthworm, trees, 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 gardening, birds, trees, 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 Dr. Hanor A. Webb of George Peabody College for Teachers, Nashville, Tennessee, for reading the manuscript and for helpful suggestions and criticisms; and to Dr. Edward E. Wildman, Director, Division of Science, Philadelphia; Elizabeth K. Peeples, Principal of Brantwood School, Washington, D. C., and Dr. John A. Hollinger, Director of Nature Study, Pittsburgh, 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 Miss Helen K. Brett, Principal of Doan Science Curriculum Center, Cleveland, and David W. Russell, of Hawken School, 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

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E. C. P.
C. L. T.

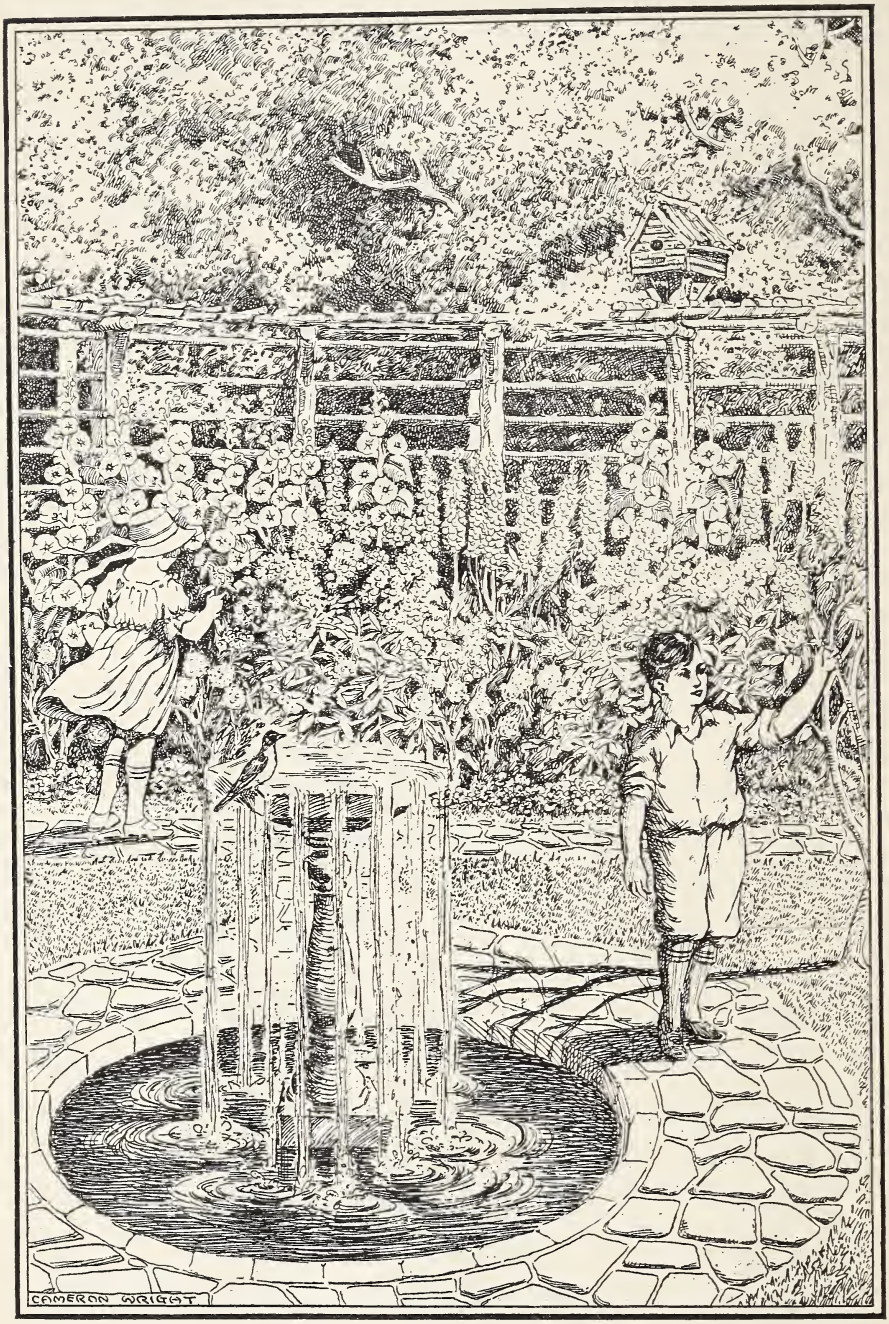
INTRODUCTION

THE GARDEN

Do you ever ask questions about things you see every day? Are you curious about plants and animals? Do you sometimes wonder about the plants in your garden? Do you know how plants get their food from the air and the soil? Do you ever wonder why some soil is black and some is the color of sand? Are you curious about the stars? Do you wonder what they really are, and why some are so much brighter than others?

Scientists, men who know a great deal about these things, tell us that questioning is the beginning of learning. The next step, of course, is to discover the answers to your questions. This science reader has been written to answer some questions about the way things work and grow. It will help you to discover for yourself the answers to many of your own *how's* and *why's* about the common things of everyday life.

Did you ever think of a garden as a small center of life, not only for flowers, vegetables, and weeds, but for birds, insects, earthworms, toads, and burrowing animals? A boy or girl can learn a great deal from careful observation in a garden. It is a good place for the study of growing things. The life stories of plants, the kinds of



THE GARDEN IS A SMALL PART OF THE GREAT OUT-OF-DOORS WHICH OFFERS THRILLING ADVENTURES IN KNOWLEDGE.

soil, what toads and earthworms do, the ways of insects—all these, and many other interesting subjects may be studied by first-hand observation in a garden. The chapters that follow will tell you many surprising facts about living things, and will encourage you to discover others by making your own experiments with a garden or window box.

The garden, of course, is just a small part of the great out-of-doors, which offers everywhere thrilling adventures in knowledge. Some of the chapters in this science reader will take you beyond the garden. In the winter when the ground is covered with snow, you will take a peep at the stars and learn the stories of some of the constellations. You will read about heat, and about the simple machines which help man to do his work.

Science is partly *doing,* you know, as well as reading and observing. In this book there are some interesting experiments which you can do at school or at home. At the end of each chapter you will find "Some Things to Do," and often the chapters themselves will suggest things to make and to look for which you may never have thought of before.

But first, let us go into the garden and learn

"......................
Where the freshest berries grow,
Where the ground-nut trails its vine,
Where the wood-grape's clusters shine;

Of the black wasp's cunning way,
Mason of his walls of clay,
And the architectural plans
Of gray hornet artisans!"

From J. G. Whittier, *The Barefoot Boy.*

CHAPTER I

THE GARDEN IN AUTUMN

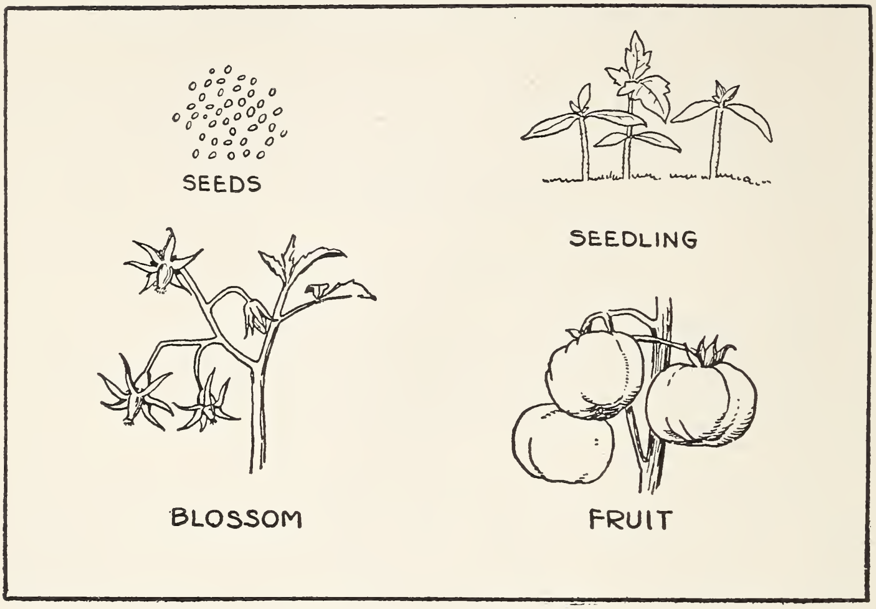
1. Of what use are the seeds of plants?
2. Did you ever notice flowers on a cabbage plant?
3. Have you ever had a garden of your own?

Perhaps you have had a garden of your own, and have followed the life stories of the plants that grew in it. In the autumn these life stories are finished. The fleshy leaves and stems cannot live through the cold winter, but most plants have grown seeds, some of which will develop into new plants.

In almost any garden through which you might walk in late autumn, you will see withered tomato vines. They are dead; their life stories have ended, but inside the tomatoes that grew on the vines are the seeds of the plant.

If you had tomatoes in your garden, probably you planted the seeds early last spring in a hothouse or in boxes indoors. When the seedlings were about an inch tall, you may have transplanted them into new boxes to give them more room in which to grow. You must have planned so that by the time the last frost disappears, the young tomato plants would be several inches tall.

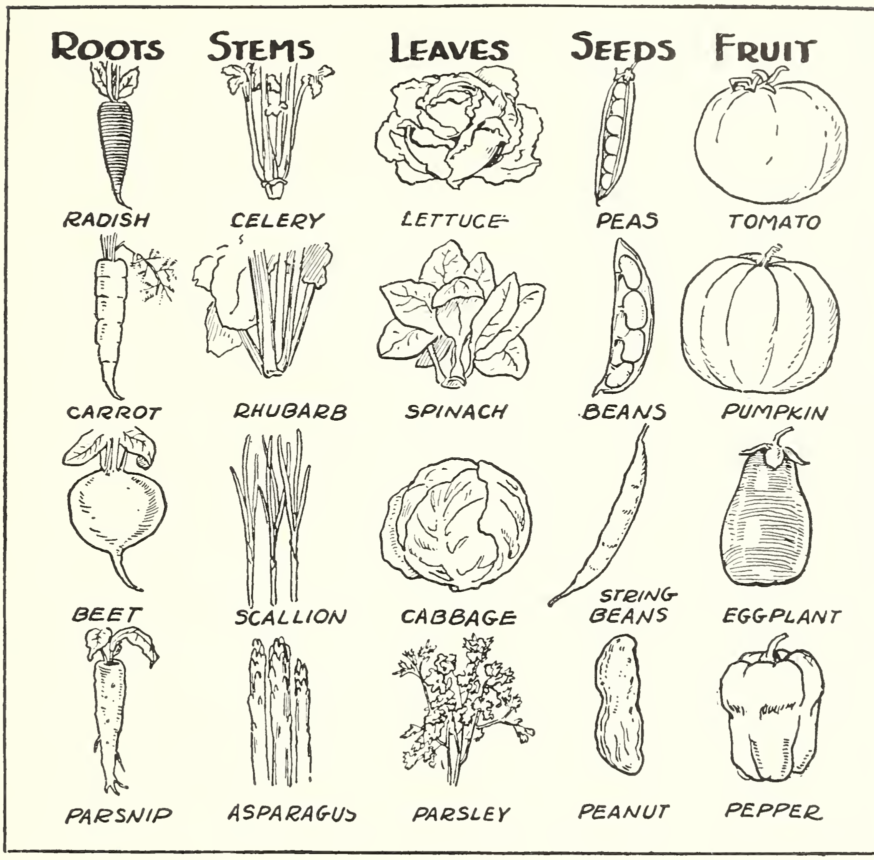
These plants were probably transplanted to the garden, where they continued to grow. No doubt



THE LIFE STORY OF A TOMATO.

you saw the yellow flowers as they came out. A little later the petals dropped off, and tiny green tomatoes grew from the part of the flowers that remained on the vines. The tomatoes are the fruit, inside of which the seeds develop. The fruit is useful in the life story of a plant because it affords protection for the development of the growing seeds.

You have probably observed that the plants in your garden have roots, stems, leaves, flowers, and fruit. No doubt you raised some plants in your garden because you wanted to use parts of them for food. Did you ever think what parts of the different garden plants are used as food by people? Peas and beans are seeds; tomatoes and berries are fruits; parsnips and carrots are roots. The stems of celery and asparagus are eaten.



PARTS OF DIFFERENT PLANTS USED FOR FOOD.

You may think that the potato is a root, but it is really an underground stem.

The cabbage is an unusual garden plant, for it does not complete its whole life story in one year. The cabbage head is a large bud which grows on the plant during its first year. If the whole plant is taken up, kept in the cellar during the winter, and transplanted to the garden in the spring, a tall stem with many branches will grow from the head. On this stem flowers will appear, from which seeds will be formed. From these seeds will grow the plants which produce the cabbage heads. Thus, you see, you must watch the cabbage plant for two years to learn its whole life story.

Celery plants receive unusual care in the garden. The stems and leaves of plants, as you know, are usually green. You have probably eaten the green leaves of spinach and the green stems of asparagus.

People prefer white celery. Therefore, in the early autumn when the plants have grown to their full size, the gardener throws soil up along the sides of the celery to shut out the light. Chlorophyll (klō′rō-fĭl), the green coloring matter of plants, forms only in the sunlight. Taking out the color is generally called *bleaching*. Darkness destroys chlorophyll. The gardener calls this process *blanching*.

When celery is blanched, it is ready for market. If it is to be kept for some time before it is used, it must be protected from the light. Otherwise the stalks will become green again.

Many of the plants in your garden, no doubt, were used during the summer. The rest must be harvested before frost and stored for winter use. Beets, carrots, and turnips keep best when buried in moist sand where it is not cold enough to freeze. Pumpkins and squash should be stored in a cool, dry place. Potatoes will keep best in the dark, for in the light sprouts will grow faster. Parsnips are not injured by freezing. They may be left in the garden and brought in when needed.

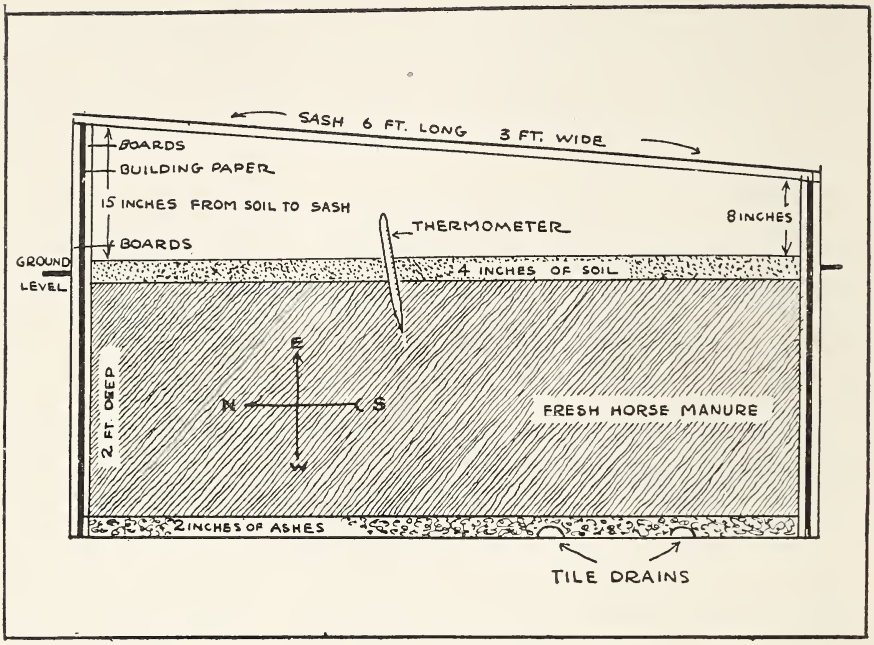
Many cities and towns hold garden exhibits in the autumn. Sometimes these exhibits are held in schools, particularly where there are school gardens.

After you have harvested your crops, your garden should be cleaned up. The removal of rubbish will improve the appearance of the plot and keep out the plant diseases that come from decaying plants.

The stems and leaves which you clean up may be made into a compost heap to be used next spring to enrich the garden soil. Have you ever seen a compost heap? It is made of sod, manure, leaves and other parts of plants. These are piled in layers, and allowed to decay for several months. In the spring the compost heap is spread out on the garden and worked into the soil. It is an excellent fertilizer.

Perhaps it would be well, also, to make a hotbed and a cold frame, and use it early next spring to grow plants for transplanting to your garden. A hotbed is a bottomless box covered with glass, and so placed that the north side is higher than the south side. This makes the glass slope to the south, catching the rays of the sun. As you know, the sun shines from the south in the early spring.

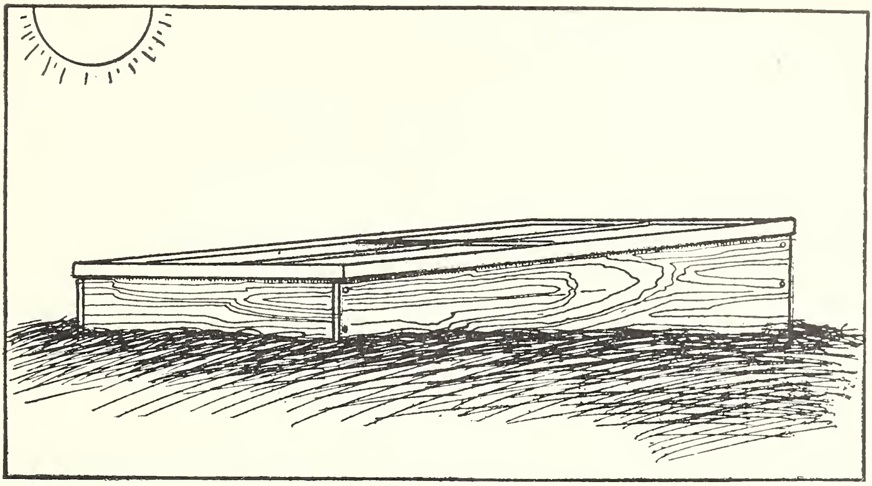
If you wish to make a hotbed, select a sunny place, and remove about fifteen to thirty inches of the surface soil from a spot as large as you wish the bed to be. This pit should be dug before the ground freezes in the autumn. The next step is to build a frame to fit it, not forgetting to make



CROSS SECTION OF A HOTBED.

it six inches higher on the side which will be to the north. Perhaps you can use old window sashes for a covering if you make your pit of the required size.

About twelve days before you are ready to use the hotbed in the spring, fresh horse manure should be put into the pit. Put in just enough to allow five or six inches of good soil on top, and still leave room for the plants to grow beneath the glass covering. This manure will ferment and heat the ground from below, while the sun shining through the glass will heat it from above. This heat makes possible the growing of plants in the hotbed in early spring while the garden soil is still cold. The fermentation of the manure often produces so much heat that it is necessary to wait



A COLD FRAME IS SIMILAR TO A HOTBED.

until the bed has cooled off somewhat before sowing the seeds. The temperature of the soil may be measured with a thermometer. It should not be more than 90°.

A cold frame is similar to a hotbed, except that manure is not used to heat it from beneath. The sun, shining through the glass, heats the soil, and the frame prevents the ground from cooling off too rapidly when the sun is not shining. Plants which have been grown indoors or in a hotbed may be transplanted to the cold frame earlier than they could be placed in the open garden. Sometimes seeds of such plants as lettuce and radishes are sown right in the cold frame so that the crops will be ready for use early in the season.

SOME THINGS TO THINK ABOUT

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

1. Peas and beans are the ..... of the plant.
2. Roots of ..... and ..... are eaten.
3. The tomato is a ......
4. The cabbage requires .... to complete its life story.
5. The cabbage head is a ......
6. ..... is the green coloring matter of plants.
7. A ..... is made of layers of sod, manure, and parts of dead plants.
8. A hotbed is covered with ......

SOME THINGS TO DO

Select the best ripe tomato that you can find on the vines, and save the seeds for planting next spring. They can be squeezed out in a pan, and the pulp washed away with water. Allow them to dry thoroughly, and put them away in a dry, cool place.

Collect seeds from other garden plants and store them in labeled paper bags for spring planting. If there are rats or mice about the premises, it will be well to hang the bags on a wire so these animals cannot get them.

If you have worked in a garden during the summer, write a report of your activities to read and discuss in class.

Make a trip to a garden, a truck farm, or a greenhouse. Perhaps you may see celery in the process of blanching. You will be interested in the cold frames and the hotbeds, and you may see a compost heap.

Hold a garden exhibit in your school.

CHAPTER II

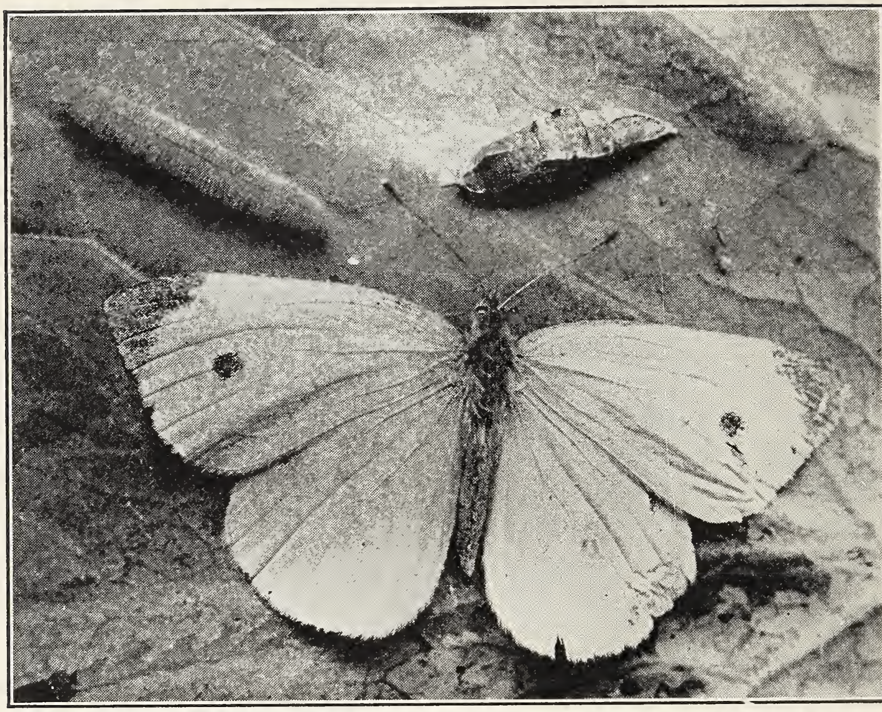
INSECT ENEMIES OF THE GARDEN

1. What insects have you seen in the garden?
2. Which of these are harmful to the plants that grow in the garden?
3. Can you suggest ways to protect the plants from harmful insects?

Have you ever seen a green cabbage worm? If you have, you would hardly guess that it is one stage in the life story of a small white butterfly. Insects undergo strange changes during their short lives. Let us see what happens in the case of the white cabbage butterfly that comes forth in the spring from the chrysalis where it has spent the winter.

You have no doubt seen these butterflies flying about your garden in early spring. After two or three days the female butterflies lay their eggs on the leaves of such plants as the wild mustard or shepherd's purse. Sometimes more than 200 eggs are laid by a single insect. These eggs are bullet-shape with many little ridges.

In a week or ten days tiny green caterpillars hatch from the eggs. These are cabbage worms. To be sure, you will not find the worms born this year devouring your cabbage heads, for it is too early in the season. Perhaps the cabbage plants have not even been transplanted to the garden.

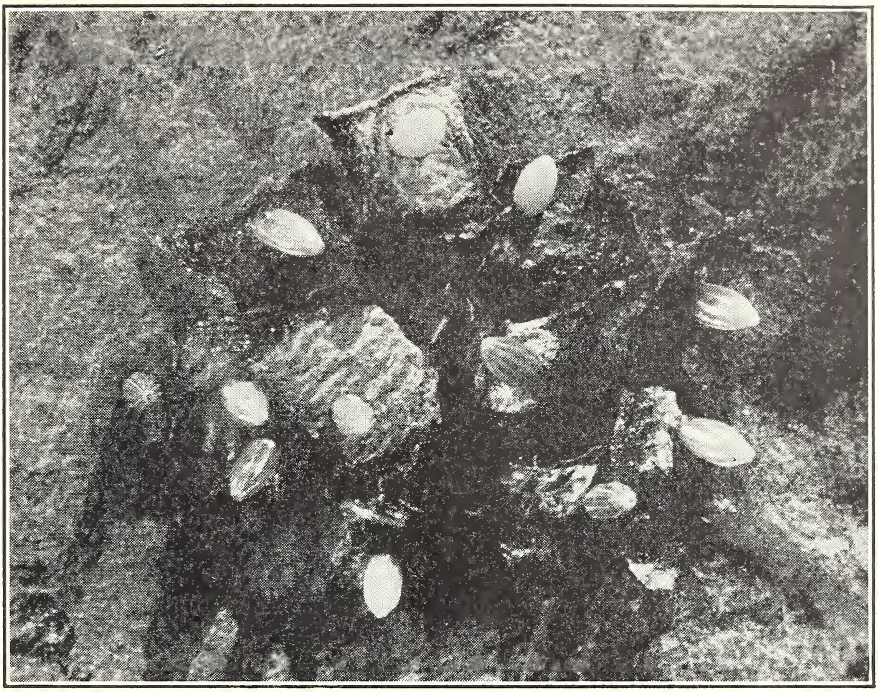


Photograph by Cornelia Clarke

LIFE STORY OF THE CABBAGE WORM; TO THE LEFT ABOVE THE BUTTERFLY IS THE LARVA; TO THE RIGHT IS THE CHRYSALIS.

However, the female butterfly always lays her eggs upon plants that the young worms can use for food.

Perhaps you already know that an insect in the first stage of its life, after becoming an egg, is called a larva. As soon as it hatches from the egg, the young larva of the cabbage butterfly begins to feed upon the leaves of the plant on which it finds itself. Soon its skin becomes too tight. What do you suppose it does then? It simply fastens itself to a leaf and crawls out of the old skin. This process of shedding the skin is called molting. As the larva grows, it molts five



Photograph by Cornelia Clarke

CABBAGE BUTTERFLY EGGS ARE BULLET-SHAPE WITH MANY LITTLE RIDGES.

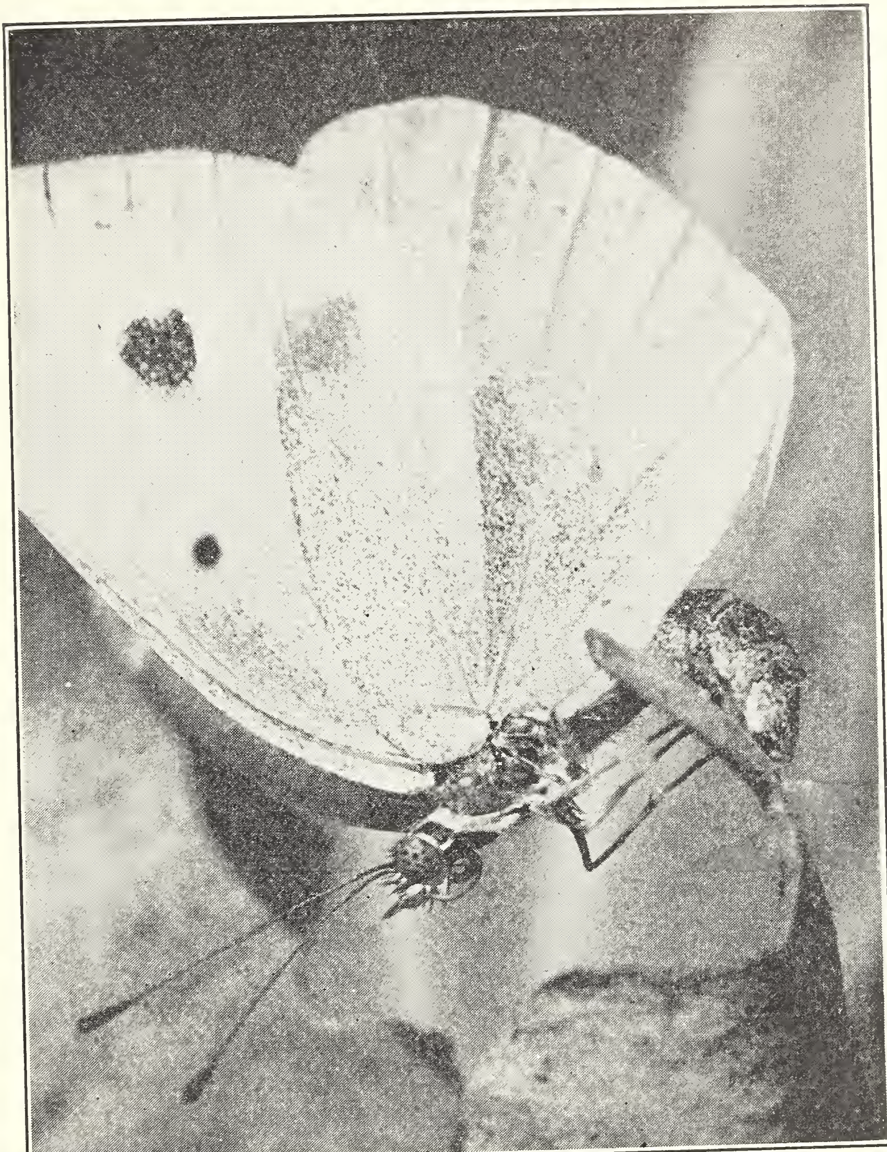
times. When full grown, it is a worm-like creature about one and one-fourth inches long, which chews with its jaws like a grasshopper.

An adult insect has six legs, but this caterpillar or larva has eight pairs, sixteen in all. You know, of course, that an adult insect is one that is full grown. Ten of these legs are prolegs that will disappear in the process of changing from a larva to a butterfly.

When the larvas reach their full size, they become restless, wandering about until they find a fence or a tree to which they fasten themselves with silken threads that they spin. The larva then becomes a pupa. A pupa is an insect in that stage of its life story when it is growing from a larva to an adult. It is during the pupa stage that the wings of the butterfly are formed, the prolegs of the caterpillar disappear, and many other changes take place in the body of the insect. The pupa stage in the life of the white cabbage butterfly lasts about ten days, during which the adult insect is fully formed.

Perhaps you have seen one of these white butterflies break its pupal skin and come forth. It is very interesting to watch its wings slowly unfold. The butterfly is very quiet until its new wings harden, and then it flies away. You have surely seen these small white butterflies flying about the fields and gardens in the early summer. By this time the garden plants have a good start. Many of these butterflies lay their eggs upon the cabbage plants, and what damage the young larva that hatch from these eggs do to the growing heads! Sometimes the gardener sprays the cabbage plant with a poison such as Paris green. The cabbage worm eats the poison with the leaves and dies.

What the cabbage butterfly eats is not definitely known. Instead of mouth parts like its larva, it has a beak that is like a tiny rubber hose. Under its head you can see this beak coiled like a watch spring. With such mouth parts it could not chew leaves. Its food must be liquids. You may sometime have seen these butterflies drinking from a mud puddle. When they drink, they uncoil their beaks. With such mouth parts, the cabbage but-



Photograph by Paul Griswold Howes

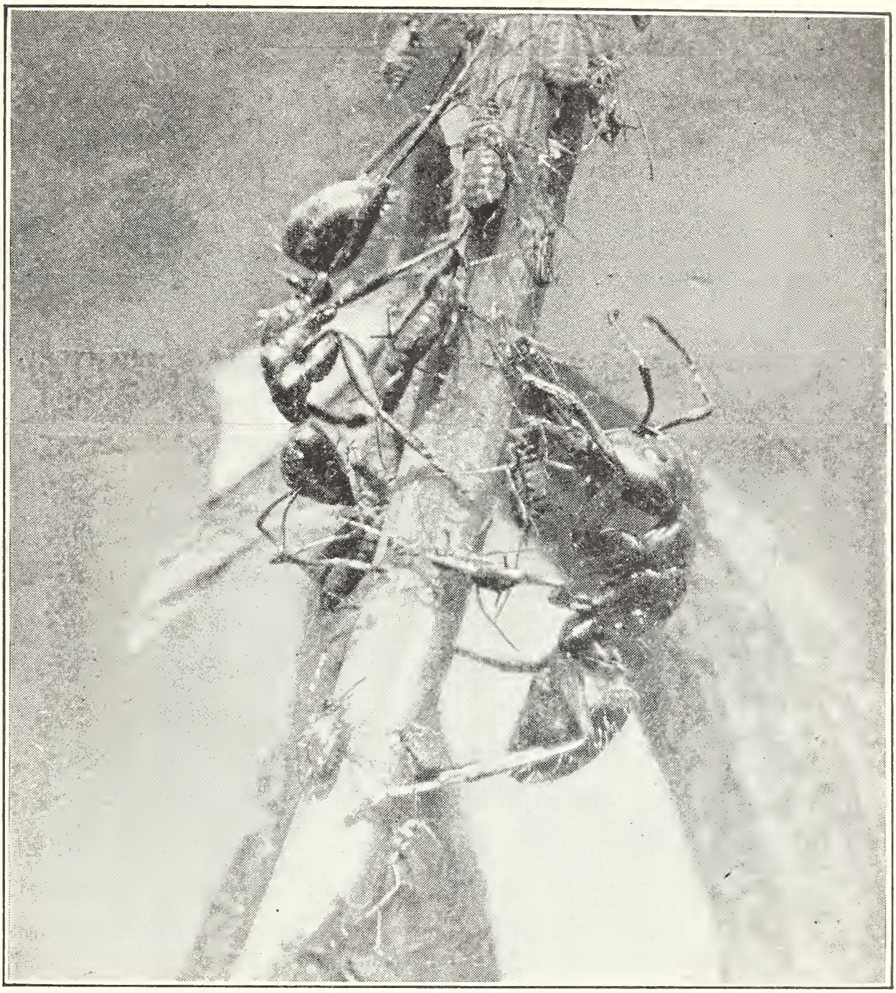
THIS CABBAGE BUTTERFLY IS READY TO FLY ABOUT IN THE GARDEN AFTER LEAVING AN EGG ON A LEAF.

terfly could not harm the cabbage plants. The damage is done by the caterpillars which feed upon the leaves.

Like most other animals, the cabbage butterfly has some natural enemies that try to devour it. There are wasp-like insects and flies that attack the caterpillars. The chipping sparrow, English sparrow, house wren, and other birds eat the cabbage worms in the summer, and destroy many of the chrysalises during the winter. You will remember that the cabbage butterfly emerged from its chrysalis in the spring. The second brood of larvas that hatch during the summer spend the winter in the pupa stage. The pupal case or chrysalis protects the insect from the cold, but it does not save it from hungry winter birds.

Have you ever seen aphids? Perhaps you have called them plant lice. They are very small insects that live on plants. Some of them feed upon roots, but most of them live on the stems and leaves, feeding upon the juices of the plants. They have long needle-like beaks which they thrust into the plant. With these beaks they suck the juices, usually taking more than they require for food. The surplus passes through the body of the aphid as a drop of clean syrup, which is the honeydew that the ants like so much. Perhaps you have read how the ants care for the aphids in order to get this honeydew. Sometimes these tiny insects are called the ants' cows. Can you tell why?

In the summer most of the aphids that you will see on the plants are little green wingless insects. They do not lay eggs, but give birth to their young instead. Later in the season another form of aphid appears. It has wings, and can fly



Photograph by Paul Griswold Howes

ANTS CARE FOR THE APHIDS IN ORDER TO GET THEIR HONEYDEW.

to another plant and start another colony. In the late autumn the females lay eggs, which last through the winter and hatch the following spring. From them come the aphids of the next summer. Thus, you see that the life story of the aphid is very different from that of the cabbage butterfly.

Great numbers of aphids are destroyed by ladybird beetles. Both the adult beetles and their larvas feed upon aphids.

SOME THINGS TO THINK ABOUT

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

1. The cabbage butterfly spends the winter in the ..... stage.
2. In the spring it comes forth from its ......
3. It lays ..... from which tiny, green ..... hatch.
4. The green cabbage worms are the ..... of the white cabbage butterfly.
5. An adult insect has ..... legs.
6. The cabbage worm has ..... legs, ten of which are called ......
7. As the caterpillars grow, they ..... their skins.
8. The adult cabbage butterfly feeds upon ......
9. Aphids feed upon the juices of ......
10. The ..... beetle feeds upon aphids.

SOME THINGS TO DO

Make a visit to the garden to look for cabbage worms and butterflies. Perhaps you may also find some of these insects in the pupa stage. Bring the insects back to the classroom for observation. If you have no insect cage, you will find suggestions for making one in Books Two and Three of this series.

If you find a cabbage worm, perhaps it will develop into a pupa if you feed it well on fresh green leaves. You will be interested, too, to watch the changes that take place during the pupa stage.

If you catch an adult butterfly, observe the coiled, hose-like beak through which the insect drinks. Notice also the eyes and the scales on the wings.

No doubt you are already familiar with the appearance of aphids. You can find them either on the garden plants or upon house plants. Perhaps next summer you can find both forms of aphid described in this chapter.

CHAPTER III

SOME INSECT FRIENDS

1. Can you name some useful insects?
2. Have you ever seen a ladybug or a tiger beetle?
3. How does the praying mantis get its name?

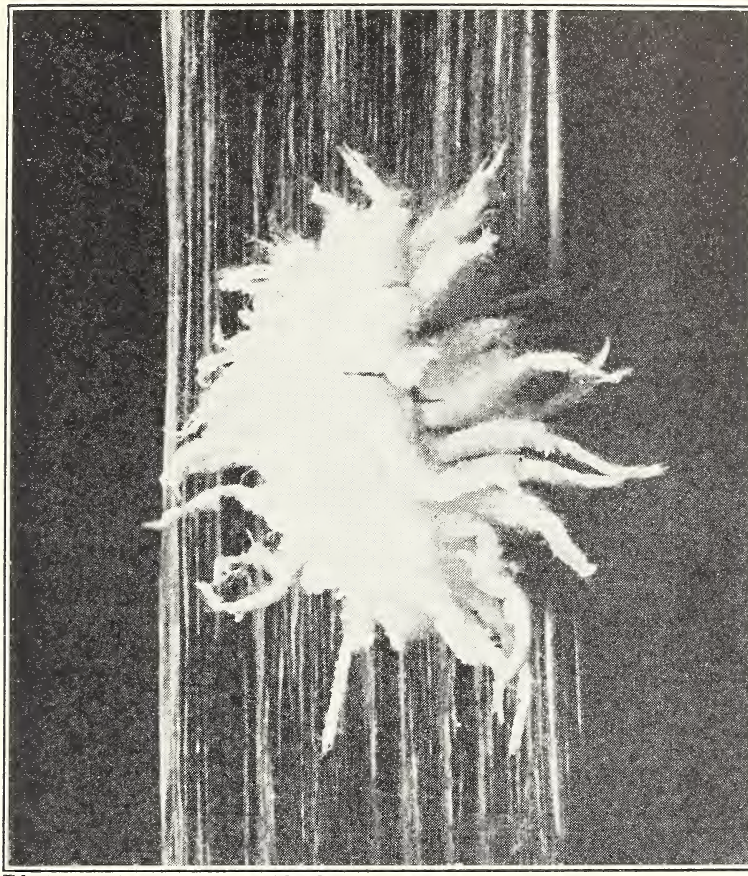
You have just read about cabbage butterflies and aphids, which are enemies of the garden. There are other insects that are useful because they feed upon insect pests. In this chapter you will read about the ladybird beetle, the praying mantis, and the tiger beetle, all of which are friends of the garden because they eat many of its enemies.

Undoubtedly you know the old Mother Goose rhyme about the ladybird beetle:

> Ladybird, ladybird,
> Fly away home,
> Your house is on fire,
> Your children will burn.

This rhyme has come to us from European countries where the hop vines are burned after the harvest. Many ladybird larvas are on the vines at that time.

Of all insects beetles are found in greatest numbers and in more places than other insect groups. There are more than 100,000 kinds of beetles. In

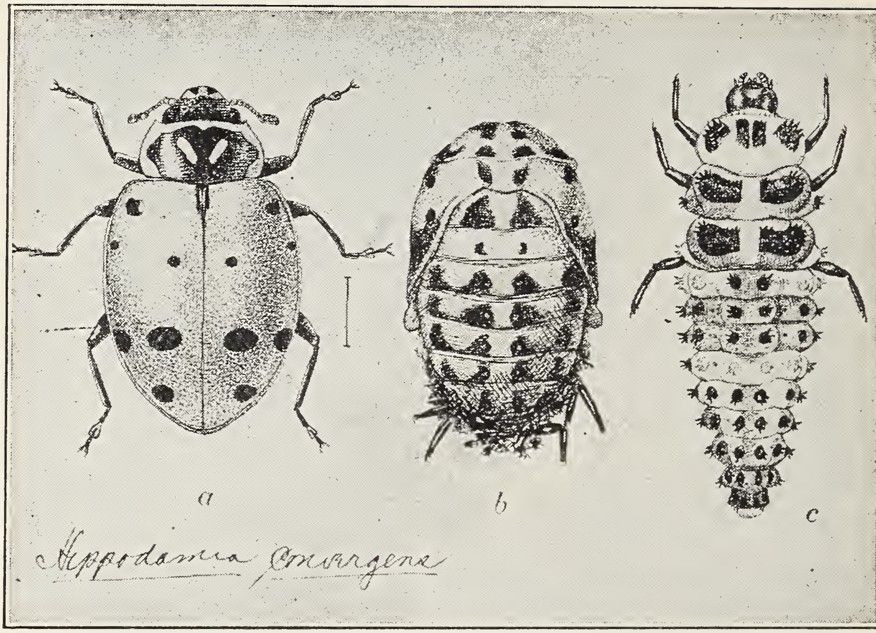


Photograph by Cornelia Clarke

THE COTTONY-CUSHION SCALE.

addition to the ladybird beetles, which you may have called ladybugs, and the tiger beetles, both of which you will read about in this chapter, there are the June beetles, the potato beetles, the fireflies, and the click beetles. The click beetles are often known as snapping bugs. All beetles have hard, shell-like front wings that come together in a straight line in the back.

You have already learned that the ladybird beetle feeds upon aphids and their larvas. They

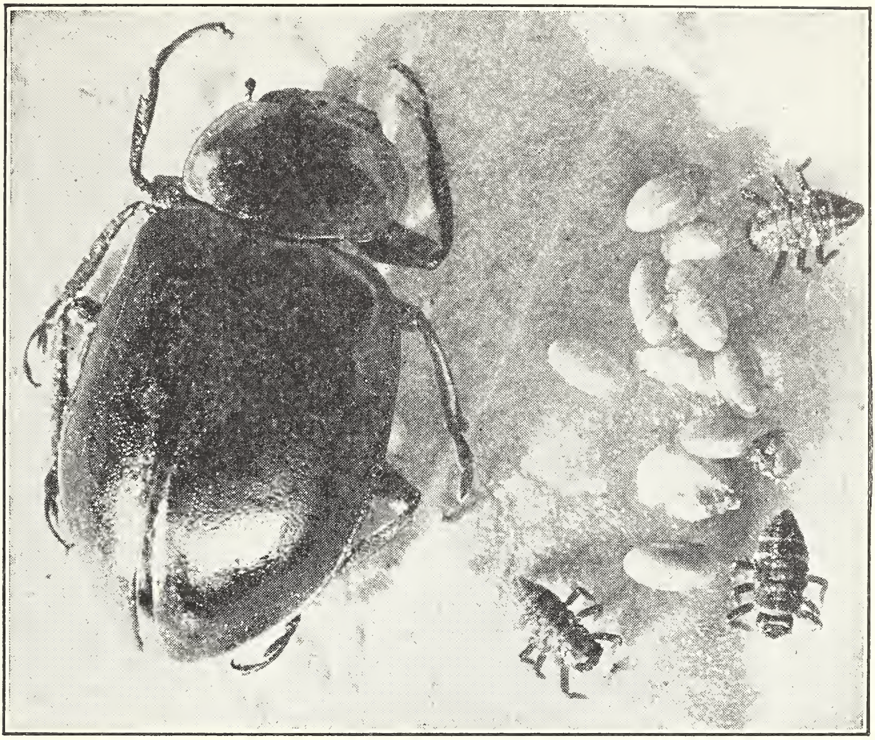


a, LADY BUG; *b*, PUPA; C, LARVA.

also eat scale insects which live on fruit trees and injure them.

One of these insects, the cottony-cushion scale, was brought to this country from Australia on some imported orange trees. Before the insect was discovered, it had spread through the orange groves of California and was doing considerable damage. Scientists were sent to Australia to find out how scale insects were destroyed there. They returned with some ladybugs which they placed in the orchards. The beetles increased rapidly in number, and have helped greatly to destroy scale insects. The method used was easier than that of poisoning the insects.

There are four stages in the life of a beetle, just as in that of the butterfly; those stages are the egg, larva, pupa, and adult. Adult ladybird



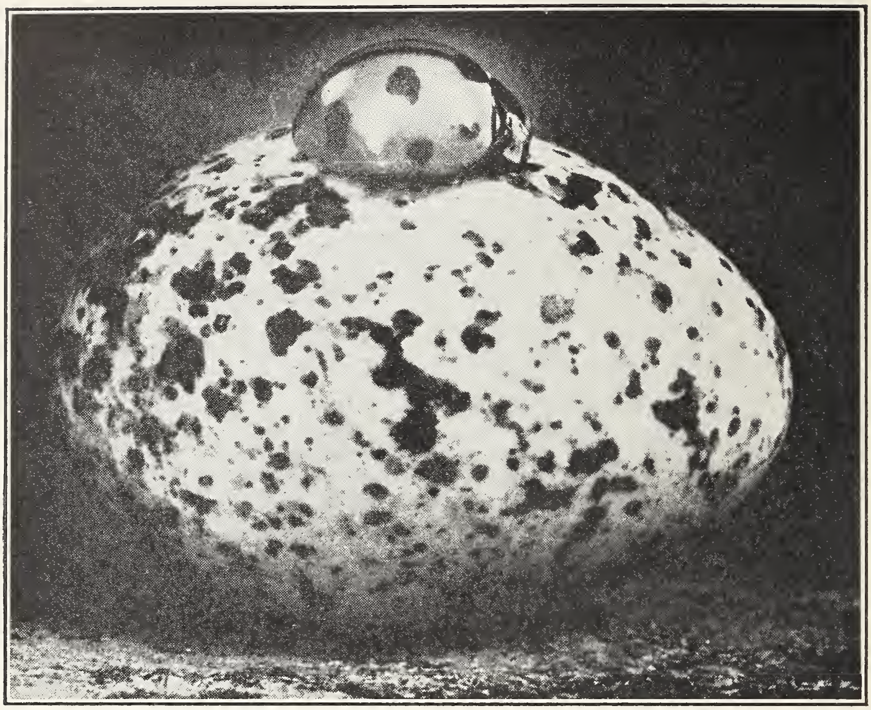
Photograph by Cornelia Clarke

SMALL CLUSTER OF EGGS LAID BY THE ADULT LADYBIRD, SHOWING SOME NEWLY-HATCHED LARVAS.

beetles spend the winter in warm protected places. In the spring the females lay small clusters of eggs upon the leaves of plants. From these eggs hatch the larvas, which begin at once to search for the aphids or scale insects upon which they feed until they reach their full size.

The larva does not resemble the adult beetle very much. It does not have the hard, shell-like wings of the adult ladybird. Its body is made up of a number of rings on which are warts or spines that make it appear very rough. Usually the larva is black with orange and yellow spots.

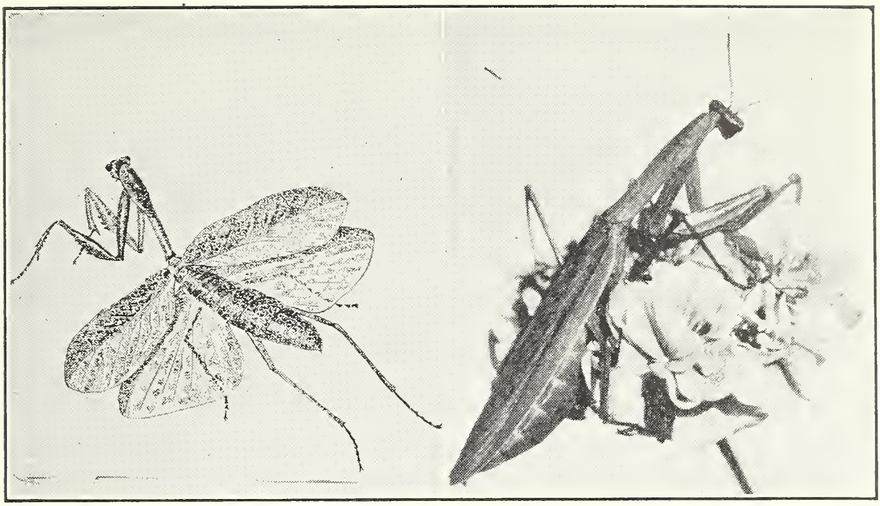
The larva moves about rapidly, crawling from



Photograph by Lynwood M. Chace

LADYBUG EXPLORES A BIRD'S EGG (BOTH ARE GREATLY MAGNIFIED).

plant to plant in search of food. It sheds its skin as it outgrows it, just as the cabbage caterpillar does, and finally when it is full grown, it fastens itself to a leaf or to a stem and goes into the pupa stage. Pushing its warty skin up about its head, it hangs motionless for several days, during which it grows inside of its skin into an adult ladybird. When the process is completed, the skin of the pupa bursts open, and the beetle comes forth full grown. It is a curious process that you will be interested in watching. If you will look carefully in near-by gardens, you may possibly find a ladybird larva or pupa to bring to the schoolroom



Courtesy of Nature Magazine

THE PRAYING MANTIS WAS NAMED BECAUSE OF THE WAY IT PLACES ITS FRONT LEGS WHEN IT IS AT REST.

where you can watch the various stages in its life story.

The praying mantis is indeed a strange insect. With the front part of its body held almost upright, it awaits the insect that it will catch for food. Because of the way it seats and the manner in which the front legs are folded when not in use, it was named praying mantis. The front legs have a row of sharp spines on them with which it grabs and holds its prey. These legs are not used in walking. The praying mantis is a friendly insect. It feeds on many of the insects that injure our gardens and orchards.

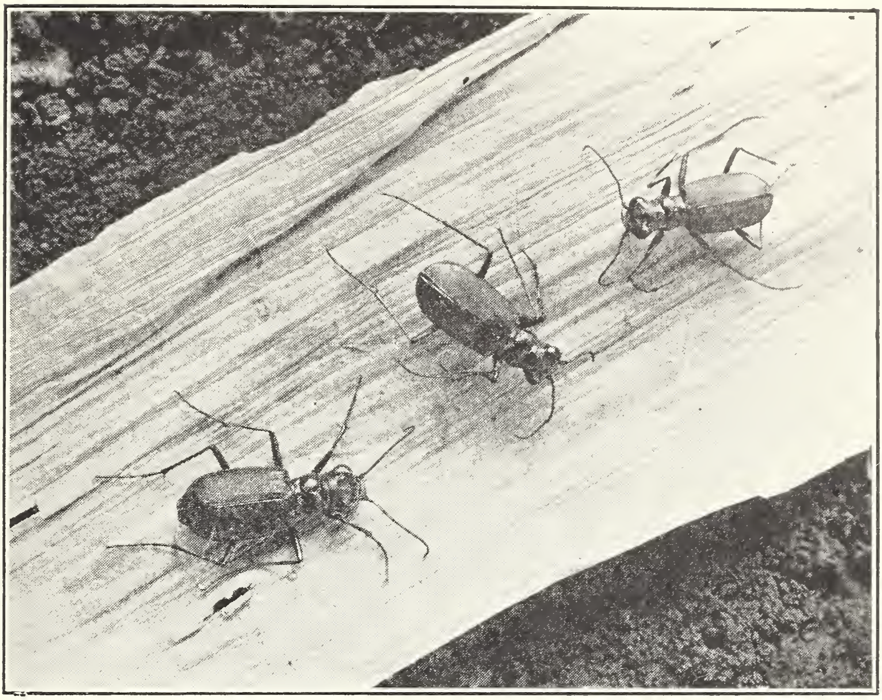
The mantis is related to the grasshopper, although you would not guess this from its appearance. Its wings are small for the size of its body, and it cannot jump. Its hind legs are used for walking instead of jumping.

Although the mantis is usually found in the tropics, several kinds are common to our southern states, and one group is found as far north as Maryland. One kind of mantis was brought to the United States some thirty years ago, probably in the form of eggs on imported fruit trees. This kind of mantis was found near Rochester, New York. A little later, another kind, native of China and Japan, was also found about the same place. Both of these groups are now common in that part of the country, and are rapidly spreading elsewhere.

During the winter, eggs of the mantis may be seen glued to a twig or branch in bunches, covered by a substance that looks like dried, brownish foam. Each bunch is about one inch long and one inch thick. Late in the spring the eggs hatch, and the young scatter in search of the insects upon which they feed. Probably you know the mantis by some other name. Sometimes it is called a rear-horse, a soothsayer, or a mule-killer.

Because of its shape and color, the tiger beetle is a favorite among collectors, who keep the beetles in small bottles and glass cases. There are more than 100 kinds of tiger beetles, varying in size from about one-half to three-quarters of an inch. Usually they are of a green or bronze color with stripes or spots of yellow, some are black, and a few are white. You can imagine how pretty these shades of color look.

Tiger beetles are usually seen in dusty roads and woodland paths, though they are sometimes



Photograph by Cornelia Clarke

TIGER BEETLES ARE USUALLY SEEN ON DUSTY ROADS AND WOODLAND PATHS.

found in cities. When you come near them, they fly away in a flash, usually alighting somewhere near and turning to watch you. If you continue to follow them, they fly ahead several rods and wait again until you come too near, when they fly again. The grasshopper does the same thing when you try to catch it.

Adult tiger beetles often attack very large insects, while their larvas are living insect traps. These larvas are very different in appearance from the brightly colored adults. They live in holes in the sand or in dry, hard ground, where they often burrow a foot deep. At the openings of their burrows, they wait for the insects on which they feed. The head of the larvas in the openings of the burrows look so much like the ground that other insects not seeing them, walk right into the living trap. It is exciting to watch them grab the insects as these pass over their burrows.

SOME THINGS TO THINK ABOUT

Select the correct ending for each of the following sentences.

1. The ladybird feeds upon { leaves. / the juices of plants. / aphids.

2. The ladybird lays her eggs { on plants. / in the water. / on the ground.

3. The cottony-cushion scale lives on { weeds. / fruit trees. / garden plants.

4. The larva of the lady-bird beetle { has warts and spines. / looks like the adult beetle. / has hard, shell-like wings.

5. The praying mantis is a useful insect because it { feeds upon harmful insects. / destroys weeds. / feeds upon scales.

6. Tiger beetles feed upon { plants. / insects. / the leaves of trees.

SOME THINGS TO DO

Go on a trip in search of ladybugs, tiger beetles, praying mantes, and other useful insects. Look for eggs, larvas, and pupas, as well as for adult insects.

Make a collection of beetles, using books on insects to discover the names of the various kinds you find.

Make a poster for your bulletin board showing the beneficial insects of your neighborhood and showing why and how they should be protected.

CHAPTER IV

OUR FRIENDS, THE TOADS AND FROGS

1. Have you ever collected tadpoles and kept them in a glass bowl where you could watch them?
2. Have you seen toads hopping about your garden in the evening?
3. Why do you see the toads more frequently during the evening than during the day?

Toads and frogs feed upon insects, many of which are very harmful to plants. They do not cause warts, as you may have heard. Neither do they come down with the rain. These are stories ignorant people have made up about them.

Probably the most interesting part of their life story is the change from the tadpole into the adult stage. This is almost as great a change as that which takes place in the caterpillar when it becomes a butterfly. The tadpole, as you probably know, lives in the water. It has gills by means of which it is able to take oxygen from the water, while adult toads and frogs have lungs just as we have. This makes it possible for them to live on land.

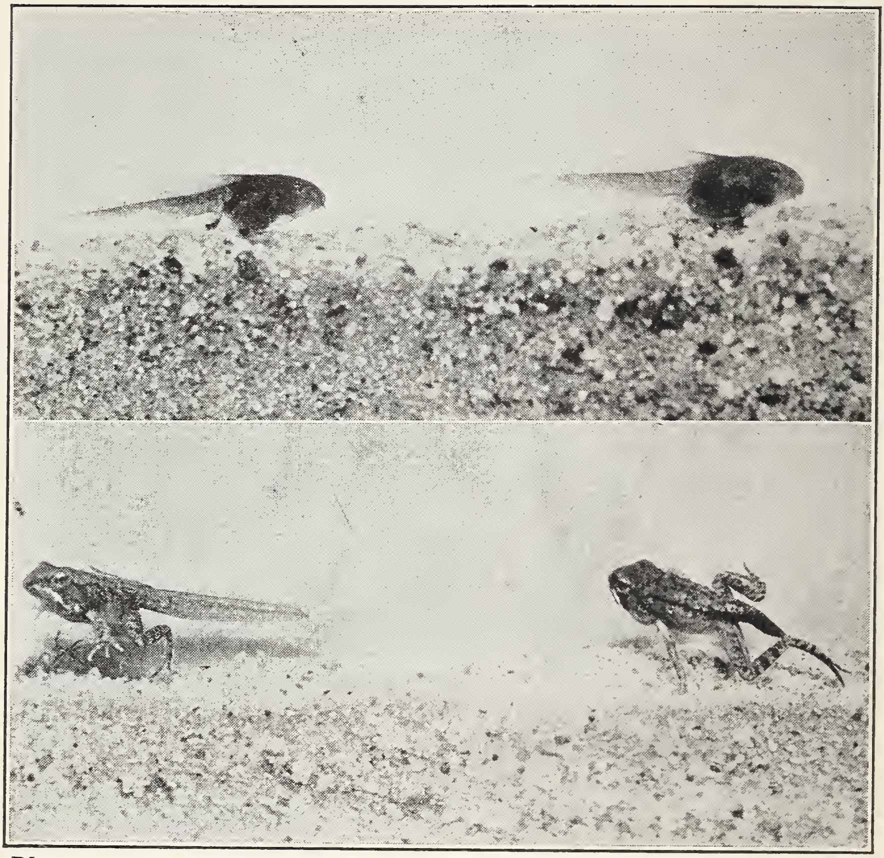
Frogs and toads lay their eggs in May and June, depositing them in ponds and streams. As many as 10,000 or 12,000 eggs can be laid by a single toad. They are laid in long strings held together by a jelly-like substance.

Photograph by Lynwood M. Chace

A SINGLE FROG SOMETIMES LAYS 10,000 EGGS.

From the eggs come the tadpoles that you probably have seen swimming about in shallow streams. They are more like fish than they are like adult frogs and toads. They have no legs or fins, but pass through the water by moving from side to side. The movement of their long, thin tails propels them through the water. The gills have many delicate blood vessels. As the water passes through the gills, the oxygen of the water is absorbed by the blood in the small blood vessels.

A very young tadpole has no mouth. Instead it has a sucker through which it gives a sticky substance that serves to fasten the tadpole to water

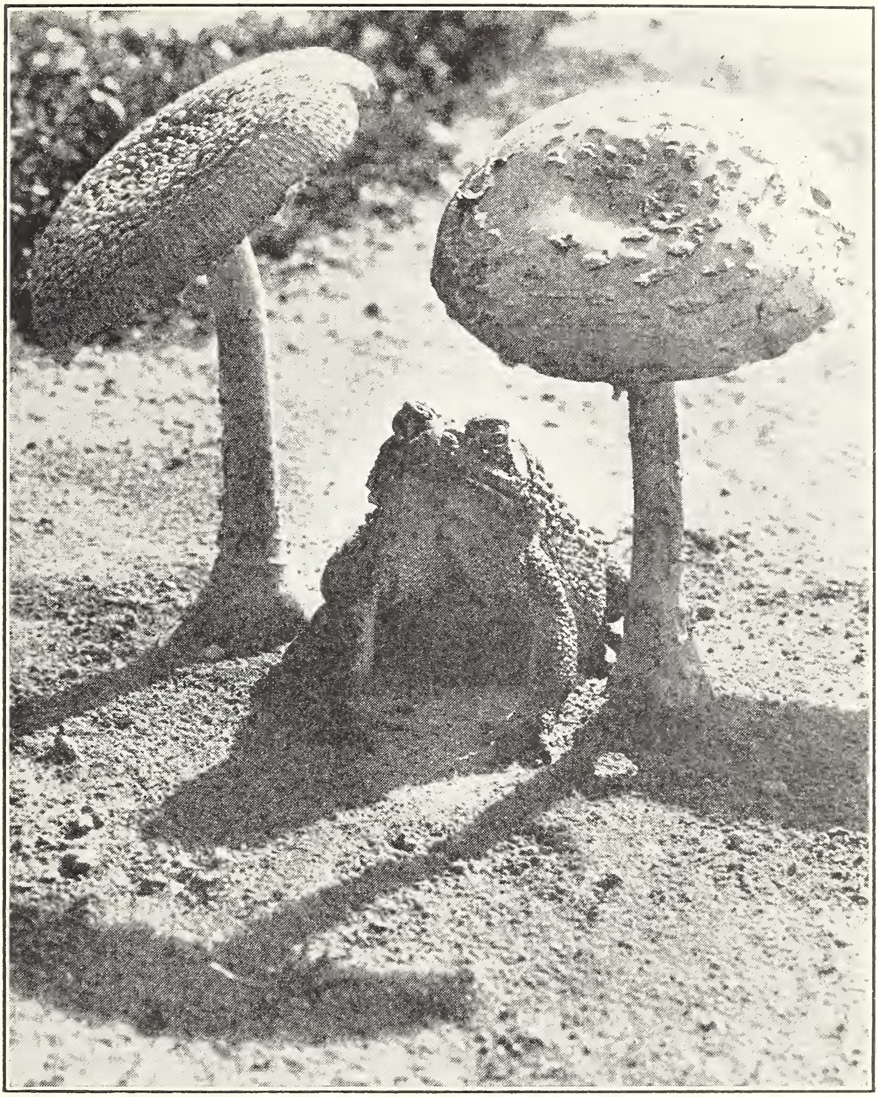


Photograph by L. W. Brownell

ABOVE: YOUNG TADPOLES. BELOW (*left*): TADPOLE WITH FRONT AND HIND LEGS; (*right*): TADPOLE, TAIL HALF ABSORBED, SOON TO LEAVE THE WATER.

weeds. When it is about ten days old, it grows a mouth with hard, horny jaws that are useful in biting off the bits of plants that serve as food.

After a month or more, hind legs begin to grow out. You will find it very interesting to catch some tadpoles and keep them in a glass bowl where you can watch them develop into toads and frogs. The hind legs have five webbed toes. The front legs, which develop later, have four toes.



Photograph by Lynwood M. Chace

WITH ITS PROTECTIVE COLORING THIS TOAD FEELS MUCH AT EASE NEAR MUSHROOMS.

These four toes are not webbed. As the legs grow, the tail becomes smaller and finally disappears. You may have heard it said that tadpoles eat their tails, but this is not true. The tails are absorbed into the rest of the body.

When the legs have grown and the tail has disappeared, the creature leaves the water and goes on land. By this time it is usually about a half-inch in length. Sometimes on a rainy day a large number of tiny frogs or toads will leave the water together. Perhaps this accounts for the story that they rain down.

Toads are often seen hopping about just at dusk in the evening. During the day they lie hidden near buildings or in shallow holes that they dig for themselves in the loose soil. Their color is so nearly like that of the soil that they are not easily seen. Perhaps you know of other animals that blend so well with the things about them that it is difficult to see them. We say that they have protective coloring, just as the tiger beetle has, because the coloring is indeed useful in protecting them from their enemies.

It is interesting to watch a toad catch an insect. It does this by thrusting out its long tongue, which is covered with a sticky substance that holds the insect fast. It is not particular about the kind of insect upon which it feeds, but since so many of the common insects are harmful, it will surely destroy many of the enemies of the garden.

Frogs are similar to toads in appearance, as well as in their life story. Indeed, in the tadpole stage it is difficult to tell them apart. However, the frog's skin is smooth and shiny, while that of the toad is dry and somewhat warty.

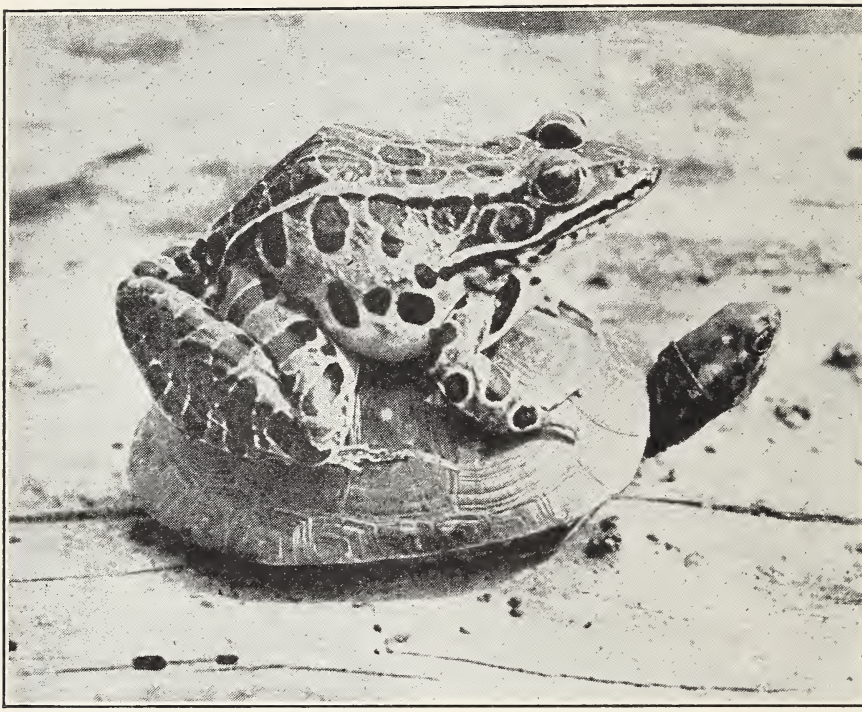
Several kinds of frogs are found in this coun-

Photograph by Lynwood M. Chace

FROGS ARE SIMILAR TO TOADS. COMPARE THE FACE OF THIS ONE WITH THE TOAD IN THE PREVIOUS ILLUSTRATION.

try. Perhaps the most common are the leopard frog and the bullfrog. The bullfrog is never found far from the water. It remains a tadpole for two years, and spends its adult life on the banks of ponds and streams. The leopard frog, on the other hand, often wanders some distance from the water. This is the frog that you probably have seen hopping about.

In the winter, toads burrow deep into the ground, and frogs bury themselves in the mud. There they remain very quiet during cold weather. The lungs are empty and the heart barely beats. When they come out in the spring they are very hungry, and begin at once to watch for insects.



Photograph by Lynwood M. Chace

THE LEOPARD FROG OFTEN WANDERS SOME DISTANCE FROM THE WATER.

Tiny frogs and toads are sometimes seen during the day on the trunks and branches of trees. These are tiny creatures, usually not more than a half-inch in length, with air sacs on their feet that help them to climb. You will have to watch very carefully if you wish to see them on the trees, for their color blends with the color of the bark. During the evening they come down and hop about in search of insects.

SOME THINGS TO THINK ABOUT

1. Why are toads and frogs useful?
2. Describe the changes that occur as the tadpole becomes an adult.

3. Explain how the tadpole gets oxygen for use in its body.
4. What is meant by protective coloring?
5. How does a toad catch an insect?
6. What kind of frog spends two years in the tadpole stage of its life?

SOME THINGS TO DO

Study a live frog or toad, either in the classroom or out-of-doors. Watch it jump, and when you have discovered just how it does it, imitate it yourself. If you have a wire cage, put your toad or frog into it, and feed it some live flies. Watch it catch them.

If possible, catch some tadpoles. Keep them in a glass bowl and watch them develop into adults.

CHAPTER V

THE EARTHWORM GARDENER

1. Have you ever seen earthworms crawling around on the surface of the earth after a rain?
2. Where do they come from?
3. In what way are earthworms useful?

You have perhaps thought of earthworms as good bait for fish. You may be surprised to learn that they are useful in other ways. They are most useful to keep the soil in good condition for growing plants. You will learn about these and other interesting things as you read through this chapter.

The earthworm burrows through the soil and makes passageways for air and water to get down to the roots of plants, and for surface water to drain away. When they burrow into hard earth, they eat the soil, which is changed in their bodies into powder. This powder mixes with lime and other valuable plant foods the worm has eaten from dead plants and animals. You can readily understand that the earth that passes out from the earthworm's body makes valuable soil for the growing plant. It is rich in plant food and is so fine that the roots of plants can easily push their way through it. The gardener himself could not make the soil better than the earthworm.

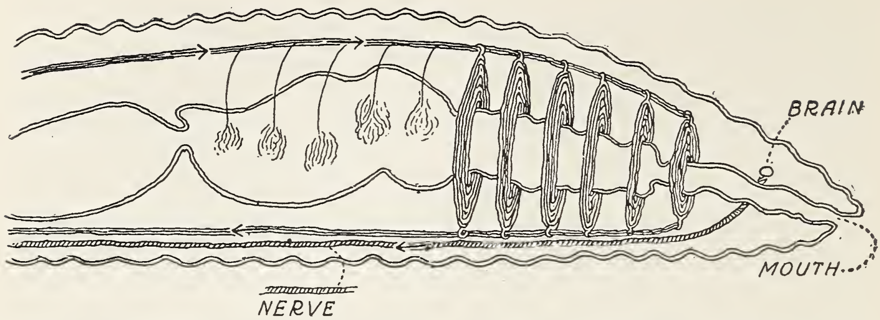
Photograph by Cornelia Clarke

YOU HAVE NO DOUBT SEEN EARTHWORMS CRAWLING ABOUT ON THE SURFACE OF THE GROUND.

You have no doubt seen earthworms crawling about on the surface of the ground after a rain. You may have heard them called angleworms, and perhaps you have heard it said that they come down with the rain. Earthworms do not come down with the rain. The truth is that the rain fills their burrows with water, and they must come to the surface or drown.

When you spade the moist soil of your garden, you will probably find earthworms in it. It is interesting to examine one carefully. Its long, thin body is made up of parts that appear on the surface as rings. Sometimes in a large worm there are as many as 150 of these rings or parts. On the underside of the body are small projections that are almost like bristles.

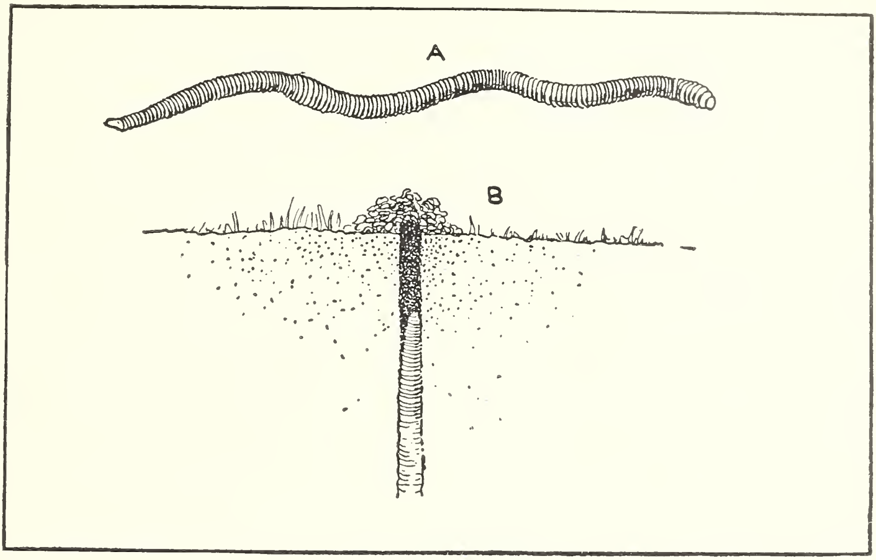
Under the skin are two sets of muscles, one of which goes around the body while the other runs lengthwise. Watch the earthworm as it crawls.



IT IS INTERESTING TO STUDY AN EARTHWORM CAREFULLY.

The muscles that go around the body (the circular muscles) shorten, while the other set of muscles stretch out in the direction in which the earthworm is going, lengthening the body. If it goes forward, it pushes its head forward. Then the circular muscles stretch, and those running lengthwise shorten. In this way the body shortens and increases its thickness, bringing the tail nearer to the head. By lengthening and shortening its body the earthworm moves forward or backward. The bristle-like projections point in the opposite direction from that in which the worm is crawling. You can understand that it is these projections that make it possible for the earthworm to stretch its body forward. It can crawl either backward or forward simply by changing the direction of the projections on the under side of its body. This is a slow way to travel, very different from walking. Using some molding clay you can show how the earthworm crawls.

The earthworm has a tiny brain and a nerve cord that passes along the underside of its body.



A: EARTHWORM SHOWING RINGS; B: EARTHWORM, BURROW, AND MOUND.

It has no eyes for seeing or ears for hearing. However, it can feel the difference between light and darkness, and has a very fine sense of touch. It has no lungs, but when the skin is moist, oxygen and carbon dioxide pass in and out of the body through the skin. You will find it interesting to learn in detail how oxygen and carbon dioxide are formed. Oxygen is the gas that is breathed into the lungs to nourish the blood, while carbon dioxide is the gas that is given off by the lungs and carries away the blood impurities.

For this reason, the earthworm seeks moist earth. When the soil near the surface becomes dry, it burrows down to moisture, eating its way through the hard earth. At the entrance of its burrow, small mounds of earth are found. These are made of the soil that has been swallowed and passed out of the earthworm's body. The earthworm, when filled with the soil it burrows, crawls backward and deposits this earth about the entrance of the hole. You may be able to find an earthworm by learning to recognize the mounds.

In the winter earthworms bury themselves in the earth below the frozen soil of the surface. In these underground burrows they roll up into balls and remain quiet until the ground thaws in the spring.

Have you ever seen a robin watching for an earthworm to come to the surface of the earth? When the worm appears and is captured, it is not an easy task for the bird to pull it out of the ground, since the tiny bristle-like projections hold tightly to the earth. Perhaps you have seen a robin tugging and pulling to get a worm out of the burrow.

You may wonder how animals as small as earthworms can do very much good to the soil. Charles Darwin, a great English scientist, has written some facts about earthworms that may surprise you. He wrote that there were more than 50,000 earthworms in each acre of garden soil in England, and that about eighteen tons of soil per acre passed through the bodies of these 50,000 earthworms every year. Each earthworm helps a little, therefore a great number of them can do much good.

SOME THINGS TO THINK ABOUT

1. How are earthworms useful in the garden?
2. Why are they often seen on the surface of the earth after rain?
3. Explain how the earthworm crawls. Of what use are the bristle-like projections on its body?
4. Where do earthworms spend the winter?

SOME THINGS TO DO

Bring some earthworms to the classroom for observation. Keep them in moist earth. Notice their movements as they crawl, and as they burrow in the earth.

Place dead leaves and grass on the surface of the soil, and see what the worm does with them.

Look for mounds around the entrances to earthworm burrows in the garden.

Illustrate the earthworm's crawling movements, using molding clay.

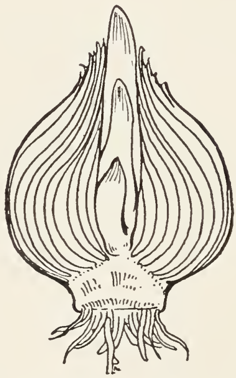
CHAPTER VI

PLANTING BULBS IN AUTUMN

1. Name some flowers that grow from bulbs.
2. What flower bulbs should be planted in the garden in the fall?
3. When do tulips, narcissuses, and daffodils bloom?

Would you like to have some early spring flowers in your garden? You can have them by planting bulbs in the fall.

You have probably seen tulip, narcissus, or hyacinth bulbs. They look much like onions. If



CROSS SECTION OF A BULB.

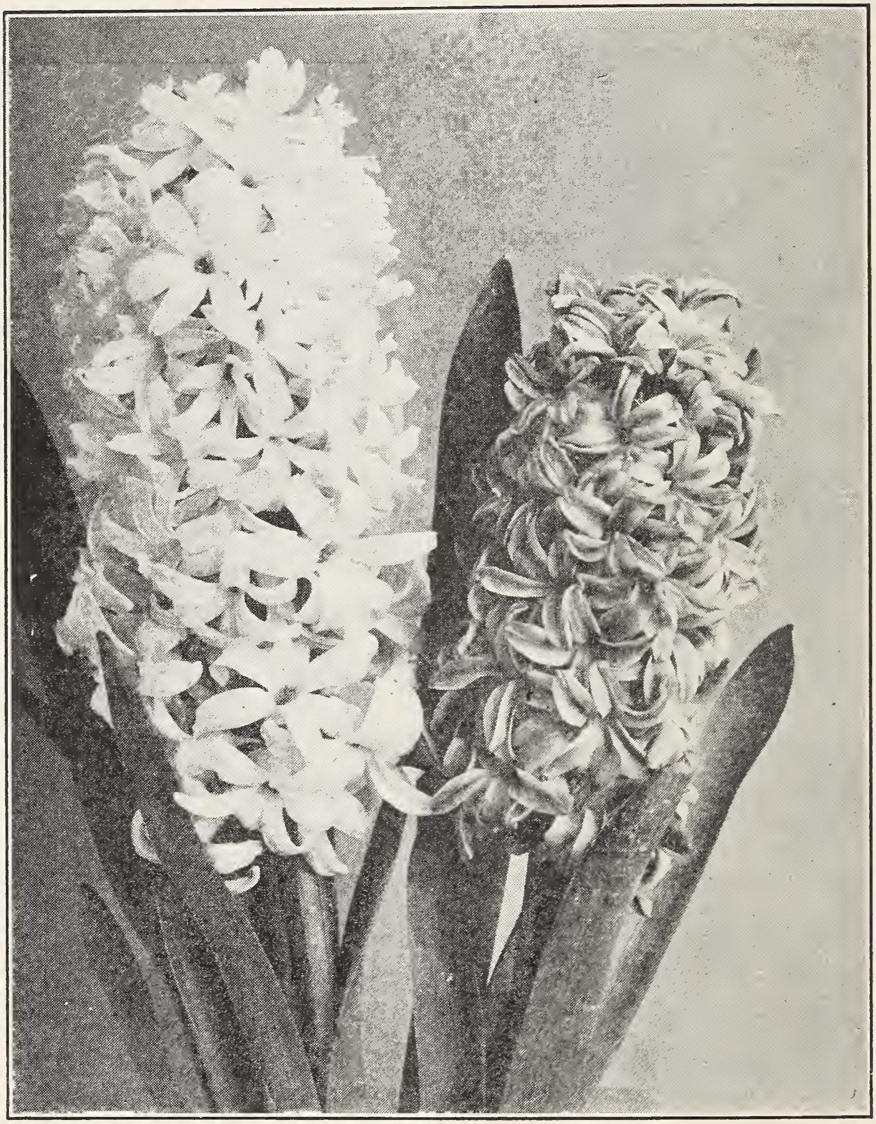
you were to cut one of them through the center from top to bottom, you would find in the center a small bud. Surrounding it are thick fleshy leaves in which food for the young plant is stored. On the outside are dry, papery layers, that serve to protect the inner layers of the bulb.

You will want your flowers to bloom as early in the spring as possible. Therefore, select a sunny place for the bed, where the snow will melt soonest. About two weeks before planting the bulbs, the ground should be prepared by digging or spading the soil about eighteen inches deep, and if you wish, mix some manure with the earth.

The first of October is a good time to make these preparations, so that you will be ready to plant the bulbs by October 15. This will give the bulbs time to send out roots before the ground freezes and be ready to grow leaves and flowers in the spring.

In planting, dig a shallow ditch about four inches deep. Set your bulbs into it, placing them a few inches apart, and covering them with the soil that you have taken from the ditch. In this way, all the bulbs will be planted at the same depth. Remember that the roots will grow from the flat bottoms, and that the stems and leaves will develop from the pointed tip, therefore, the bulbs should be set to point straight upward. Otherwise, the young plants will be crooked. It is well to spread straw or manure on the surface of the bed to protect the bulbs from sudden changes in temperature during the spring. If you follow these directions you can have a bed of plants as fine as those you see in parks and large gardens.

There are a number of kinds of bulbs from which to choose for fall planting. The blossoms of the tulip, narcissus, daffodil, and hyacinth are all so beautiful and so fragrant that you may



Photograph from J. Horace McFarland Co.
THE HYACINTH IS ONE OF THE FAVORITE SPRING FLOWERS.

shake your head in dismay before you can make up your mind to choose among them. No doubt you will feel that you want them all in your garden. The story of the tulip may help you to decide.

Many, many years ago the Chinese gave the people of Persia a few tulip bulbs. The Persians liked the flower so much that they used it as the basis for designs in their sewing and weaving. You can see some of these designs to-day on Persian cloth and hangings in art museums. The tulip was later carried to Holland, where the first bulbs were so highly prized that one of them sold for more than $1,000. The Dutch people like the tulip so much that they have made it their national flower. More tulips are grown in Holland than in any other country. Until recently almost all of the tulip bulbs sold in this country were imported from Holland, but the Dutch bulbs developed a disease that made it necessary for our government to forbid importing them.

Probably you will want to plant some tulips in your bulb bed. The flowers may be yellow, pink, lavender, red, or of other bright colors. Some of them are striped, and some are black. What a lovely spot of color a tulip bed makes in the spring garden! The flowers have an odor that is a little like the odor of freshly turned earth in the spring.

The daffodil also has a lovely blossom, as you may see in the picture here. The flowers are clear yellow in color, and about three inches in diameter. The stiff cylinder or tube that you will notice in the center is about two inches long. It has a ruffled end like an old-fashioned skirt. Inside this cylinder you can see the stamens, which bear the pollen, and the pistils, from which the seeds develop. The stamens and pistils are

Photograph from J. Horace McFarland Co.

THE DAFFODIL HAS A LOVELY BLOSSOM.

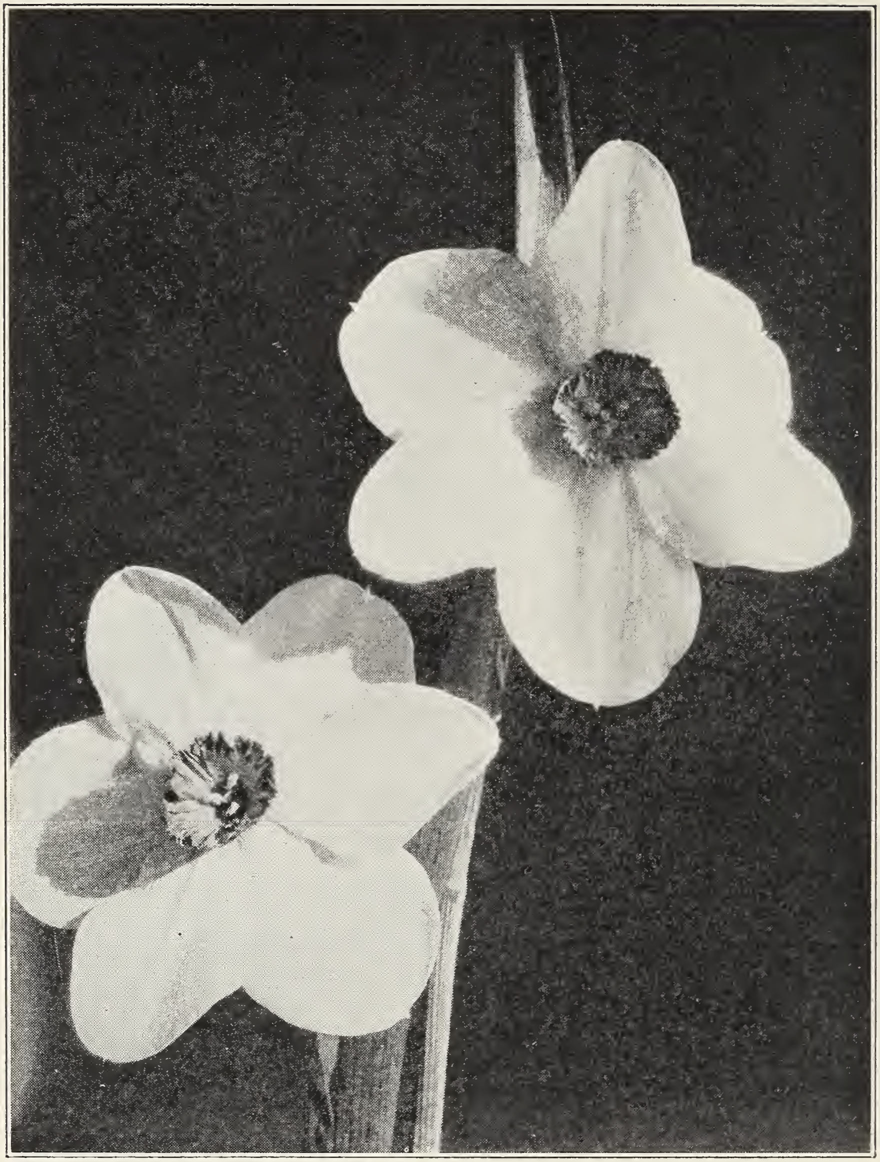
the most important parts of flowers, since the purpose of the flower is to produce seeds. The seeds develop in the pistil after the pollen from the stamens has entered it. With your teacher you may want to study a daffodil flower to learn just where the pollen enters the flower and where it leaves it. This is one of the most important things in the study of flowers.

Daffodil seeds, however, are not of very much value. They take little time to grow into plants, but the plants will not bloom until they are seven or eight years old. For this reason daffodils are usually raised from bulbs. If you will examine a daffodil bulb that has been in the ground for a year or more, you may find small bulbs or bulblets growing by its side. From these bulblets plants will grow, but it takes a long time for these to blossom. The bulblet must grow for several years to become a bulb and produce flowers.

Have you seen pictures of narcissuses and hyacinths, the bulbs of which are also suitable for fall planting in your garden? The narcissus flower is somewhat similar to that of the daffodil except that the cylinder in the center is very much shorter. They may be yellow or white. In some kinds each flower stem bears several flowers, while in others only a single flower grows on each stem.

Have you ever been told the mythical story of the narcissus flower? According to the story, a beautiful Greek youth who was very selfish, was punished by Nemesis, the goddess of fortune, to spend his life wanting to grasp his own shadow reflected in water. Unable to grasp the shadow, Narcissus died of grief and became the flower that bears his name.

Probably you have grown narcissuses or hya-



Photograph from J. Horace McFarland Co.

THE NARCISSUS FLOWER IS SOMEWHAT SIMILAR TO THE DAFFODIL.

cinths in the house. If you have not, you may find it interesting to do so. Buy the largest and the best bulbs, for the smaller ones may be bulblets, and these will not bloom for years. The bulbs may be planted in bowls of pebbles. Pour in water until they are almost, but not quite, covered with it. If they are completely covered with water, they will rot. Keep the bowl in a cool place until the green flower buds begin to appear. It will not be long before you see its fragrant blossom.

After the plant has blossomed, the leaves will wither and turn yellow, and seeds will often develop from the flowers. The seeds, however, will not produce plants that will bloom. Bulbs that have grown on pebbles will not bear flowers again the next year, for the plant food that was stored in them has been used. On the other hand, bulbs that grow in the garden will bear flowers for several years, for the roots store new nourishment in them to replace what was used by the young plant. The garden bulbs should be dug up every other year and replanted. By proper care you may grow fine flowers every year, so fine that your friends will ask you to show them how you did it.

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 false, write *No.*

1. In the center of a bulb is a tiny bud.
2. Bulbs that are planted in October develop roots before the ground freezes.
3. The narcissus is the national flower of Holland.
4. Seeds develop in the stamens of flowers.

5. Bulbs that have grown on pebbles will not bear flowers again the next year.

SOME THINGS TO DO

Cut a bulb through the center from top to bottom. Observe the bud, the thick leaves in which the plant food is stored and the paper-like covering. Draw a picture to show these parts.

Select three bulbs that look as nearly alike as possible. Plant them in three vases, placing one in a warm, light place; one in a warm, dark place, and another in a cool, dark place. Compare their growth.

You will find it interesting to plant some bulbs in your garden, following the instructions given in this chapter.

Photograph by L. W. Brownell

CLOVER, GROWING IN OUR GARDENS, IS A WEED.

CHAPTER VII

WEED ENEMIES OF THE GARDEN

1. Name some of the weeds that grow in the gardens of your neighborhood.
2. Which of these weeds is the most troublesome?
3. Which of the common weeds are most difficult to kill? Why?

A weed is any plant that grows where it is not wanted. The farmer sows clover in his fields. There, clover is not a weed, but a crop. The same plant, growing in our gardens, is a weed.

Purslane is sometimes cultivated for use as greens to be eaten. All boys and girls know what dandelion or spinach greens are. When purslane grows in gardens where it is not wanted, it is a troublesome pest. Its thick fleshy leaves and

Photograph by L. W. Brownell

PURSLANE. BURDOCK.

stems spread out over the ground, and if allowed to grow, form a thick mat that interferes with the growth of garden crops by robbing them of plant food and water. Its small yellow flowers appear in the summer and continue to bloom until the plant is killed by the frost. If the seeds are allowed to ripen, it is difficult to handle the plant without scattering them in great numbers. That is why weeds grow each year without being planted.

Many of the common weeds produce great numbers of seeds. From the flowers on one stem of buckthorn about 1,000 seeds grow. Knowing this, you can readily understand why the buckthorn, once it starts, is hard to get out of the garden. Buckthorn plants also grow not only from seeds, but they come up again each season from the roots that stay in the ground throughout the winter. To get rid of buckthorn it is necessary to dig out its roots.

Wild mustard, with its bright yellow flowers, is common in fields and waste places throughout the greater part of the United States. One wild mustard plant has been known to produce 15,000 seeds in a season. The seeds are very small. Some older person may be able to find a passage in the Bible about mustard seed. You can guess that the farmer who allows the seeds to ripen will soon have a whole field of wild mustard. In a garden plot wild-mustard plants should be destroyed before they go to seed.

Cinquefoil (sĭnk′foil) is sometimes called five-fingers because the five leaflets that make up its divided leaf somewhat resemble the five fingers of a hand. The plant sends out wire-like runners, which often are as much as two feet long. Sometimes they are so thick that you may become entangled in them. The golden yellow flowers of this plant appear from May to September. Cinquefoil should be destroyed before the seeds ripen.

Have you ever played with the sticking burs of the burdock? The burdock is a biennial. Biennials are plants that require two years to complete their life story. During the first season the burdock plant grows from seed, developing stems and leaves but no flowers. The next year the plants grow from the roots that remain in the ground

Photograph by L. W. Brownell

CINQUEFOIL IS SOMETIMES CALLED FIVE-FINGERS.

through the winter. During this second season, burdocks produce flowers and seeds, and thus complete their life story. The seeds grow inside the burs, with which you are no doubt familiar.

Burdock roots and leaves are often used in medicine, but when the plant grows in our gardens, it becomes a weed. To destroy it during the first year, you must dig out the roots. If the tops are cut off without harming the roots, the plant will grow again. Many weeds can be kept out of the garden if all roots are dug out when the garden is prepared in the spring. During the second year, it is important that these troublesome weeds be taken out before the seed ripens.

The bright pink flowers of the pink knotweed

Photograph by L. W. Brownell

CHICKWEED HAS TINY WHITE FLOWERS AND SMALL LEAVES.

are commonly seen in gardens, fields, and along the roadsides from July to October.

The chickweed, with its creeping branches, its small leaves, and its tiny white flowers, spreads rapidly when it gets a start in gardens and lawns, for it produces a large quantity of seeds.

These are but a few of the hundreds of kinds of weeds that are common in this country. The damage done by weeds in the United States amounts each year to many millions of dollars. Many of the common weeds are very hardy plants that grow again and again where they are not wanted, in spite of our efforts to get rid of them. Most of them produce seeds in large quantities that are scattered far and wide by the wind, and in other ways. Soil usually has in it many weed seeds that will grow when the conditions are right.

Weeds are enemies of the garden. Frequently they grow faster than the garden crops, robbing them of plant food and water, and if they are allowed to become taller than the crops, they will rob them of sunshine as well.

Your garden should be hoed often enough to keep it clean. The larger weeds should be pulled out by their roots before hoeing. Hoeing not only keeps the garden free from weeds, but it also improves the soil by breaking up lumps and mixing air with it. The roots of plants need air as well as water. You should never allow weeds to go to seed in your garden even after you have harvested your crops. The work of the wise gardener is not ended in the fall until the garden has been cleaned of all weeds and plants.

There is also another way in which you can help to get rid of these troublesome plants that grow where they are not wanted, and that is by protecting the birds that eat the seeds. Especially during the winter months many of the common birds feed largely upon weed seeds. You will learn more about this in another chapter of this book.

SOME THINGS TO THINK ABOUT

1. What are weeds?
2. Name some plants that are sometimes weeds and sometimes crops.

3. Name and describe some of the weeds that grow in your neighborhood, but which are not described in this chapter.
4. What is a biennial? Name a common weed that is a biennial.
5. Give two reasons for hoeing a garden.

SOME THINGS TO DO

Visit a vacant lot to look for purslane, buckthorn, wild mustard, cinquefoil, burdock, knotweed, and chickweed. Find as many of those mentioned in the chapter as you can. Make a list of those you recognize.

Observe the leaves, stems, flowers, fruits, and seeds of each kind.

Collect one leaf of each different plant and paste it on a page of your notebook, labeling it with the name of the plant.

Take a trip to a field to gather weed seeds. Put a sample of each kind in a small glass bottle. On each bottle paste a label with the name of the plant from which the seed was taken.

Make posters to show how seeds are scattered. Mount on one cardboard samples of seeds that are carried by the wind, on another those carried by water, and so on. Notice that seeds are of a size and shape convenient for their being scattered.

Give as many reasons as you can for hoeing weeds out of the garden.

CHAPTER VIII

FALL GARDEN FLOWERS

1. Name some garden flowers that bloom in the autumn.
2. How many of these have you seen growing?
3. Did you gather any flower seeds in your garden?

When you know the life stories of plants, you will find much interest in the autumn garden. You may notice how the plant prepares for the coming of more plants next year, and how the flower helps the coming of other plants.

Are you acquainted with the sweet alyssum (ă-lĭs′um), often used in the borders of flower beds? It has soft green leaves, which fade in the fall to a yellow brown. It blooms all summer long. Its small white flowers grow in spikes, which you see pictured on page 63. All the flowers on one spike do not bloom at the same time. In fact, you may sometimes see ripe seeds on the lower part of the spike while flowers are blooming at the end. These spikes of sweet alyssum are very interesting to study in the autumn, when you can see on one spike all the stages of the growth of seeds from flowers.

However, you will want to learn more about the growth of a seed than you can find out by yourself. Let us consider first the sunflower. Its large flower head is made up of many simple flowers from which you can learn something of

Photograph from J. Horace McFarland Co.

SWEET ALYSSUM FLOWERS GROW IN SPIKES.

the most important flower parts and their work.

Perhaps the sunflower was named so because its large yellow flower head looks like the sun. It is sometimes said that the sunflower always keeps its head turned toward the sun. If you see one,

Photograph from J. Horace McFarland Co.

THE SUNFLOWER HEAD HAS MANY LITTLE FLOWERS IN THE CENTER.

notice whether this is true. Usually the older flower-head hangs toward the ground because of its weight.

Look at the picture of the sunflower head.

Around its edge are bright yellow florets, which are like petals in appearance, and in the center are many little flowers, each of which is so small that we would have to use a magnifying glass to find out very much about it. In the picture you may be able to see that it looks very much like a little tube. For this reason it is called a tubular floret. Each tubular floret has a stamen and a pistil, which all flowers must have to produce seed. The stamen bears the pollen, the pistil contains the part that develops into the seed. The seed cannot grow, however, unless the pollen from the stamen falls upon the pistil. From this you can understand how necessary both stamens and pistils are in the life of the plant.

The bright yellow florets around the edge of the sunflower head are called ray florets. They have neither stamens nor pistils, so they cannot produce seeds. However, they help a great deal by attracting insects that feed on nectar, the juice of flowers. The pollen that falls on the insect while it is feeding from one flower may drop on the pistils of another flower.

Have you ever seen a sunflower head after the seeds have developed? What we call the seed is really a hard dry fruit with a seed inside. Fruits that have hard dry coverings of this kind are called akenes (a-kēns). The sunflower akenes develop in little sockets in the flower head in which they are held firmly until they ripen. As the flower head shakes in the wind, the ripe seeds are loosened from their sockets and are scattered on the ground. Some of them are eaten by the birds. Only a few develop into plants.

Sunflower seeds are sometimes fed to chickens. In some parts of the West where corn cannot be grown, sunflowers are raised in the fields to feed the cattle.

The common sunflower is an annual. An annual is a plant that must be grown from the seed each year. The seeds that are planted in the spring develop into plants that blossom and produce new seeds before they die in the autumn. There are also perennial sunflowers, but these are not so common as the annuals. Perennials do not complete their life stories in a single year. Their roots live in the ground through the winter, and in the spring send up new stems and leaves. Would you call a chrysanthemum an annual or a perennial plant?

The bright orange and yellow flowers of the calendula add a touch of beauty to the autumn garden. They have a spicy odor, too, that blends well with the odor of dry leaves and wood smoke and apples. The calendula begins to bloom in the summer, and if the flowers are cut, it will continue to blossom until late in the fall.

Like the sunflower, it has a flower head that is made up of tube-like florets in the center with ray florets around the edge. However, the calendula is quite different from the sunflower in its production of seeds in that they are grown around the edges of the flower. You recall that the sunflower seeds grew inside of its collar of yellow

Photograph from J. Horace McFarland Co.
THE CALENDULA HAS ORANGE AND YELLOW FLOWERS.

pennants. If the flowers are allowed to stay on the plant until the seeds ripen and fall to the ground, some of the seeds will no doubt grow in the spring. Thus, the calendula bed will continue from year to year, but the new plants will

YOU MAY ALSO HAVE GROWN DAHLIAS IN YOUR FLOWER GARDEN.

grow each season from seeds, and not from the old roots, for the calendula is an annual.

No doubt you can think of a number of other autumn garden flowers that are made up of many small flowers. Perhaps you are acquainted with the aster, which grows in clumps with white, pink, or lavender blossoms. The name *aster* means star-like. Do you consider it a good name for the plant? You may also have grown coreopsis, dahlias, chrysanthemums, or cosmos in your garden. The flower heads of all these plants have many smaller flowers together. You will find it interesting to examine them to see whether you can find the stamens and the pistils, and the growing seeds.

SOME THINGS TO THINK ABOUT

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

1. A flower must have a ..... and a ..... in order to grow.
2. The tiny flowers that make up a compound flower head are known as florets. Those in the center of the head are ..... florets; those around the edge are ..... florets.
3. The seeds of the sunflower develop from the ..... florets.
4. The seeds of the calendula develop from the ..... florets.

SOME THINGS TO DO

Make a trip to a garden where some of the fall flowers are blooming, and learn to know as many of them as you can. Notice, in as many plants as possible, how seeds look as they grow. Gather some seeds to plant next year, and some to feed to the winter birds.

If possible, bring a sunflower head to school and notice as many of the things that you have learned in this chapter as you can. If you cannot find a sunflower, you can bring some other flower head with florets.

If you have a magnifying glass you will find it interesting to study the florets under it. Find the ray-florets. Do any of the ray-florets produce seeds? In what part of the sunflower do the seeds develop?

Pull all the ray-florets off one flower head. Do you like it better with the ray-florets or without them?

Try to find the stamens and the pistils. Do you find them in the ray-florets or in the tubular florets?

CHAPTER IX

THE CHRYSANTHEMUM, THE LAST FLOWER OF THE AUTUMN

1. Have you ever seen chrysanthemums in the window of a florist shop?
2. Have you seen chrysanthemums blooming in the garden?
3. How are the out-of-door flowers different from the ones in the flower shop?

On cold, frosty autumn days when all the other flowers have faded, you will find chrysanthemums still blooming in the garden. In the northern states these hardy flowers appear as late as November, while in the South they frequently bloom until Christmas.

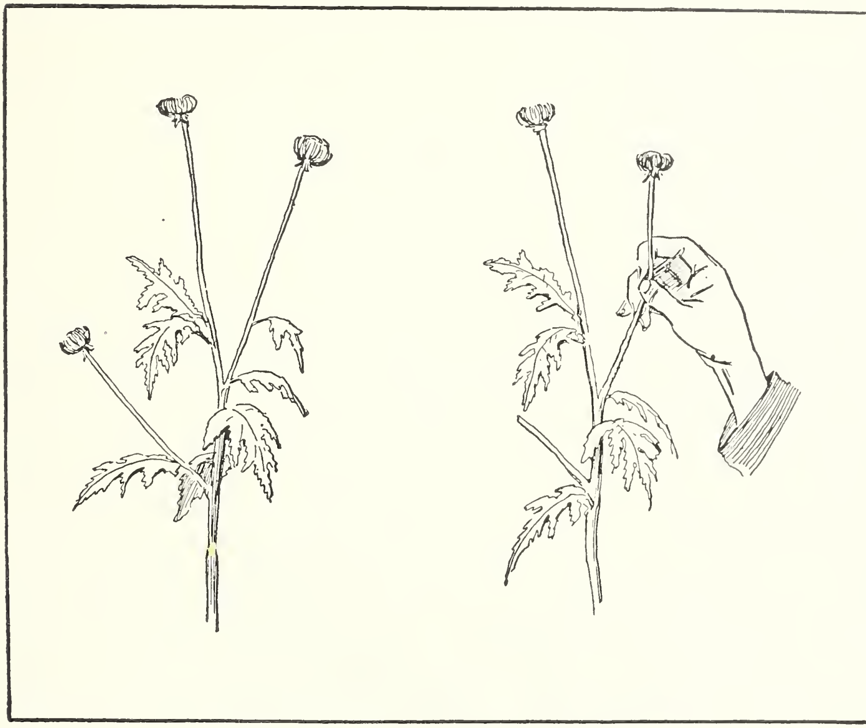
The chrysanthemum has an interesting story. More than two thousand years ago, these flowers grew in China and Japan. From there they were carried to Europe, and about the time George Washington became president of the United States, a French gardener introduced them into England. Probably chrysanthemums in those days were always yellow, for the name means "gold flower."

As you probably know, all chrysanthemums are not golden in color now. They may be white, pink, orange, or maroon. Indeed, there are more than 400 varieties of chrysanthemums, some of which

Photograph from J. Horace McFarland Co.

THE OUT-OF-DOOR CHRYSANTHEMUM RESEMBLES THE ASTER IN SHAPE.

grow in hothouses while others are among the hardiest of our garden plants. The leaves and stems of these many varieties are more alike than

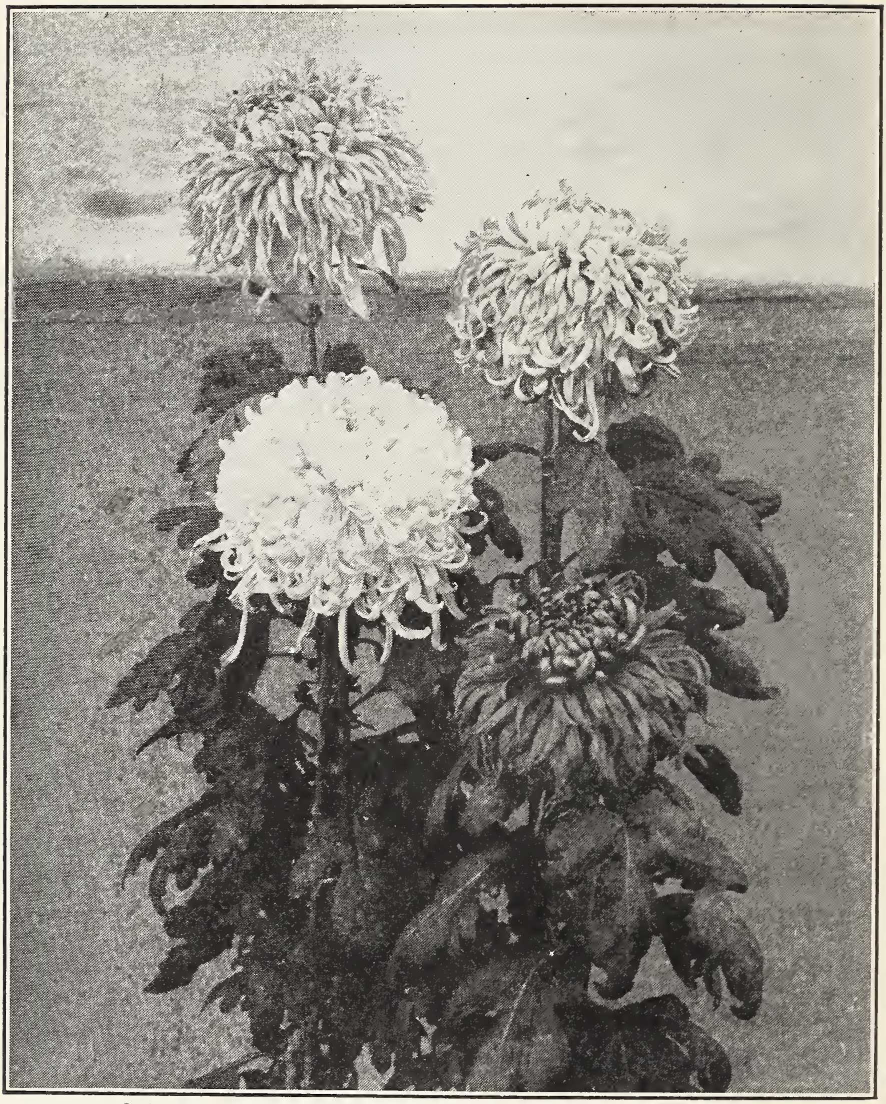


BY PINCHING OFF ALL THE BUDS EXCEPT ONE A SINGLE LARGE BLOOM CAN BE OBTAINED.

the flowers are. You may recall their fresh, spicy odor or remember their somewhat sticky surfaces. The dull green leaves are long with edges that are cut in irregular shapes like scallops on girls' dresses.

The flowers of the out-of-door varieties resemble asters in shape. They are small pompons that vary in size from one inch to four inches in diameter. They grow in graceful clusters. The ray florets usually lie flat like those of the calendula, but they are finer and less stiff. Their odor is clean and refreshing.

The flower heads of the hothouse varieties are



Photograph from J. Horace McFarland Co.

THE HOTHOUSE CHRYSANTHEMUM HAS LARGE COMPACT FLOWER HEADS.

much larger and more compact than are those that grow in the garden. In the greenhouse all except a single one of the flower heads on a plant are pinched off, and the strength of the whole plant goes into producing one gorgeous bloom, which is frequently from six to eight inches in diameter. Usually the ray flowers are long and curl toward the center, giving the head the appearance of a great colored ball on the end of a stick. You will no doubt recall that the hothouse chrysanthemum blooms at the end of a long stem.

If the flowers are allowed to remain on the plant, seeds will develop, but they are of little value to us, for only an expert gardener can succeed in raising chrysanthemums from seeds. There are much easier ways of starting the plants in greenhouses or gardens.

The common varieties of chrysanthemums are perennials. Their roots live in the ground throughout the winter, sending up new stems and leaves in the spring. The roots increase in size, spreading out farther and farther under the ground each season, and sending up more new shoots each spring.

By digging up a portion of the roots and planting them in a new place, a bed of chrysanthemums may be started. Sometimes, however, the plants are started by cutting off a part of the stem and placing it in the ground. These cuttings may be the short, stout shoots that spring up from the roots, or they may be pieces of the plant stem. If a shoot is to be used, it should be cut off near the rootstock from which it grows, either just at the surface of the ground or a little below. To make a stem cutting, the stem is cut straight across with a sharp knife just below a joint. It is well to remove the lower leaves. Either shoots or stem

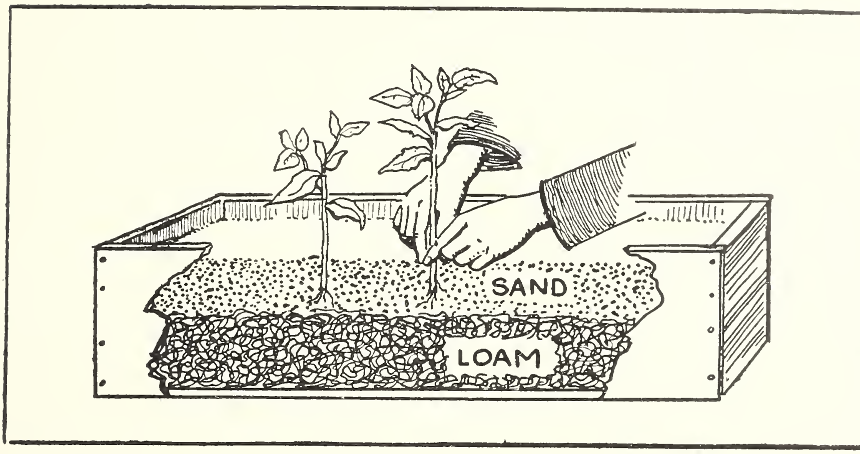
Photograph from J. Horace McFarland Co.

CUTTINGS MAY BE SHORT, STOUT SHOOTS.

cuttings are usually about two and one-half inches long.

Let us take an imaginary trip to the greenhouse to find out how new plants are raised from cuttings. Sometime in January we may find the flower growers preparing a large shallow box in a corner where the temperature will stay about 50°. How does this temperature compare with that of your schoolroom?

Into the box the workmen put first a layer of loam and leaf mold, and on top of this, a layer of sand or gravel. The cuttings are then placed upright in the sand, which is packed tightly about the stems. Usually they are so placed that about one-third of their length is below the surface. The layer of sand in the box should be just thick



THE GARDENER PLANTS THE CUTTING IN THE SAND.

enough so that the cutting will reach almost, but not quite, down to the loam. The gardener plants the cutting in the sand because loam often contains fungi that attack the soft cutting and cause it to rot before it starts to grow. By planting the cutting in the sand it is given a good start and as the roots grow they can push their way into the layer of loam and leaf mold where there is more plant food.

If we were to return to the same greenhouse later in January, we would see the workmen moving the chrysanthemum shoots or cuttings, which have grown into plants with roots, into separate small pots. Perhaps you can grow some chrysanthemum plants from cuttings if you have a cool, evenly heated cellar with good light.

Like other plants, the chrysanthemum has enemies. One of these is the black aphis, a tiny soft-bodied insect that feeds upon the sticky substance covering the stems and leaves of plants.

This insect can be killed by spraying the plant with liquid poison or dusting it with powders that you can buy for this purpose.

Because it is so beautiful at a time of the year when few flowers are blooming, and because it thrives in a great variety of soils, the chrysanthemum now blooms in many countries, but perhaps it is best beloved in Japan, one of its first homes. The Japanese have made it their national flower, and they celebrate Chrysanthemum Day each September as one of their gayest holidays.

SOME THINGS TO THINK ABOUT

1. Chrysanthemums are usually raised from the roots or from cuttings. Tell how you would start a chrysanthemum bed from the roots.
2. What are cuttings? What two kinds of chrysanthemum cuttings are used to start new plants?
3. Explain the process of growing plants from cuttings in the greenhouse.
4. Do you know of any other plants that will grow from cuttings? If so, name them.
5. Name an insect enemy of the chrysanthemum, and tell how it harms the plant. How can we protect our chrysanthemums from these enemies?

SOME THINGS TO DO

You will find it interesting to observe for yourself many of the facts that are stated in this chapter.

No doubt you will be able to find chrysanthemums blooming in near-by gardens. Observe them carefully and compare them with the hothouse varieties.

Perhaps you can plan to visit a greenhouse when new chrysanthemum plants are being started from cuttings, or you may plan to start a chrysanthemum bed in your own garden next spring. If you do this by transplanting some roots from the grown-up plants, it should be done in the early spring before the first green shoots appear. If you use the shoots instead, cut them when they are about two and one-half inches tall. Stem cuttings may be made at about the same time or later.

CHAPTER X

OUR FOREST TREES

1. Name as many trees that grow in the forest as you can.
2. Have you ever seen the blossoms of the white oak tree?
3. Why does a tree growing in the forest yield better lumber than one of the same species growing by itself in the field?

Have you ever pictured to yourself what your backyard must have looked like a hundred years or more ago? Many sections of this country were covered with forests then. Perhaps your yard may have been a part of a great forest where oaks, maples, pines, hemlocks, or other trees grew so close together that you could look up the straight trunks perhaps 100 feet before the trees began to branch. There at the tops were the leaves spreading out in the sunlight and looking like a great green tent. Birds and animals made their homes in the forest; flowers and berries grew in the deep black soil or humus, formed from the decaying leaves of the trees.

How did that beautiful forest disappear? Settlers came with their families. They cut trees to make their cabins and to use as fuel to keep them warm. They cut still more trees to clear the land for raising grain. No one in those days thought very much about the value of the great trees, because there were so many of them. The early pioneers in this country probably thought there were enough forests to serve for all time. There were once about 822,000,000 acres of forested land in this country. To-day there are but 38,000,000 acres of the original forests left and 250,000,000 acres of second growth. By using your arithmetic a little you can learn that nineteen out of twenty acres of forest have been cut down.

People have begun to help to protect the remaining forests because now they know of what great value they are. A great deal could be written on this subject, as well as upon the value of trees, but the purpose of this chapter is only to acquaint you with two groups of very important forest trees, the oaks and the pines.

In the forest the oaks often grow to a great height without branches. Their beautiful, hard wood is used for furniture, and for floors and woodwork in houses. Wherever there have been branches in the trunk of a tree, knots appear in the lumber that is made from it. From a straight trunk without branches lumber without knots can be made. You will be interested to see the difference in shape between trees that grow in the forest and others of the same kind growing apart from other trees. You will find that forest trees do not branch out like trees of the same kind growing out by themselves. When trees grow close together, as they are in the forests, they cannot branch out, therefore, they grow upwards.

Photograph by L. W. Brownell

A WHITE PINE GROWING ALONE.

Courtesy of U. S. Forest Service

A WHITE PINE FOREST.

You will be interested, also, when making a trip to the woods, to observe trees of different ages and notice whether the lower branches never begin to grow at all, or whether they get a start but do not grow and die off as the tree pushes upward toward the light.

There are many kinds of oaks. Look at the pictures of the two kinds of oak leaves that you see here. One is from a white oak tree, and the other is from a black oak. You will notice that they are somewhat alike in shape. However, the leaves of the white oaks and the black oaks are not alike. The white oak leaf is rounded at the

Photograph by L. W. Brownell

ABOVE: WHITE-OAK LEAF. BELOW: BLACK-OAK LEAF.

Photograph by L. W. Brownell

WHITE-OAK FLOWERS. BLACK-OAK FLOWERS.

end, and its lobes are rounded, while the lobes of the black oak leaf are pointed. The leaves of the black oak tree sometimes reach a length of ten inches. They are slightly larger than white oak leaves, which are seldom more than nine inches long. When full grown, oak leaves are dark green, thick, and leathery. In the autumn the leaves of the black oak turn to a brownish yellow or dark red before they fall, and the white oak leaves take on a bright red color.

The flowers of the oaks appear in the spring after the leaves have started to grow. They look like tassels hanging from the twigs. Such flowers are called catkins. There are two kinds of flowers on each tree, one of which bears the stamens

Photograph by L. W. Brownell

WHITE-OAK FRUIT. BLACK-OAK FRUIT.

and the other bears the pistils from which the seeds grow. You recall that the pistils and stamens of most flowers grow together in the same flower. The pistils, however, cannot produce seeds unless the pollen from the stamens is carried to them. On the white oak tree the catkins that bear the stamens are yellow, while the seed-producing flowers are red. How do you think the pollen is carried from the stamens to the pistils?

The fruits or acorns of the white oak grow and ripen in a single season. Those of the black oak require two years to become full grown. Black oak trees bloom every spring, but the acorns do not mature until the second autumn. Many acorns are eaten by squirrels and other animals, but some of them become buried in the soil or under fallen leaves and develop into young oak trees.

Photograph by L. W. Brownell

WHITE-OAK TRUNK. BLACK-OAK TRUNK.

As a rule the oaks grow slowly and live for many years. Many oak trees do not reach their full size until they are 100 years old. Some kinds do not produce seeds until they have lived for twenty years. There are some beautiful full-grown oak trees in many parts of this country. People prize them highly.

Both the white and the black oak get their names from the color of the bark. The white oak has an ashy gray bark that comes off when you rub your hand over it. Black oak bark is black on the outside with a yellow tint underneath. The inner bark of the black oak yields tannin, which is used in the tanning of leather.

You can now guess from where the word tanning comes.

Perhaps you know the names of some other kinds of oaks. The post, bur, rock chestnut, yellow, and swamp white oaks belong to the same group as the white oak, having leaves with rounded lobes and bearing acorns that mature in one season. The kind that belong to the black oak group are the red, scarlet, Spanish, pin, Georgia, Texas, California black, and the blackjack oaks. These trees have leaves with pointed lobes, and their acorns require two seasons to grow and ripen.

Among the evergreen forest trees the white pine is perhaps the most beautiful. It sometimes reaches a height of more than 100 feet, with a straight trunk, three or four feet in thickness. A white pine that grows in the open may have many spreading branches, but in the forest, surrounded by other trees, its trunk does not branch for a considerable distance. In this way the leaves are at the top only, and reach the light above other trees.

Look at the picture of the needles or leaves of the white pine. They are three to five inches long, and grow in clusters of five. Perhaps you think that an evergreen tree does not shed its leaves, but a walk in a pine forest would convince you that it does, for the ground is covered with needles. However, the leaves that come out in the spring do not fall the following autumn. They remain on the tree for two seasons, dropping off in the autumn of the second season. Since new

Photograph by L. W. Brownell

WHITE PINE NEEDLES AND CONES.

leaves appear every spring, you can understand that the pine tree will always have some needles in the winter, but it will not have as many as it has in the autumn.

In June, strange-looking flowers appear on the white pine tree. They are tiny cones, so small that they are not often noticed. There are two kinds, one of which bears the pollen, and then drops off the tree. The other kind of cone, which develops into the fruit of the tree, grows until it reaches a length of five to ten inches. It bears the brown-winged seeds. Look at the pictures of the white pine fruit. The wings on the seed, which are nearly an inch long, are a great advantage, since they make it possible for the wind to carry the seeds some distance. Many of them fall on places where there is more room for the young trees to develop than there would have been right at the base of the mother tree.

There are several kinds of pine trees in this country. The white pine grows principally in the forests of the northeast. The Georgia or yellow pine is found in the southern states. The sugar pine grows in the Rocky Mountains. These are but a few of the valuable evergreen trees found in the forests of this country. You will learn more about the evergreens in another chapter of this book.

SOME THINGS TO THINK ABOUT

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

1. There were once about ..... acres of forested land in this country. There are now only ..... acres of the original forests left, and ..... acres of second growth.
2. Oak wood is used for ....., and for ..... and ..... in houses.
3. White oak leaves have ..... lobes; black oak leaves have ..... lobes.
4. The ..... of the oak are catkins.
5. Acorns develop from the flowers that bear the ......
6. The acorns of the black oak require ..... years to mature.
7. New leaves appear on the white pine each ....., and remain on the tree until a year from the following ......
8. Pine leaves are called ...... On the white pine tree they grow in clusters of ......
9. The seeds of the white pine tree have ....., which are nearly an inch long.
10. The white pine is found chiefly in the forests of the ..... part of the United States.

SOME THINGS TO DO

Take a trip to the woods to study the forest trees of your neighborhood. Compare the shapes of the various trees with those of the same kind growing in uncrowded places.

If you find oak trees, observe the leaves and the acorns to see whether they belong to the white or the black oak group. If you have a tree guide, you may be able to find out the names of the different kinds.

If you find any pine trees, study them also, observing the shape of the tree, the leaves, the cones, and the seed. Use a tree guide, if you have one, to discover the names of the different kinds.

List the names of other trees, with drawings or short descriptions of leaves, fruits, seeds, bark, shape of the tree, or any other information that will help you in knowing them.

CHAPTER XI

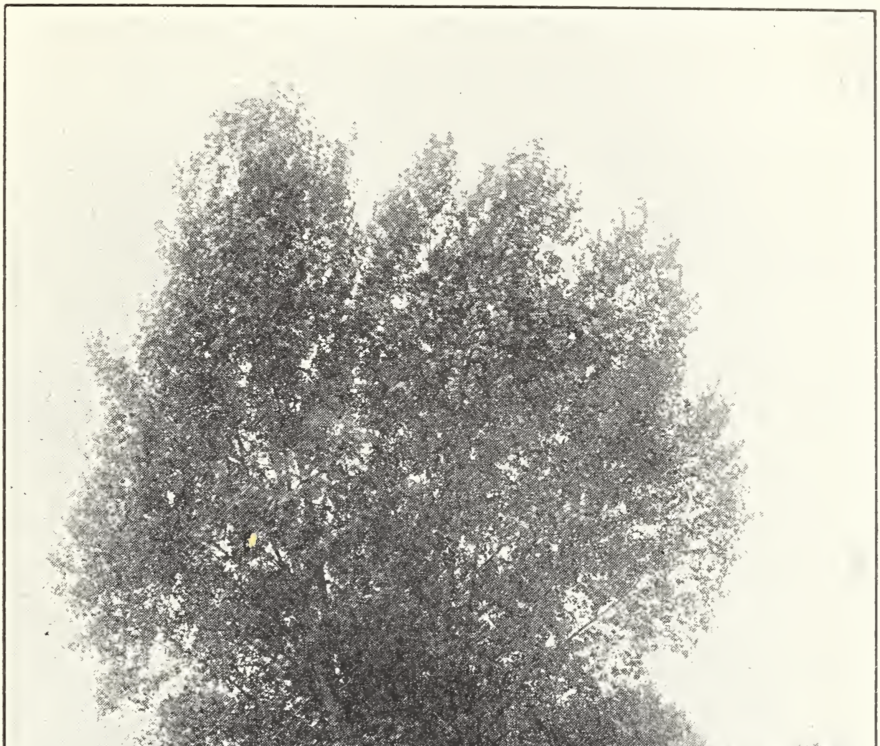
NEIGHBORHOOD SHADE TREES

1. What shade trees grow in your neighborhood?
2. Which of them do you like best? Why?
3. Which of them grow most rapidly?

If you live in a section of the country that was once forested, some of the shade trees in your neighborhood are no doubt very old. A number of them may have started in the forest as young seedlings that were left standing when the land was cleared for farming.

On the western plains where the land was not forested, the early settlers planted trees about their homes for shade and for protection against the wind. Usually those trees were selected for first planting in treeless sections that would grow rapidly. Many cottonwoods and ash-leaved maples, which were called box elders, were planted, since they grow very rapidly and they flourish in dry sections where other trees do not live.

Perhaps you know the cottonwood under another name. It is frequently called the Carolina poplar. It is often chosen for planting in newly developed sections of a city, because it grows rapidly and grows well in dusty, smoky air where many other trees do not. Its glossy leaves throw off the smoke and dirt. Like other poplars, its



Photograph by L. W. Brownell

THE COTTONWOOD IS FREQUENTLY CALLED THE CAROLINA POPLAR.

leaves tremble in the breeze when no other tree leaves can be seen to move. This is because the leaves are thick and hang on slender stems. They are glossy green above and pale dull green underneath, which gives them the appearance of twinkling as they are shaken by the breeze. In the autumn, the leaves turn yellow.

In choosing trees for planting, you must consider in what kind of soil and climate the tree can grow best. You must consider also whether the tree is able to withstand heat and cold, and if you live in the northern states, whether the branches will break under the weight of snow and ice. Whether the tree grows rapidly or slowly, is another important thing to consider. Some trees grow rapidly, but have soft wood that breaks easily. Carolina poplars, box elders, and silver maples grow very rapidly and they are able to withstand the hardships of city life, but they do not live long.

In treeless sections, whether in city or country, quick growing trees are certainly desirable, but it is wise to plant at the same time some of the longer-lived trees that grow more slowly. They will probably be large enough to give good shade by the time the rapid growers have died away.

You have already studied the oaks. They are among our most valuable forest trees. Red oaks and pin oaks are frequently planted for shade. Both of them belong to the black oak group, having leaves with pointed lobes and acorns that require two years to mature. Oaks are very sturdy. They have spreading roots that hold them firmly in place while trees near them are bent and broken by storms. In the autumn oak leaves turn a deep scarlet, and some of them hang on the tree throughout the winter.

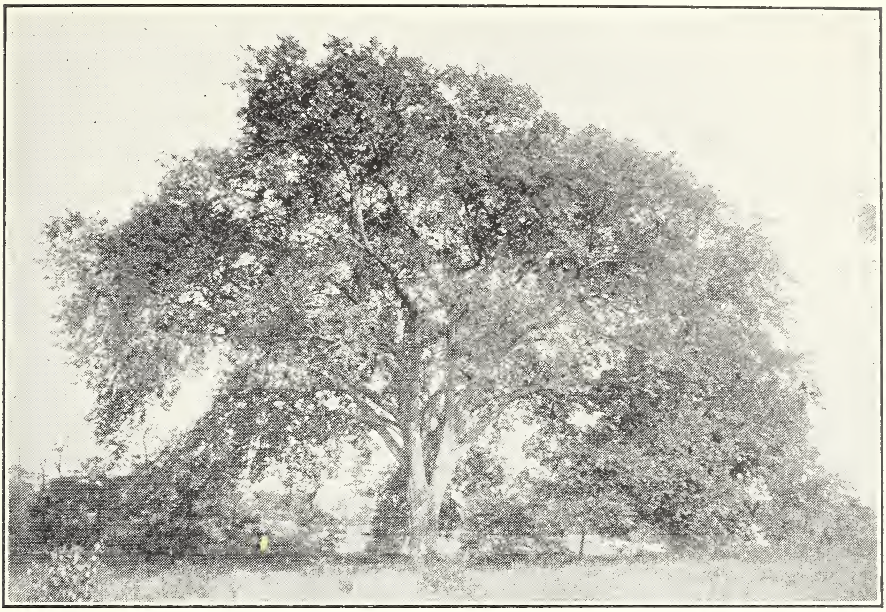
Several of the maples make fine shade trees. In twenty years sugar maples that are given proper care are large enough to be very useful for shade. Their foliage is very thick, for they have many small leaf-bearing branches. In the summer the leaves are glossy dark green above and a pale green underneath. Yellow, orange, crimson, and scarlet foliage decorates the maple trees in autumn. The shape of maple seeds helps them to be whirled by the wind.

Several other kinds of maples are also used for shade. You may know the silver and the red maples, which are native to this country, or the Norway and the sycamore maples, which were brought over from Europe. The cut-leaf silver maple was first imported from Japan, and is now used considerably for planting in parks and yards.

Elms are excellent shade trees, for they grow rapidly and often live for centuries. They are beautiful trees. Study the shape of the one in the picture. Notice that the branches shooting upwards may remind you of a spray of water. Sometimes the elm is described as vase-shaped or fountain-shaped. In the spring reddish green flowers appear on the branches before the leaf buds open. It is interesting to watch the elm

Photograph by L. W. Brownell

THE SYCAMORE MAPLES WERE BROUGHT OVER FROM EUROPE.



Photograph by L. W. Brownell

ELMS ARE EXCELLENT SHADE TREES.

leaves come out. When they first leave the buds, they are folded like tiny fans.

The ginkgo is an ornamental tree native to China and Japan. It was carried from those countries into England, and from there to America Although it is related to the pines and spruces, it is not an evergreen tree. It grows even in poor soil; it stands the heat well, and remains free from insects and disease. The pollen-bearing and seed-bearing flowers grow on different trees. A tree with pollen-bearing flowers is better for planting, for the fruit of the seed-bearing trees has an unpleasant odor. Which tree grows the stamens and which the pistils?

The ailanthus, or Tree of Heaven, which also came from China, is another tree that can grow

Photograph from J. Horace McFarland Co.

THE GINKGO IS AN ORNAMENTAL TREE.

Photograph by L. W. Brownell

THE AILANTHUS IS ALSO CALLED THE TREE OF HEAVEN.

in dusty, smoky sections of the city. Its leaves are very large, sometimes reaching a length of three feet. It has winged seeds that are carried by the wind. Do you know of any other winged seeds?

We could not even begin in one chapter to tell you about all the trees that might be planted for shade. The ones in which you will be most interested are those that grow in your own neighborhood, and you can find out about those by studying the trees themselves. You may need a tree guide to help you to recognize the different kinds.

If you wish to plant a tree, it will probably be best for you to choose the kind that grows well in your own community. You may be able to go out into the woods and dig up a sapling. It will not be difficult to select a small one growing so close to other trees that it would never have a chance to develop where it is.

In transplanting the sapling, you must take care to injure the roots of the young tree as little as possible. Remember that the roots often spread for a considerable distance in all directions below the surface of the ground, so take up plenty of soil with the tree. Perhaps you have seen trees sent out from a nursery for transplanting. Their roots are covered with wet burlap to keep them from getting dry and bruised. It is a good plan to protect the roots of the young sapling in the same way.

The best season for transplanting trees varies in different sections of the country, but it always occurs after the leaves fall in the autumn and before the leaf buds come out in the spring. Ask a nurseryman in your neighborhood or someone who has planted many trees, about this. In some localities you will find some difference of opinion as to whether it is best to plant in the spring or in the fall. Many trees are transplanted when the ground is frozen. Can you tell why?

SOME THINGS TO THINK ABOUT

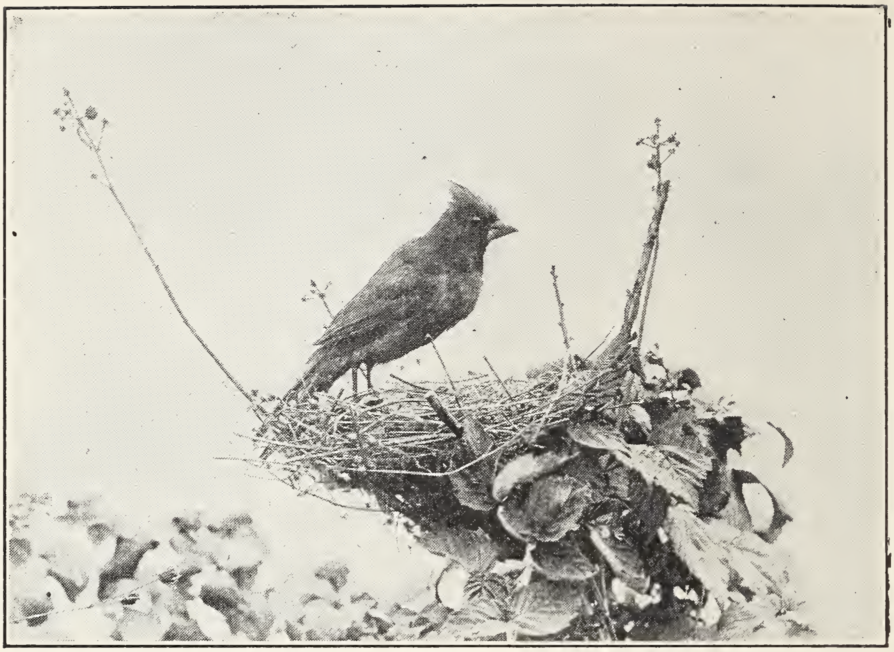
1. Select a kind of tree that you think is particularly good for shade in your neighborhood. Give as many reasons as you can for your selection.
2. Describe the trees of the species that you have selected. Make your description accurate enough so that any one in the class may know them.
3. Name the different kinds of trees that might be selected for shade to plant near your home. Tell where to find these trees.
4. When should trees be planted in your section of the country? Does the time vary for different kinds of trees? Explain why the time that you have mentioned is the best season.

SOME THINGS TO DO

Study the trees of your neighborhood. If possible, learn to know the different kinds of trees by their shapes, as well as by the bark, leaves, flowers, and seeds.

Make drawings in your notebook of leaves, seeds, and bark of each kind of tree, as you learn to know it.

Begin in the autumn a collection of leaves, fruit, and seeds of trees in your neighborhood. In the spring complete the collection by adding the flowers. This collection may be placed in the school museum when complete.



Photograph by Cornelia Clarke

THE CARDINAL IS OF A BRIGHT RED COLOR.

CHAPTER XII

SEED-EATING BIRDS

1. Have you ever seen a cardinal?
2. Do you know where birds get their food in winter?
3. What kind of bills do the seed-eating birds have?

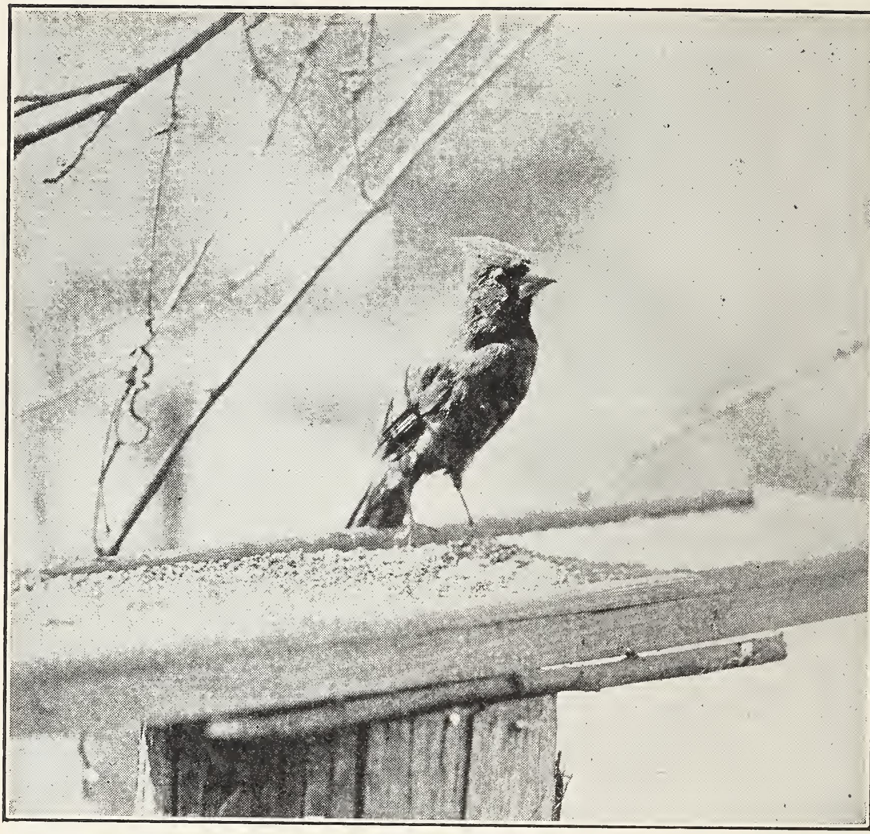
Almost all of the common birds are useful. Some of them feed upon harmful insects. Some eat the seeds of weeds. In this chapter you will learn about a few of the most common birds.

The cardinal is a permanent resident throughout the Eastern part of our country. Permanent residents are birds that spend the whole year in one community, not going southward in the autumn as many kinds do. You can recognize the male cardinal by his bright red color, and by the crest that looks like a cap on his head. The female is olive brown, with crest, wings, and tail of dull red. The male birds of all kinds are generally more beautiful than the females. In size the cardinal is a little smaller than the robin.

Cardinals spend much of the time among the smaller shrubs and bushes, and in spite of their bright colors, they are not easily seen. Their nests are built in low evergreens, bushes, or vines, not more than four feet from the ground. They are made of twigs, grass, and weeds, and are lined with bits of grass and tiny roots.

The cardinal feeds largely upon seeds, although it eats some insects also. Like many other seed-eating birds, it has a large beak with which it can take the seeds from their husks, and can even crack some of them. To be sure, the cardinal eats some wheat, oats, and other grain, but it pays well for this food by destroying large quantities of weed seeds and insect pests. In the summer large numbers of insects that attack the cotton plant, as well as potato beetles, grasshoppers and flies are devoured by cardinals. In the winter the grain having been harvested, many of the insects disappear. During this time these useful birds feed on the seeds of weeds. When the food is scarce, they will sometimes come and eat from a food shelf which has been placed outside the window.

Very early in the spring, before the bluebirds or the robins return, you may hear the cheery sound of the song sparrow. It nests from Vir-



Photograph by Cornelia Clarke

WHEN FOOD IS SCARCE, BIRDS COME AND EAT FROM A FOOD SHELF.

ginia and Missouri north as far as Canada, and spends its winters from Illinois and Massachusetts south as far as the Gulf of Mexico.

It resembles other members of the sparrow family, but you can know it by the dark spot in the center of its grayish breast. It is about the size of the English sparrow, but its body looks more slender. Its back and head are brown with gray streaks.

The song sparrow is usually found in the alders and bushes that grow along the banks of brooks

Photograph by L. W. Brownell

SONG-SPARROWS ARE GOOD INSECT CATCHERS.

and ponds and in the shrubbery of lawns and gardens. When it is frightened, it is apt to fly into the low bushes, instead of flying high in the air or taking refuge in trees.

Its nest is made of grasses and weeds lined with hair, or fine grass, and is placed on the ground or in a low bush. Do you think you could weave a nest as well as the sparrow can? Four or five spotted eggs are laid in April, hatching about ten to fourteen days later. When the young ones have learned to fly, the parent birds raise another family. Three or four broods are raised each season, and a new nest is usually built for each family.

During the summer, song sparrows feed upon aphids, caterpillars, cutworms, grasshoppers, and flies. In the winter they eat large quantities of weed seed. They are friends of the gardener and the farmer, and they should be protected. Perhaps their greatest enemy is the cat. Boys and girls can help in the protection of song sparrows by keeping stray cats away from their nesting places. You may wonder how a cat can catch a bird. Watch one sometime and you will see how cunning the cat is.

The goldfinch is usually found in orchards, shade trees, and gardens. During the summer months the male is a bright yellow bird, with black cap and wings. The female is a dull olive color all the year round, and during the winter, the male becomes this color also.

The goldfinch builds a nest of fine grasses and bits of other plants, sometimes using lichens for the outside, and places it in bushes and trees from five to thirty feet from the ground. The nest is lined with thistledown, and in this fluffy bed, from three to six bluish eggs are laid. The female bird builds the nest while her mate sings to her. Then while she sits upon the eggs, the male brings food to her, and later helps to feed the young. Not all male birds are as helpful to their mates as the goldfinch is.

The goldfinch has the thick bill that is common among seed-eating birds and which is very useful in grinding seeds as well as in getting them out of their husks. Sometimes the goldfinch is called a thistle bird, because it is so frequently seen feed-

Courtesy of U. S. Biological Survey

THE GOLDFINCH AND ITS MATE ARE FRIENDS OF THE FARMER AND GARDENER.

ing upon the seeds of the thistle, which you will no doubt recall is a troublesome weed. You may also have heard the goldfinch called a wild canary, a yellow bird, or a lettuce bird. All of these names are common in different localities.

During the winter months the goldfinch feeds almost entirely on weed seeds, but in the summer it eats insects as well.

These are but a few of the many species of birds that befriend the farmer and the gardener. The majority of our winter birds are seed eaters. Juncos and tree sparrows may often be seen in waste places where weeds have flourished, devouring quantities of seeds. The bobwhite eats the seeds of ragweed and pigweed in large quantities. You have learned how weeds spring up in fields and gardens robbing the crops of food and water. It would be difficult to guess the value of seed-eating birds in controlling these troublesome plants.

Although these useful birds are very well adapted to care for themselves, in the winter when the ground is covered with snow, they welcome your help in securing food. Seeds or crumbs of bread placed on a feeding shelf or scattered on the ground will be eagerly picked up by hungry birds. Bits of suet tied to the limbs of trees will attract those that feed upon insects. In the winter many school classes have a good time feeding birds. Children learn to know many birds this way.

SOME THINGS TO THINK ABOUT

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

1. A ..... resident is a bird that does not migrate.
2. The male cardinal is bright ..... in color.
3. The female cardinal is .... in color.
4. Cardinals, song sparrows, and goldfinches feed largely upon .... during the winter months. In the summer they eat ..... as well.
5. You can tell the song sparrow from other members of its family by the ..... spot in the center of his ..... breast.
6. During the summer months the male goldfinch is bright ..... in color.

SOME THINGS TO DO

Make a trip to places where weeds have gone to seed to find out what birds in your neighborhood feed upon weed seed. You may need a bird guide to help you to know them. Make a list of these birds, with short descriptions.

Make a simple food shelf or tray, and hang it in a near-by tree where you can watch your bird visitors. It is well to make the shelf with a raised edge about the margin so that the food will not blow away, and to place the shelf where one side, at least, is sheltered. Evergreen branches are often used for protection.

Keep your feeding shelf well stocked with seeds or crumbs of bread, and you will enjoy watching the birds that visit it. With the aid of a bird guide, identify the different kinds.

CHAPTER XIII

HOW WE CAN HELP THE BIRDS

1. Name some of the common birds of your neighborhood that feed upon insects.
2. Which of these birds are permanent residents?
3. Have you ever fed the birds that stay in your neighborhood through the winter?

You have just read about some birds that are useful because they eat weed seeds. There are others that feed upon insect pests. These possibly are the meat eaters.

You may have heard the downy woodpecker's drumming on the trunk or the limb of a tree or on a house. It may be drilling a hole in which to place a nest, or it may be hunting for food, for the woodpecker feeds largely upon worms that it finds buried in the bark and wood of trees.

Many farmers and fruit growers are inclined to suspect these birds of injuring their trees, but the truth is that they destroy insect pests, therefore, are of great value. They usually select dead limbs and trunks for their nesting places. The hole-drilling that they do in their search for food is in trees in which harmful wood-boring insects are working. The woodpecker could do nothing better to the tree than to dig out and destroy insect pests that have buried themselves in its wood. You

Photograph by Cornelia Clarke

THE DOWNY WOODPECKER OFTEN SELECTS DEAD LIMBS AND TRUNKS FOR ITS NESTING PLACE.

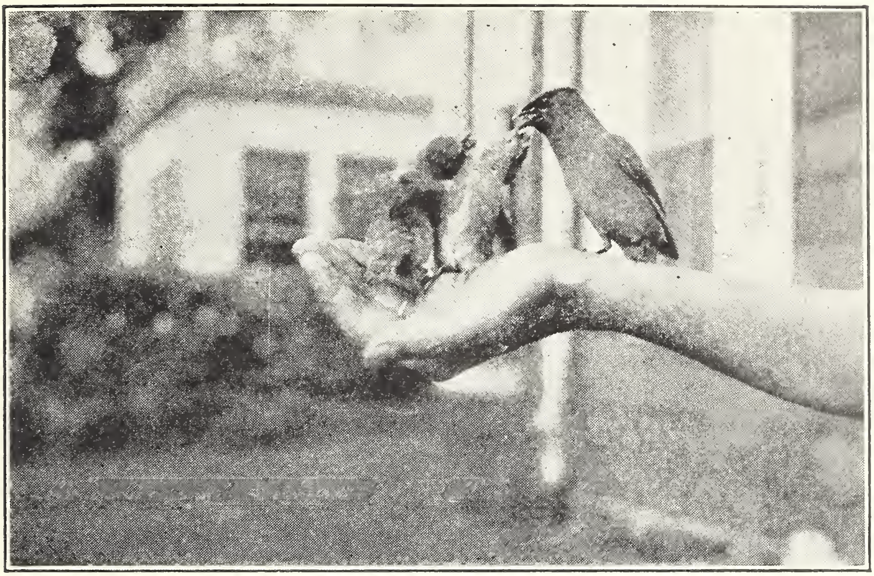
can easily imagine the damage that these insects do to the wood. If you notice a fallen tree you may find many small worm holes in its trunk and branches.

The Downy Woodpecker

The downy woodpecker is found throughout the greater part of the United States. Like many of the woodpeckers, it has a scarlet patch upon its head, but it can be distinguished from other members of its family by its small size. It seldom grows larger than seven inches in length, while the hairy woodpecker, which it resembles most closely, is usually about nine inches long.

The sharp beak of the downy woodpecker serves as a kind of chisel to cut or drill the wood, while its long tongue, which has a little row of hooks along each side, is very useful to reach the holes and pull out the insects. Wood-boring beetles, caterpillars, and ants are among the harmful insect pests that serve as food for this useful bird, which also eats many grasshopper eggs.

You have probably seen these birds running up the trunks of fruit and shade trees in your neighborhood, pecking at the bark as they go. Usually they begin their hunting low on the trunk and work upward. The two front and hind toes have sharp claws that cling tightly to the bark, while the tail serves as a prop. Altogether this bird is well equipped to get food, and is perfectly able to take care of itself during summer months.



Courtesy of Nature Magazine

THE CEDAR WAXWING IS A SMALL BROWN BIRD.

However, in the winter the food supply for all of the insect-eating birds is scarce, and it is well to help out by tying bits of suet to the limbs of trees, poles, and in other places where birds can find them.

Cedar Waxwing

The cedar waxwing is a small brown bird. It travels in flocks most of the time. You will seldom see one of these birds alone except during the nesting season, which is in June. These small birds have crests that they can raise and lower. You may see a waxwing's crest flatten out and disappear while you are watching it. Its tail is dark, but is tipped with yellow, and its wings are brown. On each wing are three little red wax-like feather tips. These give the waxwing its name.

It nests in fruit or shade trees, laying clay-color spotted eggs.

The cedar waxwing probably gets its first name because it often feeds upon the berry-like fruit of the red cedar in neighborhoods where this tree is found. It also eats many kinds of fruits, but it does not damage the orchard crops to any great extent. It also feeds on cankerworms, and among cultivated fruit trees, these are very common. The nestlings are fed largely upon these insects. Cankerworms do much harm to fruit trees. In one day a small flock of waxwings will destroy thousands of cankerworms.

In neighborhoods where these birds spend the winter, they should be given food, for neither fruits nor insects are plentiful then. They have been known to eat bits of apple from a feeding shelf.

Chickadee

The black-capped chickadee is often seen on the branches and twigs of trees and shrubs in woods and city parks, hunting for the insects and insect eggs upon which it feeds. He is, indeed, a busy little hunter.

You can recognize it by its black cap and throat. It has a back of bluish gray and underparts of grayish white. You may be surprised sometime to see it hang from a branch with head downward like a circus performer. It is a tiny bird, smaller than an English sparrow. During the winter its song is "chick-a-dee-dee-dee," but in February

Courtesy of Nature Magazine

A CHICKADEE FEEDS AN INSECT TO ONE OF ITS YOUNG.

the song changes to "fee-bee" and this call is used until the nesting season is over. Some people can call the chickadee near to them by whistling this "fee-bee" song.

The chickadee nests in a hole that it digs in a tree or a stump not more than fifteen feet above the ground. The nest is made of moss, grasses, fur, and feathers. Five to nine white eggs with brownish speckles are laid early in May.

Chickadees will nest in birdhouses and will come to the feeding trays in the winter. When tempted with food they often become quite tame and will even eat out of your hand. Like other insect-eating birds, they like suet, but they will also feed upon crumbs and seeds from the feeding shelf if these are provided.

White-Breasted Nuthatch

The white-breasted nuthatch is often seen with the chickadee running over trees searching for insects. The chickadee, however, usually does its hunting on the smaller branches, while the nuthatch prefers the trunk and the larger limbs. By studying the pictures of these two birds you may be able to discover the reason for the preference. The nuthatch has a long, sharp bill with which it can pull insects from deep crevices in the bark into which the short beak of the chickadee could not reach.

The white-breasted nuthatch, as the name suggests, has underparts of white. Its back is bluish gray, and its wings are dark brown edged with gray. It has sharp claws with which it is able to hold fast to the bark, and it climbs down the tree, with its head hanging downward, as easily as it goes up the trunk. It feeds upon nuts, as well as upon insects, and its sharp beak serves very well as a nutcracker. The nuthatch collects acorns and beechnuts in the autumn and stores them away in the crevices of the bark until they are needed. Then it breaks them open by striking them with its bill. It is from this habit that it gets the name, nuthatch.

Nuthatches nest in woods in the holes of trees. Sometimes they use a hole that has been used by

Courtesy of Nature Magazine
THE WHITE-BREASTED NUTHATCH HAS A LONG, SHARP BILL.

a woodpecker. Sometimes they drill their own nesting places. They line their nest with feathers, fur, or hair before they lay their creamy speckled eggs in it.

The nuthatch, because of its habit of storing away nuts, is better prepared to care for itself during the winter than are many of the other insect-eating birds. However, they will visit the feeding table if suet and nuts are provided for them.

SOME THINGS TO THINK ABOUT

1. Why do woodpeckers drill holes in trees? Does their drilling harm the trees?
2. How can you tell the downy woodpecker from other woodpeckers?
3. How can you recognize the cedar waxwing? Why does the waxwing eat very little fruit in the orchards?
4. How does the beak of the nuthatch differ from that of the chickadee?
5. What difference does this make in their hunting habits?
6. Why is the nuthatch better prepared to care for itself in winter than many of the other insect-eating birds?

SOME THINGS TO DO

Continue the study of your neighborhood birds that you started in connection with last chapter.

Tie some bits of suet to your feeding table, and add some nuts. Notice what food the different birds like.

CHAPTER XIV

EVERGREEN TREES

1. Are there any evergreen trees in your neighborhood?
2. Where do white pine trees grow?
3. How can you tell a spruce tree from a pine tree?

Much of the paper in our books, newspapers, and magazines is made from the wood of the spruce tree. The Douglas fir of the West is used in the building of ships and bridges. Yellow pine from the South and white pine from the North are valuable in home building.

These are but a few of the useful evergreen trees that grow in our country. An evergreen tree, as you probably know, is one that does not lose all its leaves in the autumn, as many trees do, and which, therefore, remains green all the year round. In the winter the evergreens, scattered among other trees with their bare branches, make a pretty picture. With their dark green leaves or needles, they are most beautiful when the ground is covered with snow.

You can recognize each of the different kinds of evergreen trees in three ways, by the size and color of the needles, by the placement of the needles on the twigs, and by the fruit or cones.

You have already read about the white pine, which is one of the most valuable evergreens that

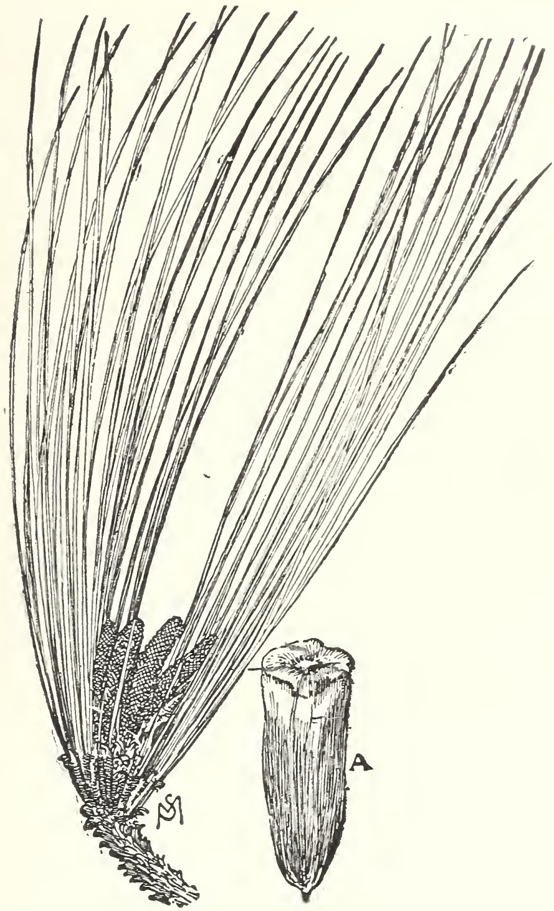
Courtesy of U. S. Forest Service

GEORGIA PINE FOREST.

grow in our forests. You will recall that its needles, which are from three to five inches long, grow in clusters of five, and that its cones bear brown-winged seeds. Its wood is white, soft, and light, and can be whittled easily with a knife.

Pines

The Georgia pine, which grows in the forests of our southern states, supplies rosin, turpentine, tar and pitch, which are useful in shipbuilding and in the making of paints and varnishes. This tree is also called the long-leaf pine and the turpentine pine. Some people think that turpentine



GEORGIA PINE NEEDLES. A : SCALE OF A CONE.

and rosin are made from the sap of the tree, but this is not entirely true. When cuts are made in the trunk, a substance called resin comes out of the body of the tree into the openings. This substance is gathered and taken to a distillery, where it is heated. Turpentine is given off as a vapor, which is collected in pipes and cooled. As it cools it becomes a liquid. What is left of the resin after it gives off the turpentine is known as rosin. There is doubtless some rosin in the varnish that covers your desk, and there may be some in the soap that you use to wash your hands. Tar is obtained by distilling the wood of this tree. Pitch results when tar is boiled.

The Georgia yellow pine sometimes grows to a height of 100 feet. Its trunk, which may measure four feet in thickness, is usually straight and grows to a considerable height without branches. You will remember that wherever branches leave the trunk of a tree, there are knots in the lumber, and that a trunk without branches yields lumber that is free from knots. The wood of the yellow pine is used for woodwork and flooring in houses.

The needles of the Georgia yellow pine are from eight to fifteen inches long, and grow in clusters of from three to five needles. The flowers that bear the stamens are small and are not easily seen on the tree. Those that bear the pistils, however, are small cones from two to three inches long. During the two years required for the seeds to mature, these cones become much larger, sometimes reaching a length of ten inches.

The pitch pine will grow on land that will produce little else. It is the only pine that sends up shoots after a forest fire. It thrives in sandy, dry soil or in swamps. It gets its name from the resin that is found in large quantities in the wood, which is useful for fuel but not for lumber.

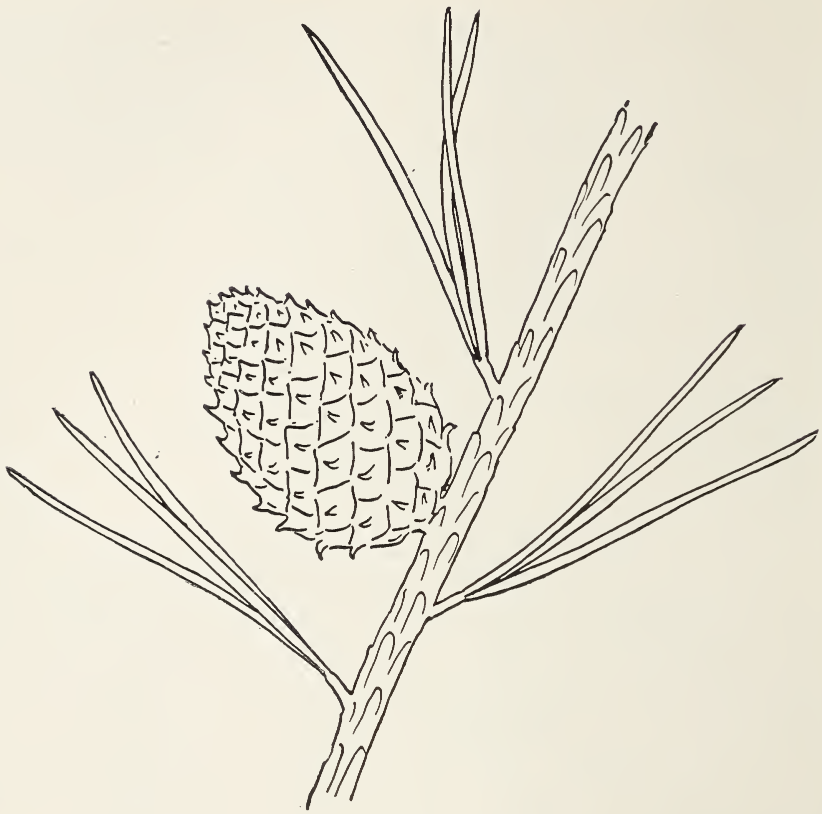
In the forest where it is protected by other trees, the trunk of the pitch pine is straight, but in the open, the trees often grow in strange shapes. It is a small tree that usually does not

Photograph by L. W. Brownell

THE PITCH PINE.

reach a height of more than forty or fifty feet.

Its leaves are dark green needles from three to five inches long, and grow in clusters of three.



PITCH PINE NEEDLES AND CONE.

Its flowers are cones, some of which produce pollen, while others bear the pistils from which the seeds develop Two years are required for the seeds to mature, and the cones in which they grow often remain on the branches for several years. These cones are from one to three inches long.

Hemlocks

The hemlock grows on mountain sides, in cold swamps, and in river gorges. Its wood splinters easily, and is generally used only for rough boards

Courtesy of U. S. Forest Service

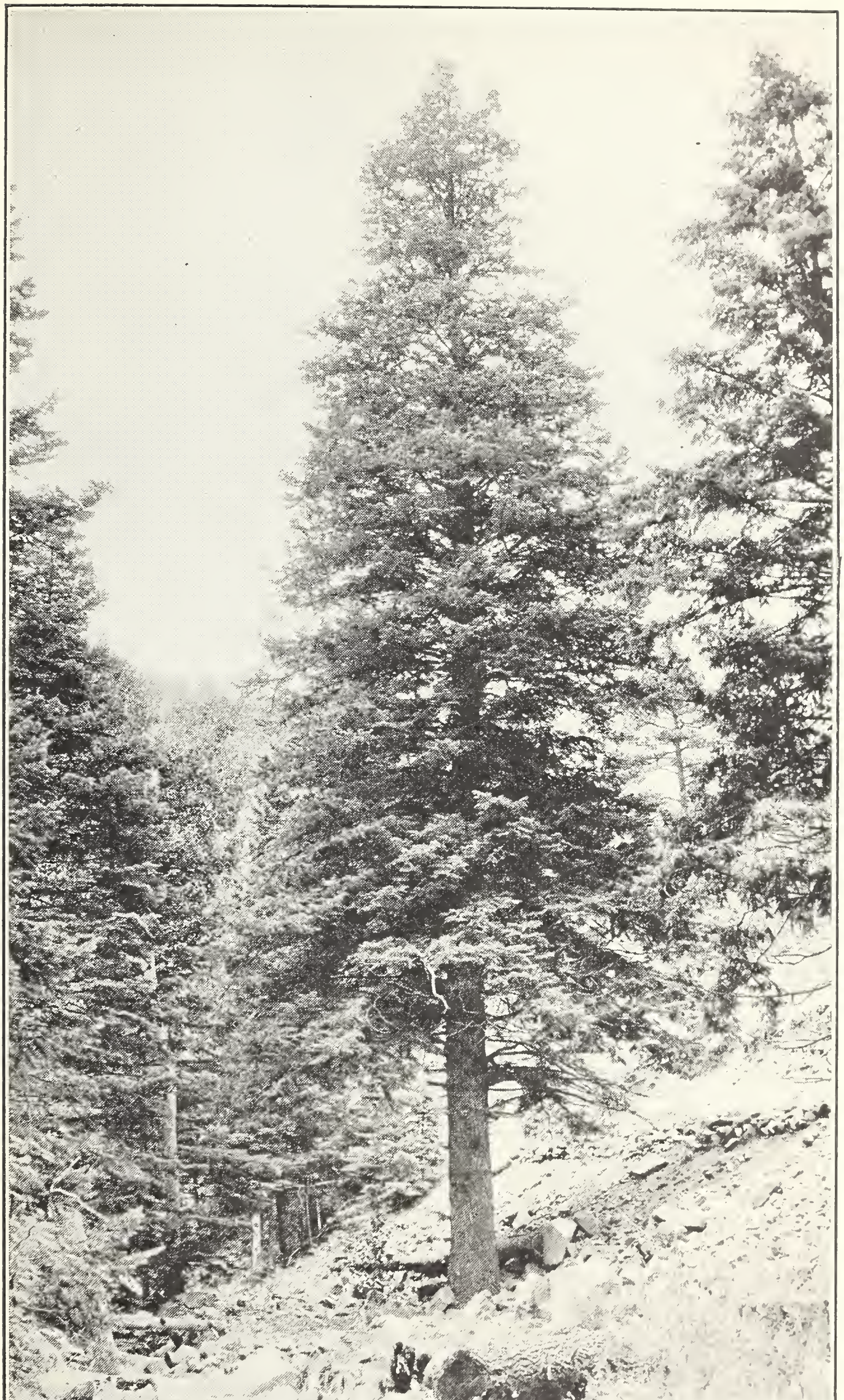
THE HEMLOCK.

and for joists in buildings. There is, however, a western hemlock growing along the coast and as far inland as Idaho that yields lumber used for flooring.

HEMLOCK NEEDLES AND CONES.

The bark of the hemlock is more valuable than the lumber, for it is rich in tannin, a substance used in the tanning of leather. Each year about 1,000,000 cords of hemlock bark are used in the leather industry.

The hemlocks are beautiful cone-shaped trees that often reach a height of from 60 to 100 feet. Their foliage is very dense, and the branches droop a little, thus throwing off the snow in the winter. The needles, which are flat and about one-half inch long, are a glossy green above, with two white lines on the underside of each, as well as a distinct leaf stalk. Small cones are borne on the ends of twigs, and often hang on the tree through-



Courtesy of U. S. Forest Service

A YOUNG DOUGLAS FIR.

DOUGLAS FIR NEEDLES AND CONE.

out the winter, although the seeds ripen in the autumn. Two small seeds with short wings develop under each scale of the cone.

Firs

In the western states there are large forests of Douglas fir, an evergreen tree that often reaches a height of 200 feet with a trunk from ten to twelve feet in diameter. The lumber is known in

Courtesy of U. S. Forest Service

RED SPRUCE.

the market as "Oregon pine." In the eastern states the Douglas fir is often planted as an ornamental tree.

The firs are pyramid-shaped trees with flat, blunt needles, which are a dark green above and a bluish green below. They bear slender cones,

SPRUCE NEEDLES AND CONES.

from two to four inches long, in which the seeds ripen during the first season.

Spruces

Small spruces are frequently used as Christmas trees, and many of you may be familiar with their appearance. Their needles do not grow in clusters as pine needles do, but are scattered all over the stem. They are small, usually not more than an inch in length, and are sharp pointed.

White, black, and red spruces are found in the forests of the eastern states, and the Sitka spruce is common in the west. The red spruce frequently grows to a height of 100 feet with a trunk of two or three feet in diameter.

Spruce wood is used for flooring, box making, and for wood pulp, of which paper is made. Red spruce is used also in the making of violins and pianos.

SOME THINGS TO THINK ABOUT

Using the following words, fill the blanks in the sentences below.

Christmas	Georgia
cone-shaped	pyramid-shaped
distilling	spruce
fir	tannin
five	three

1. The needles of the white pine grow in clusters of ......
2. Turpentine and rosin are made by ..... resin, which is obtained from the ..... pine.
3. ..... is obtained by distilling the wood of the Georgia pine.
4. The needles of the pitch pine grow in clusters of ......
5. The bark of the hemlock yields ......
6. Hemlocks are ..... trees.
7. Firs are ..... trees.
8. The Douglas ..... grows extensively in our western forests.
9. Spruces are often used for ..... trees.
10. Much of our paper is made from the wood of ..... trees.

SOME THINGS TO DO

Study the evergreen trees of your own neighborhood. Make drawings to show the characteristic shape of each kind, the arrangement of the needles on the twigs, the cones, and the seeds.

Make a collection of cones from the various species. Look for seeds in them.

Make a collection of woods from the different evergreens. Find out about the uses of each.

CHAPTER XV

THE BAT, A FRIEND OF THE GARDEN

1. Have you ever seen a bat?
2. What strange stories have you heard about bats?
3. What do bats eat?

Bats are strange creatures about which curious tales are oftentimes told. You may have heard that they will fasten themselves to a woman's hair, or that they bring bedbugs into a house. Neither of these stories is true.

Perhaps you have heard, also, that bats suck the blood of other animals. It is true that in some countries there are blood-sucking bats, but those found in North America are small creatures that feed upon insects. Because of this, they are so useful that people in some sections build roosts for them.

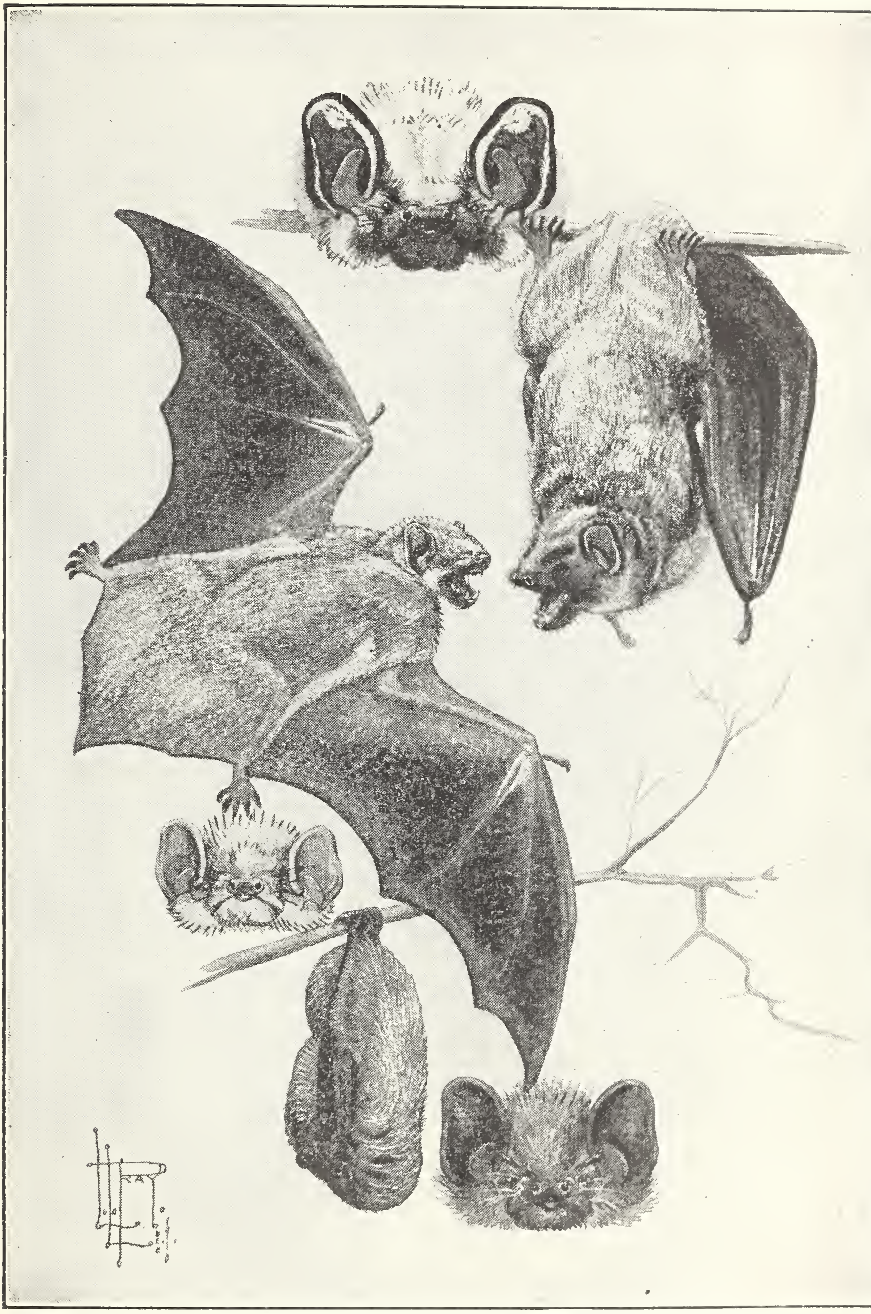
Little is really known of the habits of bats, for they are night flyers, and spend their days hanging quietly in some hiding place. If you have ever seen a bat, it was probably in the early twilight just as it was starting out upon its nightly search for food. They fly swiftly and silently in a zigzag path, catching insects as they go, and occasionally coming into a house through an open window.

Some people think of a bat as a queer kind of bird, but it is really not a bird at all. Its body is more like that of a mouse, except for its wings, and they are very little like those of a bird. The body of the little brown or red bat common in this country is usually about three inches long, and is covered with soft fur. The wings are hairless and measure, when outstretched, almost a foot across. They are made of very thin skin that looks almost like rubber, and they fold up so closely that they hardly show.

The bat has a small head, with round ears, flat nose, and a small pink mouth. It has four legs, but if you study their shape, you will see that they cannot be of much use for walking or crawling. When a bat goes about on all fours, it wabbles along in a very clumsy fashion. On the front legs or arms are four long fingers to which the wings are attached. The wings are attached also to the ankles and the tail.

The bat's wings are really an extension of the skin that covers the body. They are very sensitive to touch. You will recall that an earthworm feels through its skin. The bat seems to feel through its wings.

Many years ago a scientist made an interesting experiment to discover how sensitive the bat's wings really are. He hung threads from the ceiling of a room just far enough apart to allow a bat to fly through without touching the tips of its wings. Then, he turned a blind bat loose in the room. It flew about among the threads, without



Drawing by L. L. Pray, courtesy of Field Museum of Natural History.

ABOVE: RED BAT; CENTER: HOARY BAT; BELOW: SILVERY BAT.

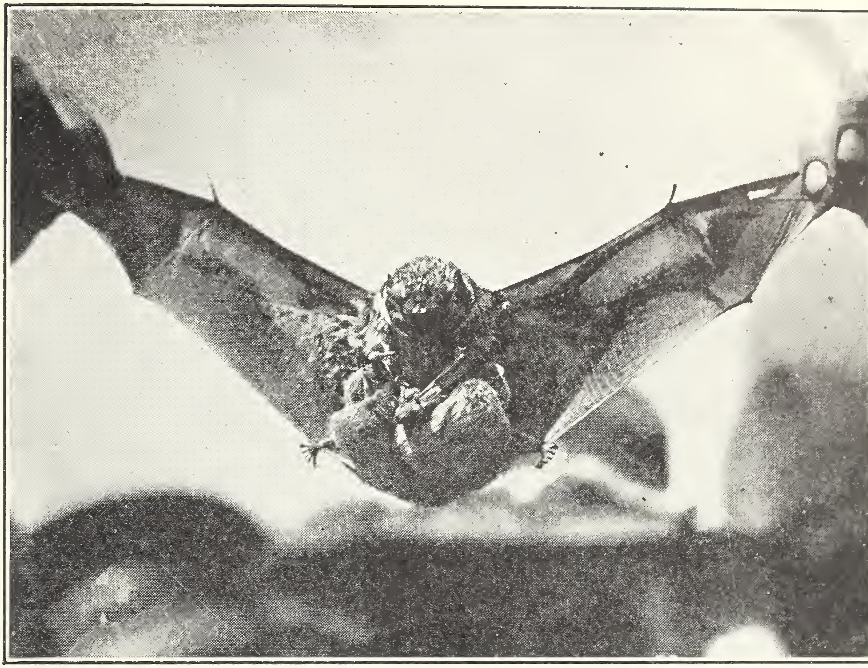
touching one of them. From this it seems that the bat can feel its way with its wings.

Have you ever heard the expression, "blind as a bat"? Bats have small jet-black eyes, and they can probably see very well in the twilight and even in places that would seem to us quite dark. They are probably somewhat blinded, however, by strong daylight, just like other creatures whose eyes are not accustomed to strong light. It is this fact that has led people to think bats are blind.

Unlike other creatures with wings, the bat does not perch. On each of its arms is a small hook, in about the same place as our thumb. With these hooks it clings to a pole or branch and hangs, head downward. If you should discover its hiding place in the daytime, you would find it sleeping in an upside-down position.

Bats choose dark, hidden places in which to spend the days. You will find them in attics, caves, barns, in thick bushes and in trees with much foliage. If you should discover a bat's hiding place in June, it would be interesting to explore it at night. You will then probably find young bats alone while the mother is out getting food.

The bat does not lay eggs. The young are born, and are fed upon milk from the mother's body. Animals that feed their young in this way are known as mammals. Generally only one young bat is born at a time, but there may be two or even three. At first they hang to the mother's body when she flies about hunting for



Photograph from American Museum of Natural History, N. Y.

HOARY BAT AND YOUNG HANGING FROM HER BODY.

food. After two weeks, they hang by their toes, head downward, just as the adults do. The mother leaves them while she goes in search of food, but returns to them later in the night. When they are three months old, they are able to leave the roost and to fly in search of their own food.

The bat, like many of the birds you have already studied, eats harmful insects. As it goes through the air at night it catches many moths, flying beetles and mosquitoes. Because of this, the bat has been called the policeman of the air. There are known about 450 different kinds of bats. They are found throughout the world except in very cold countries. In South America there are beautiful bats with bodies and wings of white,

Photograph by Paul Griswold Howes

FRUIT BAT HEAD (MAGNIFIED).

orange, or white spotted with orange. They look like large butterflies. Some of them feed upon fruits and do a great deal of damage in the orchards.

In Malay, Japan, and the Philippine Islands, there is a very large bat known as the "flying fox," because of its resemblance to a fox. It has pointed ears and a sharp nose. Its body is a foot long, and its wings, when outstretched, measure a foot across. It is a destructive bat because it feeds on fruit, therefore it is not allowed to enter this country.

Unlike their foreign relatives, however, the bats that live in our country are all small, harmless creatures that do a great deal of good by feeding on harmful insects. Because of this, bats should be protected.

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 false, write *No.*

1. Bats often fasten themselves to a woman's hair.
2. The bats found in this country feed upon insects.
3. The bat's wings are extensions of the skin that covers its body.
4. Bats perch on the branches of trees in the daytime.
5. Animals that feed their young upon milk from their bodies are known as mammals.
6. The bat is a mammal.
7. The bat lays eggs.
8. Some bats feed upon fruit.
9. All bats are blind.
10. The wings of a bat are very sensitive.

SOME THINGS TO DO

If you can capture a bat, bring it into the schoolroom and keep it in a cage for a few days while you study it. You can feed it upon bits of raw meat or flies by giving them to it on the point of a pencil or a toothpick.

Study the wings to see how the tail and legs make a skeleton for them. Notice that the bat closes its wings just as you would close a jackknife.

If you cannot get a live bat, find as many pictures of bats as you can and study them.

Draw a diagram of a bat with outstretched wings, showing the wing skeleton.

Look for bats in attics, barns, bushes, and trees. If you find one, notice how it hangs, head downward. How does it act if you disturb it?

CHAPTER XVI

RATS AND MICE

1. Where have you seen rats or mice?
2. What do these animals eat?
3. Have you ever found a mouse's nest?

Rats and mice are found all over the world. They live both in the country and in the city. They seem to follow man wherever he goes. They cross the ocean in boats, and travel long distances on railroad trains.

There are many kinds of rats and mice, but the two most common varieties are the brown rat and the gray house mouse. You have already read about the field mouse. If you live in the city, perhaps you have never seen one of these little creatures, but you have surely seen the little gray house mouse.

The brown rat, which is about nine inches long, has many names. It is called the barn rat, alley rat, wharf rat, or sewer rat. These names suggest the many different places in which the animal lives.

This rat is dangerous, for it carries the germs of a disease called the bubonic plague. Rats have this disease, as well as people, who usually get it from the bites of fleas that have been living on the bodies of diseased rats. The Black Death

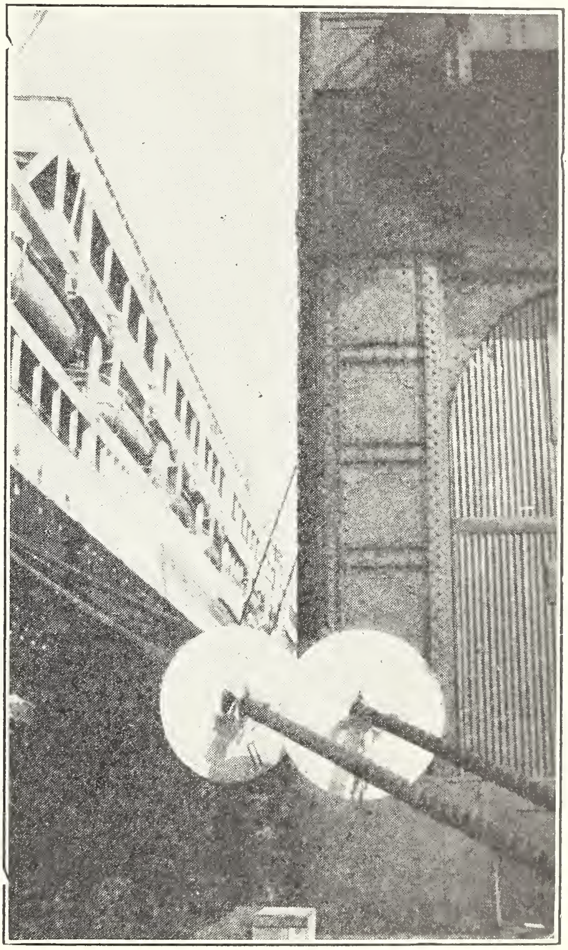
Photograph from American Museum of Natural History, N. Y.

THE BROWN RAT IS A DANGEROUS ANIMAL.

that occurred in Europe about six hundred years ago was caused by the bubonic plague. This plague is still common in some oriental countries. The United States Public Health Service protects us from this disease by supervising incoming ships to prevent rats on them from crawling ashore. When a ship comes from a foreign port where there may have been people sick with bubonic plague, it is cleaned of all rats.

Rats are destructive, as well as dangerous. They devour almost every kind of food that comes in their way. Usually you will find them numerous where they can find food easily. For this reason, garbage should not be allowed to accumulate, and should be kept in tightly closed cans.

Even piles of rags and paper will attract rats, since they gnaw almost everything that comes in their way. They gnaw leather and clothing and make holes in the walls of buildings. Sometimes reservoirs of water are lost because rats have made holes through the walls. They gnaw the covering from electric wires, sometimes causing fires. It has been estimated that rats do \$200,000,000 worth of damage annually in the United States. This means that each year rats destroy nearly \$2 worth of property for every man, woman, and child in this country. Rats are truly destructive animals.



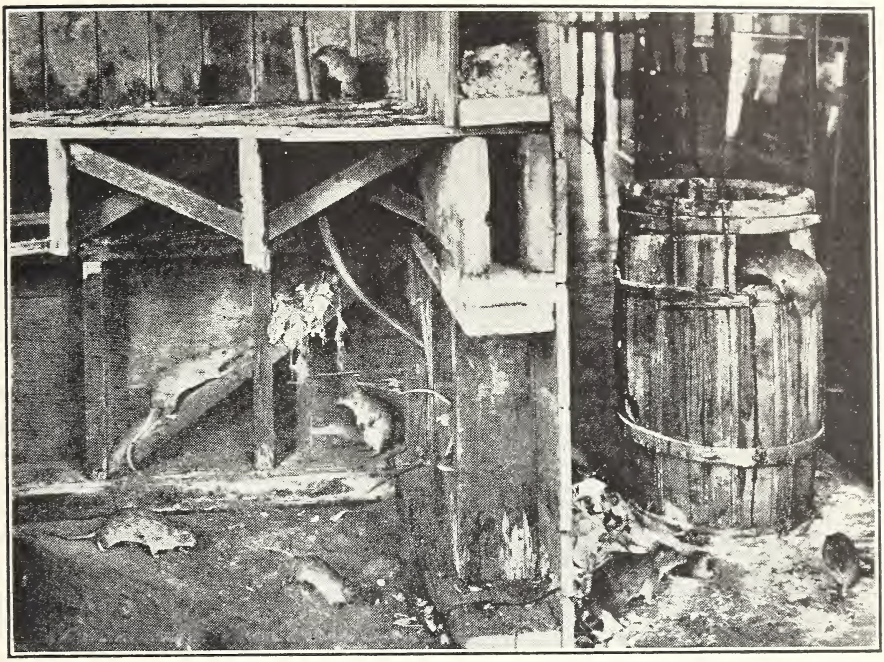
THE WHITE DISCS ARE RAT GUARDS USED ON SHIPS TO PREVENT RATS FROM CRAWLING ASHORE.

Rats increase in number very rapidly. At the age of three or four months the female rat bears her first young ones. There are usually about ten

Courtesy of U. S. Biological Survey

RATS GNAW ALMOST EVERYTHING THAT COMES IN THEIR WAY.

young rats in each family, and young ones are born to each female from six to ten times in a year. You might find it interesting to figure how many grandchildren a mother rat might have at the end of the first year of her life. Someone has figured that if none of the young were killed, a pair of rats might in three years have about 360,000,000 descendants. This is about three times the number of people in the United States.



Drawing by L. L. Pray, courtesy of Field Museum of Natural History
GARBAGE ATTRACTS RATS, WHICH ARE CARRIERS OF DISEASE.

There are several ways of getting rid of rats. Sometimes traps are set for them; sometimes food is poisoned and placed where they can easily get it. Sometimes when they become very numerous, gas is pumped into their holes to suffocate them, but great care must be taken in doing this, since gas is poisonous to people and to other animals as well. Fox terriers are usually good rat hunters, and one of these quick, little dogs will often keep a place free from both rats and mice. Rats become very cunning with age, and they learn to avoid all the schemes to destroy them.

Rats are always harmful to people. They are not only very destructive, but they are dangerous as well, for they are carriers of disease.

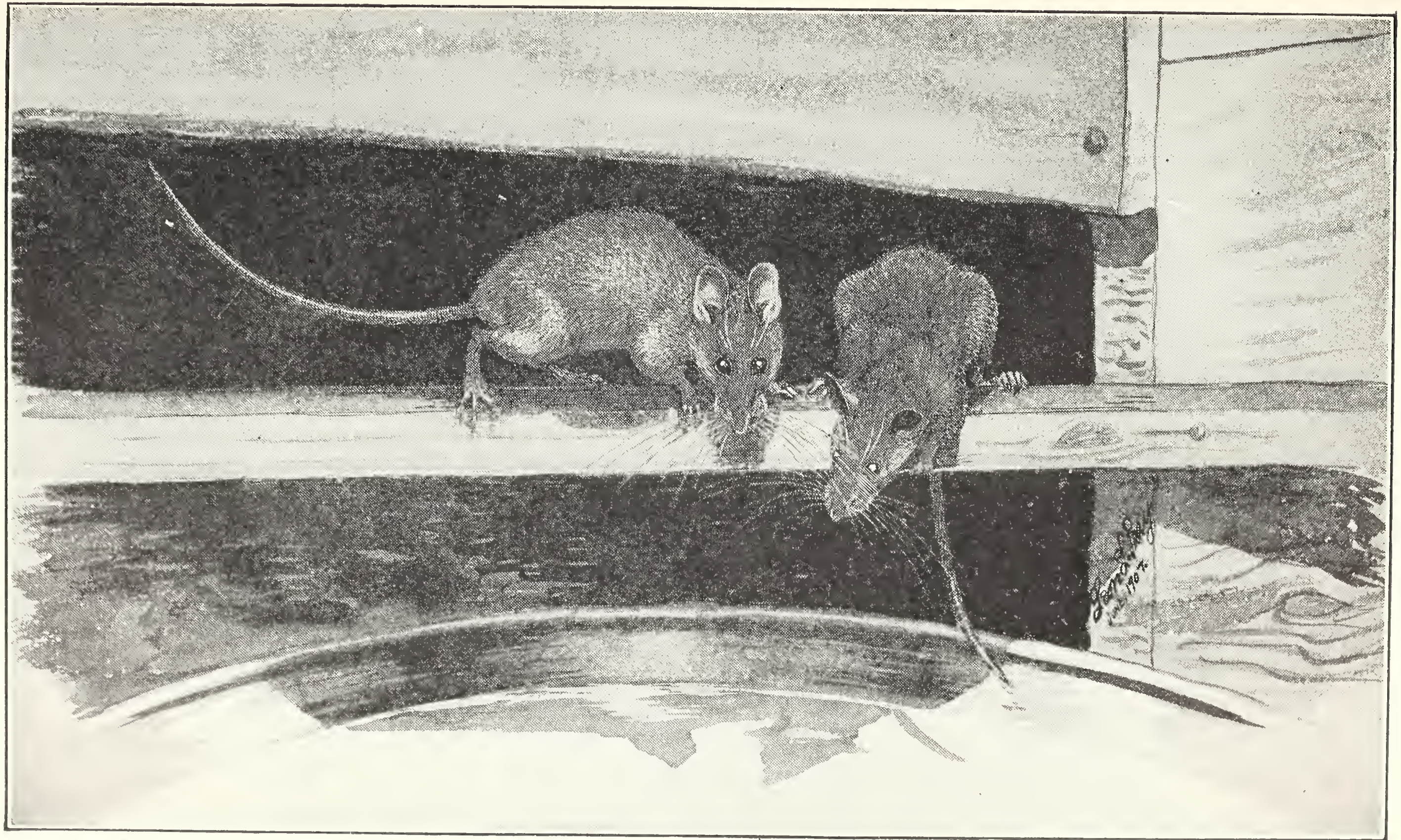
Unless we keep up our fight against them, they will surely increase in number, since they breed rapidly and their natural enemies, the hawks and the owls, are decreasing in number each year. Rats have natural enemies just as insects have.

The little dust-colored house mouse is so well known that we need not stop to describe it. Except for its small size, it is very similar in appearance to the rat. You have all probably seen a mouse scamper through some small hole out of sight, when you attempted to catch it. Perhaps you have seen people jump upon chairs and tables to get out of the way of one of these tiny little creatures.

Mice are not dangerous, for they do not carry disease germs as brown rats do. Because they are so much smaller than rats, the damage they do is not so great, but they are destructive also. They may gnaw holes in your best suit of clothes, or nibble the corners off some prized cookies that you have made.

Mice make their nests of tiny bits of paper and clothing. If you were to shake one of these nests out of an old mattress that had been stored in an attic or some similar hiding place, the bits of paper would probably fly like so much confetti. You might find some young mice in the nest, too.

Mice multiply as rapidly as rats, and if they are not destroyed, they can become a great nuisance. The best ways to get rid of mice are to keep all foods well covered so that there will be nothing to attract them and to set traps or keep a cat to catch



Drawing by L. L. Pray, courtesy of Field Museum of Natural History

HOUSE MICE ARE DESTRUCTIVE BUT DO NOT CARRY DISEASE GERMS.

those that come. It is wise, too, to protect their natural enemies. A small screech owl, living in or near a building, will destroy many mice.

SOME THINGS TO THINK ABOUT

1. The brown rat is also called by other names. Make a list of some of them.
2. Brown rats are both dangerous and destructive. In what way are they dangerous? What do they destroy? How much damage has it been estimated that they do every year in this country?
3. Rats increase rapidly in number. How many young rats are usually born at a time? How many young ones are usually born each year to a female rat? It has been estimated that one pair of rats might in three years have how many descendants?
4. Mention several common ways in which rats are destroyed.
5. Are house mice dangerous? Are they as destructive as brown rats?

SOME THINGS TO DO

If possible, catch a rat or a mouse in a box trap and bring it to the classroom for observation.

Collect different types of traps used for catching animals. Which kind causes the least suffering?

Make posters to show the destruction and damage done by rats. Make graphs or diagrams to show the cost of feeding them.

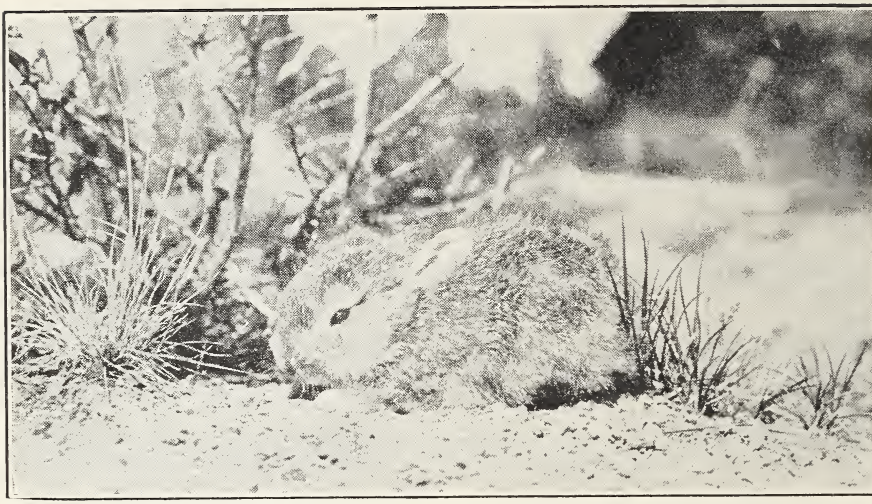
CHAPTER XVII

BURROWING ANIMALS, ENEMIES OF THE GARDEN

1. What animals live under the ground a part of the time?
2. What animals live under ground almost all the time?
3. What do these burrowing animals feed upon?

If you have not already met "Brer Rabbit" in a book named *Uncle Remus,* written by Joel Chandler Harris, you should read the book soon. You will surely agree that he is one of the most lovable and funniest animals that was ever described in a book. He was often in trouble, for he dug holes where they were not wanted and he stole things to eat. Of course "Brer Rabbit" never meant to do anything wrong. Neither do his brothers and sisters, the rabbits of our fields and gardens, but they are often very troublesome to the farmer and the gardener.

The rabbits and the hares, which are members of the same animal family, are perhaps the best known of all the creatures that dig and burrow in the earth. It is very interesting to watch them as they go hopping through the fields and gardens and to learn about their habits, but the crops have a better chance of growing if none of these animals are about. In the summer rabbits and hares feed upon green twigs and



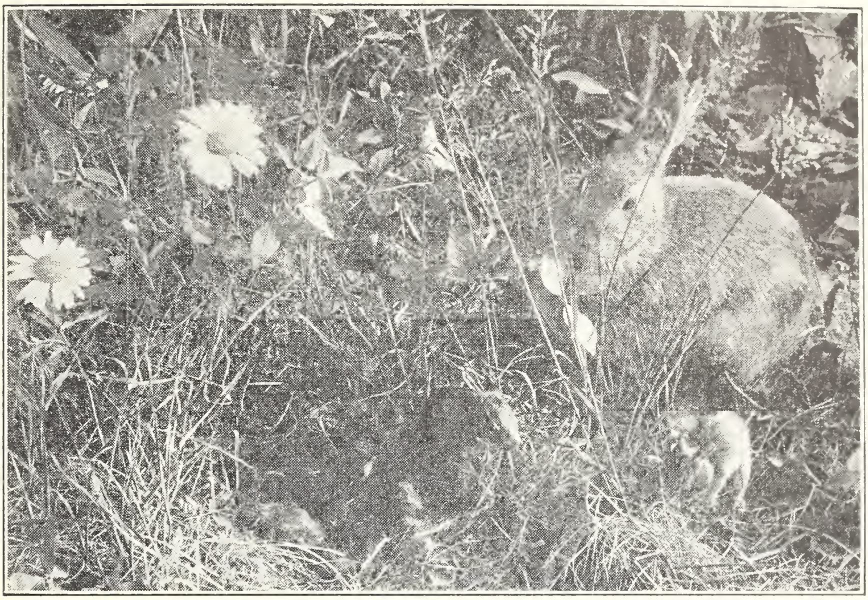
Photograph by Robert B. Rockwell

THE COTTONTAIL RABBIT BREEDS VERY RAPIDLY.

branches, buds, bark, and leaves of plants. They like to nibble the fresh green grass and the tender leaves of the garden crops. In the winter when other food is scarce they gnaw the bark of trees and bushes, sometimes destroying many of the young trees in orchards.

The cottontail is perhaps the best known of all the rabbits that live in this country. It is a small, grayish brown rabbit, which usually does not weigh more than two or three pounds. It gets its name from the fluffy, snow-white fur that covers the under side of its tail. No doubt you have seen the cottontails hopping about the fields and gardens of your neighborhood, for they are found throughout the greater part of the United States.

These small rabbits live either in burrows under the ground, or in shallow holes on the surface of the earth. They frequently make their homes in holes that other burrowing animals have



Photograph from American Museum of Natural History, N. Y.
HARE AND YOUNG IN THE NEST.

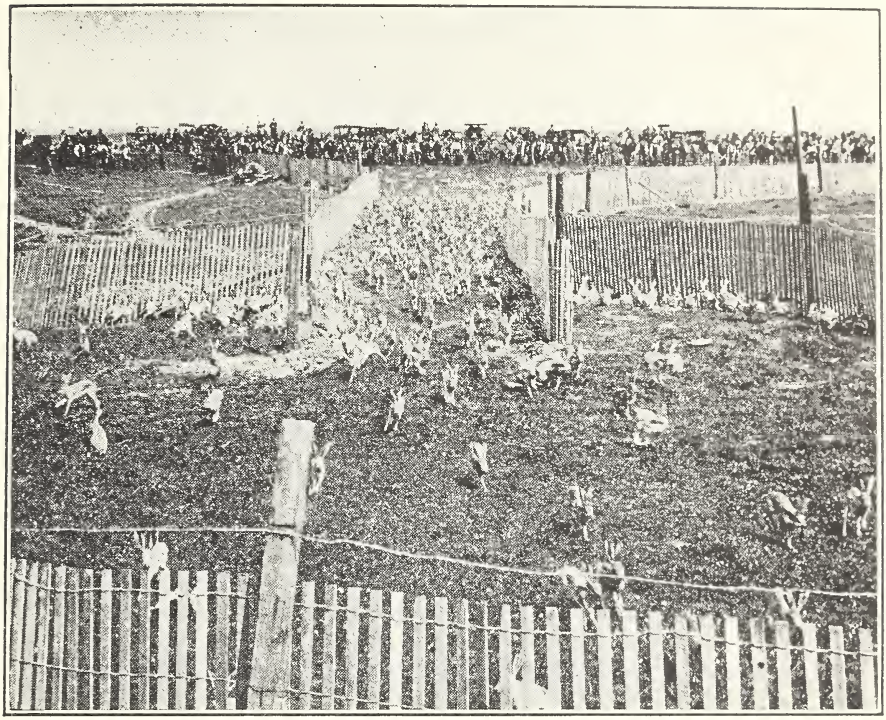
dug. Sometimes, however, the mother rabbit merely digs a shallow hole in the earth's surface. She may make it just large enough to hold herself and her family of young rabbits, lining it with grass and with fur from her own body. Have you ever seen a rabbit nest of this kind?

When a cottontail is frightened, it is likely to stand erect on its hind legs for a moment, and then to crouch low on the ground, in hiding but all ready to spring. If you approach it, away it hops in flying leaps, so swiftly that it looks like a gray streak. In two or three seconds only the white tail is seen, and then that is gone.

Although many cottontails are shot by hunters, they are numerous enough to be a great nuisance in many parts of the country. They breed very rapidly. Families of three to eight young ones are often born to female rabbits four to eight times during the year. Since rabbits usually live for seven or eight years if they are not killed, you can see that they might increase in number very rapidly. This is especially true since many of their natural enemies, such as the weasels, wolves, eagles, hawks, owls, and snakes have decreased in number.

If you live in one of the western states, you have no doubt seen the jack rabbit, which is common throughout the western part of our country. It is really a hare, not a rabbit. Hares are larger than rabbits, and have longer legs and ears, as you can see by comparing the picture of the jack rabbit with that of the cottontail.

You may recall that the cottontail and other wild rabbits are grayish brown in color that is so much like the surroundings that they are not easily seen. Many hares have protective coloring that is still more interesting. California jack rabbits, for instance, have different colors according to their surroundings. On the desert they are sand color, while in other localities they range from very light to dark gray. Unlike the rabbits, which spend much of their time hidden in the shrubbery, the hares live in the open fields, where their protective coloring is very useful to them. Snowshoe rabbits, so called because their large hind feet, heavily covered with fur, resemble snowshoes, change from brown to white in the winter time. It is very difficult to see these white



Courtesy of U. S. Biological Survey

SOMETIMES JACK RABBITS BECOME SO NUMEROUS IT IS NECESSARY TO ROUND THEM UP AND KILL THEM.

animals on the snow-covered country where they live.

Like the rabbits, the hares multiply very rapidly, and in some sections of the country they are numerous and become very troublesome. In one section of California the farmers found it necessary to make plans to get rid of them to save their crops. In one great drive 40,000 hares were killed.

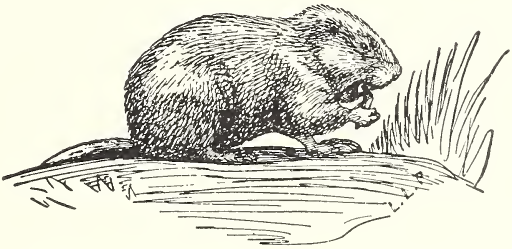
There are other burrowing animals that do more damage to the crops in some sections of the United States than the hares and rabbits do, and which are much harder to fight. One of these

Photograph by L. W. Brownell

THE POCKET GOPHERS ARE SEEN BY FEW PEOPLE.

is the pocket gopher, which is found in many of the states west of the Mississippi River.

The pocket gophers are seen by few people, even where they are numerous, since they spend most of their time underground. They are brown or gray animals about the size of rats. They have round, blunt heads, very short necks, heavy shoulders, and wide bodies. Their ears look like small rims on the sides of their heads. Their small eyes are rather useless in strong daylight, but serve the gophers well in the darkness where they spend most of their time. Their front teeth are broad and sharp like chisels. Their short tails are naked, and are very sensitive. Sometimes gophers run backwards, feeling their way along with their tails. On each side of the head under the skin there is a large pocket, from which the pocket gopher gets its name. These pockets are lined with fur and open on the outside of the head, rather than into the mouth. With its front paws, the animal fills them with the food that it carries, emptying the pockets later by pressing with its paws on the outside.



THE GOPHER FILLS THE POCKETS ON THE SIDE OF ITS HEAD WITH FOOD.

About six inches below the surface of the earth the gopher burrows, eating the bulbs, roots, and woody fibers that it finds as it goes along. Gophers sometimes eat the roots of fruit trees. They have been known to tunnel under a row of potatoes, eating the potatoes and killing the plants. Sometimes they eat the roots of grain or of alfalfa, doing much damage to the crops.

It is interesting to watch a gopher dig a hole. It digs with its sharp claws, pushing the dirt out of the hole and hurrying back for another load. Soon the entrance to the tunnel is covered with a mound of the dirt that has been removed from beneath the surface. This mound is made larger by the dirt that the gopher pushes up underneath it as it continues to dig. These gopher mounds or hills are very common in neighborhoods where these animals make their homes. They are found not only at the beginning of the tunnel, but at different places above it, since much of the earth from the tunnels is brought to the surface through side passages.

Gophers have some natural enemies. Among them are the foxes, coyotes, weasels, some snakes, owls, and hawks. In spite of these, however, there are still many gophers, for as many as seven young ones are often born at one time. Farmers and gardeners sometimes make war upon them by setting traps in their tunnels or by driving them out with water. When the fields in the west are irrigated in the spring of the year, thousands of gophers are drowned or driven from their holes. Many of those that come out alive are killed by men and dogs.

Gophers, hares, and rabbits are but a few of the burrowing animals that damage the gardens and fields. Moles, wood rats, and field mice are common in many places. Field mice look like house mice, but they make their homes in grassy meadows, in the banks of streams, in swamps, marshes, and in the woods.

Wherever they live, you will find smoothly worn roads or runways about an inch in width. Whole networks of these can often be found. They lead to burrows or underground rooms filled with large nests of dry grass. In wet ground the nests are built above the ground in the grass.

Some swamps are full of the nests of field mice and they can be seen as you pass by.

In the summer these mice feed upon growing grass, clover, alfalfa, grain, seeds, bulbs, root crops, and garden vegetables. In the harvest season they live under shocks of wheat and corn, eating the grain. In the winter time when food is scarce they gnaw the bark from trees and chew the roots. Sometimes entire orchards are destroyed in this way.

At times field mice increase in number and do a great deal of damage. They have been known to destroy whole fields of grain and alfalfa. Wherever there is enough food and their natural enemies are scarce, wild life increases rapidly in number.

SOME THINGS TO THINK ABOUT

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

1. The ..... rabbit gets its name from the fluffy snow-white fur that covers the underside of its tail.
2. The jack rabbit is a ..... instead of a rabbit.
3. Snowshoe rabbits change from brown to ..... in the winter time.
4. Pocket gophers are ..... or ..... in color, and are about the size of ......
5. They make ..... under the earth with ..... of dirt at the entrances.

SOME THINGS TO DO

You will find it interesting to observe as many of the facts stated in this chapter as you can. If you live where you can see these burrowing animals out-of-doors, you can find out a great many things about them by observing them carefully.

Nothing was told you in this chapter about the kinds of tracks that are made by rabbits. This is one of the things that you can probably find out for yourself. If you are keeping a science notebook, draw some pictures of rabbit tracks in it, and explain just how the animal makes these tracks. Try to discover this by yourself.

You can make a very interesting science notebook by recording what you notice from day to day. You may wish to form a science club that will go on field trips and have meetings to discuss what the different members have seen.

CHAPTER XVIII

THE WONDERS OF THE SKY

1. How can you locate the North Star?
2. Why is it often called the Pole Star?
3. Do you know any myths about the stars?

Since very early times people have gazed at the stars. The Persians, Egyptians, Greeks, and Romans imagined they saw in the constellations, or star groups, the shapes of lions, bulls, fish, chairs, and people.

They gave names to the constellations and invented stories about them. These stories are called myth stories. They found one star group they thought looked like a big and a little bear, and they made up an interesting story about it.

Once upon a time, they said, there was a most beautiful woman, of whom the goddess Juno became so jealous that she changed her into a bear. This woman had a son who never knew of the change. When he grew up he became a hunter, and one day attempted to kill the bear that was really his own mother. The god, Jupiter, seeing what was about to happen, changed the son into a little bear, and placed him with his mother in the sky, where they appear as shining stars. Juno, according to the story, never allowed these stars to rest, but kept them forever moving around and around the North Star.

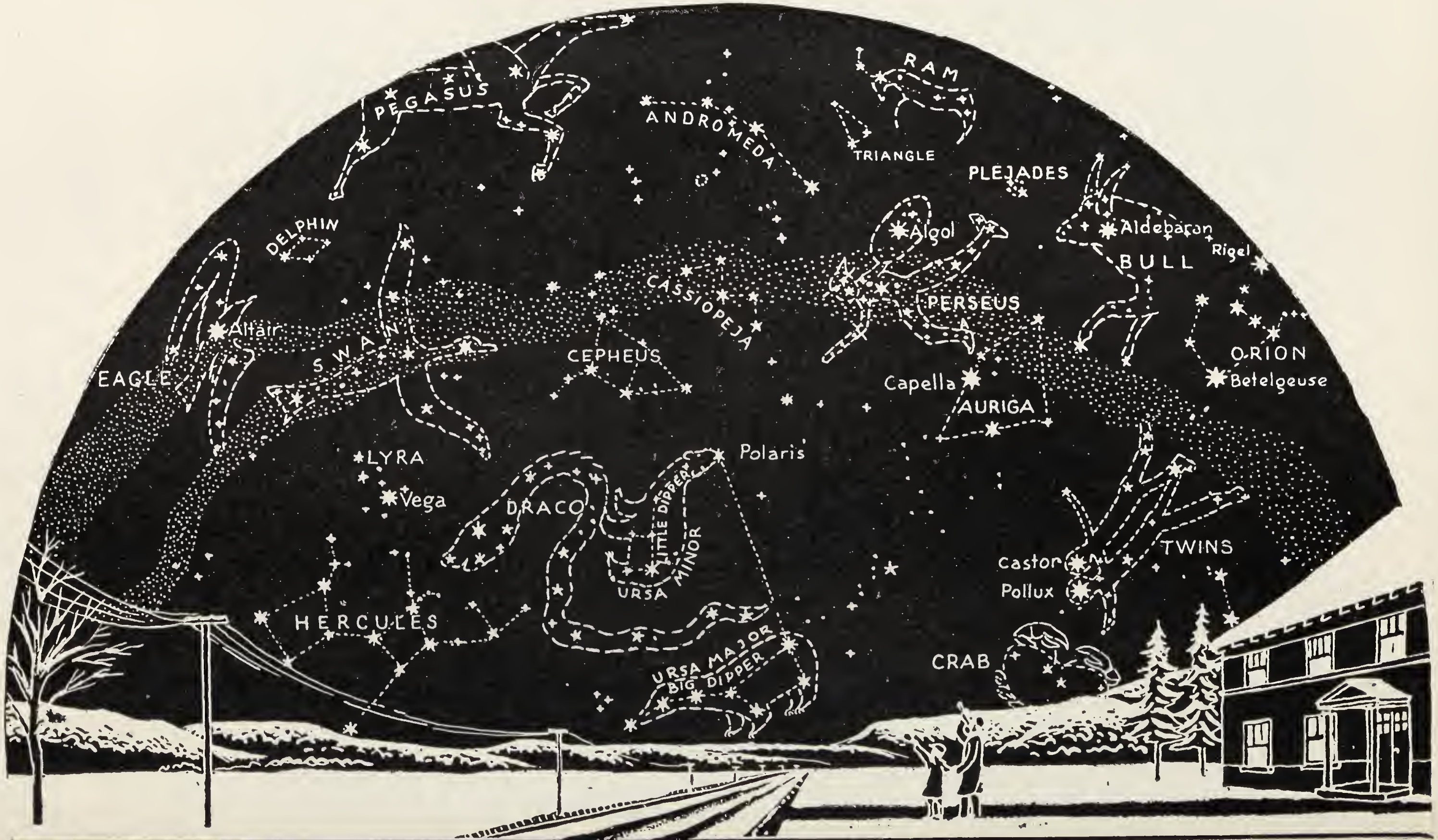
ONE DAY HE ATTEMPTED TO KILL THE BEAR THAT WAS REALLY HIS OWN MOTHER.

If you have studied the stars in the lower grades, probably you have already learned to locate the North Star, the Milky Way, the Big and Little Dippers, and Cassiopeia's Chair, which are all in the northern sky, and Orion and his dogs in the southern sky. If you have not, the map on the opposite page will help you to find them.

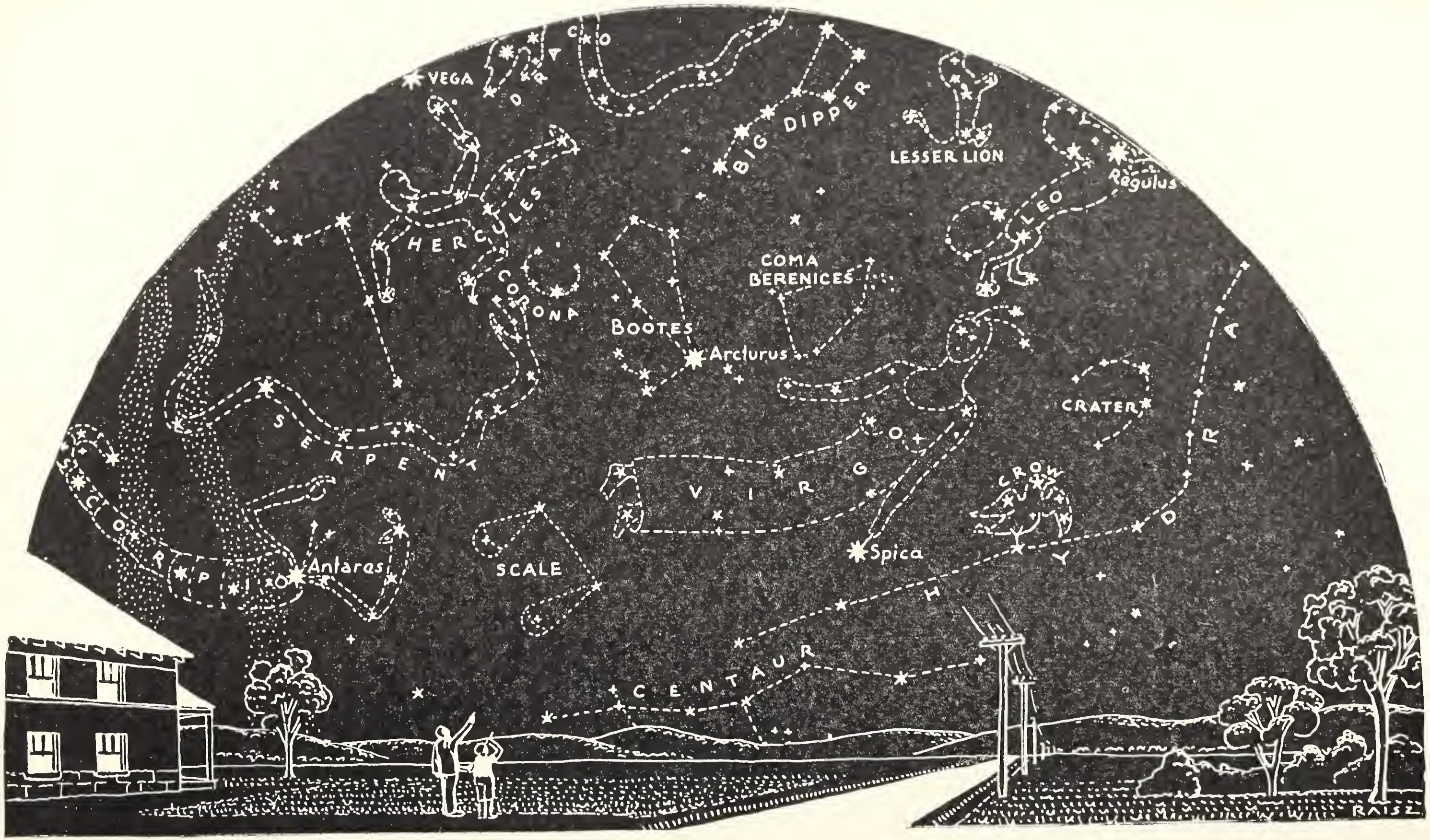
The Big Dipper can be found very easily, for it looks like a great dipper with a bowl and a long handle. The two stars that form the outer edge of the bowl are called The Pointers. They point toward the North Star, which is right at the end of the handle of the Little Dipper. The Little Dipper is the Little Bear of the ancient myth, the handle being the tail, and the Big Dipper forms a part of the Great Bear. You may think, as most people do, that they resemble dippers more than they do bears.

The North Star lies just above the North Pole, and therefore, from the northern hemisphere, it appears never to set. Can you tell why? Think over what you know of the rotation of the earth, and you can readily discover the reason. The Dippers, or Bears, do not set either, but as the earth rotates, they appear to travel around the North Star. The ancients based the myth about the constellation on this fact. They could not account for it as we can to-day, for they did not know that the earth rotates.

You will find it interesting to study the stars and to learn to know some of the constellations. When you have located the Big Dipper and the



LOOKING NORTH AT THE CONSTELLATIONS ON A WINTER'S EVE.



LOOKING SOUTH AT THE CONSTELLATIONS ON A SUMMER'S EVE.

North Star in the sky, they will help you to find the other northern constellations. Using the star maps in this chapter as your guide, you can readily find Cassiopeia's Chair, Cepheus, and the Dragon by tracing their positions from the North Star and the Big Dipper.

During January, February, and March, the constellation of Orion can easily be seen in the southern sky. Three stars in a row form Orion's belt. From the belt hangs a sword made up of a curving line of stars. Above the belt is the red star, Betelgeuse, and below the belt, the white star, Rigel. In this group of stars the people of ancient times saw a hunter with belt and sword. Rigel was a spur on his heels; Betelgeuse, a great red jewel on his shoulder.

Orion's club was raised to strike a bull, the head of which is represented by a V-shaped star group called the Hyades, with the ruddy star, Aldebaran, as the eye.

Behind the hunter are Sirius and Procyon, which the ancients declared to be his dogs. Sirius, the Great Dog Star, is the most brilliant of all the stars. Procyon is the name of the Little Dog Star, although it is also a very bright star.

Northwest of Orion is a constellation known as the Pleiades, which are often called the seven sisters. Only six stars in this group can be seen without an instrument, but the legend about it says that once upon a time there were seven. Many stories have been invented to account for the lost star. The truth is that the telescope shows nine large stars, each of which has been given a name, and over 3,000 smaller ones in this foggy spot.

Northeast of Orion are the twin boys, Castor and Pollux. This constellation is called Gemini, the Latin word for twins. The story says that these twins loved each other so much that they were placed in the sky so that they could always be together.

To-day we know many facts about the stars that were not known to the ancient people. Astronomers have studied the heavens with the aid of the telescope and have learned many interesting things.

No doubt you have looked into the sky and have wondered how far away the stars are, and why they are not all of the same color. Astronomers tell us that the color of a star depends upon its age. A young star shines white or blue. As it grows older, it turns yellow like the sun, and then red. Finally it becomes dark. Scientists tell us that there are many dark stars in the sky. No one knows just how old the stars are, but from their colors we can tell which are older.

The stars are so far away from the earth that if you were to speak of the distances in miles, the numbers would be so great that they would not be easily understood. For this reason, astronomers use the light year instead of miles to tell us the distance of stars from the earth. Light travels 186,000 miles every second. One light year is the distance that light travels in one year.

The nearest star is so far from us that it takes four years for its light to reach us. In other words, it is four light years distant from us. It is difficult for us to understand that the light that reaches us from the most distant stars really left those stars thousands of years ago.

The stars have been divided into six groups according to their brightness. The most brilliant ones are said to be stars of the first magnitude. Those that can barely be seen without the aid of instruments are stars of the sixth magnitude. The difference in the brightness of the stars may be due, either to the amount of light that the star gives off, or to the distance of the star from the earth.

No doubt you are wondering what these stars are, which appear to us as only dots of light in the sky. You may be surprised to learn that each of them is a great sun, similar to the sun about which our earth revolves. In other words, each shining star is a great mass of white-hot gases that gives off light and heat. Some stars are smaller than our sun, but others are many thousands of times larger. You will learn more of the wonders of the sky as you continue your study of science.

SOME THINGS TO THINK ABOUT

1. Tell in your own words the myth that was invented in ancient times to account for the constellations of the Great and Little Bears.

2. Explain how this constellation is located as compared to the "dippers."
3. Tell what the ancient people saw in the constellation of Orion.
4. Explain what scientists have learned about the ages of the different stars, and about their distance from the earth.
5. Explain how stars are grouped by scientists according to their brightness.

SOME THINGS TO DO

Study the stars to find out how many of the constellations you know.

Make a drawing of the heavens and put in the different stars and constellations that you know in the sky. Do not put in any that you have not actually seen without help from any one. You can keep this map until the end of the year, and it will be a record of your knowledge of the stars by themselves and in constellations.

You can use the maps in this book to help you to find the constellations, and you may be able to find someone who will help to point them out to you.

CHAPTER XIX

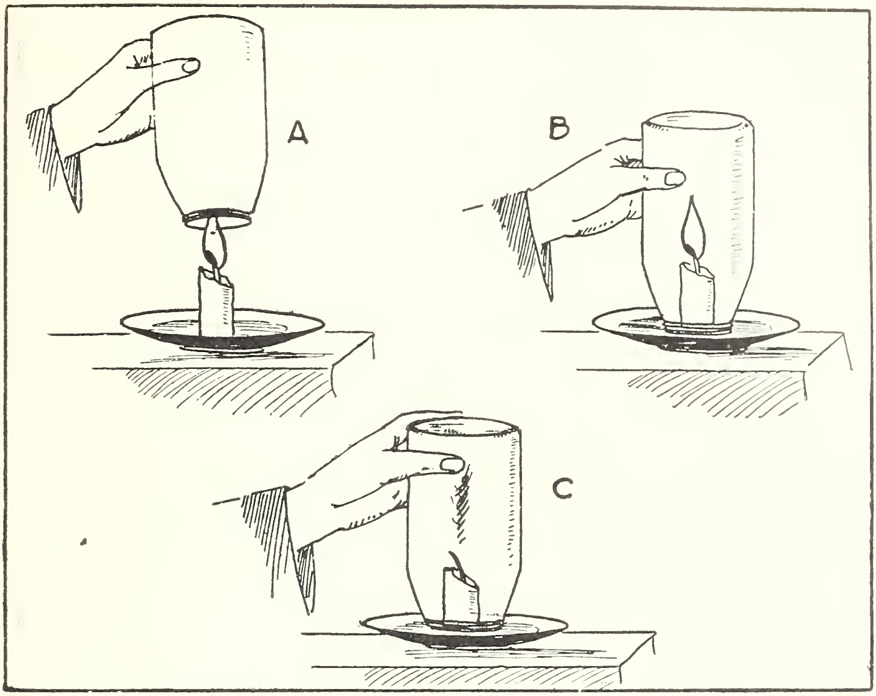
OUR SERVANT, HEAT

1. What makes the sand hot in the summer?
2. Why do you get warm when you stand in front of a fire?
3. Why do your hands get warm when you slide down a rope?

What is the hottest thing that you know? Some of you will say "the sun," while others will say "a hot stove," "a burning match," "a glass," "hot water," "steam" and ever so many other things. We know some of these are hot because they burn us. We know the sun is hot because it makes us warm in the summer time. We can tell that some things are hot when we see steam come from them. From where does the heat come?

We know that the sun gives us much of our heat. In the summer time when it passes straight above our heads the days are hot. It must take a lot of heat to make the air and everything about us so warm. The hot stove and the hot water get their heat from things that burn. Anything that is near fire for a length of time gets hot. There are other ways of making heat.

If we rub two half dollars together, they get hot. The Indians used to rub soft sticks together until they became so hot that they burst into



A: PLACE FRUIT JAR OVER A BURNING CANDLE. B: WHILE THERE IS AIR IN THE JAR, THE CANDLE BURNS. C: THE OXYGEN IN THE JAR HAS BEEN CONSUMED.

flame. Indians used to make their fires in this way. Perhaps you can tell how Boy Scouts make fire. If you slide down a rope, your hands may get so hot that they become blistered. Rubbing things together always makes heat. When two rough things are rubbed together, there is more heat made than when smooth things are rubbed. This is true because the rough parts hinder one another when we try to slide one over the other. This rubbing is called friction. Heat, then, may come from the sun, from burning, and from friction.

Of the three ways of producing heat, burning

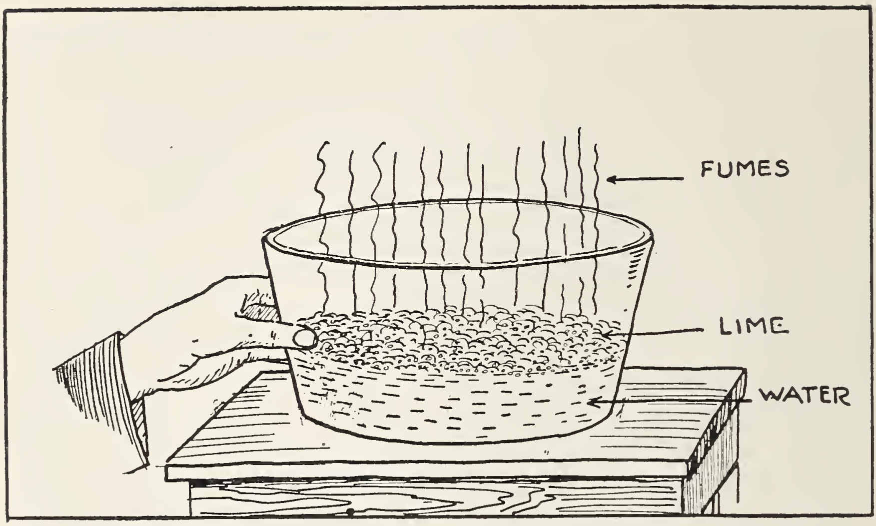
Photograph by Ewing Galloway, N. Y.

A BOY SCOUT CAN MAKE FIRE BY SPINNING THE STICK AGAINST A PIECE OF SOFT WOOD.

is the one most commonly used. What do you think happens when things burn? You can find out by thinking of some things which you already know. If you put a fruit jar over a burning candle, as shown in the picture, what do you think would happen? Of course, the flame would go out after a few minutes. You may have been told that the flame goes out because the flame needs air to keep burning. There is something in the air that keeps the candle burning. It is a gas called *oxygen*. That is a new word but one you will hear many times. All air is a mixture of gases of which oxygen is one. Any time a fire cannot get oxygen it will stop burning. That is why we smother fires by throwing sand or blankets on them. You might be interested to know that if people cannot breathe oxygen they are smothered, too. Can you understand why?

There is one more thing about burning you should know to understand how fires are started. The Boy Scout turns the round stick in the hole made in a soft piece of wood until the wood becomes very hot. If you remember about friction, you will know why. When the wood gets hot enough, the oxygen in the air joins with the wood and burns. So in order to burn anything we must have air, and the thing to be burned must be so hot that it will combine with the oxygen in the air.

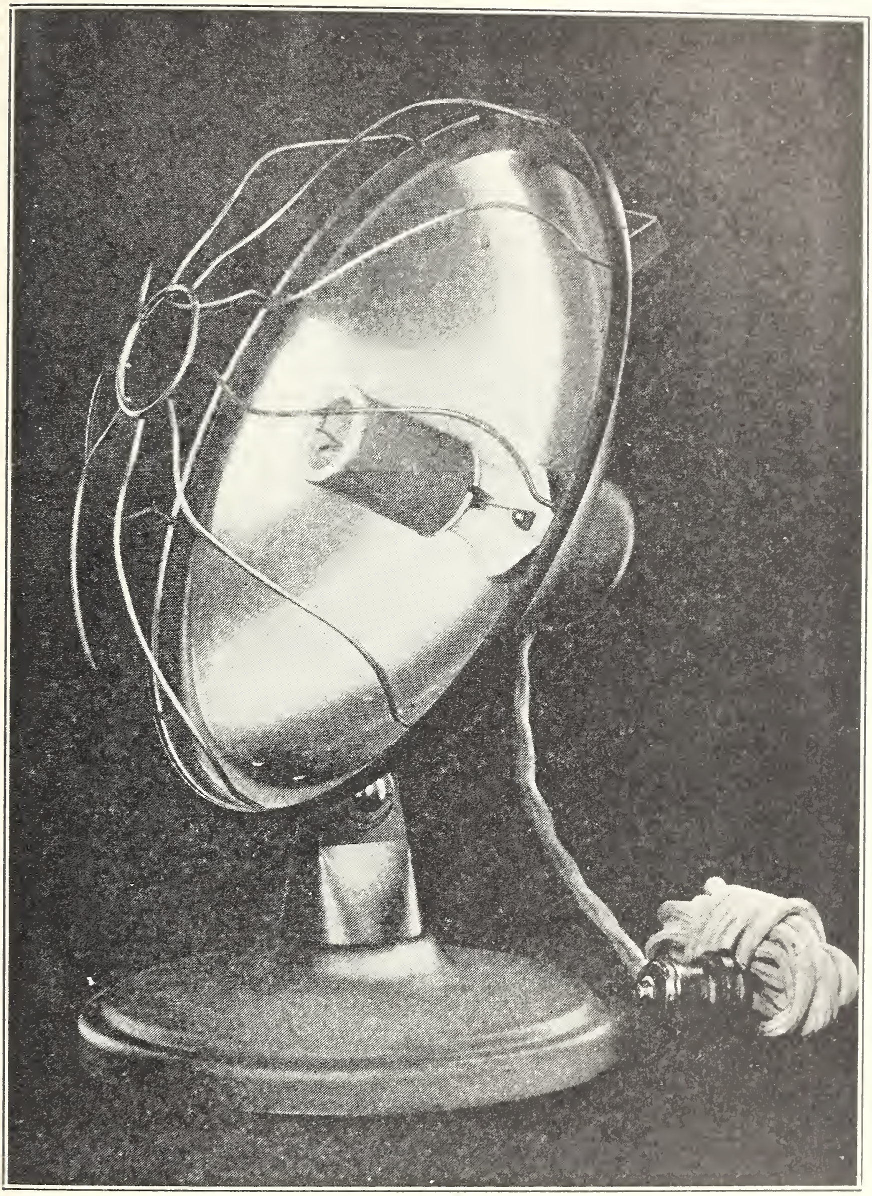
There are one or two other ways of making heat which you may know. If lime is put into water, it will boil and send off steam. This is heat from mixing things. When you pump up an automobile tire, the pump will become hot partly because of the friction of the piston inside of the pump. Heat will also come because the air inside the pump is being squeezed together



HEAT IS GIVEN OFF WHEN LIME AND WATER MIX.

or compressed. Whenever air is compressed, it becomes warmer.

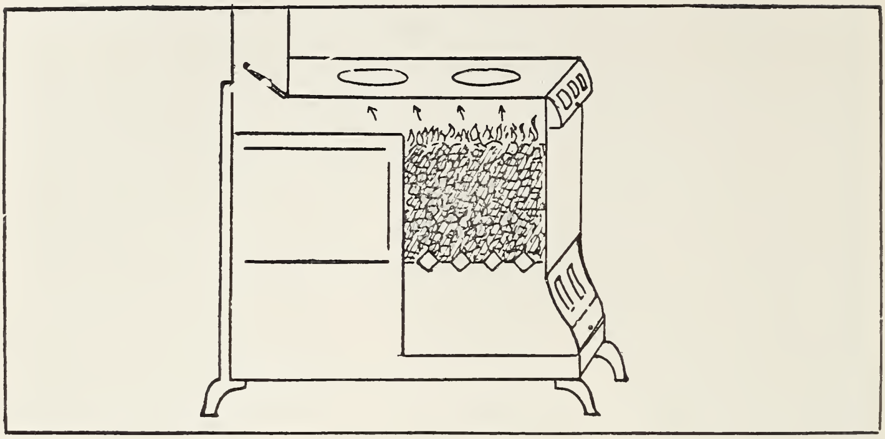
Getting heat from electricity is also becoming very common now-a-days. In many homes are toasters, electric heaters, water heaters, and electric stoves. Getting heat from electricity is very simple. All you need is a wire or metal through which electricity does not easily pass. If you watch an electric heater, you know that the wire becomes red hot and stays that way until the electricity is turned off. If large copper wire were placed in an electric toaster, instead of the special kind of wire used, it would be impossible to toast bread because the copper wire does not get hot enough. Iron wires are heated more than copper wires of the same size. A wire called nichrome (nī-krōm′) is generally used in toasters, heaters, and stoves. The coils on the stoves are larger than those on the toaster but are made



Courtesy of Edison General Electric Appliance Co.

HEAT FROM ELECTRICITY.

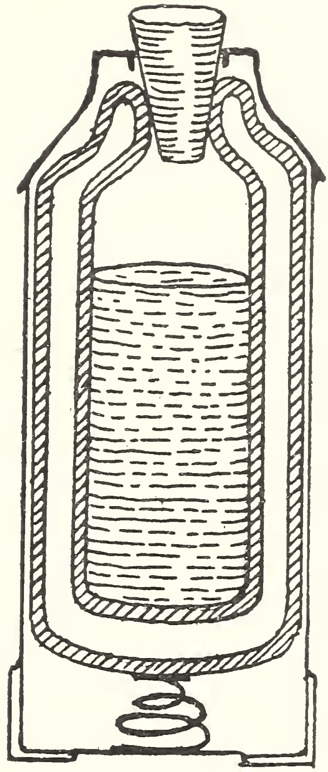
in the same way. It is not only possible but probable that electricity will be used for nearly all cooking and heating a hundred years from now.



HOW HEAT IS CARRIED TO THE LID OF A STOVE.

When a fire is burning in the stove, the stove becomes hot. The heat is carried to the lid from the fire under it. When you stir something hot with a silver spoon, and the spoon gets so warm that you cannot hold it, the heat has been carried through the spoon. When anything feels hot, it is because heat has been carried or conducted through it. Heat carried in this way is said to be carried by *conduction.* Things through which heat passes easily are said to be good conductors of heat. Wooden handles are put on cooking forks and cake turners because wood is a poor conductor of heat.

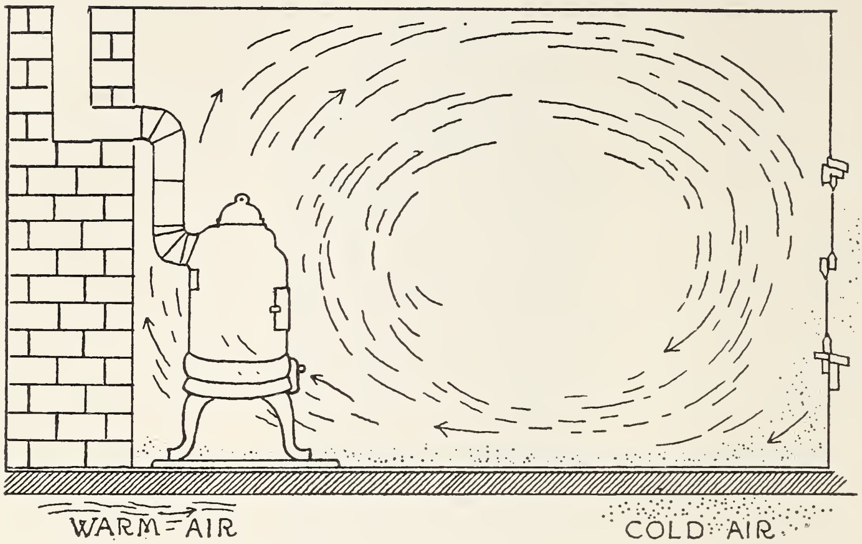
One of the poorest conductors or carriers of heat is air. A bed comforter is warm because there is air in the fluffy padding, and heat, therefore, does not pass easily through it. The comforter does not make heat but keeps the heat of the body of the one sleeping under it from escaping. Warm clothes all hold the heat of the



CROSS SECTION OF A
VACUUM BOTTLE.

body. A vacuum bottle has a space around it in which there is little or no air. The air is pumped out just as it is from electric light bulbs. Because heat does not pass through space without air in it, the coffee or hot things in the vacuum bottle stay warm. Likewise if cold lemonade or ice water is placed in a vacuum bottle, it will keep cold because the heat cannot get to it from the outside.

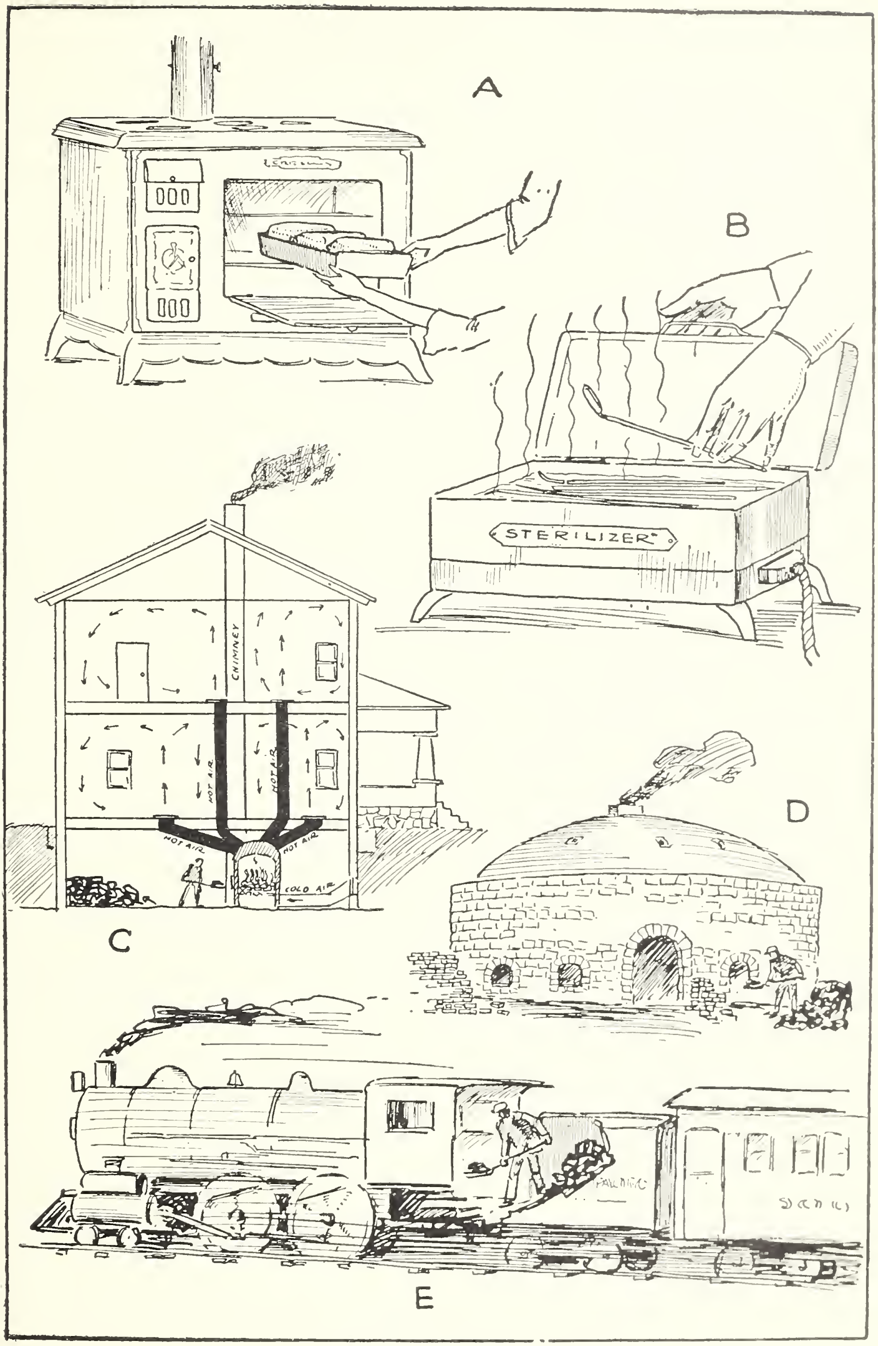
You may wonder how heat from a stove can warm a whole room if the air is a poor conductor of heat. There are two other ways of



A STOVE WARMS A ROOM BY RADIATION.

carrying heat other than by conduction. Heat may be carried as it is from the sun. The sun's heat reaches the earth in the same way light does. This way of carrying heat is called *radiation.* You can remember that word from the radiator on the automobile. The way heat from a radiator or stove warms a room is by means of currents of air carrying heat around the room. The currents are caused because the warm air is lighter than the cool air and so goes up toward the ceiling. The cool air comes down. This makes round or circular currents like that shown in the picture. You may like to know that this way of carrying heat is called *convection.* When you study science in the seventh and eighth grades, you will learn more about that word.

Heat comes to us from the sun, which is 93,000,000 miles away, in eight minutes. We have



USES OF HEAT.

A: Cooking; B: Sanitation; C. Heating; D: Brick-making; E: Transportation.

just learned that it comes to us by radiation. It could not come in eight minutes by conduction or convection. If you turn on an electric light holding one hand near the bulb, you will feel the heat striking your hand before the glass bulb even gets warm. This is called radiation. The radiator sends out heat by radiation, too. You have now learned the three ways by which heat is carried, but not much has been said about the use we make of heat.

If you were asked to name all the ways heat is used, it would take a long time to do it. We could not live or work with much comfort in the winter time if our homes, factories, and stores were not heated. There are many things that we could not make without heat. We could not bake bread, pies, cook food, make brick and dishes, and ever so many other things if we did not have heat. We could not run trains and boats without heat to make steam engines go and heat to make electricity. There are just thousands of things that heat does for us. That is why we call it our servant.

SOME THINGS TO THINK ABOUT

1. How do you know that friction releases heat?
2. How were fires started before we had matches?
3. Describe the three ways in which heat travels.
4. In which way does heat come to us from the sun?
5. List as many ways as you can in which heat helps us.

SOME THINGS TO DO

This chapter suggests many interesting experiments that you may perform. You will probably wish to try to start a fire by friction. It is not so very easy to do, because a great deal of friction is needed to make the thing to be burned hot enough to burst into flame.

You will be interested in studying the ways homes are heated. You can find out a good many things about it by yourself, and perhaps you can talk it over with some older person, and then explain what you find out to the class. If you have a fireplace, you may be able to trace the currents of heated air in the room by placing a thermometer in different places.

Place a lighted candle in a saucer as shown in the diagram in this chapter. Cover it with a fruit jar. Watch it and see what happens.

CHAPTER XX

OUR TOYS AND OTHER MACHINES

1. What toys do you like best?
2. What toys do you have that are like the machines men use?
3. What machines do you use every day?

Did you ever wonder what kind of toys the boys and girls of cave-man times used to have? They must have been very simple compared with those we have and use to-day. In early times people did not have large complicated machines like those we use now to do our work. The only tool of the earliest savages was a club. To-day men need many tools and machines to help them in their work.

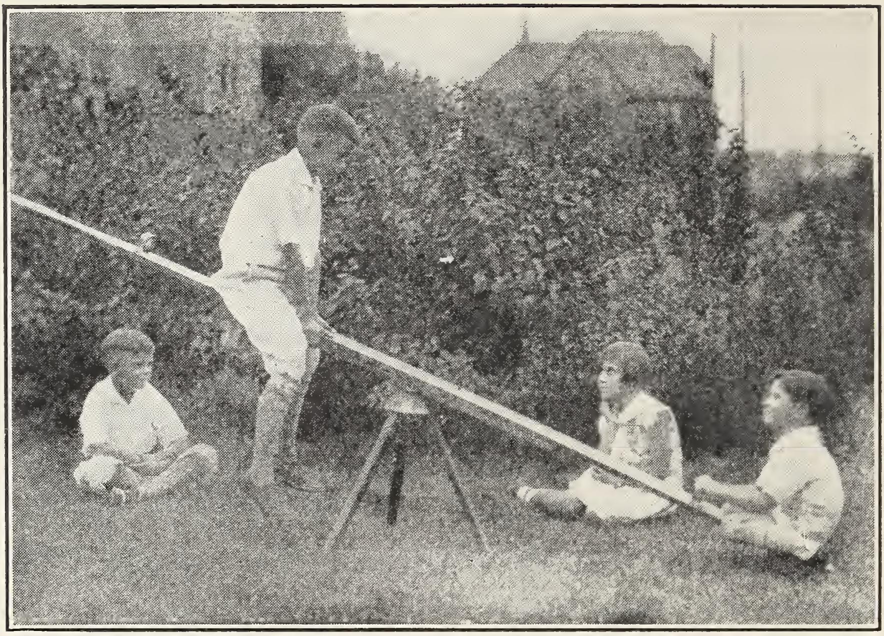
If some one asked you to describe a machine, you would probably say that it has wheels, a crank and screws and that it also has a frame, bolts, and a body. The automobile is a very complicated machine, but it is really made up of many simple machines. If someone should tell you that the door knob, the scissors, the hammer, and your toy wheelbarrow are simple machines, you might be surprised. They, too, are machines. There are many common devices about us like these that are really simple machines. You are now going to read about some of these devices that help us work and make us happy in our play.

Machines We Like to Use

We are all familiar with the seesaw or teeter-totter. Let us look at it again and see how it works as a lever or simple machine. It consists of a long board resting on some kind of support which is called the fulcrum (fŭl′krŭm). One person on the seesaw is the weight and the other is the force. Let us say that the person on the end nearest the ground is the weight and the person on the other end is the force. If the force is greater than the weight it will lift it. The weight and force change, and work is being done, as the seesaw is moving up and down, up and down.

Perhaps you do not know that you are doing work while you are having a good time on the seesaw. Even though children are playing, they are working each time one lifts the other on this simple machine. The elevator is doing work when it takes you up to the next floor in the department store. No work, however, is being done when the elevator is stopped at one of the floors. Some weight must be moved before we are doing work. When we lift or move a weight, we are doing what the scientist calls work. Let us see how many times in our play with toys we are really doing work.

Do you know that a little four-year-old boy can lift you on the see-saw? If you will try some



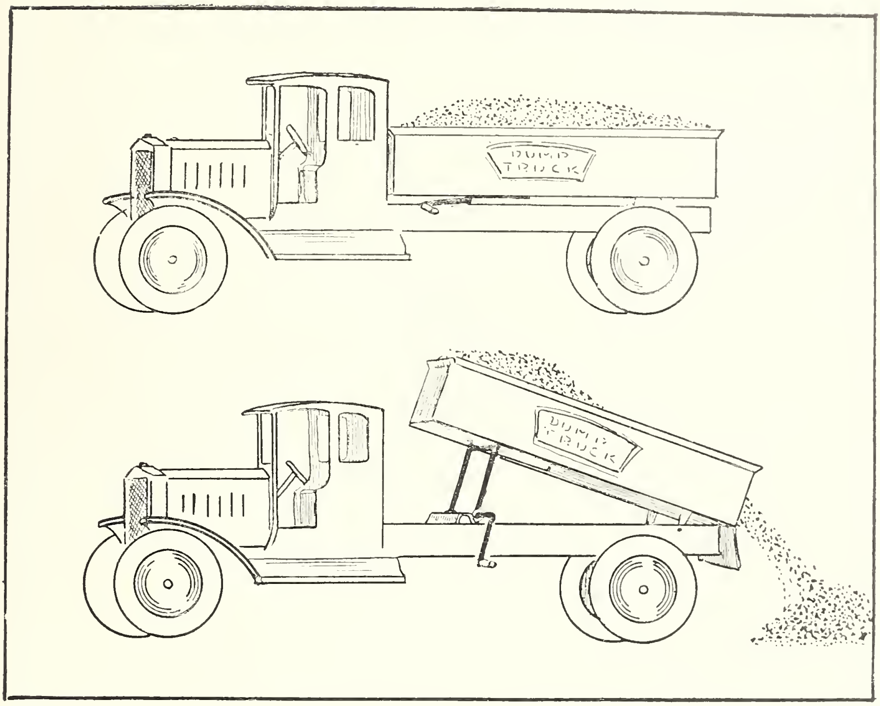
Photograph by K. M. Persing

A LITTLE FOUR-YEAR-OLD BOY CAN LIFT AN OLDER BOY.

experiments, you will find out how this can be done and how to use a lever of this kind. Ask a heavy boy to sit on one end of the seesaw, and then try to have a lighter boy lift him by sitting on the opposite end. The lighter boy should sit at the very end. Then ask the heavier boy to move toward the fulcrum until the other boy can lift him.

If you are just using a long board for your seesaw, it will be easy to move the board on the fulcrum so that the two boys will balance on the seesaw.

If you have a toy dump truck like the one in the picture, you can easily see the levers. When you pull the lever, the front end of the body of the truck rises and dumps the load. With this little

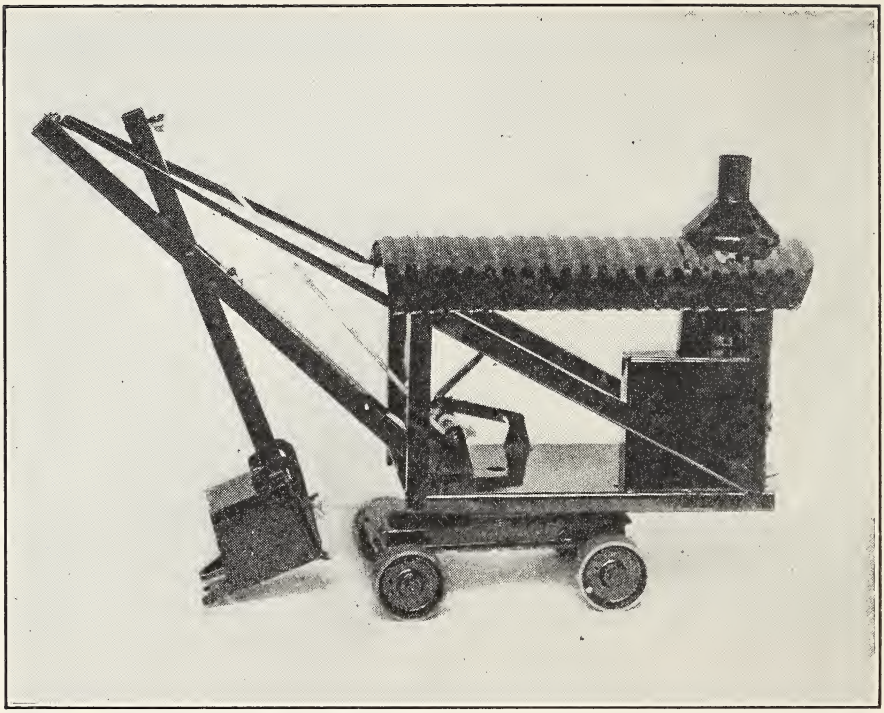


WHEN YOU PULL THE LEVER OF THE DUMP TRUCK, THE FRONT END RISES.

device you will find it easy to unload sand from your truck. How would you unload sand if you could not dump it?

You will see that the lever on this truck is much like the seesaw, but the two sides are not equal. One side is longer than the other. Can you tell why? Do you remember what happened when one side of the seesaw was longer than the other? Find the fulcrum in the picture of the toy dump truck. The force is usually applied by pulling with the hand and the weight you lift is the load on the front part of the truck.

If you will look at a real dump truck, you will find several levers. Watch the driver apply the

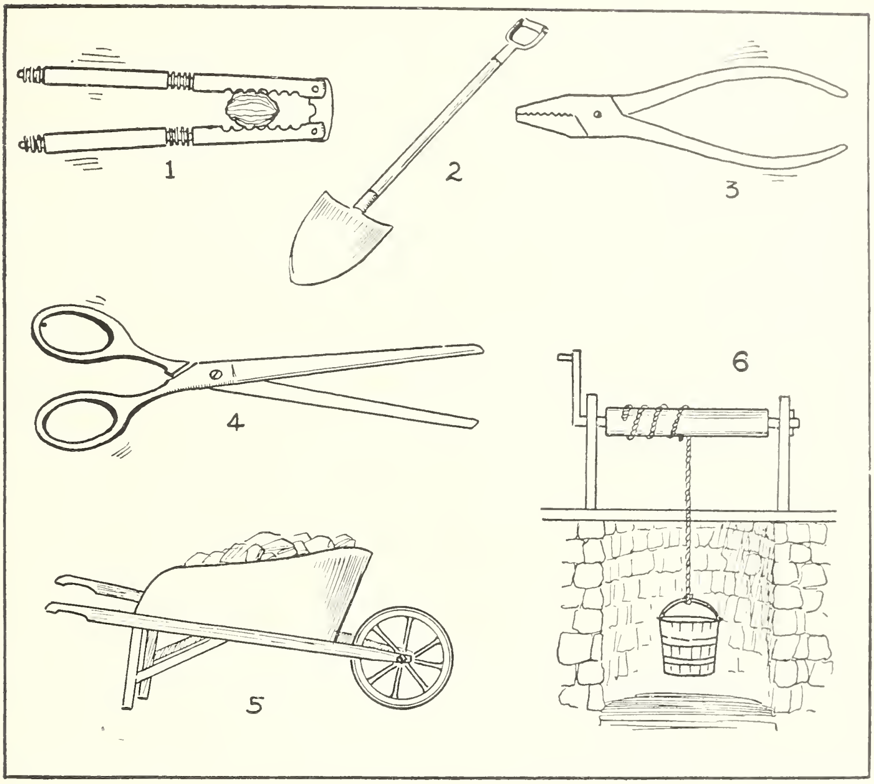


Courtesy of Moline Pressed Steel Co.

THE WEIGHT IN THE TOY STEAM SHOVEL IS LIFTED BY THE CHAIN ATTACHED TO THE WINDLASS.

brakes. If he puts his foot on the brake pedal, he is using a lever, and if he pulls the hand brake, he is using another lever. There are also many other simple machines that you cannot see unless you examine the truck carefully.

In early times man used nothing but a sharp stick for digging. Then he learned to make a simple kind of hoe by fastening a piece of bone to a handle. These devices could not well be used to-day. It would require too much time to do our work with them. Instead of these crude instruments we now have the steam shovel. This huge digging device will load a truck with sev-



LEVERS THAT ARE IN DAILY USE.

1: nutcracker; 2: shovel; 3: pliers; 4: scissors; 5: wheelbarrow; 6: windlass.

eral tons of rock or sand in a few minutes. In the toy steam shovel shown on page 184 you will see that several levers are used as well as a windlass, which you will read about a little later. The load or weight in the shovel is lifted by the chain which is attached to the windlass. Unlike the large steam shovels our toy is run by hand.

There are many other levers that we use nearly every day. Although we could get along without them, our work is made easier and quicker if we use them. If you have tried to crack an English walnut with your fingers, you know how hard it is to do. When you use a nutcracker, the hard shell of the nut breaks easily. You will see that the fulcrum is at the end in this lever and the weight is applied at the walnut.

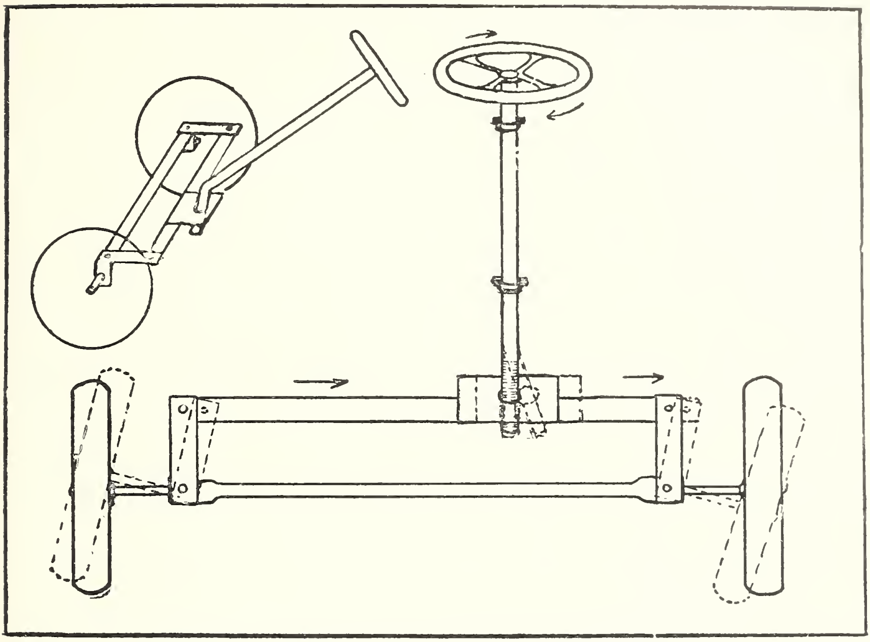
The shovel, the pliers, and the scissors are also useful levers. Can you tell how they work?

The wheelbarrow is really a kind of lever that we push about from place to place. The fulcrum is at the axle of the wheel. The weight may be anywhere on the wheelbarrow and the force is applied at the handles where you lift them.

Toys Like Machines Men Use

You probably have used the wheel and axle in playing with some of your toys. The steering wheel on your dump truck is an example of this simple machine. You can see that it is fastened to an iron rod that turns when you move the wheel. Under the automobile the iron rod is attached to the front wheels. When the steering wheel is turned, the front wheels are turned toward one side of the road. If you try to move the wheels with your hands you will realize how much more difficult it is than to move them by means of this simple machine.

In some of our toy fire trucks a windlass is used to raise the ladders. If you will examine it you can easily see that it is a round piece of wood or iron with a crank attached to it. The windlass is really a wheel and axle. The round piece is the axle and the crank serves as a wheel. You

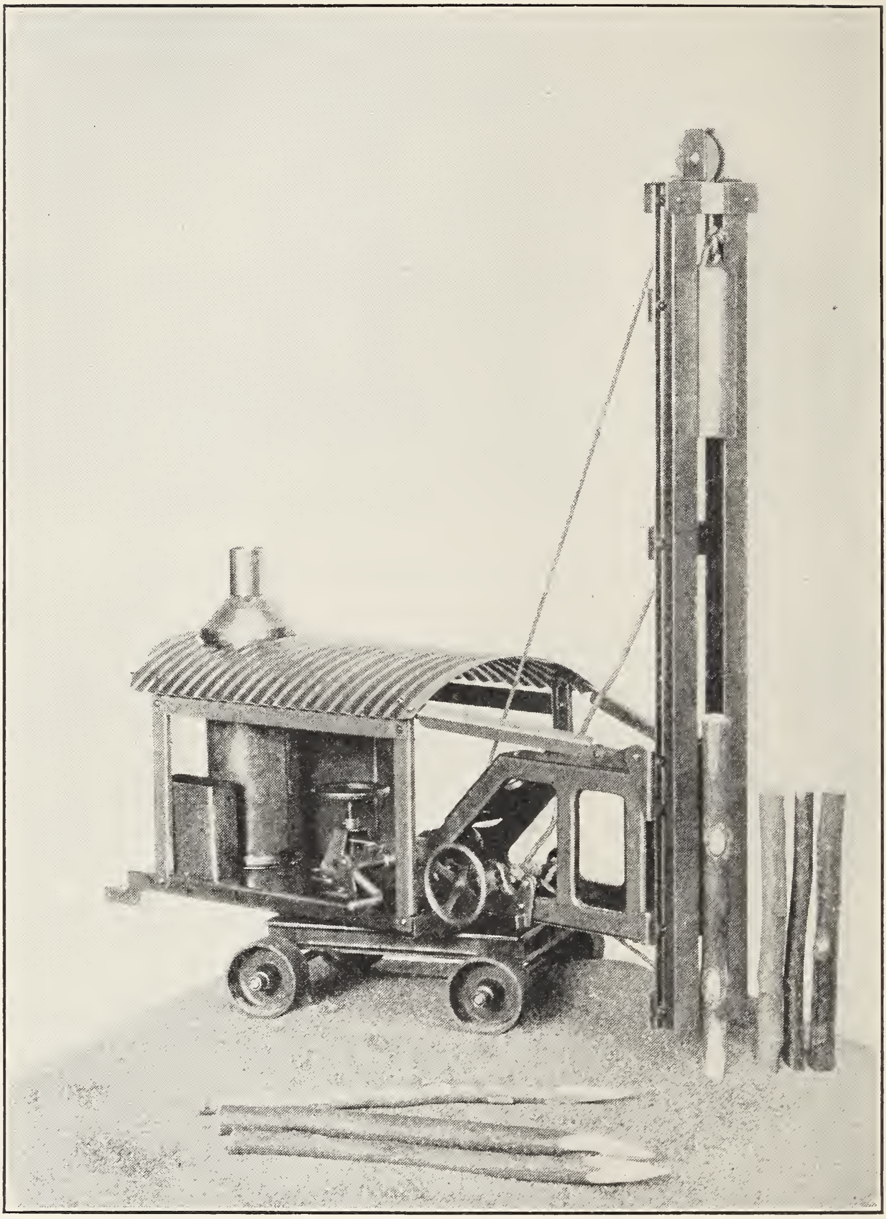


WHEN THE STEERING WHEEL IS TURNED, THE WHEELS TURN TO ONE SIDE OF THE ROAD.

can imagine the circle the crank makes as it is turned around. This should help you to understand how the crank is used instead of a wheel.

The pile driver is familiar to you all. Perhaps you have seen men driving posts in the sand with a large machine. Your toy probably does not work like the machine men use. Instead of using a steam engine to make it go you turn the crank by hand. As in the toy fire engine and the steam shovel the windlass is used. In your toy the weight is lifted six or more inches and then dropped. Again it is picked up and lifted by the windlass.

The windlass was used long ago to lift water in large buckets from the wells. A rope was fas-



Courtesy of Moline Pressed Steel Co.

THE CRANK OF THE TOY PILE DRIVER IS TURNED BY HAND.

tened to the bucket and to the windlass. As the crank was turned, the rope was wound on the windlass and the bucket lifted from the bottom of the well. It was much easier to turn the crank and lift the bucket than to pull it up with the hands.

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 *Yes* beside each number. If it is false, write *No*.

1. The lever is a simple machine.
2. The toy dump truck has levers.
3. A boy lifting sand to his toy dump truck is doing work.
4. The elevator had stopped at the second floor but it was doing work.
5. We never do work while playing.
6. The nutcracker is a lever.
7. The wheelbarrow is not used as a lever.
8. A small boy cannot lift a heavier boy on the teeter-totter.
9. The wheel and axle is used to steer the automobile.
10. The windlass is a complicated machine.

SOME THINGS TO DO

Try to crack an English walnut with your fingers. Then use the nutcracker.

If you have a see-saw on the playground try the experiment suggested in this chapter.

You can easily make a little see-saw by using a ruler or yardstick. Make a block of wood for the fulcrum.

Bring a toy dump truck to school and look for the levers. What is the use of each lever you find?

Look at the steering wheel of the toy dump truck. Then tell the class how it works.

Look for examples of the wheel and axle in your toys and about your school and your home. How are they used for work? How are they used for play?

CHAPTER XXI

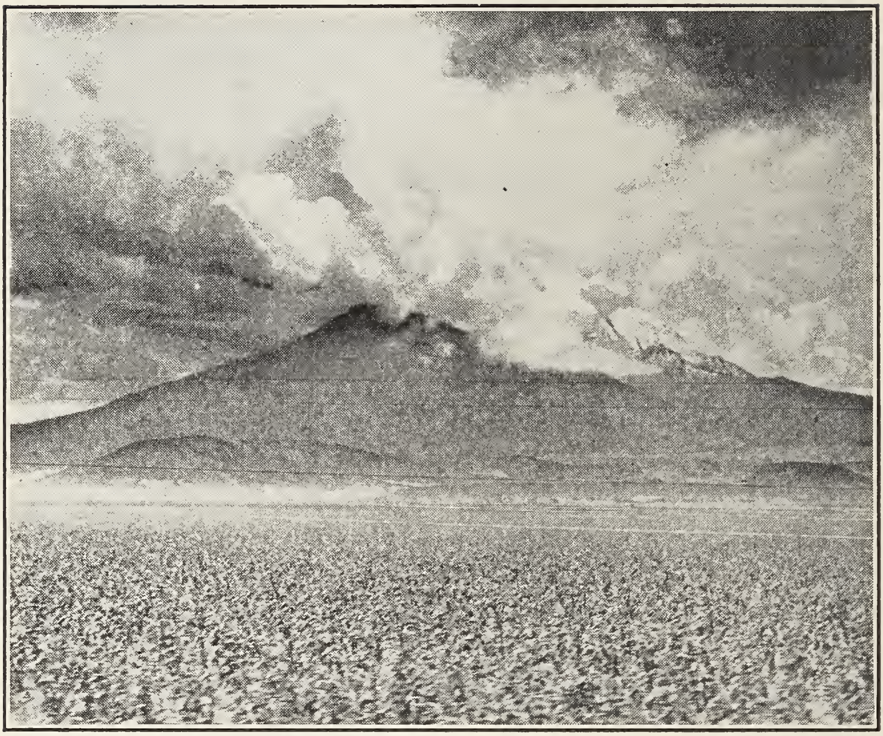
HOW ROCKS WERE MADE

1. Describe some of the different kinds of rocks that are found in your neighborhood.
2. Do you know the names of any of them?
3. Can you scratch all rocks with a knife?

No matter where you dig you will always find a rock bottom if you dig far enough. Scientists tell us that at one time the surface of the earth was solid rock. They say that once upon a time, millions of years ago, the whole earth was hot lava, steam, and fire. Do you know that lava is melted rock? As the lava on the surface cooled, it formed a crust or layer of rock. The outside of this layer has since crumbled into soil, but under the soil, the solid rock remains.

Lava immediately makes us think of volcanoes. Few of us have ever seen a volcano, but we have all read of the smoke and flame and molten lava that pour out of the great openings in the earth. Sometimes lava covers the ground for miles in all directions.

It may be hard for you to believe that granite and some of the other rocks were once molten lava. When lava cools and hardens, it forms *igneous* rock. The word *igneous* comes from a Latin word, *ignis,* that means fire. Igneous, or



Photograph by Ewing Galloway, N. Y.

SMOKE, FLAME AND MOLTEN LAVA POUR OUT OF A VOLCANO.

fire-formed rocks, are very hard. They are of various colors, according to the kind of mineral in the lava.

Perhaps you would like to learn the names of some of these minerals. Granite is made of quartz, feldspar, and mica. Sometimes they are so well mixed that they cannot be recognized. In coarse granite, however, you can see the white glass-like crystals of quartz very easily. The mica appears as black particles, while the feldspar may be red, pink, gray, or nearly white. It is the feldspar that gives the stone its color.

Have you ever seen a piece of granite? It is the strongest and most lasting of building stones.

FLOW OF LAVA FROM AN HAWAIIAN VOLCANO.

It is very expensive because it is so hard to split and prepare for use. You may have seen monuments or parts of public buildings that were made from it. It is found in more than half of the states of our country. Many large granite quarries are found in the New England States.

You must not think, however, that fire did all the work of forming the rocks. Did you ever pick up a handful of pebbles by the side of a lake or a river, or at the seashore? If you thought about them at all, you probably noticed that their sur-

GRANITE, SHOWING THE WHITE GLASS-LIKE CRYSTALS OF QUARTZ.

faces were smooth, and guessed that the water had worn them away.

As the earth's surface cooled, it wrinkled somewhat as the surface of an apple does when it dries. When this happened, the layers of rock were bent and broken. In the low places water collected, forming lakes and oceans, streams and rivers.

Some of the water ran down into cracks in the earth, where it was heated and formed into steam, as the water in a kettle does when it is heated on the stove. This hot water dissolved some of the minerals in the rock, just as sugar dissolves in water. After a while, the pressure of the steam caused the water to rush out from the earth as hot springs. The melted minerals in the steaming water were left on the surface of the earth, where they cooled and formed rocks.

Often igneous rock was worn away by water and the particles deposited in other places to

A SPECIMEN OF CONGLOMERATE, OR CEMENTED GRAVEL.

harden again. This washing away was not all done by hot water. Wherever streams were formed on the earth's surface, they carry with them small pieces of the rock over which they pass, sometimes in the form of sand or gravel, and sometimes in still smaller particles, which made the water muddy.

If you take some muddy water from a running stream and allow it to stand quietly in a glass,

Courtesy of U. S. Biological Survey

LAYERS OF SEDIMENTARY ROCK, SANDSTONE AND SHALE.

you will see that the water at the top becomes clear as the solid particles settle to the bottom of the glass. These settlings are called sediment. When a muddy stream empties into a lake or an ocean, the sediment settles in the bottom. After a long time the particles become cemented together, forming sedimentary rocks. Deep layers of sedimentary rocks have been formed in many places on the earth's surface. Some of them are shale, or cemented mud; others are sandstone, or cemented sand; others are conglomerate, or cemented gravel.

Sandstone is used very often as building stone

LIMESTONE FOSSILS, SHOWING IMPRINTS OF SMALL WATER CREATURES.

in regions where it is found. It is much softer than granite, and is therefore much more easily prepared for use. Because it is soft and porous, it wears away readily and for this reason buildings made of it often look old in a very short time.

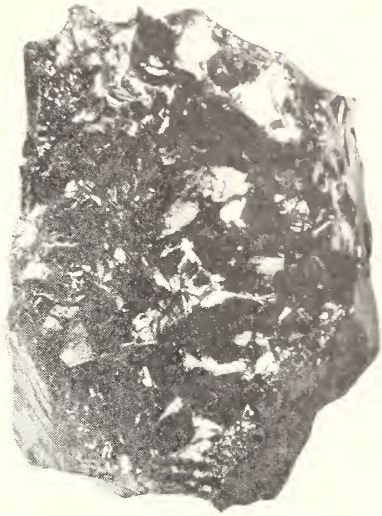
Limestone is a sedimentary rock that has in it lime from the shells of small water creatures that died and sank to the bottom. Here they were covered with other deposits and pressed into rock. If you live in a neighborhood where there are deposits of limestone, perhaps you will wonder how they happened to be there. Wherever there is limestone, the land was once covered with water. This may seem hard for you to believe, but in any limestone quarry you will find the remains of the shells of sea animals. These remains are called fossils. The ocean once covered the dry land and sea animals lived wherever limestone fossils are found.

Coal is another sedimentary rock. It is the remains of plants that once grew in great swamps. Some great change in the earth's surface covered these plants with layers of rock. The pressure on these layers on the earth changed them into coal. At the same time the mud in the swamp became shale.

Sedimentary rock, as you have just learned, is made from igneous rock by the action of water. Sometimes sedimentary rock undergoes another change and becomes what scientists call metamorphic rock, which means "changed rock."

There are places on the earth where a great sheet of lava has covered a layer of sedimentary rock. The hot lava has melted the sedimentary rock and changed it to other kinds of rocks. Limestone changes to marble. Soft coal becomes hard coal or perhaps changes to graphite, a substance with which you are surely familiar. It forms the lead of your pencil. Shale becomes slate. Slate

SOFT COAL.



HARD COAL.

is found in hard coal mines. All of these rocks were once sedimentary rocks.

Marble is one of the most beautiful of all building stones. Because of its scarcity and its high cost, it is used mainly for ornamental purposes in public buildings and for statues. Over half of the marble used in this country comes from Vermont, where a great layer of it, from 1,000 to 2,000 feet in thickness, runs the whole length of the state. We also get beautiful marble from Italy.

SOME THINGS TO THINK ABOUT

Using the following words, fill the blanks in the sentences on the following page. Some of the words will be used in more than one sentence.

feldspar	limestone	quartz	water
igneous	metamorphic	sedimentary	molten lava
lime	mica	soft coal	

1. Granite is an ..... rock.
2. Granite was once ....
3. Granite has in it .... and ......
4. Sandstone is a ..... rock.
5. Limestone is a ..... rock.
6. Limestone contains ..... from the shells of water animals.
7. Wherever limestone is found, the land was once covered with ......
8. Marble was made from ......
9. Graphite was made from ......

SOME THINGS TO DO

If possible, collect samples of granite, sandstone, limestone, soft coal, hard coal, and marble and study them.

Try to know the quartz, mica, and feldspar in a piece of granite.

Visit a running stream and observe the sediment that it carries. Notice how pebbles and bits of rock are rolled along on the bed of the stream.

Fill a glass jar with muddy water and watch the sediment settle to the bottom, leaving the water clear.

Collect samples of the different kinds of rocks in your neighborhood and find out as much as you can about them.

CHAPTER XXII

HOW ROCKS BECOME SOIL

1. Have you ever seen a steep hillside where rock was crumbling and falling down?
2. Can you think of any reasons why rocks crumble into soil?
3. Is all the soil in your neighborhood alike in color?

The story of how the soil is formed begins with the crumbling of the rocks that once were the earth's surface. There was a time, long, long ago, when the earth was not covered with soil, as it is now. Its surface was solid rock. In the last chapter you learned something of how these rocks were formed. In this chapter you will learn what caused the surface rock to crumble into soil.

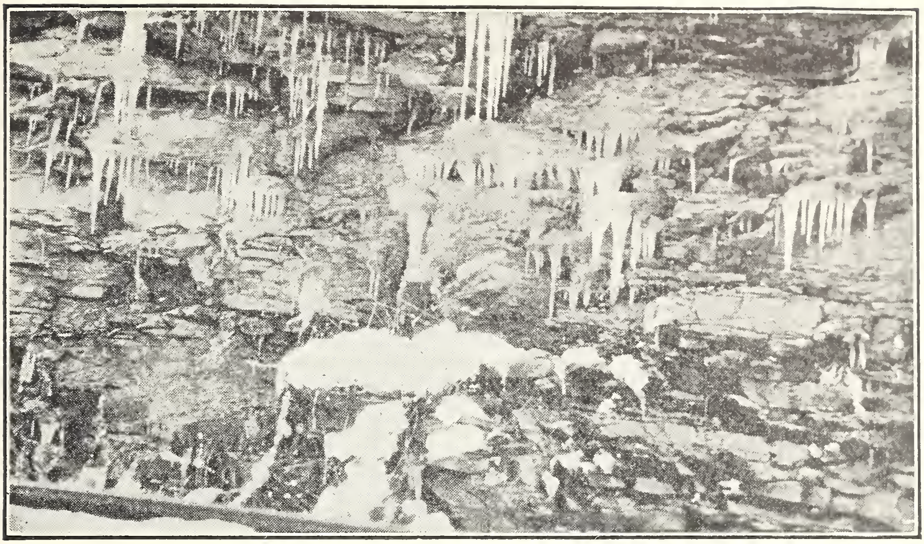
You must not think, however, that soil is not now being formed. If you will examine the soil when you are out-of-doors, no doubt you will see some rocks being changed into soil right in your own neighborhood.

Did you ever try to pick up what looked like a piece of stone and have it crumble in your hands? If you have had this experience, no doubt you wondered what had softened the hard rock. Such a change as that which had taken place in the rock is known as weathering. Weathering is brought about largely through the work of air,

WATER AND WIND CAN CUT ROCK AWAY TO FORM SOIL.

water, and changes in temperature, from hot to cold and from cold to hot.

No doubt you have seen a piece of iron rusted from being in moist air. Iron, as you know, is a very hard substance, but iron rust is so soft that it will rub off on your hand. When a piece of iron is rusted through it will crumble, just as the rock did that you picked up. Many rocks contain iron, and there are other substances in them, too, that are "weathered" by water, leaving the rock



WATER FREEZING IN THE CRACKS OF ROCKS SPLITS THEM TO PIECES.

soft and porous. Rock is said to be porous when it lets water pass through it. Rain water takes up carbon dioxide gas from the air, and this gas with the water forms an acid. You have probably seen acid in an automobile battery. The acid from the mixture of carbon dioxide and water dissolves substances out of rocks and helps to weather them.

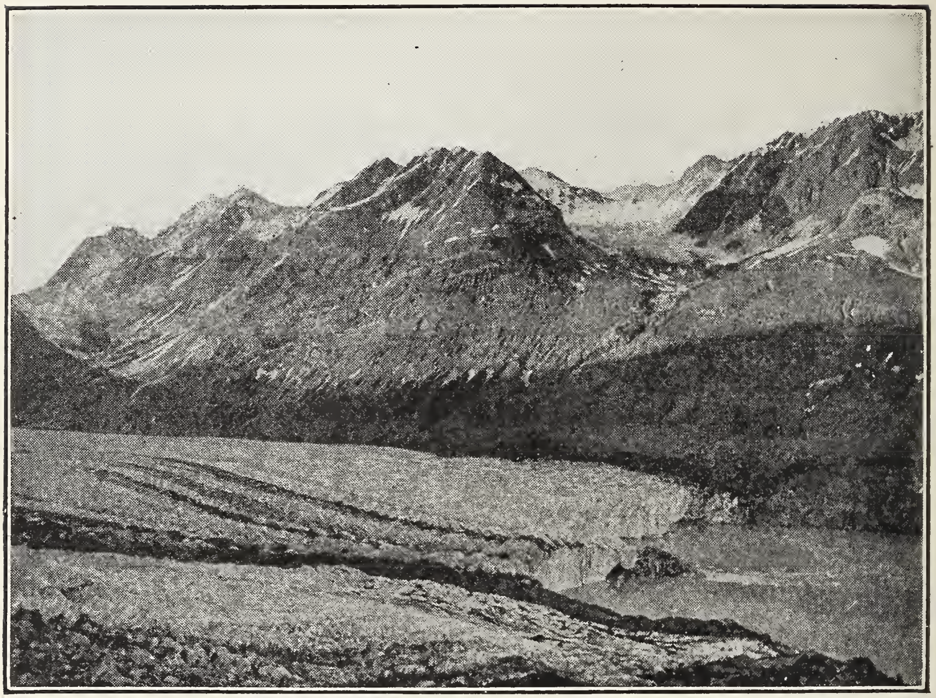
Have you ever seen a bottle broken by freezing water? If you have, perhaps you wondered why it happened. The reason is that the ice takes up more space than the water from which it was formed. Water freezing in the cracks of rocks splits them to pieces in the same way that the ice breaks the bottle. As the water in the crack freezes, it expands and makes the crack larger. In regions where freezing and thawing occur many times during the winter, large rocks may crumble when spring comes. Farmers often plow their fields in the fall. Plowing sometimes uncovers rocks and brings them to the surface where they crumble faster than they would under ground. Can you think why?

If you have ever watched a stream or a river, you know that it gradually wears away the surface of the rocks over which it runs. Even clear water dripping continuously upon one spot in a hard rock will make a hole in it. The running water of a stream usually carries with it soil, pebbles and sometimes large stones, which are rolled along on the bottom. These pebbles and stones go tumbling along, rubbing against each other, and slowly wearing themselves away. You can easily imagine, too, that the soil and the stones that are carried by a stream help to wear away the surface of the rocks over which it runs.

Did you ever learn what causes a waterfall? Some rocks are softer than others, and are, therefore, more easily worn away by running water. As a stream passes from a bed of hard rock to one that is softer, which may be washed away, a waterfall is formed. Niagara Falls was formed where the Niagara River passed from a bed of hard limestone to a bed of softer rock. You will be interested to learn that the water at Niagara Falls is cutting its way back through the limestone at the rate of about four and one-half feet each year.

Glaciers have also worn down rocks. A glacier is a sheet of snow and ice that moves over

A STREAM PASSING FROM A BED OF HARD ROCK TO ONE THAT IS SOFTER WEARS AWAY THE SOFTER ROCK, FORMING A WATERFALL.



GLACIERS CREEP SLOWLY DOWN MOUNTAIN SIDES, CRUSHING THE ROCKS OVER WHICH THEY PASS.

the surface of the earth. Have you ever seen a picture of a glacier? Thousands of years ago a great glacier moved down from the far north until it covered the northern part of the United States. As it moved along, it crushed many of the rocks over which it passed, and scoured and scratched the surface of others. Some of the scratches made by the great glacier can still be seen. Quantities of soil and of rock were carried along by the ice sheet to places many miles away. Glaciers are frequently formed on high mountains. They creep slowly down the mountain sides, crushing the rocks over which they pass. Every spring small sheets of ice and snow slide down hillsides and along river valleys. Many of them are not large enough to be called glaciers, but they help to grind the rocks on the earth's surface into soil.

Even the wind helps to wear away the surface of rock against which it blows. Like running water in the stream, the wind will crumble the rock more easily if the moving air carries with it particles of sand. Strong winds help to tear down the cracked and broken rock surfaces of cliffs against which they blow. Probably you have seen men clean stone buildings by blowing sand against them.

Have you ever seen plants growing right on bare rock? Lichens are simple, rootless plants that stick to the surfaces of rocks. There are lichens of different colors—brown, orange, blue, scarlet, gray, yellow, or white. If you have never noticed them, you can probably do so on your way home from school for they grow almost everywhere from mountain tops to seashore, and from the equator to the frigid zone. They look almost like thin cushions on the rock surface.

Lichens are the plants that grow most easily. They grow on rocks so hard that no other plant could find a foothold on them. As they grow, they give off a liquid that in time causes the rock to begin to crumble. In this manner they prepare the way for other plants.

The growing roots of the larger plants push their way into the cracks of rocks, widening them much as freezing water does. The juices of the

LICHENS ARE SIMPLE ROOTLESS PLANTS THAT GROW ON THE SURFACE OF ROCKS.

plant help along the crumbling by taking away certain substances from the rocks into which the rootlets have grown.

You must not think, however, that soil is made up altogether of crumbled rock, or "rock flour," as it is sometimes called. Fertile soil is a mixture of a number of substances. In addition to "rock flour," it must contain humus, a black or brown substance that is made up of decaying plants. You will learn more about humus in another chapter.

SOME THINGS TO THINK ABOUT

1. How does water help to cause rocks to crumble into soil?
2. How does the air help to form soil?
3. How do changes in temperature help to form the soil?
4. What causes waterfalls?
5. Tell how the great glacier that covered a part of North America helped in soil formation.
6. Explain how lichens prepare the way for other plant life.

SOME THINGS TO DO

Examine some soil under a magnifying or reading glass. Can you see that it is made up of bits of rock?

Find rocks that show the result of weathering. If possible, find some that seem almost ready to crumble into soil.

Crush them, using a hammer if necessary. How does the rock flour that you have made differ from the soil in your neighborhood?

Crush enough rock so that you can fill a small flower pot with rock flour. Fill a similar flower pot with soil from your garden. Plant some of the same kind of seeds in each, and compare the growth of the plants.

CHAPTER XXIII

SAND, CLAY, AND LOAM

1. Describe some of the different kinds of soil that you can find in your neighborhood.
2. What has caused the differences that you notice?
3. Have you ever made marbles out of clay?

If you will look about you, you will discover that all soil is not alike. Perhaps sometime you have played in the light, fine sand on the beach of a lake or an ocean. If you have, you know how sand feels when you pick it up. If you were to examine it under a microscope, you would find it made up of grains that look almost like bits of glass. Sand is usually composed of bits of quartz and feldspar.

Clay is very different from sand. It is made up of very fine particles of rock. Perhaps you have used clay for modeling. If you have, you know that it is sticky and slippery when wet, and that it becomes very hard when it dries. If you have ever walked on wet clay, you know that it sticks to your shoes and that it is very hard to get off when it dries. Clay is used in the making of pottery and bricks because it sticks together and gets very hard when it dries. In the garden clay is not so useful, as you will know if you have ever cultivated a soil that had hard lumps in it.

Loam is another kind of soil and it consists of

CLAY SOIL IS MADE UP OF VERY FINE PARTICLES OF ROCK.

a mixture of clay, sand, and humus. It is the best soil for growing plants. If there is more clay than sand in the mixture, it is called a clay loam. If there is more sand, it is a sandy loam.

Humus is a mixture of decayed plant and animal matter. It serves as plant food, and also makes spaces in the soil so that air and water may enter freely. You recall that the earthworm makes the soil porous. Both air and water are important to the roots of the growing plant. You can easily tell why plants do not grow well in hard clay.

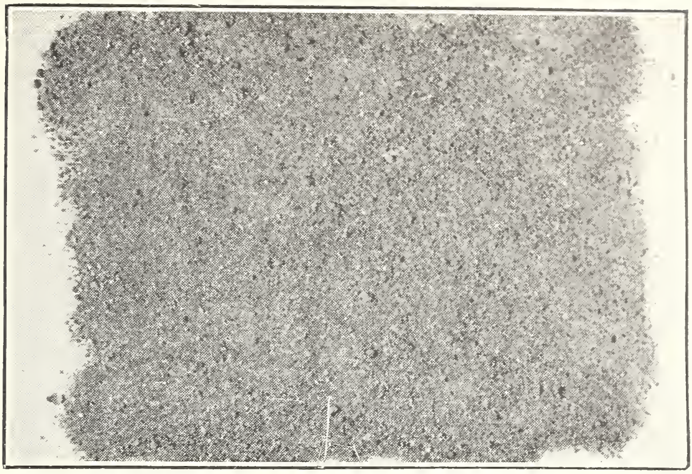
The roots of the plant cannot take in dry food. Instead they absorb water in which is the food they need for growth. From this you might think that the best soil would be that which had water standing in it and was therefore very wet. If you have ever cared for a plant in a flower pot, you know that this is not true. If water

LOAM IS THE BEST KIND OF SOIL FOR GROWING PLANTS.

stands in the soil, air is kept away from the roots of the plants. For that reason plants in pots should not be watered every day.

You know that water runs through sand very quickly. A sandy loam dries out quickly and, unless rains are very frequent, plants will not grow well in it. A sandy soil holds little water, for the particles are coarse. A clay loam holds water well, and if it is rich in humus, the water can sink into it and drain down through it easily. However, a clay soil is difficult to cultivate, and it packs in hard lumps into which the garden plants cannot push their way. Then, also, it is a cold soil, for water evaporates from the surface and cools it. You may perhaps have felt how cool your hand becomes when gasoline evaporates from it.

Garden plants grow best in a loam that has considerable sand in it, for it is warmer than a clay loam. The water sinks into it, you see, in-



SAND DRIES OUT QUICKLY, THEREFORE PLANTS DO NOT GROW WELL IN IT.

stead of evaporating from the surface. It is not so hard for plants to push their roots into a sandy loam as it is into a clay loam where the particles cling tightly together. Farm crops such as corn, wheat, oats, and grass thrive on a loam that has more clay in it.

Of course the sandy loam in your garden must have humus added to it frequently. The plants that grow in any soil take out the elements they need to build into their bodies. Then, too, the water which runs down through the sand so rapidly carries some of the plant food with it down beyond where the roots can reach it.

You learned in the first chapter about making a compost heap by piling manure and dead parts of plants from the garden in layers and allowing them to rot. This well decayed organic matter can be mixed with the top soil when you spade your garden in the spring.

SOIL RICH IN VEGETABLE MATTER TOGETHER WITH CLAY OR SAND MAKES GOOD SOIL FOR PLANTING.

Stable manure, alone, can be used to mix with the soil, too, but the plants cannot use the organic matter in it until it has decayed. The humus which you add to a sandy soil helps it to hold more moisture. That which you add to clay soil makes it more porous so that the water can sink into it instead of standing on the surface to evaporate and cool the ground.

From this, you can see that whether your garden plot is clay or sandy loam, it is important that you add humus to it. If you made a compost heap last fall, you will be glad to have it to work into your garden this spring.

SOME THINGS TO THINK ABOUT

Fill the blanks in the following sentences with the words: loam, clay, sand, sandy, humus.

1. ..... is made up of very fine particles of rock.
2. ..... consists of coarser particles of rock.
3. ..... is a mixture of clay, sand, and humus.
4. ..... is decayed plant and animal matter.
5. Water runs through ..... more quickly than through ......
6. A ..... loam is colder than a ..... loam because more water evaporates from the surface.
7. ..... is slippery and sticky when wet.
8. A ..... loam is harder to cultivate than a ..... loam.

SOME THINGS TO DO

Bring some sand and some clay into the classroom to study. Put some of the clay into a small flower pot, and some sand in another. Add water to both, and notice how much longer it takes for the water to drain through the clay. Set both flower pots in the sun. When the water has disappeared from the surface, test the temperature of each soil with a thermometer.

Get some sandy loam and some clay loam. Test them in the same way.

Collect samples of soil from different places in your neighborhood. Put them in small glass bottles. Label them—sand, clay, sandy loam, or clay loam.

CHAPTER XXIV

KEEPING SOIL GOOD FOR PLANTS

1. What does a gardener mean when he says that the soil in his garden is worn out?
2. What is a fertilizer?
3. What is meant by crop rotation?

Scientists who have studied plant life have found that plants need fourteen different kinds of things to live. Every plant does not need all fourteen of them, however, and the different plants require different mixtures of them. Three of the most important of these things or elements, as they are called, are supplied by the air and the water. They are gases known as carbon, hydrogen, and oxygen. The other elements must be obtained from the soil.

When a gardener says that the soil in his garden is worn out he means that some element needed by his garden plants is not there. Soil may be worn out because it lacks one of the elements that the plant needs.

Of all the elements that the growing plant gets from the soil, only four are likely to be used up. The others generally remain in the soil. The four that are used more have difficult names. They are called nitrogen, potassium, phosphorus, and calcium. You can buy fertilizers that contain these elements.

A fertilizer is any substance that helps to increase the supply of plant materials in the soil. You have already learned something of the use of manure and the decayed parts of garden plants to make the soil richer. These are the most commonly used fertilizers, but you can buy fertilizers that contain the things needed for plants to grow. Have you ever seen sacks of lawn fertilizer?

As you know, the plant can never use dry food. The roots can take in only the food that is in the water of the soil. Manures must decay before they will supply usable plant food. Before adding fertilizer to the soil, however, you must know what is missing in the soil to make the plants grow. Fertilizers that are made for sale usually have only one kind of plant food. Natural fertilizers, such as stable manures and compost heaps, have different kinds of plant food and can be used for almost any plant need. If you are not careful you can put too much of one kind of food in the soil, and do more harm than good.

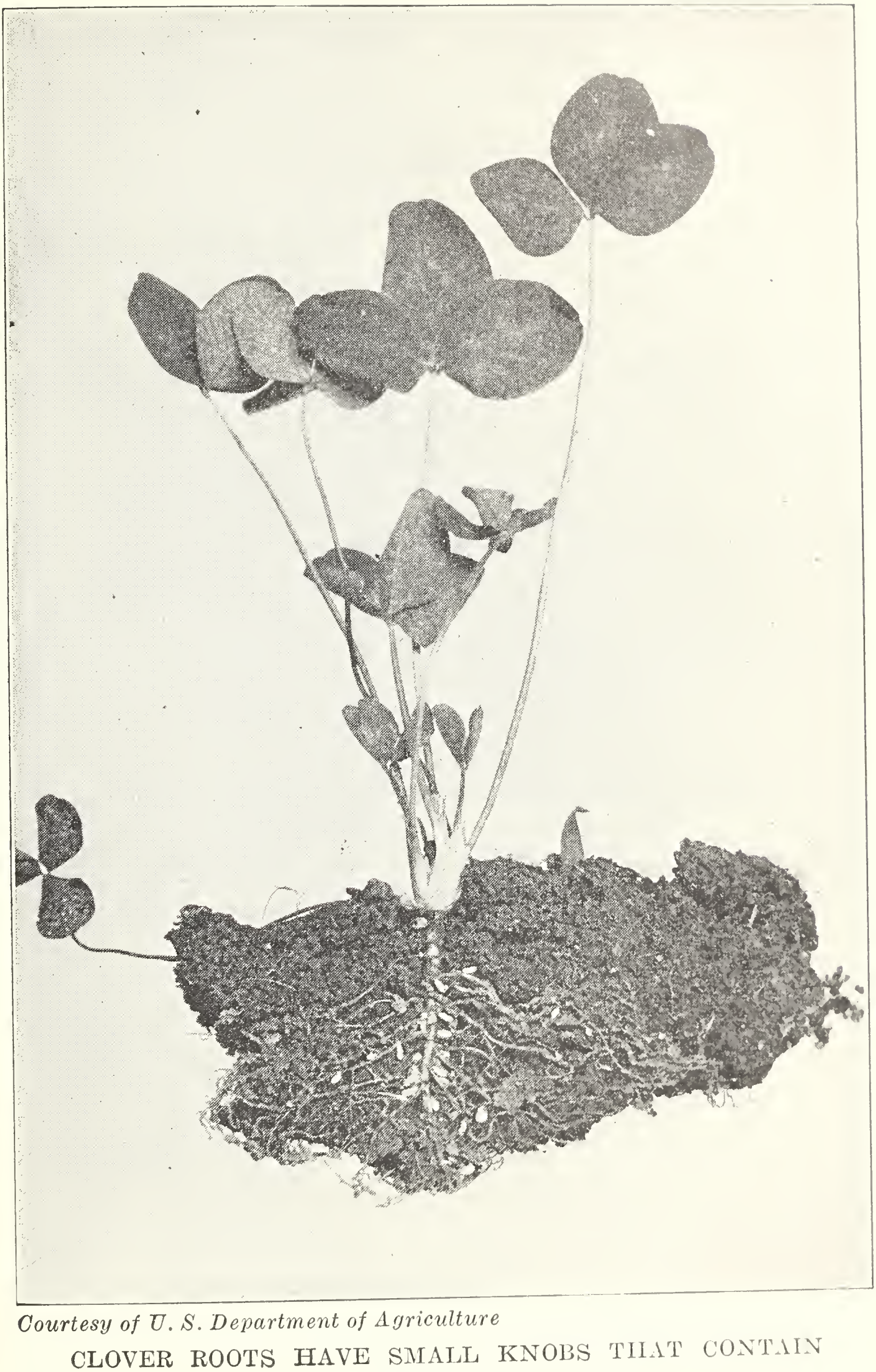
Nitrogen, for instance, is a leaf builder. Lettuce, spinach, cabbage, and other crops grown for their leaves need a large amount of nitrogen. Crops grown for their roots and seeds need less nitrogen, and if you were to add a nitrogen fertilizer in large amounts to the soil in which these crops grow, you would probably find that the plants developed large leaves, and that the other parts would be small. Have you ever heard a gardener say that some of his root crops all grew up to tops? He meant that the plants developed many leaves, but the roots were small. This would be good if the leaves were the part that you wished to use, but you would not like it so well if you were raising a crop of turnips or carrots.

Nitrogen is one of the gases that are found in the air. You would think that the garden plants, therefore, would have no difficulty in getting as much as they need. They take in carbon dioxide from the air, you know, and use it in building their bodies, but they are not able to take in nitrogen in the same way. They must get it combined with other elements.

There is one class of plants known as the legumes that take nitrogen from the air and unite it with other elements into a form that other plants can use. Peas and beans are legumes, and so are clover and alfalfa. In a later chapter in this book, you will learn that it is not the legumes that take nitrogen from the air, but something inside small knobs on their roots. Probably you have already heard it said that clover enriches the soil. If you examine clover roots you will find small knobs in them that contain the nitrogen.

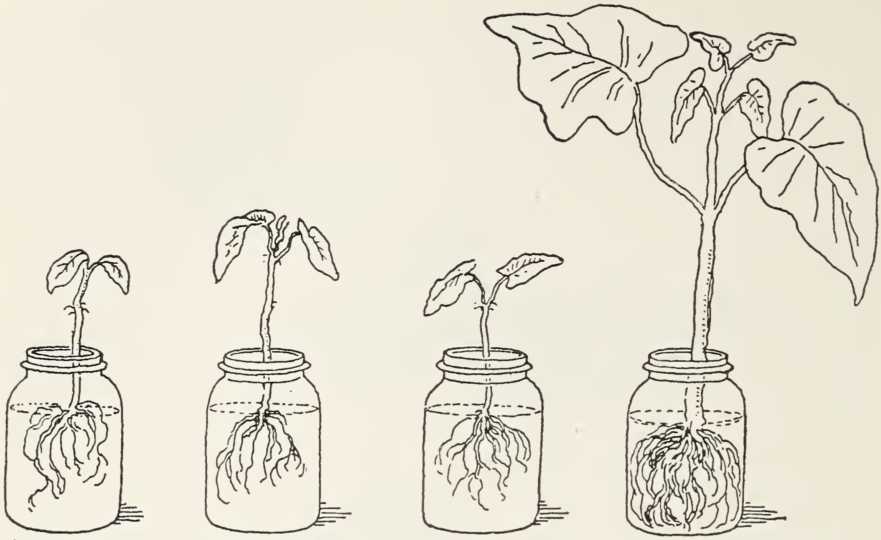
If peas and beans are raised on a part of your garden, the soil there will be pretty sure to have enough nitrogen in it for spinach and other leaf crops the next year, particularly if the legumes are allowed to decay and are spaded into the soil.

In making your garden plans, you should not plant the same crops in the same rows year after year. The farmer changes the crops that



Courtesy of U. S. Department of Agriculture

CLOVER ROOTS HAVE SMALL KNOBS THAT CONTAIN NITROGEN.



THIS PICTURE SHOWS THE EFFECT OF THE ABSENCE OF ANY OF THE THREE ELEMENTS, NITROGEN, POTASSIUM AND PHOSPHORUS. THE PLANT IN THE JAR CONTAINING THE THREE ELEMENTS HAS GROWN NORMALLY.

he plants in his fields season after season. He calls this crop rotation. You know, of course, that to rotate is to go around something. Some farms in the south that have been used to raise tobacco year after year have become very poor in the plant food needed for that crop. Many of the southern farmers are now learning to raise different crops on the same soil every year. The soil where tobacco has been raised is worn out for tobacco, you see.

Nitrogen may be bought in the form of nitrate of soda. It is also found in dried blood, ground fish, tankage, bone meal, and cotton-seed meal, all of which may be bought for use as fertilizers. If you see the leaves of plants turning yellow before it is time to harvest the crop, this is a good sign that nitrogen is needed. Any of the fertilizers mentioned above may be used, but nitrate of soda will probably give you the quickest results. The fertilizers that supply nitrogen should always be applied in very small quantities, otherwise the plants are apt to die.

If phosphorus is lacking in the soil, fruits will not develop well on the plants. Phosphoric acid is a compound of phosphorus that is found in fruits, and so of course is needed for their growth. Many commercial fertilizers contain phosphorus, among which are bone meal and rock phosphate.

Potash, which contains potassium, is the builder of fibers in plants. It is needed by all plants, but is required in large quantities by the root crops—turnips, carrots, parsnips, and radishes. The cheapest source of potash is wood ashes. Potash is the part of the fiber of the tree that does not burn, and is left as ashes. Sometimes wood ashes with a little poison is dusted on plants to kill insect pests. At the same time, the ashes enrich the ground.

Soil often contains too much acid for plants to grow in it. Litmus, a dye that is sold on strips of colored paper, is used to test the soil. Moist soil having acid turns the blue litmus paper pink. If the soil is acid, lime may be added to it in small quantities and this helps the plants to grow better.

Of all the fertilizers that you might use, stable manure is the safest, and is often the one that can be had more easily. Fertilizers that are sold in stores often show bad effects if they are not applied well, while stable manure may be added to the garden year after year. It contains many different kinds of plant food; it makes clay more porous so that water can sink into it, and it makes sandy loam hold water better.

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 *Yes* beside the number. If it is false, write *No.*

1. Any kind of commercial fertilizer is good for any kind of soil.
2. Potash is found in wood ashes.
3. Bone meal contains both phosphorus and nitrogen.
4. Nitrogen is found in the air.
5. It is best to plant the same crops on the same soil year after year.
6. It is a good thing to add lime to acid soil.
7. Potash is the fiber builder in plants.

SOME THINGS TO DO

Collect samples of as many kinds as possible of fertilizers that are sold in the stores.

Experiment with them by adding them to soil and growing different plants in it.

Different members of your class may think up problems that you may solve for yourselves in this way. For example, it will be interesting, too, to watch the results of applying fertilizers bought in the stores, in different amounts. You could work out your problems using small sections of the garden, a window box, or flower pots.

CHAPTER XXV

PLANNING YOUR GARDEN

1. Do you expect to have a garden of your own this year?
2. If so, what is the size of it?
3. If not, would you enjoy making a plan for a garden that you might have some day?

There are many kinds of gardens. In the country and in small towns, almost every family has a garden that supplies them with vegetables for the table. In crowded sections of the city, where there are neither backyards nor vacant lots, plants may be grown on roofs, on porches, or on window boxes. In such locations, flowers are more often grown than vegetables.

Whether your plot of ground is large or small, the first step in gardening is to make a plan. This should be made during the winter or in the very early spring, so that by the time you can work in the garden, the plan is completed.

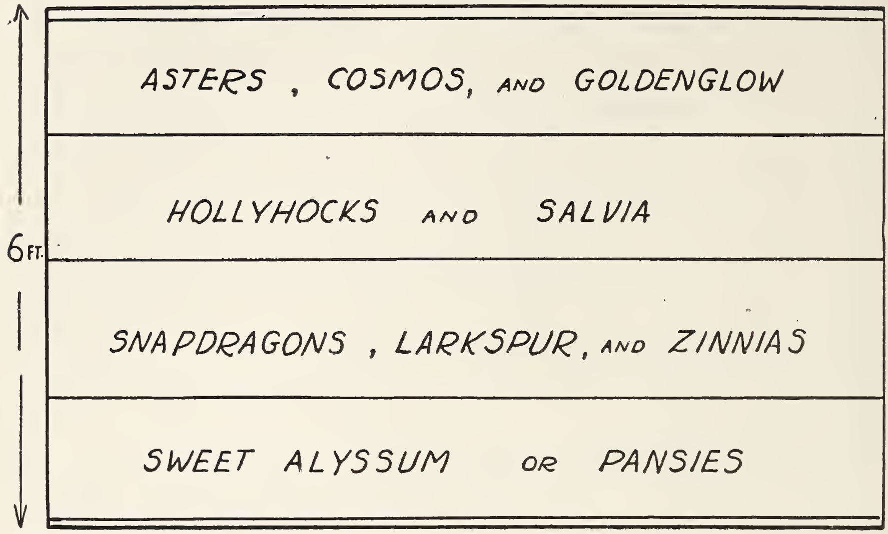
If your vegetable plot is small, you will no doubt wish to raise such crops as radishes, lettuce, and spinach, but if you have a larger space, you may decide to plant corn and potatoes as well. In planning, you must take into account the size of your particular garden.

You will need to consider, too, the kind of soil in your plot and how much sunshine your plants will get, in order to select crops that will grow there. To make a good plan, you must know the best time for planting each crop, and the length of the growing season needed for each. This information is very important if the plot is small, since you will no doubt want to use the ground more than once by planting early crops that grow rapidly followed by others to be harvested at the end of the season.

A few good seed catalogues will help you in making your garden plan. Many of them advise you as to the time for planting the different kinds of seeds. Some catalogues tell also the time required for the crop to grow, and how far apart the rows should be.

Sometimes gardeners speak of the garden plants that may be started as soon as the ground is ready to work in the spring, as the cool-season crops. Leaf lettuce, early peas, kohl-rabi, cress, radishes, early spinach, and early beets are cool-season crops that are full grown in a short time, and can be replaced by others that grow better later in the season. Among the latter are the late peas and beans, cucumbers, muskmelons, watermelons, squash, lima beans, and okra.

Head lettuce, cauliflower, cabbages, and tomatoes should be started early, but they can not be harvested in time to put another crop in their places. Since the plants for these crops are started indoors and are not set into the garden until the weather is warm, it is possible to raise



YOU MAY WANT A BORDER OF FLOWERS IN YOUR GARDEN.

a crop of radishes or lettuce first on the plot that they are to occupy.

The roots of some plants become strong during the cool moist spring, but are not full grown until late summer or autumn. Among these are carrots, parsnips, and beets.

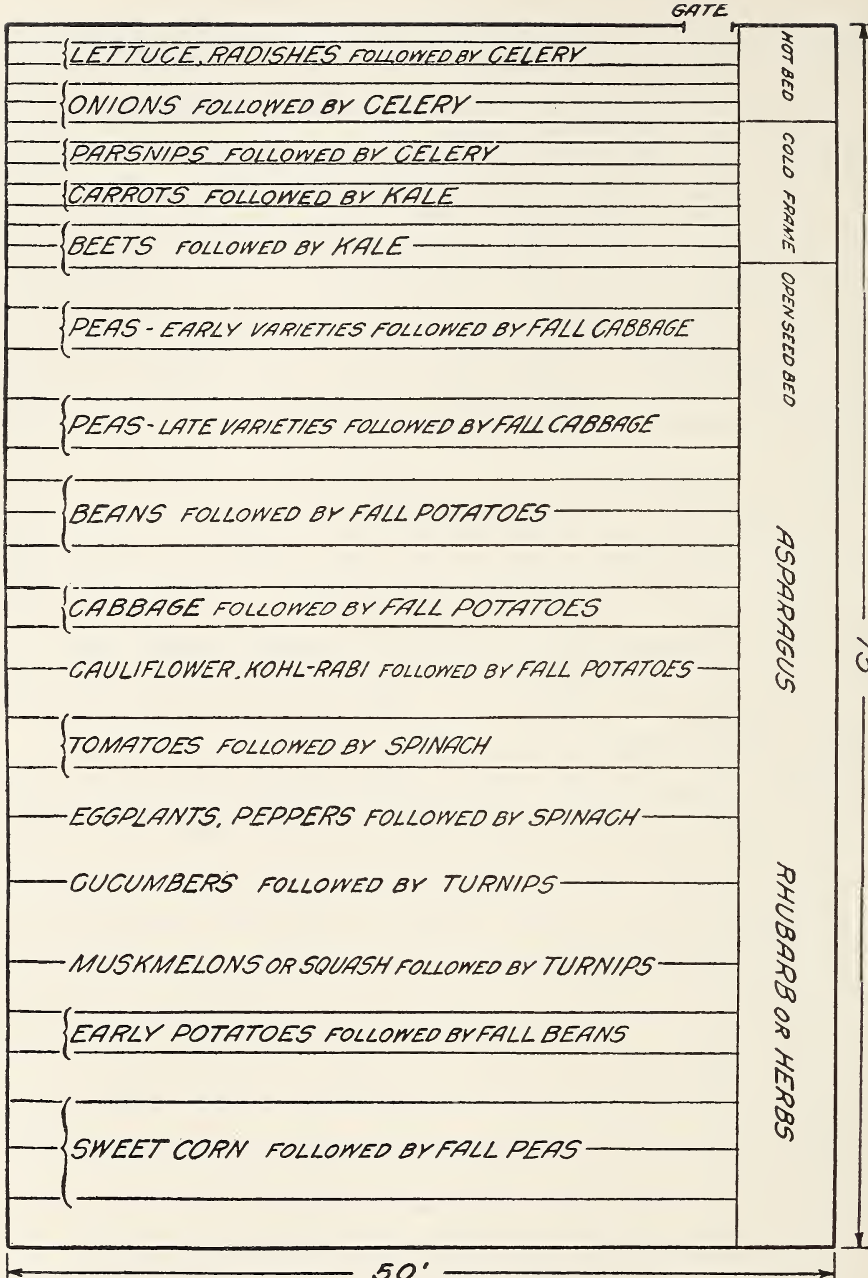
Perhaps you will want a border of flowers in your garden. There are many from which you may choose. You will want the tallest plants for a background—asters, cosmos, and goldenglow, probably. In front of these you may want a row of dahlias or some hollyhocks. If you decide upon the hollyhocks, you might plant some salvia among them. After the hollyhocks have stopped blooming, they may be cut down to make room for the salvia, which will be beautiful in the autumn. You may want some poppies, mignonette, snapdragons, calendulas, larkspur, marigolds, or zinnias. In the foreground, a row of smaller plants may be grown—pansies or nasturtiums.

In planning the border you should think of the colors, as well as the kinds of flowers, and plan so that the colors will go well together. You can be helped in your planning by studying the seed catalogues, many of which have colored illustrations. Notice that many of the garden flowers are perennials that will come up again season after season, and think of this in making your plan.

If you are to have a garden it will be well for you to measure your plot and draw a diagram of it as you would like to have it. If you do not have a garden now, probably you would find it interesting to plan one that you would like to have some day.

The plan shown here will help you, but you will not want to make one exactly like it. You must decide first what crops you wish to have and then make your plan to fit your own needs. The time for planting is not the same in all sections of the country. The seed catalogue, if put up in the part of the country where you live, will give you useful information. You can learn more, however, by talking to some successful gardener in your own neighborhood.

Your diagram will not only help as a guide in planting your garden, but it will also be a record that will help you in your planning next year. If this is your first year of gardening, you will make some mistakes. Perhaps you will find that some crops will not grow in your plot, or that



CROP ROTATION PLAN FOR VEGETABLE GARDEN.

some of your early vegetables were not ready to harvest in time to grow another crop, as you had planned. These are but a few of the many things about gardening that you will learn by experience. Indeed, you will find that learning by doing is one of the most interesting results of having a garden.

SOME THINGS TO THINK ABOUT

1. Name the vegetables that are raised in the gardens in your neighborhood.
2. From the seed catalogues, find the names of as many other vegetables as you can.
3. Which of these do you think would grow in your garden?
4. Name the garden flowers that are grown in your neighborhood.
5. Make a list of others that you would like to try to raise.

SOME THINGS TO DO

Collect seed catalogues, and make a plan for a garden. If you can get a plot of ground, make a school garden. This can be planned for a group, while each member of the class may plan his own home garden.

It is best to draw your garden diagram to scale. You have probably drawn maps to scale, so you will know how this should be done.

CHAPTER XXVI

PLANTING THE SCHOOL GARDEN

1. How is the soil in the garden prepared for the planting of the seeds?
2. Have you ever raised plants indoors to be transplanted to the garden?
3. Describe a hotbed.

If you have ever helped to make a school garden you know that it is very much like the garden that you will probably have in your backyard at home. Usually a school garden allows a plot about four feet wide and eleven feet long for each child. Each boy and girl is allowed to plan his own garden and plant it when the right time comes. Many of the ideas about gardening that you will gain from this chapter apply equally to a school or a home garden.

A few simple garden tools are necessary to do the garden work. The spade and fork are used for digging in the ground. Some people use the spade, and others prefer the fork. The fork is also used to harvest such crops as potatoes which grow under the ground. For this reason, it is sometimes called the potato fork.

The garden rake has many uses. After the ground is spaded, the rake is used to break up

Photograph by Ewing Galloway, N. Y.

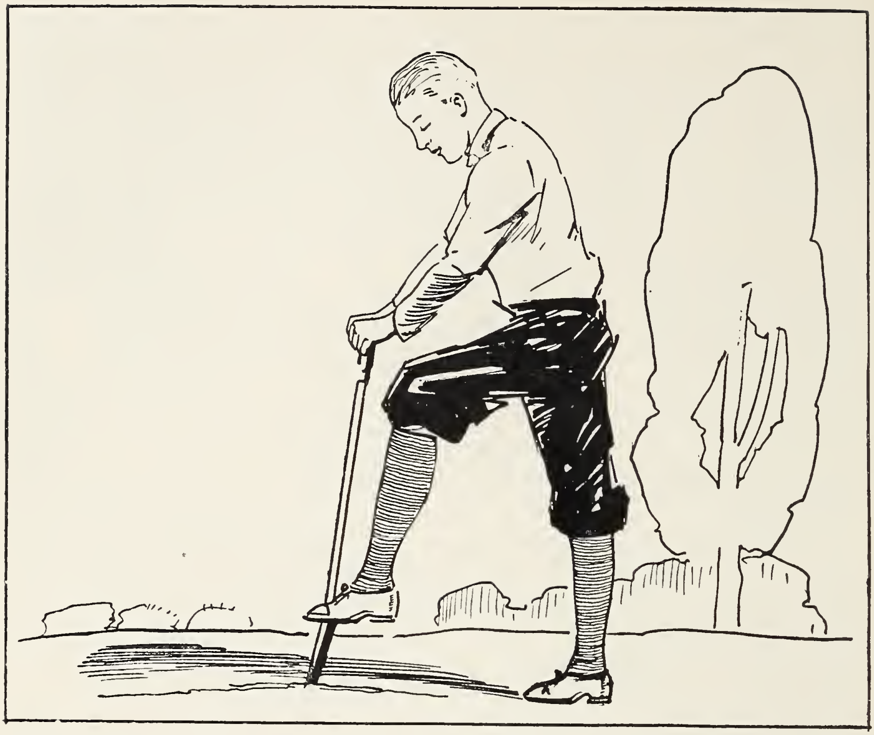
USUALLY A SCHOOL GARDEN ALLOWS A PLOT FOUR FEET BY ELEVEN FEET FOR EACH CHILD.

clods and to prepare the seed bed. It is also used to make rows for planting.

Perhaps you are already familiar with the hoe. There are several kinds of hoes, each of which has its special use, but the common hoe is most helpful for work in the garden. It is useful in planting, weeding, and cultivating.

To make straight rows you will need a line and stakes. Ordinary string will serve for the line, and pieces of board about one inch square and two feet long can be used for stakes.

A trowel is used in transplanting cabbages, to-

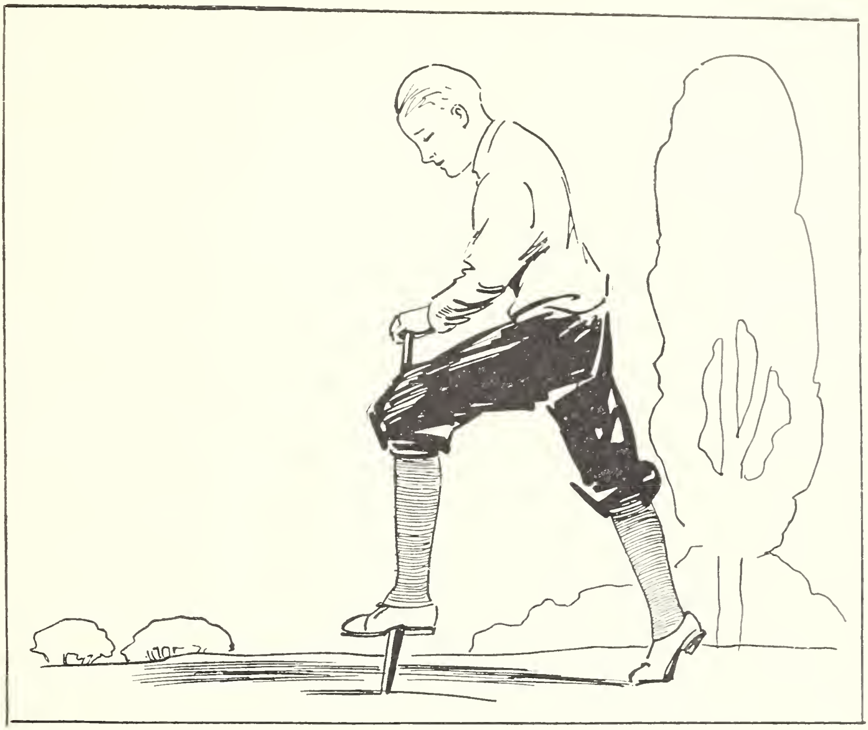


THE RIGHT WAY TO SPADE. IN THIS POSITION THE FORCE OF THE WHOLE BODY GOES IN THE OPERATION.

matoes, and other plants, and in making rows for very small seeds. The kind most commonly used has a curved blade about five inches long.

A watering-pot which holds about two gallons will be useful to water plants and to spray the leaves of potatoes and cucumbers with Paris green or arsenate of lead.

There are other garden tools which you may use, but these are the most essential. It is important to buy a good grade of tools and to keep them in good condition. A few simple tools well cared for will be a source of pleasure while working in the garden.



THE WRONG WAY TO SPADE. THIS METHOD IS TIRESOME AND DEVELOPS SERIOUS PAIN IN THE INSTEP.

First of all, of course, you must prepare your garden for planting, whether it is at home or at school. Large gardens are usually plowed, but plots that are too small for the horse and plow to move about in are spaded instead. While spading a garden is a difficult task, it is the best possible way of preparing the soil.

Gardens are sometimes spaded in the fall, and sometimes in the early spring. Occasionally a garden may be plowed in the fall, and then spaded in the spring. Of course you will want to begin working the soil of your garden as early as possible, but you must wait until the soil is ready.

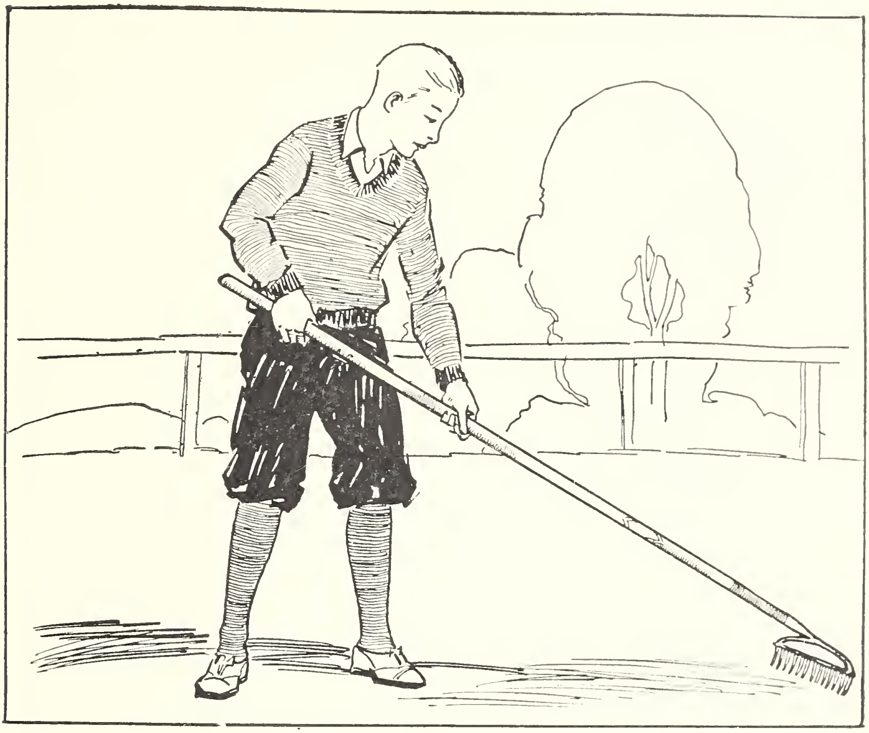
It should not be so wet that it will cake or cling together in lumps; instead, it should fall loosely apart when you strike it with your spade.

One good way to spade is to lift the soil with the spade, turn it over, and drop it again in the same place, breaking the large lumps and clods by striking them with the spade. In England a method known as trenching is used, but that is rarely done here. While you are spading, remember that the soil should be made fine, not only on the surface but from eight to ten inches in depth before planting. You must be ready to give plenty of time and hard work to the soil. It is on the proper preparation of the soil that the success of a garden depends.

Unless the soil of your garden is already rich in humus, it is a good plan to add manure. This can be done by spreading manure on the surface of the ground before you start to spade, and then working it into the ground as you go along. Other fertilizers may be added at this time, too. Do you recall the different kinds that may be used?

The next step is to work the soil thoroughly in order to break up the lumps that were not broken by the spade. You will probably use a hoe and a rake for this purpose. Remember that the good gardener makes sure that his soil is fine and porous before he plants a single seed.

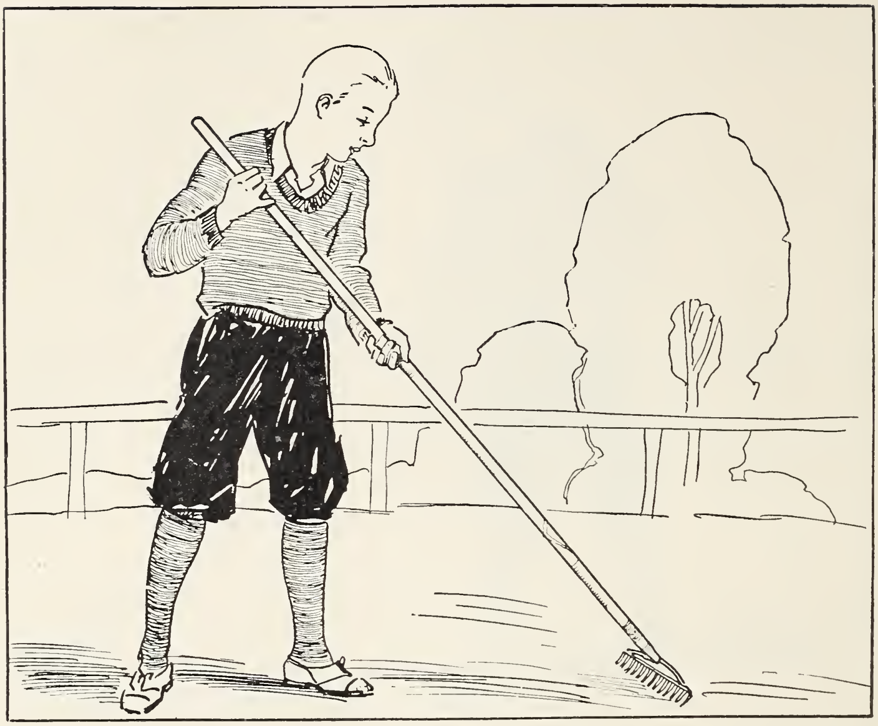
Your plan has been made before you start to spade your garden, so when you have completed your preparation of the soil you are ready to begin



THE RIGHT WAY TO HOLD A RAKE. THE BODY IS FREE TO DO ITS SHARE OF THE WORK AND THE ARMS HAVE PERFECT CONTROL OF THE RAKE.

planting. Some seeds can be planted right in the garden. Other plants will have to be started in the hotbed, or in boxes in the house or schoolroom since they require a long season in which to grow and cannot stand the cold weather in the early spring. Among these plants are cabbage and tomato plants, which will have to be started inside and transplanted later in the spring.

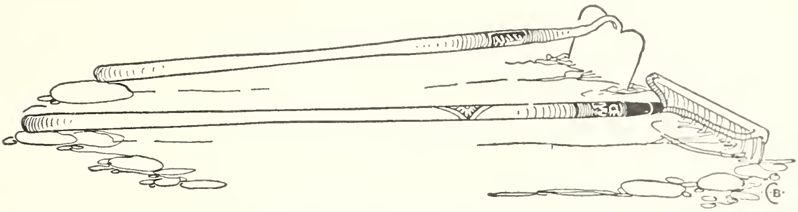
If you have no hotbed you may raise these plants in a box, inside the house. Select a box about three or four inches deep with holes drilled in the bottom for drainage.



THE WRONG WAY TO HOLD THE RAKE WHILE RAKING THE SOIL. NOTICE THE POSITION OF THE HANDS.

Fill it with garden loam. Scatter the seed on the surface, covering it to its own depth by sifting a little soil over it. Water it well, but use a fine spray. Do not flood the surface.

When the seedlings appear, the box should be kept in the warm sunlight. If the plants seem to be crowding each other before it is time to set them into the garden, you may transfer them to a larger box. You may wish, also, to start summer squash, cucumbers, or beans in your indoor box so as to have an earlier crop of them. While these plants will not stand transplanting as well as your cabbages and tomatoes, you can man-



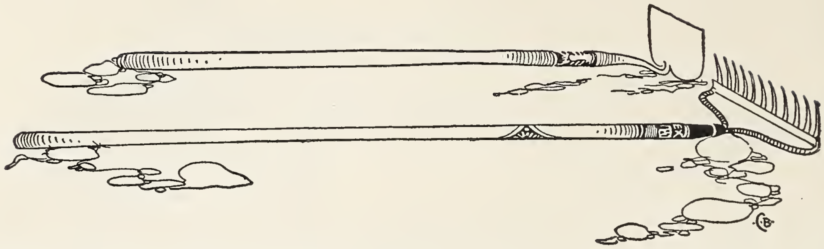
THE RIGHT WAY TO LEAVE THE RAKE AND HOE WHEN NOT IN USE.

age it by raising them in single strawberry boxes, from which you can remove the sides and bottom when you wish to transfer the plant into the garden. In that way you need not disturb the roots at all.

It is interesting to raise your own plants for transplanting, but keep in mind that when you want a small quantity of tomato or cabbages they can easily be bought.

Plants should be watered thoroughly several hours before they are to be transplanted, for wet soil will stick to the roots better than dry soil. Transplanting should be done on a cloudy day or in the late afternoon. Holes are made with the hand or the trowel in the garden soil. The plants are lifted from the box or cold frame with as much soil as will stick to the roots. They are placed in the holes and the soil is packed around them carefully. If the garden soil is dry, water should be placed in the holes before the plants are set into them.

The first seeds that you will probably sow will be radish, lettuce, onions, smooth peas, early spinach, and early beets. These may all be



THE WRONG WAY TO LEAVE THE RAKE AND HOE WHEN NOT IN USE.

planted as soon as the soil is fit to work. Each of these vegetables can stand cool weather and plenty of rain, and both of these are common in the spring. Another group of vegetables that may be planted quite early are those known as "long season crops"—carrots, parsnips, early potatoes, Swiss chard, parsley, and cabbage. These grow well during the cool, moist spring, can stand the heat of summer, and are full grown by the summer or autumn.

Perhaps you like to have fresh radishes, onions, and peas all summer long. You may have them by planting your seeds a week or two apart, so that you will always have peas or string beans or radishes "coming on." Of course you will need to supply additional moisture for these crops when you plant them in early summer instead of spring. In the same way you may plant early and late cabbage, and early and late beets. In some sections of the country you may plant sweet corn three times in July—on the first, on the fifteenth, and on the thirtieth—which will allow a long season in which to enjoy it.

Sweet corn is one of the vegetables that matures in a short, warm season. Others in this group are cucumbers, string beans, muskmelons, squash, and pumpkins, none of which can be planted until the soil is warm. Another group of hot weather vegetables includes tomatoes, egg-plants, peppers, and sweet potatoes. All of these must be started in hotbeds, or indoor boxes, since they take a long time to mature and cannot be planted in cool weather. While a light frost does not injure your early spring crops of radishes, lettuce, onions, and early peas, it would kill your small tomato plants if you set them out too early.

Lettuce is the most important garden crop for salads, and fortunately, it grows in almost every kind of soil. The ideal soil for it, particularly for head lettuce, is a sandy soil rich in humus. Leaf lettuce is sown right in the garden, but head lettuce must be started indoors, or in a hotbed, and transplanted to the garden after the soil is warm. Like the cabbage and tomato, it cannot stand cold weather. When you are setting out head lettuce, give it plenty of room. The heads should be about a foot apart each way. When the leaves reach a length of six to eight inches, they may be tied together at the top so that the inner leaves will blanch.

Some kinds of vegetables grow tall and must be supported. There are kinds of peas that will grow best with a little chicken-wire to support them. As your tomato plants grow tall, whittle sticks about two feet long and push the sticks on each side of the plant to hold it up.

TOMATOES GROW TALL AND MUST BE SUPPORTED WITH STICKS AND WIRE.

It is unnecessary to give you here exact directions for planting each of the different garden crops, since on the packages in which you buy your seed you will find these directions. It is important that you follow them accurately. You will find that even different kinds of the same plant must be treated a bit differently. The directions will give you hints about many things, such as to plant your peas in a furrow six inches deep, but to cover the seeds with not more than two inches of loam. Perhaps you will not see the reason for that, nor for many of the directions, but when you think that peas must have plenty of water, you will be willing to follow the directions that come with every package of seeds.

Then, as you start work in your garden, begin a garden diary. Keep a record of the temperature in the morning, at noon, and at night. Make a record of the planting of all seeds, whether in the hotbed or in the garden, and of the date upon which you did your transplanting. Later you will be happy to record the harvesting of your crops. Such a day-by-day record will not only make your gardening more interesting, but it will help you to plan your garden for next year. If you have made mistakes, you will want to correct them in your next garden. You will find it interesting to talk over your gardening adventures with someone else, and you are fortunate to have a school, as well as a home garden.

SOME THINGS TO THINK ABOUT

1. In connection with your work on the last chapter, you made a plan for a garden. Which of the plants that you have planned to raise must be planted indoors or in a hotbed, and transplanted to the garden?
2. When should you plant the seeds for these plants? When should the plants be transplanted to the garden?
3. How can you tell when to spade the garden?
4. From your garden plan, make a list of the different plants, the seeds of which are planted right in the garden. Tell how deep the seeds should be planted, and how close together in the rows.
5. Which seeds should be planted in furrows? Why?

SOME THINGS TO DO

The most interesting things for you to do in connection with this chapter are suggested right in the chapter itself.

Prepare the soil of your garden. Raise some cabbage, tomato or other plants indoors to transplant to it. The seeds for these should be planted about six weeks before it is time to spade the garden.

Plant the seed for your crops, following the instructions on the packages very carefully.

CHAPTER XXVII

WEEDING, CULTIVATING, AND HARVESTING

1. Why is it necessary to cultivate a garden?
2. Name some of the garden vegetables, and tell when they should be harvested.
3. Why are weeds harmful to the garden?

No doubt you have seen neglected gardens. What a great disappointment they must have been to their owners! When you have made a plan, prepared the soil, and planted the seeds, you have made a good start in gardening, but you must remember that it is only a start.

As soon as the garden plants begin to come up, weeds will also appear in your well-prepared beds. You will soon learn to distinguish them from your own seedlings by the difference in the shapes of their leaves. Weeds usually grow faster than the garden plants, and if you do not begin at once to pull them out, they will soon crowd out your crops.

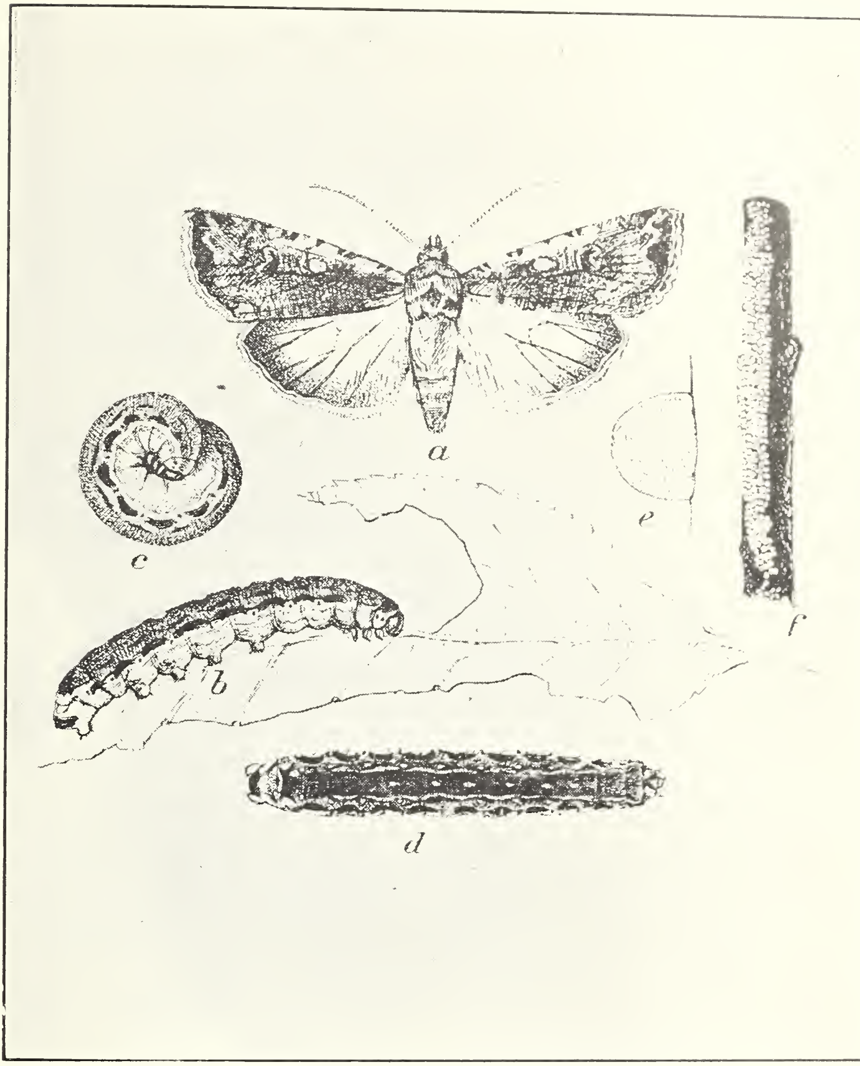
Hoeing the garden kills the weeds by pulling them up and exposing their roots to the air and sunlight. It keeps the soil fine and the roots of the plants can push their way into it. It also helps the soil to hold the moisture that is so necessary to plant life. When the ground is cultivated, a layer of mulch of fine soil is formed on the top.

A layer of mulch is any layer protecting the soil. This layer itself dries out very quickly, but it prevents the water in the soil below from evaporating as fast as it would evaporate otherwise.

If you live in the country, your garden will have to depend for water upon the rains. If you live in the city or in a village where you have a city water supply, you can sprinkle your garden in dry weather. It is important that the soil be watered thoroughly every time, for it does very little good to wet only the surface. It is a good plan to take a trowel and dig down to see how deeply the water has really sunk. You may think sometimes that you have done quite a thorough job of watering and then find that only the very top of the soil is wet. It takes more than just sprinkling to water a garden.

As you cultivate your garden, keep your eyes open for insect pests and worms that may be harmful to your flowers and vegetables. A great many of the larger ones may be picked off by hand. If there are too many or if they are too hard to catch, you may have to supply yourself with some liquid poison to use as a spray for your plants, or some powder with which you can dust them to protect them from their insect enemies. Stores sell many preparations that may be used for this purpose.

The cutworm is a bad enemy, since it works at night underground. Often the first hint you have of it may be a plant cut off in the morning. The plant may be lying flat on the ground, or it may



Courtesy of U. S. Department of Agriculture

LIFE STORY OF A CUTWORM.

a: moth; *b*: caterpillar, side view; *c*: caterpillar in curved position; *d*: caterpillar, back; *e*: greatly enlarged egg; *f*: egg mass on twig.

still be standing in its place, but if you examine it, you will find that it has been cut across just below the surface of the earth. If you dig carefully around the base of the injured plant and its

Courtesy of U. S. Department of Agriculture

THE TOMATO WORM IS A STRANGE-LOOKING INSECT LARVA.

neighbor, you will probably find a fat, gray worm about an inch long. It will curl up when it is touched. You can kill the cutworms that you find, but the difficulty is to locate them all. If you have cutworms in your garden, it is a good plan to protect your young cabbage and tomato plants from them by wrapping the stems with paper. Cutworms attack only young plants.

The tomato worm is a strange looking insect larva. It is about four inches long, and is bright green striped with white. It has a horn rising from its tail, and jaws that snap when it is disturbed. In spite of its fierce appearance, it is quite harmless to people, but it will eat the leaves of your tomato plants if you do not destroy it. Like the cabbage worm, of which you read in the second chapter of this book, the tomato worm is the larva of a moth.

You have learned how the florists grow large chrysanthemums by picking off all but one of the flower buds that grow on a plant. If you wish to grow large tomatoes, you can do so by picking off some of the smaller ones in each cluster. The plant may be pruned, too, by cutting off the branches that have no blossoms. This saves its strength for the growing fruit. Cucumber vines may be treated in the same manner.

You will have to learn just when your vegetables are ready to pick, for they are not good to eat if they are harvested too soon or if they are left on the vines too long. Have you ever picked sweet corn for the table? When the ears are ready to use, the tassels turn brown. It is best to pull back the husk a little to look in and make sure, however, before you pick the ear. When you pull off the ear, use both hands, grasping the stalk as well as the ear. Pull the ear downward and give it a little twist.

Summer squash must be picked while the skin is still soft enough so that you can scratch it with your thumb nail, but winter squash and pumpkins should remain on the vines until autumn. Squashes should be cut off the vine with a knife.

If cucumbers are to be used for pickles, they are usually picked when they are very small. Remember that the vine is still growing, and cut each tiny cucumber off with a sharp knife, so as not to jerk the vine and injure it. For use in salads, cucumbers must be full grown, and cut from the vine while they are still dark green. When they turn yellow they are too old for salads, but they may be used for seeds.

Carrots are particularly delicious when young. You may find that out some day accidentally,

Photograph by Ewing Galloway, N. Y.

THE JOY OF HARVESTING WILL FULLY REPAY FOR THE WORK PUT IN A VEGETABLE GARDEN.

when you are thinning your carrot rows, if you wash off and nibble some of the tiny ones that you have pulled to allow room for the others to grow. To see whether carrots are ready, scratch away a little soil near the leaf stems. If you see a little bald head, about three-quarters of an inch in thickness, grasp the stem and pull the carrot slowly from the ground. If you are too hasty you will pull up several carrots at a time, and not all of them will be large enough for use. You must also pull up one or two beets and radishes before harvesting them to find out whether they are old enough to eat.

Peas are ready for use when the pods are full. They should not be allowed to remain on the vine until the pods are wrinkled and hard, unless you wish to raise some seed. Green beans, too, should be picked while the pods are crisp and before they begin to turn brown.

SOME THINGS TO THINK ABOUT

1. Explain all the reasons for hoeing a garden.
2. Name the weeds that will probably come up in your garden.
3. Name the insect enemies from which you must protect your plants. Tell how you plan to do this.
4. Why do gardeners sometimes pick some of the small green tomatoes off the vines?
5. Explain how you can tell when each of the vegetables that you have planned to raise in your garden is ready to harvest.

SOME THINGS TO DO

The most important thing to do is to take care of the garden that you have planted—hoeing it, protecting it from its insect enemies, and harvesting your crops when they are ready.

Although you will no doubt agree that your pleasure in raising the crops is the greatest return from your garden, you will find it interesting to keep a record of just what the garden has cost you and what it has produced. The following form, which was prepared by the Bureau of Education, Department of the Interior, Washington, D. C., is suggested for your use. If many of the members of your class have gardens, it might be a good plan to have a meeting next fall to compare your records. Notice that you are to use a separate blank for each month.

HOME GARDEN MONTHLY REPORT [1]

Month .... *Year* ....

Name of Pupil ....

Address (street and number) ....

PRODUCTS HARVESTED

Name of Crop	Amount Used at Home	Amount Sold	Money Value
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

[1] From *Bulletin* No. 40, 1916, "How Gardening May Be Promoted by the Schools," Dept. of the Interior, Bureau of Education, Washington, D. C.

Expenses

Quantity	Articles	Price	Amount
....	....	....	....
....	....	....	....
....	....	....	....

Work

.... hours worked at .... cents per hour ....

....

CHAPTER XXVIII

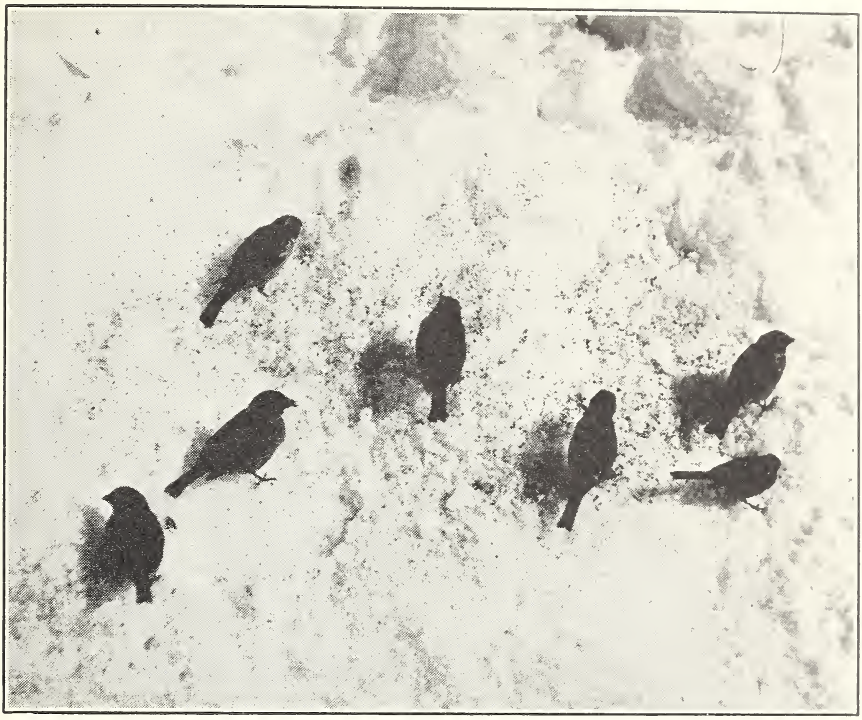
BIRD FRIENDS OF THE GARDEN

1. Can you tell why the wrens are good neighbors?
2. How can you tell the swallows by their flight through the air?
3. Name some of the birds that nest in your community, but which migrate southward to spend the winters.

You have already read about some common birds that help to rid the garden of weeds and insect pests. You learned of some birds that are permanent residents, spending the whole year in one neighborhood. Many of the permanent residents feed upon insects during the summer months, and in the winter eat the seeds of weeds. You learned of others that nest farther north, and which migrate southward to spend their winters with us.

Almost all of the winter birds are seed-eaters. As you know, insects are very scarce during the winter months. Some adult insects spend the winter in warm, secluded spots, but the majority of them exist through the winter in the form of pupas or eggs. Some winter birds eat insect eggs, and pupas, but these are not nearly so plentiful as the seeds of weeds.

On a certain season flocks of sparrows and juncos were seen day after day feeding upon



Photograph by Frank M. Chapman

SPARROWS AND JUNCOS ARE FRIENDS OF THE GARDEN.

smartweed seeds on a Maryland farm. The next year the smartweed had almost disappeared from the entire farm. The smartweed is an annual, you see, and must grow each season from the seeds, and the birds had eaten them.

The United States Department of Agriculture in 1910 estimated that the sparrows of this country saved the farmers more than $80,000,000 by eating the seeds of troublesome plants.

How delighted we always are to see the birds that spend the winters in the south return to us each springtime! It is pleasant to watch them building their nests and to hear their calls. These summer birds are among the most useful of all

Photograph from Bureau of Information, Salt Lake City, Utah

CARVED-BRONZE BASE OF SALT LAKE GULL MONUMENT COMMEMORATING THE SAVING OF A CROP BY GULLS IN THE PIONEER DAYS OF UTAH. THE CROP WOULD HAVE BEEN DESTROYED BY CRICKETS HAD NOT THE GULLS EATEN THE INSECTS.

the feathered friends of the garden, since some of them feed entirely upon insects.

It has been said that the descendants of one pair of potato beetles would number more than 60,000,000 in a year, if none of them were killed. The larvas of many insects eat large amounts of food. A caterpillar in one day may eat twice its own weight in leaves. It is indeed difficult to tell the amount of damage done by insects, but one man who studied the problem estimated that in 1921 more than 1,000,000,000 dollars' worth of forest and farm products were destroyed by insect pests. How much greater this damage would have been had there been no birds to eat the insects!

In pioneer days in Utah, crickets once destroyed almost the entire crop. They appeared again the next year, but before they had eaten the second crop, great flocks of gulls appeared and ate them. It was a great relief to the early settlers, for the railroads had not yet been built and it would have been very difficult to get food, had their second crop been lost.

The house wren is one of the gardener's friends, for it feeds upon grasshoppers, cutworms, beetles, and other insects. This friendly little bird nests near our homes in old tin cans, gourds, and other suitable holes, or in bird houses if they are provided. It builds a nest of twigs, lining it with grass and feathers, and laying six to eight speckled eggs in it. Like many of the other insect-eating birds, it does not spend the entire year in one community, but migrates southward to spend the winter.

Perhaps you have seen swallows circling about

Drawing by L. A. Fuertes

THE BARN SWALLOW MAY BE RECOGNIZED BY ITS DEEPLY FORKED TAIL.

over ponds and meadows, flying for a long time without stopping. Their long wings are very useful to them, for they spend most of their time in the air. They feed largely upon insects, which they capture as they fly. They also eat caterpillars, and a few weed seeds.

The barn swallow may be recognized by its deeply forked tail and by its habit of flying low. It builds its nest of mud on the rafters of barns and sheds. It feeds upon beetles, ants, bugs, flies, and other insects, which it captures in the air, and it eats snails which it finds as it gets mud for its nest.

There was a time, perhaps, when all of the swallows nested in rocky caves and cliffs, but four of the seven kinds of swallows found in this country now prefer nesting under the eaves or on the rafters of buildings. There is one kind, the bank swallow, that tunnels in the earth to make its nesting place. It usually selects a bank of earth by the side of a road or a river and tunnels back into it for a distance of about two feet. In such a protected spot it places its nest of grass and feathers.

It is a great mistake to tear down the nests of swallows from rafters or eaves, for these useful birds should be encouraged in every possible way to live in our neighborhoods. Instead, we should cut a small hole in the gable of the barn to make sure that they have an entrance. We may help them, too, in their nest building by providing a shelf for their nests. The purple martin, which is a member of the swallow family, may be encouraged to nest in the dooryard if a house is provided. They prefer to live in colonies, and martin

Courtesy of U. S. Biological Survey

THE BLUEBIRD EATS BEETLES, GRASSHOPPERS, AND CATERPILLARS.

houses are usually planned with apartments for a dozen or more families.

Many of the other summer birds, also, feed upon insects. The bluebird eats beetles, grasshoppers, and caterpillars. The wood thrush feeds upon beetles, ants, caterpillars, and other insects. The orioles, the cuckoos, and all of the warblers are insect eaters. Some of them hunt their food on the trunks and branches of trees, while others go over the leaves and twigs.

Birds require more food for their size than we do for ours. Many of them eat their own weight in food each twenty-four hours. Think how many insects, insect eggs, or weed seeds this would mean. Do you see why it would be very difficult for us to raise gardens at all without the help of our feathered friends?

SOME THINGS TO THINK ABOUT

1. Name some birds that are permanent residents in your community.
2. Name some birds that spend the winters in your neighborhood, but which nest farther north.
3. Name some of the birds that nest in your locality, but which migrate southward to spend the winters.
4. From what you have seen, what do you know about the feeding habits of these birds?
5. Describe the nesting habits of the swallows.

SOME THINGS TO DO

Go to a pond or meadow and watch the swallows circling about.

Take a trip to some barn to find swallow nests.

Make sketches in your science notebook of the bill of a house wren and a barn swallow.

You will find it interesting to build some nesting shelves for the swallows, or a bird house for one of the other useful birds of your neighborhood. *Farmers' Bulletin* No. 1456, published by the United States Department of Agriculture, Washington, D. C., is a useful guide to bird-house construction.

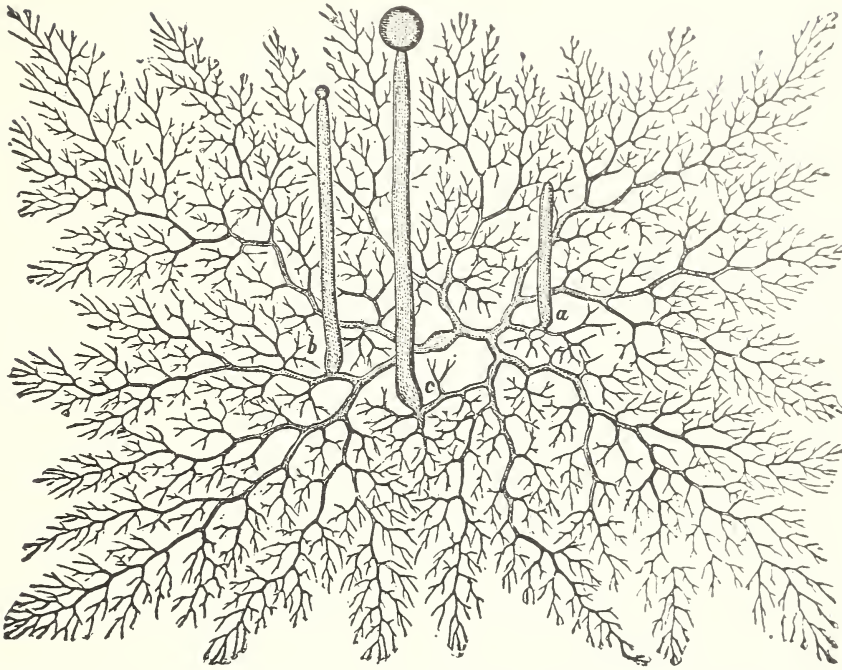
CHAPTER XXIX

SOME STRANGE PLANTS

1. What are the smallest plants you know?
2. Have you ever seen germs? Are there different kinds of germs?
3. Is any of the germs a plant?

Even if you should choose sides and have a contest in naming plants, it is doubtful if any one in your room would mention the plants that you are going to read about in this chapter. Some one would surely think of the rose, violet, potato, and cabbage. Perhaps some one would name the peach or the apple tree, and that would be right, for they, too, are plants.

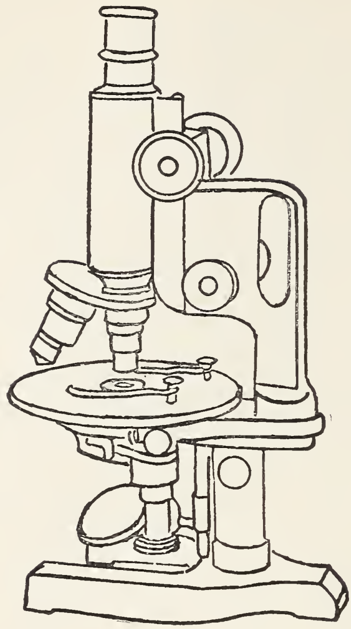
Suppose some one asked you to describe a plant. You would probably say that it has flowers, stem, leaves, and roots, and that it may have fruits and leaves if the flowers are not picked. If some one should tell you that the scum on pond water, the mold on bread, and many of the disease germs, which you have heard so much about, are also plants, you might be surprised. They belong to a group of plants that are called fungi. Fungi are very simple plants that have no chlorophyll (green coloring matter) and which are therefore unable to make their own food as green plants do.



SOME FUNGI ARE SMALL PLANTS SO TINY THAT THEY CAN NOT BE SEEN WITHOUT A MAGNIFYING GLASS.

Instead, they take their food from other plants and animals.

Can you imagine a plant so small that it would take 400 of them to reach across a period on this page? Many of the common disease germs are tiny one-celled plants called bacteria, which are often as small as the plants mentioned. They are the smallest of all known living things. Although bacteria are in the air all about us, they are so small that we cannot see them. A single bacterium is so small that it cannot be seen without the help of a strong microscope. If you know that "micro" in Greek means *small* and "scope" means *watches* couldn't you guess why the instrument was named this way? When we wish to look

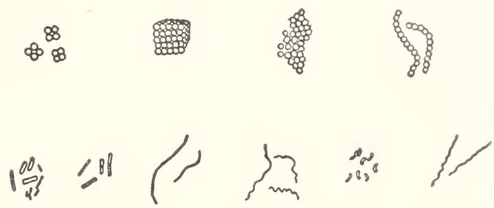


AN UP-TO-DATE MICROSCOPE MAGNIFIES 1,000 TIMES.

at microbes or bacteria, we use this instrument. It can make whatever is seen through it appear about 1,000 times larger than it really is. With the microscope it is possible for us to see many kinds of bacteria, but some of them are too tiny to be seen even in this way.

You must not think, however, that all bacteria are germs that cause disease. Some of them are very useful. For instance, bacteria cause the decay of dead logs and leaves in the forest, thus producing humus which enriches the soil. If there were no bacteria, the material in dead plants could not be changed so that it would become useful to growing plants.

If you should pull up several clover plants, you



BACTERIA AS SEEN THROUGH THE MICROSCOPE.
Above: shot-shaped forms; Below: rod-shaped and spiral-shaped forms.

might find tiny little lumps on the roots. In these lumps there are bacteria. These are very useful to the farmer since they help to enrich the soil, by adding to it certain substances that plants need. These bacteria are able to take nitrogen from the air and to use it to make fertilizers. It is because of their work that clover helps to enrich the ground upon which it grows.

Bacteria are useful in other ways, too. They are necessary in the making of vinegar, and in several steps in the tanning of leather. They help to give butter and cheese their flavors.

On the other hand, however, there are bacteria which are very dangerous, for they enter our bodies and cause disease. Some of them are harmful because they destroy parts of the body; others, because they give off substances called toxins, which are poisonous. Diphtheria, typhoid fever, and tuberculosis are all caused by bacteria which produce toxins. The bacteria that causes tuberculosis produces a toxin and also destroys parts of the body. Usually these bacteria destroy the lungs, but may destroy even bones.

The body is well fitted to fight disease-producing bacteria. When toxins are given off by the bacteria, the cells of the body may produce substances known as *antitoxins,* which make the toxins harmless. You can tell the meaning of the word if you know that *anti* means *against.* Sometimes, enough antitoxin is stored in the blood to make it unlikely that the person will ever have the disease again. If you have once had measles or chicken-pox, you are much less apt to have them again for this reason.

The skin that covers our bodies is an excellent protection against disease-producing bacteria. When it is cut, the wound should be covered frequently with iodine or some other good disinfectant, which will kill any germs that may enter. Tetanus or lockjaw is caused by bacteria that enter the body through wounds. Boys stepping on rusty nails often get lockjaw from the bacteria on the nail.

Unless the skin is broken, however, bacteria on the surface of the body can do very little harm. Most of the disease germs that enter the body get in through the nose and the mouth. They may be in food or water, particularly if dishes and drinking cups are not kept perfectly clean. That is why you should be so careful when drinking from fountains and cups. Bacteria may be in the air, but unless there is some one ill with a contagious disease near-by, there will probably not be enough disease-producing bacteria in the air to do you any harm.

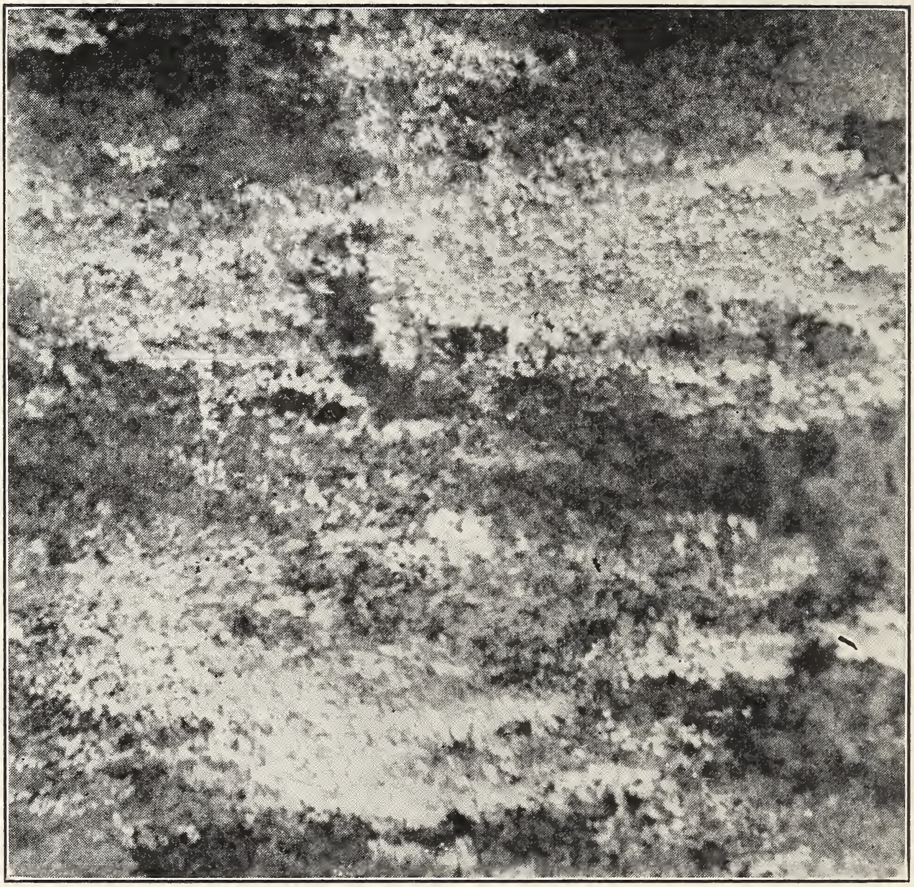
Bacteria increase in number very rapidly if the conditions are right for them. They take their food from the liquid in which they live, and when they reach their full size, which usually requires but half an hour, they divide into two. Green plants grow better in sunlight, but bacteria are killed by the sun's rays. They may also be killed by heat, or by disinfectants.

You have learned that bacteria cause decay. This is sometimes a very useful thing. It is through decay that dead plants are made into plant food. However, unless we prevent it, bacteria will cause our food to spoil, and thus make it unfit for us to eat.

Perhaps you have seen your mother canning vegetables or fruits. She heats both the food and the cans in order to kill any bacteria that may be in them. Then she closes the cans, making sure to get them air-tight so that more bacteria cannot get in. Foods are also preserved by drying, salting, and cold storage, all of which make it impossible for bacteria to live.

Have you ever seen bread covered with mold? Bread-mold is a tiny plant which, like bacteria, belongs to the fungi group. Similar plants grow on fruit, leather, clothes, and other things. Perhaps you have seen mold on canned fruits and jellies. Do you know how these plants get a start?

If you will look carefully at the mold on a loaf of bread, you will find that it is made up of white, fluffy threads, some of which have tiny, black knobs at the ends. Within these knobs are very



BREAD MOLD IS A TINY PLANT.

small spores, from which the new plants develop. When the spores have matured, the knobs burst, and the spores are blown out into the air and float about until they settle upon some substance where it is possible for them to develop into new plants.

Many plant diseases are caused by fungi. Among them are the blights, smuts, and rots. Potato blight will sometimes destroy a whole crop. Brown rot damages thousands of dollars' worth of peaches and plums each year. The damage done annually in this country by wheat rust is estimated at $50,000,000. Corn smut is a fungus growth found in almost every corn field. If you examine it under a microscope, you can easily see the tiny spores by which the plant is spread.

Fungi have no chlorophyll, and therefore, cannot make their own food. They must get it from other plants or from animals. Sometimes in getting their food they produce changes that are useful to us, as when they cause dead plants to decay so that living plants can use the material in them, or when they change milk into cheese. Sometimes they are harmful. Some bacteria produce disease; others cause our food to decay. We would not wish to kill all fungi, but we are surely interested in finding ways to keep the harmful ones from growing where we do not want them.

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 *Yes* beside the number. If it is false, write *No*.

1. Fungi have no chlorophyll.
2. Molds and bacteria are plants.
3. Many disease germs are bacteria.
4. All bacteria cause disease.
5. Diphtheria is caused by bacteria.
6. Some bacteria are useful.
7. Bacteria grow well in the sunlight.
8. Some bacteria help to enrich the soil.
9. Antitoxin is produced by bacteria.
10. Plant diseases are often caused by fungi.

SOME THINGS TO DO

There are many interesting experiments that you may try in connection with your study of bacteria and molds.

Boil some slices of potato and some saucers to sterilize them, or in other words, to kill any bacteria that may be on them. To make sure that they are sterilized, you will have to boil them twenty minutes every day for three days.

Using a sterilized fork, place a piece of sterilized potato on a sterilized saucer, and cover with another sterilized saucer. Do not touch the potato with your fingers.

Do the same with the other pieces of potato, with the following exceptions. Leave one piece uncovered. Touch another piece in several places with your fingers. Wash your hands with soap and water, and touch a third piece of potato immediately. Touch other pieces with money, a pencil, or any other common thing.

Allow the pieces of potato to stand for several days in a warm place. Compare the number of colonies of bacteria that you find growing on the different slices. Each colony really is made up of thousands of bacteria, but it will appear as a mere spot on the surface of the potato.

You would find it interesting, too, to grow some bread mold. All that you need to do is to keep a part of a loaf of bread in a moist, warm place. If possible, examine the mold under a magnifying glass.

CHAPTER XXX

NATURE'S FLOWER GARDEN

1. What early wild flowers do you like best?
2. Have you ever picked any of the woodland flowers?
3. If you did, how long did they live after you took them home?

What fun it is to go to the woods in the early spring to hunt for the first wildflowers! Perhaps you have learned the names of most of those that grow in your neighborhood.

You probably know the dainty blossoms of the hepatica, which is one of the earliest as well as one of the most beautiful of the woodland flowers. You may be familiar with the lovely white blossoms of the bloodroot, the stems of which are encircled by the green leaves of the plant.

Spring beauties brighten many of the woodlands in the early spring. A little later you will find the russet yellow flowers of the dogtooth violet, which is not a violet at all, but a lily.

In wet, swampy meadows or beside brooks, the golden, yellow blossoms of the marsh marigold appear. This flower looks somewhat like the buttercup. It blooms in early April.

Do you know the very earliest of all the spring wildflowers, the skunk cabbage? Although it can

Photograph from J. Horace McFarland Co.

THE YELLOW BLOSSOMS OF THE MARSH MARIGOLD APPEAR IN SWAMPY MEADOWS IN THE SPRING.

hardly be called beautiful, it is interesting in appearance. Its odor is probably not pleasant to you, but it must be attractive to the insects, for within its folds you will find the remains of many small creatures that have been drawn to the plant in some way.

You will be sorry to learn that many of the familiar wildflowers are decreasing in number each year. As you know, many of them are woodland plants, and as the forests are cut, they disappear. Then, too, many thoughtless people pick the flowers, sometimes carelessly destroying the plants. Even if the plants are not destroyed, how-

SPRING BEAUTIES BRIGHTEN MANY OF THE WOODLANDS IN THE SPRING.

ever, when the flowers are taken away the seeds are destroyed.

Dutchman's breeches and squirrel corn are close relatives. Their flowers are heart-shaped with two spurs or legs. Perhaps you know the garden flower called the bleeding heart. Except for its red color, the bleeding heart is very simi-

Photograph by L. W. Brownell

THE SKUNK CABBAGE IS INTERESTING IN APPEARANCE.

lar in appearance to these wildflowers. The heart-shaped flowers are scattered along a stem. You will find it very interesting to study them to see where the stamens and the pistil are found.

The flowers of the Dutchman's breeches are white, tipped with cream color. Those of the squirrel corn are greenish white, tipped with rose, and the spurs are rounded and bag-like. These spurs are really two petals of the flower, which form closed tubes or bags in each of which is a drop of nectar. There are two other petals that are shaped like spoons. These spoon-like petals

Photograph from Wild Flower Preservation Society

BLEEDING HEART FLOWERS ARE RED.

serve to protect the important parts of the flower, the stamens and the pistil. The nectar in the spurs attracts the bees, and the flowers are so shaped that the insect, in gathering the nectar, will scatter the pollen. Pollen, as you have already learned in other chapters of this book, is of no value in producing seed, unless it reaches the pistil of the flower.

Dutchman's breeches grow from bulbs; squirrel corn grows from a root or a tuber like a potato. The round, yellow tubers or underground stems of the squirrel corn are scattered along the roots. The plant gets its name from the resemblance of

Photograph from Wild Flower Preservation Society

SQUIRREL CORN IS A WILD FLOWER THAT SHOULD NOT BE PICKED.

its tubers to grains of corn. Probably some one said, "These look like grains of corn that have been buried by a squirrel. Let's call this plant *squirrel corn.*"

The food that is stored in the bulbs and the tubers makes these plants develop very quickly in the spring. The leaves manufacture food to store in tubers and bulbs for the next year while the branches of the trees are still bare. You will recall that sunlight is necessary to the plant in its work of making food.

The fruit of the squirrel corn and the Dutchman's breeches is a pod with ten to twenty seeds. Not many seeds are produced by each plant. This is often true of perennials, which grow from bulbs, tubers, or roots that live in the ground throughout the winter.

Dutchman's breeches and squirrel corn are among the wildflowers that should not be picked. They are plants that grow only in the woodlands, and which are therefore destroyed when the forests are cut down. Wherever they are found, they should be protected.

The scarlet and yellow blossoms of the columbine look bright in open woodlands and meadows. Sometimes it is found growing on rocky cliffs where there is scarcely enough soil to cover its roots.

The five scarlet petals of the nodding flower, each a thin tuber, form the five spurs that point upward. In each of these tubers is a drop of nectar. You may sometime have seen a humming bird draining the nectar from this scarlet flower with its long, thin bill, or a bumblebee clinging to its petals.

The bumblebees and the humming birds that take the nectar from the columbines help to carry

Photograph from Wild Flower Preservation Society

THE SCARLET AND YELLOW BLOSSOMS OF THE COLUMBINE LOOK BRIGHT IN OPEN WOODLANDS AND MEADOWS.

the pollen from the yellow-tipped stamens, which hang downward from the flower, to the pistil, where the seeds grow.

The columbine is another of the wild flowering plants that needs our protection. If we pick the flowers, they cannot do their work of producing seeds from which plants can develop next season.

The spiderwort will probably be more familiar to you as a garden flower than as a wildflower. Its little blue flowers have three petals and six bearded stamens. They grow in clusters on the plant, which is usually from twelve to eighteen inches tall. The flowers wilt very quickly, and should never be picked, for the plant grows wild in few sections of the country.

The ox-eye daisy, on the other hand, does not need our protection. These field daisies are beautiful flowers, but the plant is also a weed for it often grows where it is not wanted. Perhaps you have seen fields covered with daisies, which may look very beautiful to you, but which are crowding out the farmer's crop.

How does it happen that while many of the wildflowers are disappearing, the daisies are difficult to stop growing? One reason is that they are not woodland flowers, so the cutting of the forests does not rob them of their natural homes. Then, too, the flower head of the daisy has a great many simple flowers or florets, each of which produces a seed. You will recall that many of the fall garden flowers that you studied were of this type. Such, for instance, as the sunflower. You are no doubt glad to learn of one wildflower that you may pick as freely as you wish.

The flowers that have been mentioned in this chapter are but a few of the many kinds of wildflowers that are found in this country. No doubt you will find many others growing right in your own neighborhood. You may find some which, like the daisies, are weeds, and which you may, therefore, pick freely. You will find others that are delicate little woodland plants that need your protection. These you should learn to enjoy right where you find them. If you pick their flowers at all, you should take only a few, leaving some to develop into seeds and being careful not to injure the plants.

SOME THINGS TO THINK ABOUT

1. Name and describe some of the wildflowers that grow in your neighborhood.
2. Which of these are woodland flowers?
3. Which of them grow by the roadsides and in the meadows?
4. Are any of them found in the woodland and in other places as well? If so, which ones?
5. Are any of your wildflowers weeds? What is a weed?
6. Which of the wildflowers that grow in your neighborhood need your protection? Why?

SOME THINGS TO DO

Take a trip to the woods to see how many of the flowers mentioned in this chapter you can find.

With a wildflower guide, find out the names of as many of them as you can.

Study the shapes of the different flowers. Find the stamens. As the flowers wither, watch the growth of the pistils in which the seeds of the plant are developing. You will find it interesting to select some different kinds of plants and observe them once in a while until the seeds mature.

Watch for insects visiting the flowers. Find some flowers that are so shaped that when the insects visit them to get their nectar, they are certain to be covered with pollen.

CHAPTER XXXI

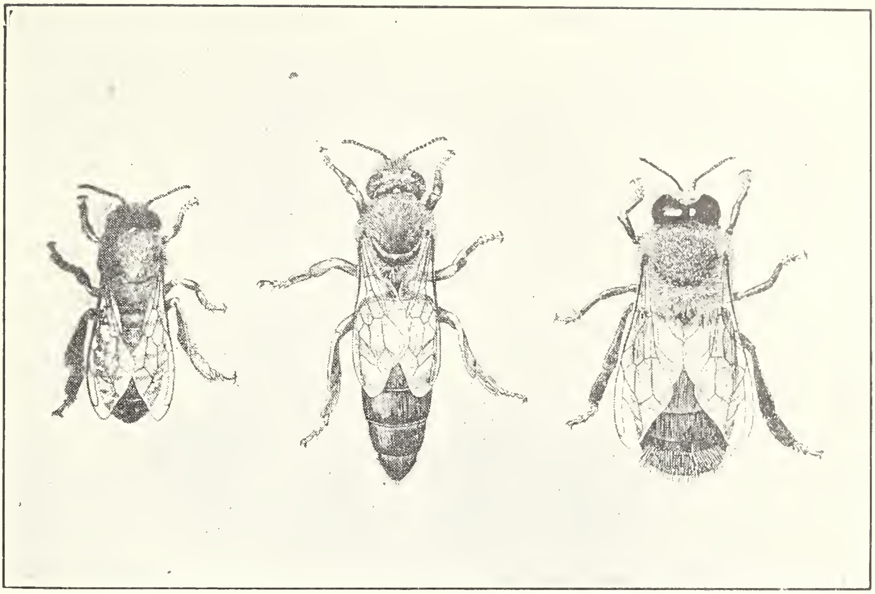
BUSY BEES

1. Can you draw a "bee line"?
2. Do you know that young bees have nurses?
3. Have you ever heard of the bee's bread?

Did you ever hear any one say, "busy as a bee"? If you could follow a bee about through one day, you would know exactly what is meant by the expression, for a bee is very busy, indeed!

But the fact that bees are busy is far from being the most interesting thing about them. It is the way they work, and the way they live, that makes the bee the most interesting of all insects to study. There is so much to tell about bees and their ways that one scarcely knows where to begin.

In the first place, can you tell a bee when you see one? Can you tell a bumblebee from a honey-bee? If you cannot, perhaps you can learn to do so by studying the pictures on this page. The bumblebee is particularly useful to the farmer, because it is the only insect that carries the pollen of the red clover blossom. Do you know where the pollen is carried? No other bee has a tongue long enough to reach the clover nectar. Many a farmer would have a poor crop of red clover if there were no bumblebees about. You learned in the last chapter how the bumblebees carry the pollen of



HONEYBEES.
Worker Queen Drone

the columbine. Other insects are not attracted to the columbine, for its nectar, like that of the clover blossom, is located so that only insects with very long tongues can reach it.

In each colony of honeybees, there are drones and workers and a queen. Study the pictures below. Notice that the queen and the drone are much larger than the worker bee. You can tell the queen from the drone by the shape of the body. From your study of the picture, tell how the body of the queen differs from that of the drone.

The body of an adult insect consists of three parts, the head, the thorax, and the abdomen. As you see in the pictures, the head of the bee is very short. It carries the eyes, antennas (the feelers growing out in front of the head), and the mouth. Fastened to the thorax are three pairs of legs and

Photograph by Lynwood M. Chace

WHEN THE WORKER BEE FINDS A FLOWER WITH NECTAR, IT STICKS ITS TONGUE DOWN INTO IT AND SUCKS THE SWEET JUICE.

two pairs of wings. Can you find these in the picture?

The abdomen is made up of parts, which look like rings on the surface. If you place a bee in a glass tumbler, you can see the parts that have just been described, and if you could catch a bee and examine it closely under a magnifying glass, you could see its interesting mouth parts, and the place under its body from which it shoots out the stinger to fight its enemies. You would see, also, that what appear to be bristles on the bee's legs form small pockets. You will hear more about these later.

If you watch a worker bee, it may seem to you that it is just buzzing about from flower to flower with no very definite reason, but this is far from the truth. It is really hunting for the flowers with sweet juice, or nectar. When it finds one, it sticks its tongue down into it and sucks the nectar. The nectar that the bee takes enters its "honey stomach," which is really a honey sac in which the nectar is changed into honey. When the bee is laden with honey it returns to the hive. There it stores the honey in the wax cells in the honey-combs, and hastens away to get more. Now, do you understand why we speak of the "busy bee"?

You may be wondering what the queen bee and the drones are doing while the workers are busy gathering nectar. Each of the three types of bees found in a bee hive has a special job. The great bee family or swarm is really a very wonderful family, and the more that you learn about it, the more you will find to marvel about.

In each swarm there is one queen, which stays in the hive and lays the eggs. Sometimes she lays as many as 1,800 eggs in one day. There are usu-

Photograph from Publishers Photo Service

WITH THE AID OF A MICROSCOPE WE ARE ABLE TO SEE THE INTERESTING CELLS OF A HONEYCOMB, EACH CONTAINING AN EGG FROM WHICH A BEE LARVA WILL HATCH.

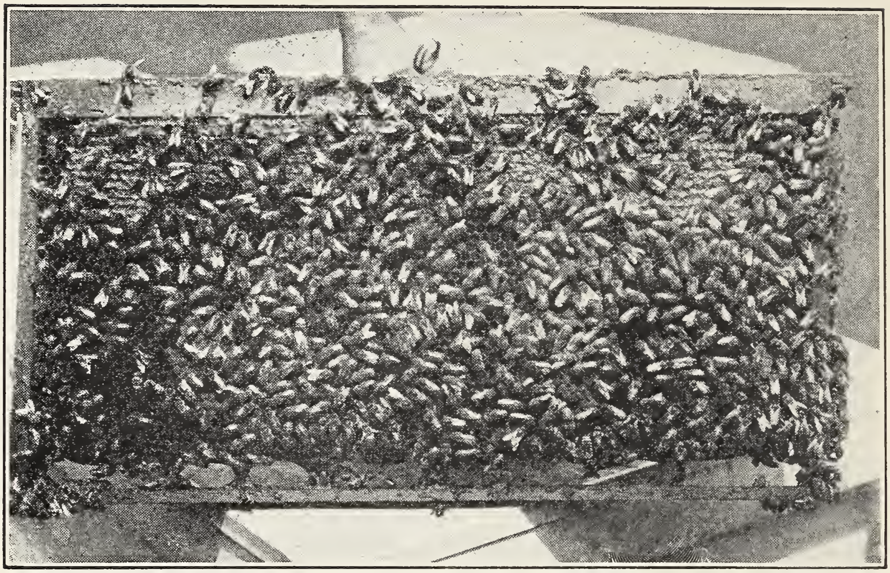
ally a few hundred male bees, which are called drones because they do not work, and often as many as 80,000 to 100,000 worker bees in each colony. The drones are the male bees. They have no stingers and no pockets on their legs, and so they are really helpless so far as gathering food goes.

One of the most interesting parts of bee life is the life-story of a queen bee. The worker bees make the cell about a chosen egg and enlarge it. When the egg hatches, they feed the little white bee grub or larva that comes from it with special food, and more of it than the other grubs get. In about five days the queen-to-be weaves herself a silken cocoon and becomes a pupa. In the meantime the workers have sealed her cell with wax. When the queen is full-grown, she cuts open a door in her cell and pushes through it to make her first flight. Sometimes when a new queen develops, the swarm is divided; sometimes the new queen kills the old one. In either case, the young queen soon begins her life business of laying eggs.

From this story of the growth of the queen, you have learned that bees, like butterflies, pass through four stages in their life story: first, the egg; then, the little white grub or larva; then, the pupa, which is a resting stage during which the larva becomes an adult insect, and finally, the full-grown adult bee. It is interesting to know that the worker bees act as nurses for the young larvas, feeding them upon bee's bread and honey.

Bee's bread is made from the pollen of flowers. It is carried from the field in the pollen pockets in the worker's legs, and is packed into some of the cells in the hive to be used as food for the bee grubs. The workers carry honey to the young bees as well. Now you know about the bee's bread and honey!

When the bees are old enough to leave the hive, they are able to find their way home when taken two or three miles away. More than that, they always go home in a straight line. That is where we get the expression, "making a bee line for home." Scientists believe that bees can smell a flower when they are as far as two miles from it.



WHEN A HONEYCOMB IS NEEDED, A NUMBER OF WORKERS EAT A GREAT DEAL OF HONEY AND SET ABOUT TO WORK TO MAKE IT.

How would you like to be able to smell a nice juicy peach or an apple that was two miles away!

Perhaps you wonder how long these small busy bees live, working as they do. You know that they begin early and work until sundown. The workers that live during the summer months live only three or four weeks, but those that live during the winter have longer lives, sometimes living for several months. The drones are usually killed by the workers at the end of the summer season. Queen bees live from five to ten years.

So far we have said nothing at all about the making of the honeycomb. It is really a marvelous piece of work, and it is hard to believe that it was really made by insects. If you will examine a piece of honeycomb, you will be amazed to see how exactly these tiny cells have been made. Each one is six-sided. The wax used for building it is made by the bees. When a honeycomb is needed, a number of workers eat a great deal of honey and set about to work to make it. When a cell is filled with honey, it is sealed with a tiny cap of wax.

If bees were honey makers only, we should call them wonderful, but you have already learned that they do another very useful service. Honeybees, as well as bumblebees, carry pollen from the stamens to the pistils of flowers. You will recall that the pollen must reach the pistils before seeds can develop. Sometimes gardeners take pollen with a fine brush from one flower and place it upon another. How many people with brushes do you think would be needed to do the work of the bees?

Sometime, perhaps, you may have a hive of bees of your own. When you study them you will learn that we could not begin to tell you in one short chapter the wonderful story of the bee.

SOME THINGS TO THINK ABOUT

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

1. The bee has ..... pairs of legs and ..... pairs of wings.
2. Honey is made from the ..... of flowers.
3. Bee bread is made from the ..... of flowers.
4. The workers ..... the hives by keeping their wings going. This makes a ..... sound.
5. The ..... bee lays eggs.

6. The male bees are called ......
7. There are more ..... than drones in the swarm.
8. Bees carry ..... from the stamens of the flowers to the pistils.

SOME THINGS TO DO

If you can find a hive of bees, you will find it interesting to observe them as they fly in and out of the hive.

Watch a bee as it sucks nectar from a flower. Notice whether or not it gets covered with pollen.

Put a live bee under a glass so that you can see its appearance and the three principal parts of its body. What are they?

It will be safer to use dead bees for closer examination. You will need a magnifying glass to see the mouth parts, the pollen pockets, and the place where the stinger shoots out of the body.

CHAPTER XXXII

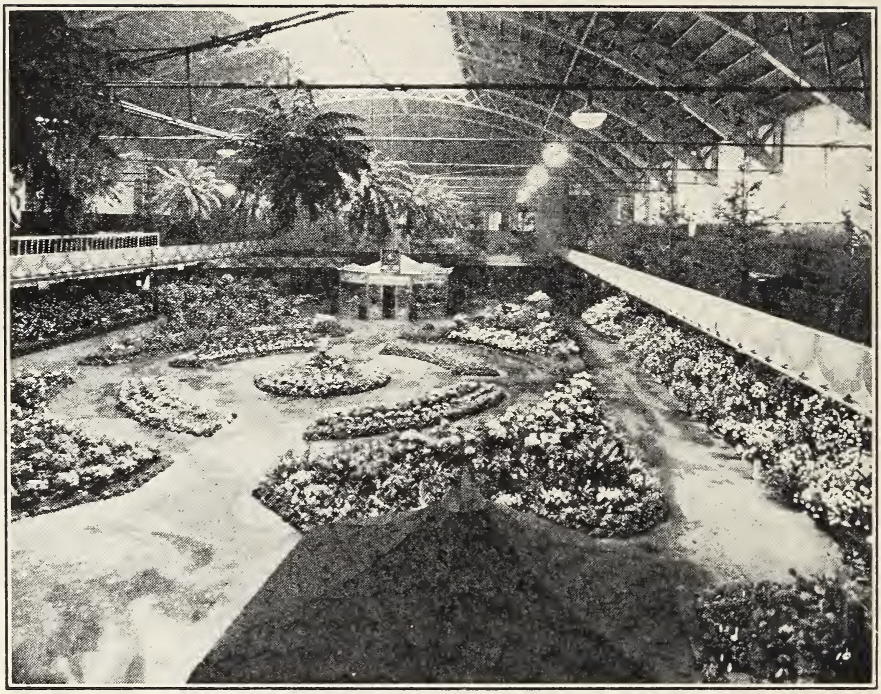
THE FLOWER SHOW

When you were younger, no doubt you often said: "Let's make believe,"—and what thrilling adventures you had then! We are going to say that to you now. Let us finish our study of the garden by pretending that we are visiting a great flower show. Perhaps you have gone to a garden exhibit at your school or to a flower show in your own city. If so, it will be easy for you to imagine that we are all going together to see the spring show in a great public auditorium.

As we enter the door we see gardens everywhere. The whole main floor of the auditorium is covered with gardens, large and small. On the lower floor are booths for smaller exhibits, but we shall visit them later.

It is interesting to find here many of the things that we have read about in our science reader. Here is a garden with shade trees about it, and a clipped hedge. It looks as if much work has been done in it. We must look closely to see if we know the trees, and to discover to what group the evergreens belong. The lawn is velvety green, and that reminds us how important it is to keep the lawn free from weeds.

Spring flowers are blooming in this garden,



Courtesy of Walter de LaMare Co.

THE WHOLE MAIN FLOOR OF THE AUDITORIUM IS COVERED WITH GARDENS, LARGE AND SMALL.

arranged so that the colors are pleasing to the eye. There are beds of crocuses, tulips, iris and daffodils. Perhaps you planted some bulbs in your own garden last fall. If you enjoyed your early spring flowers, you may be planning to plant some more this fall. No doubt you can get some ideas about the arrangement of the beds here.

Next to this garden is a miniature rock garden complete, with moss and stones and a tiny artificial brook. What do you know about the soil that is used in these two gardens?

Across the way is a garden that has been planned to show midsummer flowers, climbing sweet peas, a bed of nasturtiums, and long rows

Courtesy of Walter de LaMare Co.

SPRING FLOWERS ARE BLOOMING IN THIS GARDEN, ARRANGED SO THAT THE COLORS ARE PLEASING TO THE EYE.

of cosmos, gladioli, larkspur, and California poppies, a mixture of colors and odors. There is also an autumn garden near-by. There, as you would expect, are dahlias and chrysanthemums. How do you think they managed to have autumn flowers ready for a spring flower show?

Someone else has planned an old-fashioned garden, with hollyhocks, verbena, mignonette, marigolds, bachelor's buttons, and phlox, brightly gay and ever so sweet-smelling. You have not studied all of these flowers, but perhaps you can learn to tell them next summer, if you cannot do so now.

It is difficult to leave the garden floor. Perhaps you stop to look at the orchids, strangely spotted with purple, orange, and pale pink. They are

Courtesy of Walter de LaMare Co.

THE MINIATURE ROCK GARDEN IS COMPLETE, WITH MOSS AND STONES AND A TINY ARTIFICIAL BROOK.

very different from the wildflower garden next to it, in which you will recognize many of your favorite wildflowers. But we must go on, for in the booths on the lower floor there are many reminders of the happy year that we have spent studying the science of gardens and of out-of-doors.

How attractive the seed catalogues are! We can learn a great deal about the garden plants by studying the pictures. There are great baskets of bulbs, as well, but perhaps you are wondering whether this is the time of year to plant bulbs. You have studied some of the bulbs that should be planted in the fall, but there are others that should be set out in the spring. Among these are gladioli. You may choose any color you like, for the label on each basket tells you the name of the bulb, the color of the flower that will develop from it, and the price.

In the next booth are fertilizers, which reminds us that we must know something about our soil if our garden is to be a success. There is a sign in this booth advising gardeners to buy humus. You will remember that humus is decayed plant or animal matter, which enriches the soil. Some gardeners spade manure, dead leaves, and straw into the garden, but others buy humus in bags, as well, and add it to the soil to make rich food for their growing plants. Some gardeners buy peat brought to this country from Holland.

Some one has remembered the importance of birds in gardening, for here in a booth is a large chart showing the common birds and their foods. These charts remind us that the birds help to rid our gardens of insect pests, and that they help to keep down the crop of weeds by eating the seeds.

And speaking of weeds, the next booth shows half a dozen devices for weed killing. A long-handled hoe looks useful, and if you will recall the chapter on simple machines, you will understand why the long handle helps, for the hoe is a lever. For digging close to the garden plants, a little short-handled trowel may be easier to use. Other garden machinery is to be seen in this booth. There are hand cultivators, drills for sowing seeds, poison sprayers, and other interesting devices.

The sun's part in gardening has not been forgotten, for in the last booth that we visit, we see hotbeds and cold frames. Perhaps you built one or both of these last fall for your own garden, and used it this spring to start your plants.

We feel we would like to stay longer at the flower show. There is so much to see, and so much to learn! It brings to our minds that there are garden problems for every month in the year, delightful problems, which science can help us to solve. It makes us think, also, that a school exhibit of flowers and vegetables in the fall might be an interesting project by means of which we may carry out some of the ideas that we have gained at the flower show.

SUGGESTIONS TO TEACHERS

General

1. The theme of this book is the garden. Around this theme are grouped such topics as insect friends and enemies, bird friends of the garden, how rocks become soil, types of soil, cultivating and harvesting, all bearing on the main theme in such a way as to make for unity of subject matter.

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. The subjects of many of the chapters in the book are such things as may be found by anyone within a short distance of almost any school.

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, poems, scrapbooks, and collections.

Chapter I

Give the pupils an opportunity to tell about their experiences in their own gardens during the summer, or in any others in which they have worked.

Visit the nearest large vegetable garden. In some cases, it may be advisable to make a trip to a truck farm.

In some cities it will be possible to make a cold frame for the school garden.

The hotbed and cold frame are not difficult to make and will be an interesting experiment for children in the fifth grade.

Chapter II

It is important that specimens that are collected be properly cared for. Take the butterflies in the net and place in the killing bottle. From this bottle, they should be arranged on the drying board. In about two weeks they may be taken from the drying board and pinned in boxes or placed in boxes with cotton. The Collector's Set supplied by the W. M. Welch Manufacturing Co. contains the apparatus and materials and directions for this work.

The so-called contact sprays such as kerosene emulsion, soap washes, and nicotine sprays are used to control aphids. Directions for making and using these sprays will be found in Farmer's Bulletin, No. 804, pp. 34-39.

Chapter III

Encourage pupils to spend some of their leisure time in park, garden or some vacant lot to find lady bugs, tiger beetles and praying mantes.

Pupils should be allowed to observe the activities of some of these insects such as walking, flying, and eating.

It is a good plan to begin collecting any stages of the life history that you find and continue during later seasons until you have the history complete—eggs, larvas, pupas, and adults. These collections will be valuable material to supplement the specimens brought in by the children. The collection for the school museum will stimulate pupils to look for insects in the neighborhood and to bring them to school.

Chapter IV

Ask pupils to bring in one or two specimens of toads for study. Try to keep them comfortable and, when the study is completed, take the specimens back to the fields.

Chapter VI

Even in the most congested sections of a large city, bulbs may be forced and the blossoms enjoyed in the schoolroom.

If you desire a continuous bloom, plant one or more dishes of bulbs every four to six weeks.

Chapter VII

Write to the Agricultural Experiment Station in your state for the weed manuals that are prepared for free distribution. These will help in the identification of weeds.

Considerable interest is added to the work when classroom collections are made. Bottles for weed-seed samples are included in the Collector's Set, made by the W. M. Welch Manufacturing Co. They may, however, be purchased at almost any drug store. The best collections may be kept in the school museum.

The weeds offer excellent material for the study of seed distribution. The seeds of these hardy plants are so well adapted for transportation by wind, water, and animals that they supply excellent illustrative material.

Most of the autumn flowering plants may be gathered without danger of extermination and for that reason children may make a weed booklet. In fact, so long as they collect plants that are pests, they are doing a good turn.

Chapter VIII

Pupils will be glad to bring flowers from their gardens for this lesson.

Encourage the pupils to study the common garden flowers and to be able to recognize them. Seed catalogues with illustrations will be helpful to both teacher and pupil in identifying garden flowers.

A trip to an estate or model garden is stimulating and helpful.

Chapter IX

If pupils have gardens of their own, they will no doubt be glad to bring flowers for class study. Seed catalogues with their descriptions and colored illustrations will be helpful in the identification of garden flowers.

Chapter X

Take the class to the park or woods to observe the oak trees, and collect leaves and acorns.

Encourage pupils to bring in oak leaves and acorns and use the tree books to identify them.

Use some of the most complete collections as exhibits for your school museum.

Go on a trip to observe the white pine and other pines. If you do not find cones on your trip, the pupils may be able to collect some when they go out in the country on hikes or week-end trips.

Keep your best materials collected; this will be a good nucleus to begin with next year.

The pupils' notes on each tree may make a part of a tree booklet if they are able to observe and include in it as many as eight or ten trees. On the other hand, you may wish each pupil to make a science notebook and include their notes on trees as part of the general notebook.

Chapter XI

Encourage pupils to observe and identify the shade trees on their street. They should use the available tree books to help them in their identification.

Make collections of leaves and fruits for an exhibit in your school. Insist on neat, carefully arranged and labeled exhibits. The school museum will be an incentive for making some of the collections. These materials will also be an incentive for the next class to do a similar piece of work.

Chapter XII

You may obtain from the Department of Agriculture, Washington, D. C., a list of bulletins on the topic of birds, from which the pupils may write for certain bulletins.

If possible, take the class into the field such as park or vacant lot to observe birds.

Encourage pupils to be on the lookout for birds. You may stimulate this activity by posting at least once a week the names of the pupils and their observations.

Chapter XIII

Encourage pupils to look for winter birds out-of-doors and keep notes of what they see.

Food houses, food trays, food shelves, and feeding sticks may be made and put out even in the cities. They may be made of store boxes and pieces of materials about the home.

You will find pictures and directions for making some of these feeding devices in the text and others in Farmer's Bulletin No. 621. This bulletin may be obtained by writing to the Department of Agriculture, Washington, D. C.

Pupils will be glad to tell of their experiences with the feeding devices which they make.

Post a list on the bulletin board as the pupils report the birds that come to the feeding places.

Chapter XIV

Take the class to the park or the woods to observe evergreen trees and collect cones and seeds.

Encourage pupils to contribute some specimens for the collection for the school museum. This collection, if properly mounted and labeled, will be valuable material to begin the work next year. Cases may be made for such collections or they may be purchased from dealers in laboratory supplies.

Begin a collection of the kinds of wood obtained from evergreen trees. Your dealers in lumber will usually be glad to give you information and assist you in obtaining specimens of the wood.

Chapter XV

Use pictures and lantern slides to show characteristics and habits of the bat.

Chapter XVI

Write to the U. S. Public Health Service for bulletins on the control of rats.

Arrange assembly programs and exhibits to interest the public in the problems relating to this chapter.

Chapter XVII

Lantern slides and pictures should be used to learn more about the characteristics and habits of this group of animals.

Allow your pupils to investigate the topic of animal tracks. *The Field Book*, by E. Lawrence Palmer, will be helpful.

Chapter XVIII

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 XIX

Allow your pupils the opportunity to experiment. *The Secrets of Science*, by Ellis C. Persing (Welch Mfg. Co.), will suggest apparatus and how to use it.

Warning: One cannot be too careful when working with fire. Pupils should learn how to handle fire safely.

Chapter XX

Children will be glad to bring their toys for this lesson. Select the toys that make use of levers and the wheel and axle.

Help the children to see the use of other levers about the home and school.

If a seesaw is available, make use of it for this lesson.

Help the children to make a toy seesaw. They can cut triangular blocks of wood with sides about one inch or more for the fulcrum. The weights in Set No. 1 (W. M. Welch Manufacturing Co.) can be used to show how it works.

A miniature windlass and old well may be made in connection with the lesson. Demonstrate to the children how much easier it is to lift the bucket from the well with the windlass than by hand.

Allow children to lift a half-pound weight with the windlass of the steam shovel, then lift it with their hands.

Chapter XXI

It is essential that you first make use of the rock materials in your vicinity. But a collection of rocks carefully labeled will be valuable supplementary aid. Such a collection is contained in Set No. 1 (Welch Mfg. Co.).

Chapter XXII

A trip to observe some place where soil is in process of formation will be interesting to students.

Chapter XXIII

It will not be difficult to make this chapter a problem of a large unit on gardening, or it may be taken as a separate problem if gardening is not being emphasized.

Chapter XXIV

Write to your State Experiment Station or the U. S. Department of Agriculture for bulletins on fertilizers.

Chapter XXV

Encourage children to use available space for home gardens if parents will allow it. Check the pupil's plans to see that the suggestions made in this chapter are included.

Send to the U. S. Department of Agriculture, Washington, D. C., and to your state university for bulletins on gardening.

A trip to the hardware and seed stores will be time well spent in connection with this study.

Chapter XXVI

If you do not have a school garden, the plan may be made for the school if land is available. If the children have home gardens, this may be omitted.

The garden club will help encourage activities in gardening.

Send to the Department of Agriculture, Washington, D. C., for bulletins on gardening.

Chapter XXVII

Take the class to the nearest garden to see how it is cultivated.

Encourage the children to make a weed collection and label as many varieties as possible.

Store boxes or flower pots may be used to test.

Chapter XXVIII

Encourage pupils to go to the field to study birds. If possible, take a trip as suggested in "Some Things to Do."

Appoint a committee to send to the U. S. Department of Agriculture at Washington, D. C., for a list of bulletins on birds. Then select and send for the bulletins you think will meet your needs.

Chapter XXIX

You may make gardens for these strange plants as suggested in the chapter. The slice of potato may be placed on an ordinary saucer and cooked in a kettle. When the potato is cooked, drain off the water and cover with another sterilized saucer. The cover may be sterilized by boiling in the same kettle.

One or more saucers with the potato may be used for one class. When you have completed the study, put the saucer in a kettle and boil again to kill the bacteria. Then the saucers may be washed.

Encourage pupils to grow molds as suggested under "Some Things to Do."

Petri dishes, if available, may be used instead of the saucers for the growing of bacteria. The petri dishes may be obtained from the supply houses. They are included in the set of materials for this grade by the W. M. Welch Manufacturing Company, Chicago.

Chapter XXX

It is important that one trip or hike be taken to the park or woods to look for early wild flowers. Observations in the field should include brief notes and sketches.

Observe the habitat, the leaves, the stem, the flowers, the fruit, the seed, etc.

If you do not have in your region the flowers mentioned in this chapter, observe those that are available.

Help the pupils to find the flower and their parts in the composite group. The daisy is suggested as a type for study. Use pictures and lantern slides to aid you in identification and to learn more about the habitat.

Chapter XXXI

A demonstration hive of bees can be obtained from the A. I. Root Co., Medina, Ohio, for a reasonable rental fee for use in the schoolroom.

Chapter XXXII

If there is a flower show in your city, take the class to visit it for a half day.

If there is no such exhibit, pupils will be interested in planning and holding an exhibit, even though it be on a small scale. The local florists, nurserymen, and dealers in garden supplies are usually willing to coöperate.

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