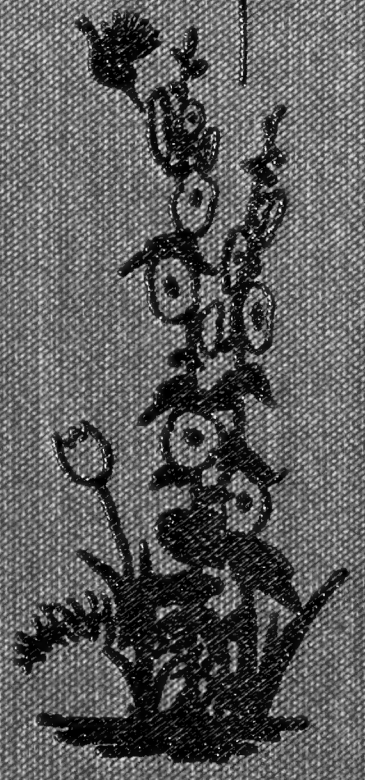
The GARDEN of the WORLD

By JANET McGILL



The GARDEN of the WORLD

UNIFORM WITH THIS VOLUME

HOW THE WORLD BEGAN
The Story of the Beginning of Life on Earth

HOW THE WORLD GREW UP
The Story of Man

HOW THE WORLD IS RULED
The Story of Government

THE WORLD OF ANIMALS
The Story of Animals

HOW THE WORLD IS CHANGING
The Story of Geology

THE WORLD'S MOODS
The Story of the Weather

THIS PHYSICAL WORLD
The Story of Physics

WHAT MAKES UP THE WORLD
The Story of Chemistry

OTHER WORLDS THAN THIS
The Story of Astronomy

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THOMAS S. ROCKWELL COMPANY
Publishers
CHICAGO

Publishers' Note

This book presents in popular form the present state of science. It has been reviewed by a specialist in this field of knowledge. An excerpt from his review follows:

> *"I believe that 'The Garden of the World' will go far toward satisfying the child's natural curiosity about plants. The contents are well chosen and attractively presented."*

Signed: MERLE C. COULTER,
Associate Professor of Plant Genetics
The Department of Botany
The University of Chicago

"Yon pretty daughters of the Earth and Sun"

THE SHEPHERD TO THE FLOWERS

Sir Walter Raleigh

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JANET McGILL

Drawings by

ELECTRA PAPADOPOULOS

THOMAS S. ROCKWELL COMPANY
CHICAGO
1930

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Chapter I

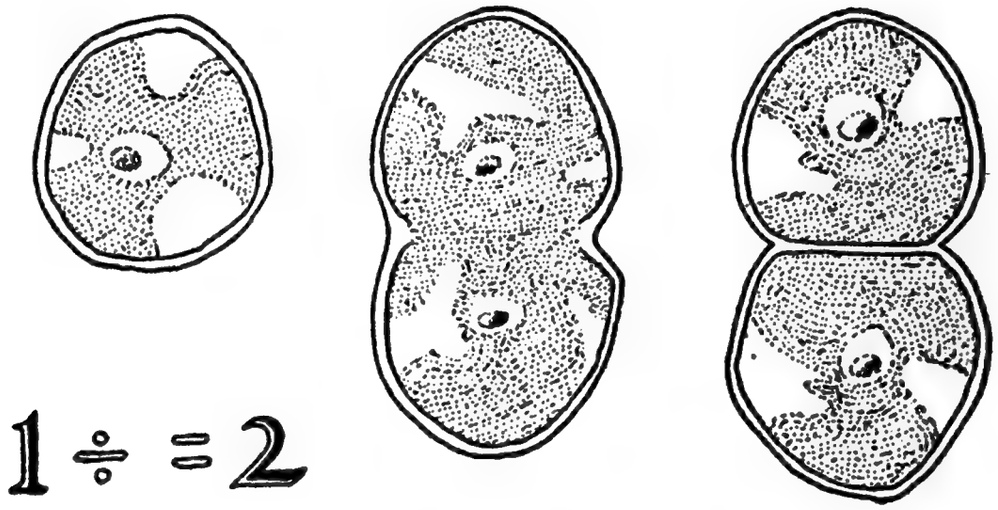
PLANTS WITHOUT SEEDS

THE green scum that floats on ponds of stale water is made of many hundreds of small plants. There are usually many kinds of these plants in one pond, but they are all very small. Each plant is only one cell. A cell is a mass of living matter enclosed in a wall which protects it. Every cell is so small that it can be seen only through a microscope. Every living thing is made up of cells. These tiny plants which grow in the ponds have just one cell, but in spite of their small size, they are independent and well able to do all of the different kinds of plant work.

What is the green scum on water?

A plant, no matter what its size, has three kinds of work to do: it must grow; it must get food; and it must always provide for the growth of new plants.

These one-celled plants grow by dividing the cell into two or more parts. A wall will grow through the center of the cell, dividing the liv-



Another cell is formed by a wall that divides the original cell into two parts

ing part into two pieces. When the wall is finished, the cell will split in two and each part is then a complete cell ready to carry on the work of the plant.

These one-celled plants are green. This is important because it means that each cell contains a substance called chlorophyll (pronounced klo′ro-fil). All plants which contain chlorophyll are able to manufacture food for themselves. The cell can take carbon dioxide

from the air and water from the pond and with the help of the chlorophyll turn them into food that the plant can use in its growth.

The pond scums provide for new plants in at least two ways. One is by dividing the cells as was mentioned before. Each division of the old cell is a new plant. It can go on starting new plants by this method so long as the weather is favorable, but when the pond freezes, the plants die. New plants are started the next spring by means of spores. A spore is a special cell which has dried up. It can live a long time without moisture or warmth. It doesn't grow but just rests. When the good growing weather comes again, the spore is ready to start a new plant. In this way a spore is something like a seed, but it is not a seed. It is not formed in the same way, nor is it made of the same parts.

The pond scums belong to a large family of plants known as the Algæ (pronounced Al'je). The other plants in the family are not all so small as these, but they are all very simple. The large brown seaweed is an alga. None of the

algae are very important to us. They are not good for food, and they are not even dangerous as some of the simple plants, like bacteria, are. People often have an idea that pond scum is poisonous. It really is harmless, but the water in these ponds often contains poisonous bacteria so it is not safe for drinking.

If the algae are not important in themselves, however, they are very important in the history of plants. Probably the very first plants in the world were one-celled just like the green scum floating on ponds. Gradually, through millions of years, they changed and finally became the complicated plants with stems, leaves and roots which we have now. We are sure that the very first plants grew in the water because simple plants can grow much better there. They do not have to provide against drying out as the land plants do. Every living cell must be full of water. This is always true whether the cell is growing alone or as one of many in a large and complicated plant. It is true of animal cells also. Plants which do not live in water

must have thick walls or skin to keep the water from evaporating, and they need root systems to get the moisture from the ground.

Green scum on the water is made of the living members of the family that were the very first of all plants that ever lived on the earth.

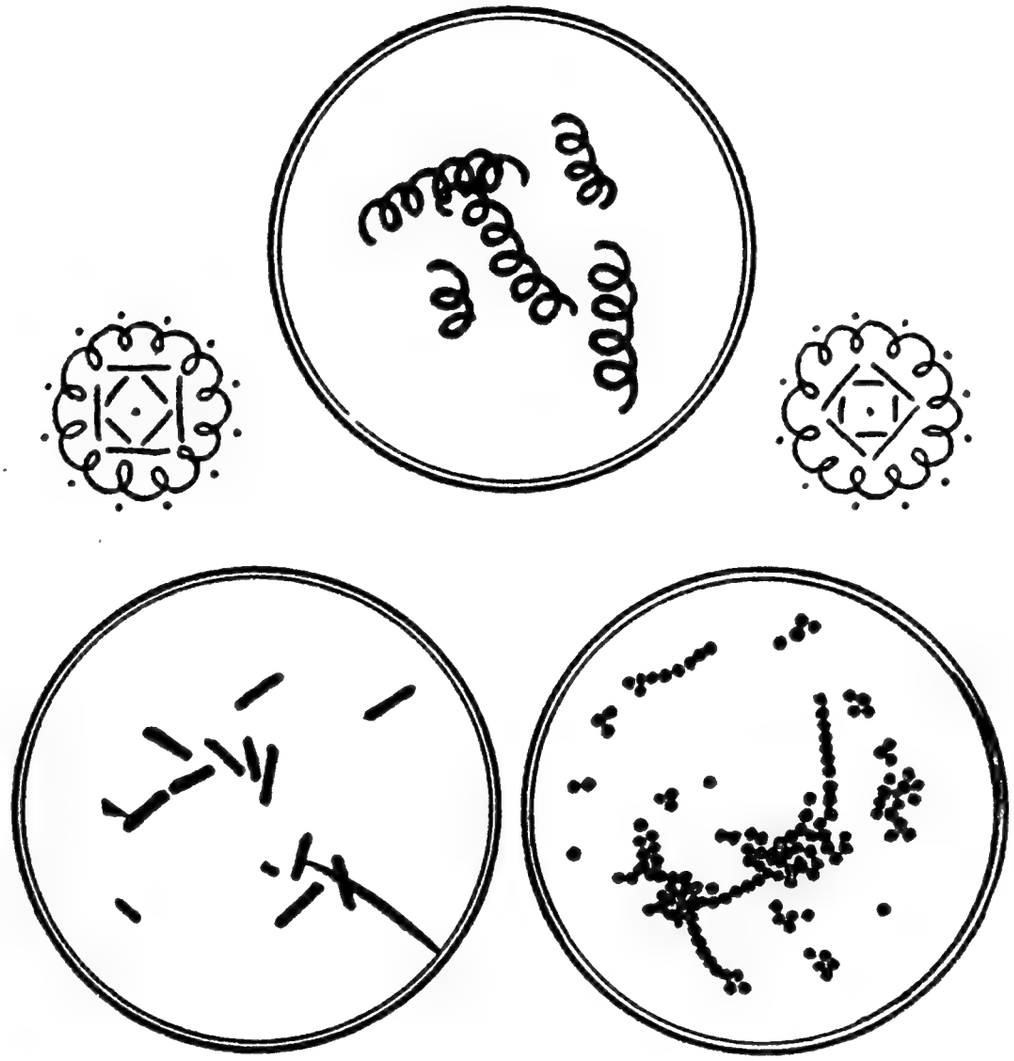
What are the smallest plants?

The smallest plants are so small that no one knew they existed until about one hundred years ago. Until the time when microscopes were invented, people did not even suspect that there were such things. They are called *bacteria,* and in spite of their small size, they are very important to the lives of human beings. A great many of them are useful. They help us to get linen fiber, to tan leather, to turn milk sour, to make cheese and butter, to make vinegar, and to get rid of dead plant and animal material. A few are very harmful; they spoil food which we wish to eat, and they cause a great many diseases. We often call the harmful bacteria by the name of germs or microbes.

Let us see how these bacteria work. In order to see them at all we must use a powerful micro-

scope. Even then they seem to be very tiny. None of them are large enough to be seen by the eye alone. They come in three different shapes, like balls, lead pencils, or corkscrews. They are only shaped like these articles, but are nothing like them in size. They do not produce seeds, but they multiply by dividing into two pieces. It is a very simple performance. Each plant becomes thin in the middle and finally breaks apart. Each new piece continues to grow and breaks apart again. They do this very fast. One plant can produce one million new plants in twenty-four hours. Usually after dividing, they separate, but some kinds hang together in strings, or bunch together in clusters. Some of the bacteria have little hairlike feelers and with these they can swim about very freely. They are not green, and they do not make their own food, but take food which is already made from the place where they are living. If they cannot get food suited to them, they die. Bacteria are found everywhere on the face of the earth. They are

in the ground, in the water, in the air, clinging to our bodies, clothing, and food. They are



Bacteria are of three shapes—like balls, lead pencils, and corkscrews

ever present, but we seldom think of them until they are harmful to us.

There are a great many more useful bacteria

than there are harmful ones. In fact, there would be no life upon the earth at all if it were not for the bacteria of decay. When a great tree dies and falls, these bacteria attack it, and gradually it crumbles and disappears. The task takes years, but is finally finished. When animals die, the bacteria of decay dispose of them also. If the plants and animals which had once lived on the earth did not decay, but were still lying about, it would be impossible for us to live at all.

We want the milk that we drink to be sweet and fresh, but we need sour milk also. It is used to make butter and cheese. There is a certain kind of bacteria that turns milk and cream sour. Another group of bacteria turns cider into vinegar. There are thousands of helpful kinds.

Some bacteria, for all their small size, have the dangerous power of making poisons. They seem to be able to change the food they have used into substances that are poisons for people and animals. That is what these disease bac-

teria do when they get into our bodies. Once they are in, they grow and multiply, and of course the more of them there are, the more poison they make. Sometimes our bodies are strong enough to resist this poison and throw it off. At other times it is too strong and makes us sick. Of course the best way to prevent sickness is to keep the bacteria out. They come in chiefly through our mouths, noses, and cuts in the skin. They cannot stand heat. We can kill them by boiling food, and by washing articles that may carry bacteria in boiling water. This is called sterilizing. Diphtheria, tuberculosis, and influenza are three common diseases brought by bacteria.

The farmer is fighting bacteria all the time. They cause diseases of plants as well as of animals and people. They get through the skins of fruit and vegetables that have been cut or bruised and cause them to spoil. They spoil meat. They produce bad odors, and are the cause of most of the smells around the barn. The farmer's best weapon in fighting them is

cold. They cannot spoil fruit and meat which are kept cold. The ice box is one of our best protections against harmful bacteria.

What causes bread to mold?

It is interesting and very easy to grow a little crop of bread mold to study. Moisten a piece of bread with water, leave it exposed to the air for a short time, and then put it into a covered tumbler. Keep it covered and in a warm place. In a day or two, it will be covered with fluffy white stuff that looks like cotton. In another day there will be tiny black balls scattered over the fluff. If you break these, a fine black powder comes out and floats away.

The white cottony material forms the roots and stems of the bread mold plant. The roots go all through the piece of bread to soak up food and moisture. (It cannot grow unless the bread is moist.) The black powder is made up of a great many *spores*. Spores are not seeds, but they take the place of seeds for some plants. They are so small as to be invisible, and the air is full of them. When a spore happens to alight on a good place to grow, it

can produce a new plant. Spores, which you cannot see, floating about in the air, settled on your piece of bread and grew into the bread mold you found. The blue colored mold which grows on jam and cheese and other foods is a relative of the bread mold.

All the molds belong to the Fungus family. They are larger than bacteria, but are much more simple in their formation than the green plants. They do not make their own food but steal it. Therefore, they are parasites, a word which means "eating at another's table." They are usually not poisonous, but harm us by spoiling the food we want to eat. They must have warmth and moisture in which to grow. We can protect our food by keeping it cool and dry. Molds are not so dangerous as bacteria, but they do quite a lot of damage. They do not attack living plants or animals, and they do not enter into our bodies to cause disease as do bacteria. Bacteria and molds often grow together, as they both like warmth and moisture. Boiling or cold temperatures will kill both of them. If

we cook our meat and keep our apples in the ice box, neither of these enemies will attack them for a long time. Bread should be kept cool and dry and away from the air where the spores of bread mold are always floating.

Bread molds belong to a family of plants which are called fungi. Other members of the family which you may know are these: mushrooms, wheat rust, puff balls, and the large fungus brackets which are often seen on trees. These different kinds of fungi do not look at all alike, but they are known to belong to the same family because they are not green and cannot make their own food and because they do not produce seeds but form new plants by dividing cells or by making spores.

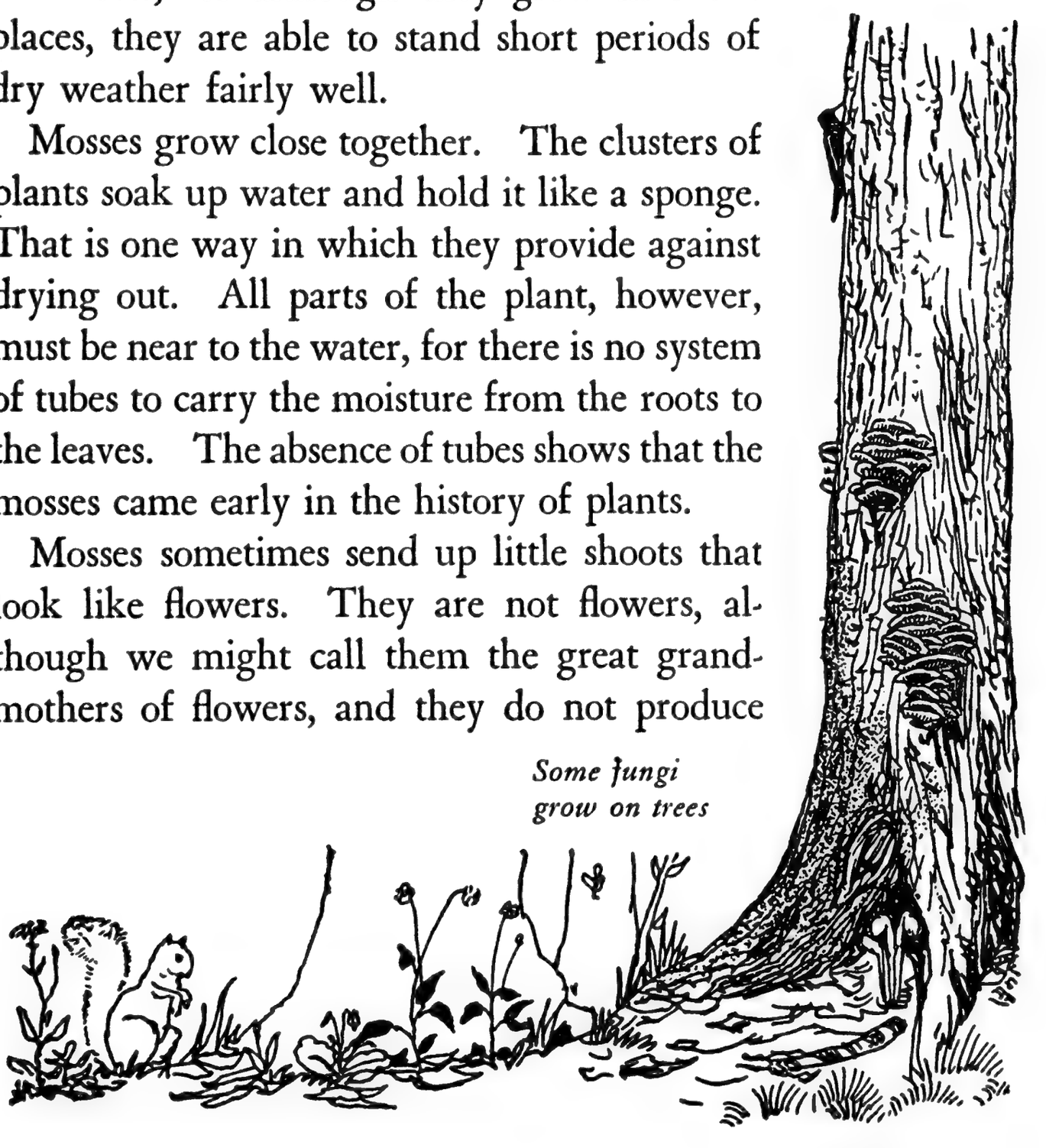
What is moss?

The plants of the moss family are very simple. They are not quite so simple as the algae, for they are able to live on land. They have roots, stems, and leaves. All of these parts are very simple, but they are a step towards the higher plants which are now so common. The algae were probably the first plants in the world.

The first land plants were the liverworts. These are like the algae except that they developed roots and thicker cell walls to keep the water from drying out. The liverworts could live on land, but it had to be moist. They could not stand more than a short dry spell. The mosses seem to have come next after the liverworts, for although they grow in moist places, they are able to stand short periods of dry weather fairly well.

Mosses grow close together. The clusters of plants soak up water and hold it like a sponge. That is one way in which they provide against drying out. All parts of the plant, however, must be near to the water, for there is no system of tubes to carry the moisture from the roots to the leaves. The absence of tubes shows that the mosses came early in the history of plants.

Mosses sometimes send up little shoots that look like flowers. They are not flowers, although we might call them the great grandmothers of flowers, and they do not produce



Some fungi grow on trees

seeds but spores. A spore is only a special cell that is able to stay alive over a long resting period. At the end of that time, it can grow and develop into a new plant. A seed is a much more elaborate arrangement than a spore.

Mosses are pretty to look at and soft to feel, but they are chiefly interesting to us when we study the history of plants. They are the first plants which managed to live *successfully* on the land.

What are ferns?

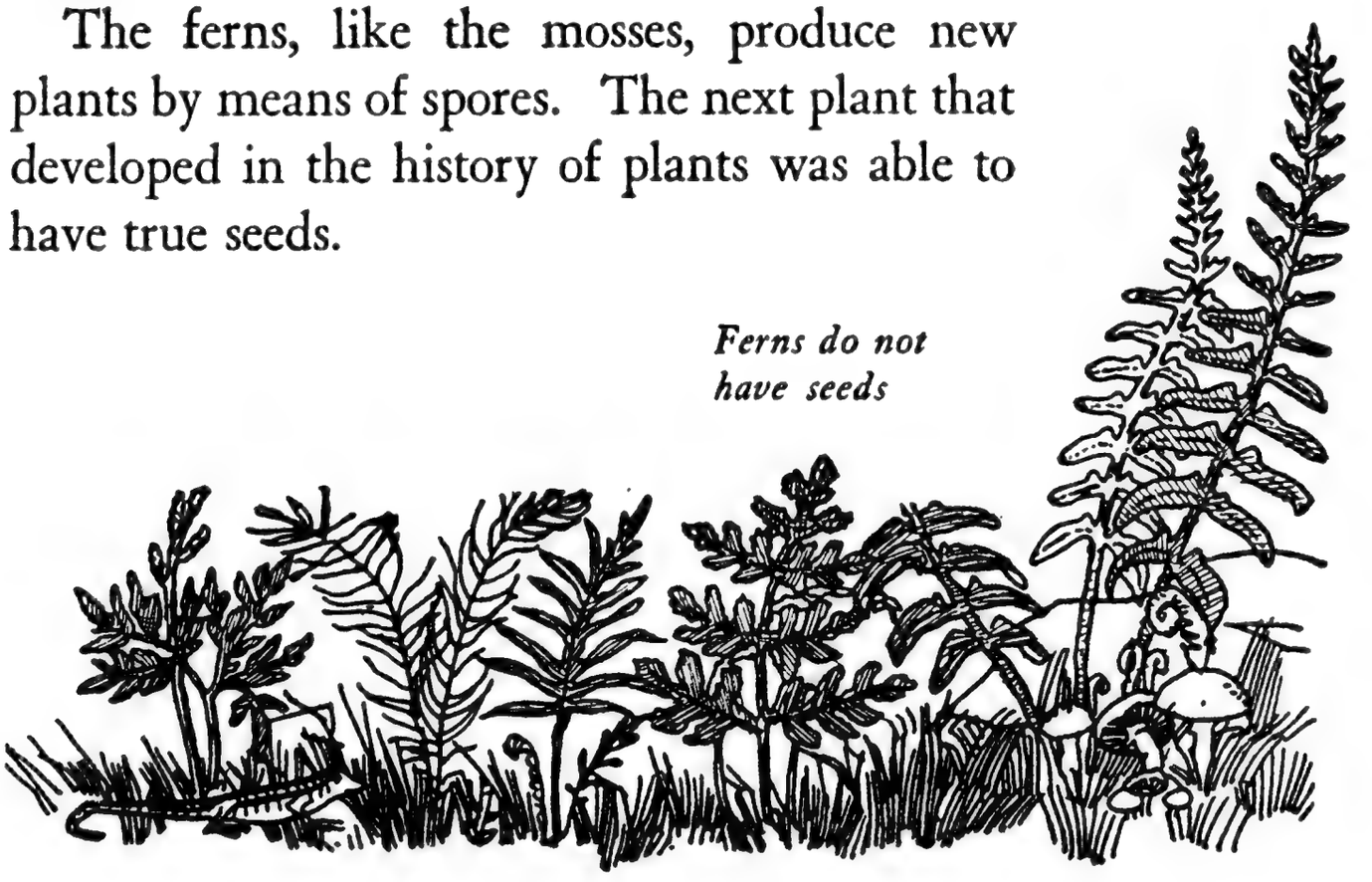
Ferns were once more important than they are now. In the time, ages ago, when coal was being formed, ferns were the most plentiful of all plants. We know this because the imprint of fern leaves is often seen in coal, much more often than the print of any other kind of leaves.

Ferns show a big improvement over mosses in the attempt of plants to grow well on land. The new parts which they developed are tubes which carry water from the roots to all parts of the plant. Mosses cannot grow very large because when they get away from the ground, they cannot get water, but ferns can grow tall

because these tubes carry water to any part of the plant that needs it. During the coal-forming ages, many ferns were as tall as trees. Indeed there are tree-ferns still, but they grow only in warm countries, or in green-houses. It is a big advantage for a plant to be able to grow tall, for then its leaves can get more sunlight. Sunlight is necessary for the manufacture of food. From this advantage comes another one: if a plant can manufacture a great deal of food, it can store some away for the winter season. Then it can stay alive all winter and be ready to grow in the spring. The mosses and earlier plants never have extra food nor storage places. The ferns are a big improvement over them. They can stay alive much longer.

The ferns, like the mosses, produce new plants by means of spores. The next plant that developed in the history of plants was able to have true seeds.

Ferns do not have seeds



Chapter II

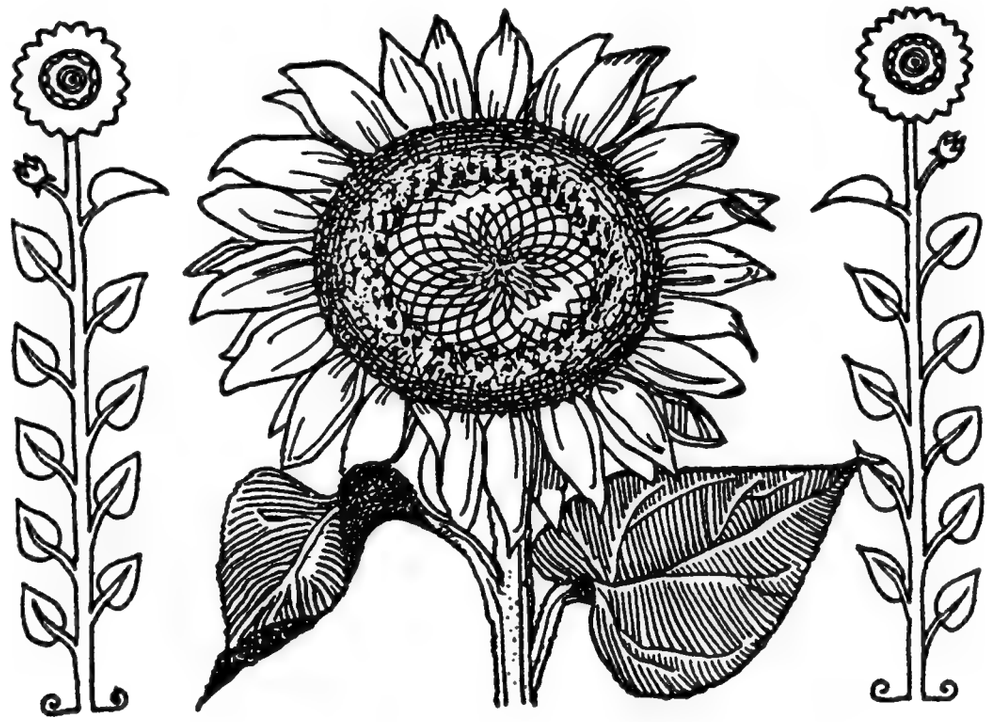
FRIENDS AND ENEMIES

Why are sunflowers yellow?

WE ENJOY the brilliant colors of many flowers, but the plant is not trying to attract us when it puts on its golden petals. It is attracting the bees and wasps who have an eye for color also. The sunflower is anxious for the bees and wasps to see it and to visit it, for unless they do, it may never have any seeds.

Every plant has three objects in life: to live, to grow, and to produce other plants like itself to carry on its life when this plant has died. Most of our common plants accomplish this third object by means of seeds. You all know the hard, dry seeds which we plant in the garden, but perhaps you have not paid so much attention to the young seeds. The seeds are born in the flowers. If you pull the center of a sunflower early in the summer, you will see

the baby seeds, which are white and milky. At the end of August or early in September, you will find that they have become hard and dry and much darker in color. Now a curious thing about seeds is that they never become full



The seeds will never become full grown unless they have been pollinated

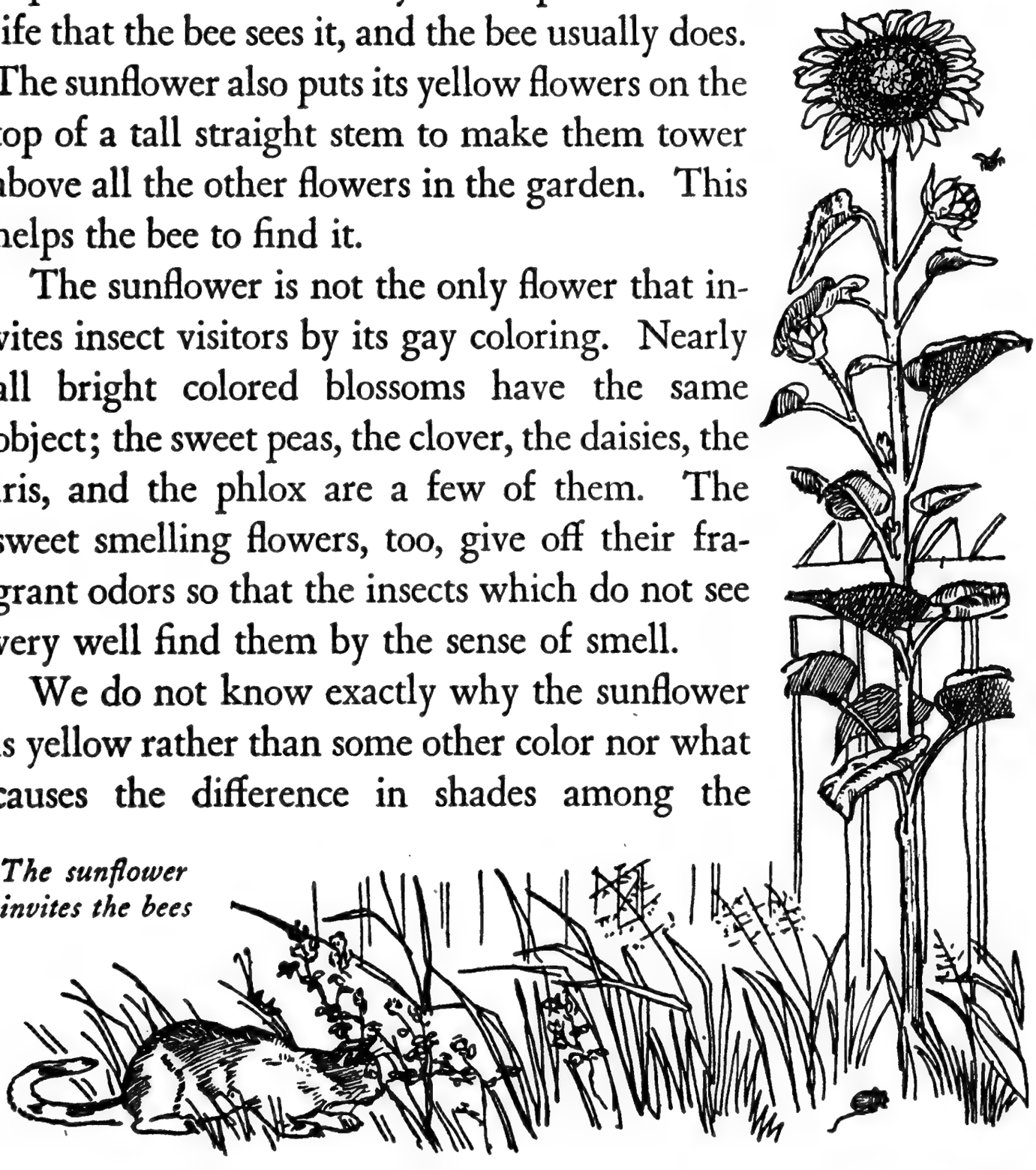
grown so that they can be planted unless they have been pollinated. That is what makes the difference between the baby seeds and the ripe ones which grow into new flowers.

Pollen is the yellow powder that comes off on your fingers if you rub them across a flower. The part of the flower that holds the baby seeds is called the *pistil*. It usually has a sticky point called the *stigma*. The pollen must be put on to this stigma in order for it to get to the young seed. It might just happen to fall there, or the wind might blow it, but the sunflower cannot depend on such uncertain methods. If a bee, however, should walk across the flower, the pollen would stick to his hairy body, and then, when he rubbed against the sticky point of the stigma, it would be rubbed off again. There are so many stigmas close together on one sunflower that one bee would pollinate a great many. This, then, is the very best way for the sunflower to have its seeds ripen, so it tries in every way to make itself attractive to bees and wasps. But the insects do not pollinate the flower just to help it out. They want something for themselves. What they are after is the pollen. They eat it and feed it to their young. The sunflower has a great deal more

pollen than it needs, so the insects may carry off all they wish without hurting the flower. When a bee is out hunting for pollen, he goes to the plant that he sees first. Yellow is a very noticeable color, so the sunflower puts on big yellow petals to make itself as gay and bright as possible. It is necessary for the plant's future life that the bee sees it, and the bee usually does. The sunflower also puts its yellow flowers on the top of a tall straight stem to make them tower above all the other flowers in the garden. This helps the bee to find it.

The sunflower is not the only flower that invites insect visitors by its gay coloring. Nearly all bright colored blossoms have the same object; the sweet peas, the clover, the daisies, the iris, and the phlox are a few of them. The sweet smelling flowers, too, give off their fragrant odors so that the insects which do not see very well find them by the sense of smell.

We do not know exactly why the sunflower is yellow rather than some other color nor what causes the difference in shades among the



The sunflower invites the bees

flowers. The color is made by a substance called anthocyan (pronounced an-tho-si-an), but men who study flowers do not know a great deal about this substance.

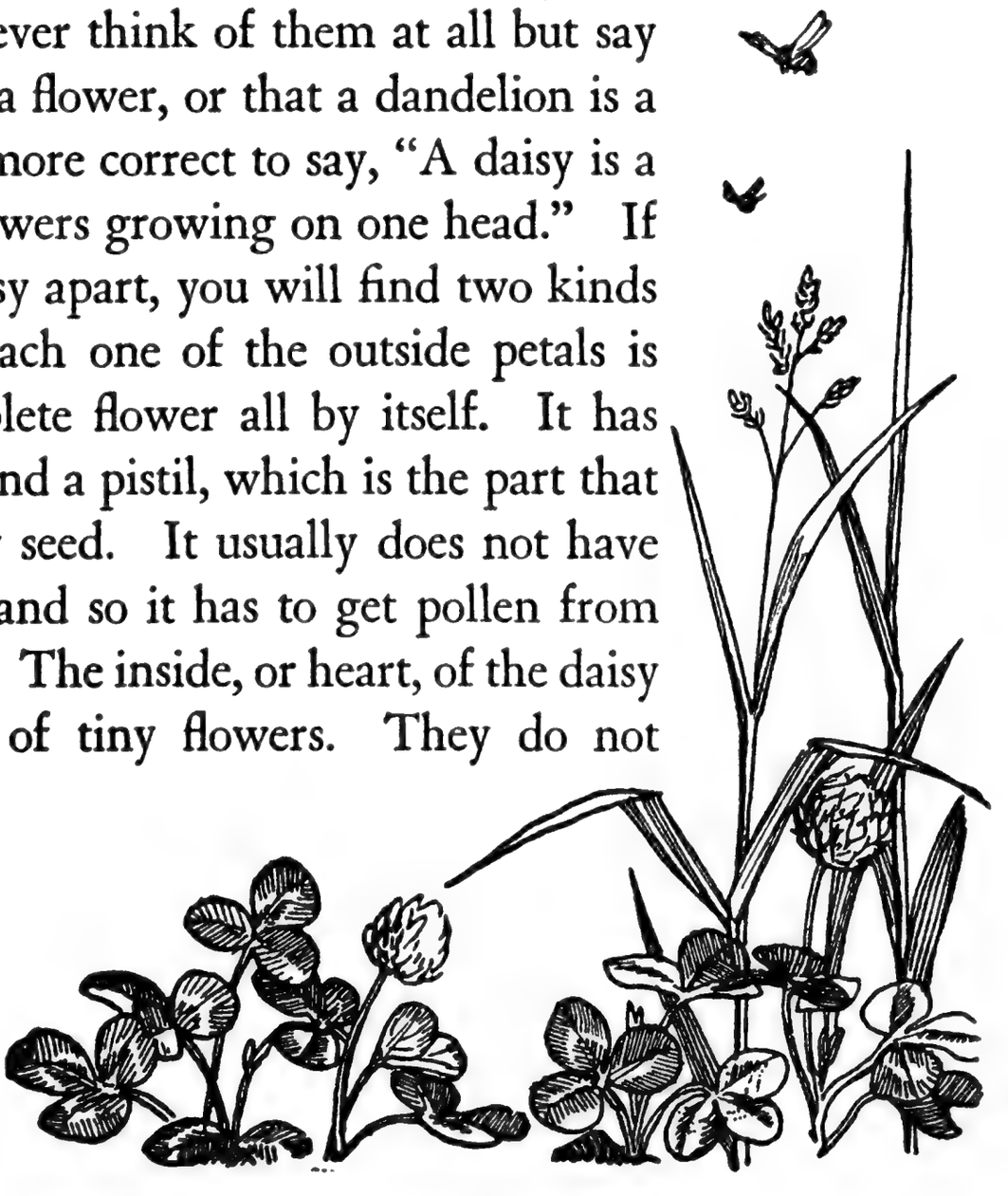
How do plants club together?

A fact which we must never forget for a moment when we are thinking about flowers is that the flower is only interested in attracting insects to itself so that its seeds may be pollinated. Large flowers like the water lily are easily seen, and they can get along by themselves. Small flowers, however, are often hard to see; therefore, we often see them growing in groups. Lilacs are groups of flowers, and you know how easily seen they are. The bridal-wreath which blooms on bushes in our gardens in early spring is another example. So is the hyacinth. You can see the separate small flowers very readily. This group arrangement has two advantages—the flower can be seen better, and the insect can pollinate a large number of seeds at one time.

Some flowers are so small that we think of the whole group as just one flower. Clover is

an example of this kind. Did you ever notice that one clover blossom is made of dozens of tiny flowers? If you haven't, pull one apart the next time you have a chance and you will see them. Bees love clover because of its sweet nectar, but they could never find it if these tiny flowers grew by themselves. Because they have clubbed together into a good-sized group, the bee has no trouble whatever in finding them.

There is another family which has even smaller flowers. These flowers are so tiny that most people never think of them at all but say that a daisy is a flower, or that a dandelion is a flower. It is more correct to say, "A daisy is a great many flowers growing on one head." If you take a daisy apart, you will find two kinds of flowers. Each one of the outside petals is nearly a complete flower all by itself. It has one big petal and a pistil, which is the part that holds the baby seed. It usually does not have any stamens; and so it has to get pollen from other flowers. The inside, or heart, of the daisy has hundreds of tiny flowers. They do not



Clover is made of many blossoms

have big petals, and are so small and yellow that many people think they are just stamens. When they are magnified, however, each is seen to be a tube of small petals, containing a pistil and some stamens. All of the parts needed to pollinate the seeds are there. Try to imagine, though, what a hard time such a little flower would have growing by itself. A bee would never see it, for it is no bigger than a bee's leg.

The plant put all these small flowers on one big head which is bright and showy. The two kinds of flowers that make a daisy have their own separate work to do. The outside flowers with the large petals are called "ray flowers" because they stand out like the rays of the sun. The smaller, inside ones are called "disk flowers," because they grow on a round, flat disk. The ray flowers are the most attractive. They tell the bees that here is a blossom with pollen and nectar for them. The disk flowers are the workers. They produce the seeds. The ray flowers are able to have seeds, but usually they do not.

The dandelion is another plant which has a head made up of many flowers. You can tell how many flowers there have been when the seeds are ripe and ready to blow away. Every

The clover, dandelion, daisy, and many other common flowers are really many flowers in one

seed stands for a flower. Sometimes there are as many as two hundred flowers on the head of one dandelion.

Plants which have heads holding many small flowers belong to the Composite family. Many

of our commonest flowers belong to this family. Besides the daisies and dandelions, there are the sunflowers, brown-eyed susans, dahlias, chrysanthemums, and thistles.

Why do flowers open and close?

Flowers close to keep out the rain, to keep warm, and to keep unwelcome insects away from their pollen. They stay open during the business hours of the insects they favor. If bees and butterflies are wanted, the flower is open in the daytime when these insects are flying. It closes at night to protect its nectar from the rain and dew. The flowers which prefer moths, however, are open at night and closed in the daytime because moths fly at night.

About four o'clock in the afternoon, the small flowers of the white honeysuckle begin to open, and the sweet fragrance becomes very strong. Soon the sphinx moth, attracted by the perfume, begins to hover over the blossoms. It is a large moth and resembles a humming bird when flying. It has a long tongue which it carries rolled up. At each honeysuckle this tongue is unrolled and thrust deep into the

flower for a long drink of nectar. At the same time the moth dusts off onto its body some of the pollen, which it carries to the next blossom. It takes a great many honeysuckles to satisfy a thirsty sphinx moth. It flies about all night, guided by the perfume of the flowers, and by their white color.

White shows up much more plainly at night than red or other colors. That is why more white flowers than any other color smell sweet. They are designed to attract night flying insects. Sometimes the moths do not get to all the flowers before morning. The honeysuckles that have been pollinated turn yellow and close as a sign that they do not need any more visitors. The ones which have not been visited by the moths stay open for a time in the morning to let the bees and the butterflies do what they can. They come around anyway to get what is left. If the night has been clear and calm, they will not find much nectar or pollen because the moths have taken it all, but if the night was stormy, the moths would have had to find

shelter from the wind and rain, and the bees may have a feast.

The Jimson weed also waits for four o'clock to entertain the sphinx moth because its nectar tubes are too long and narrow for any other insect to reach. Sometimes it opens early and the bees come and take the pollen.

The beautiful evening primrose stays closed all day to protect its pollen from bees and flies, for it is also waiting for the sphinx moth. If the moth misses a flower, that flower stays open in the morning until a bumblebee visits it. It must be pollinated at once because its petals last only one day.

There is a family of blossoms called the Catchflies. The night blooming catchfly is a pale pink and has a sweet perfume to attract the moths. The day blooming catchfly has no odor at all, but has bright colors to guide the butterflies which fly by day.

On the whole, colored flowers bloom by day and close at night, while white flowers open at night and have the sweetest perfume. There

are exceptions, to be sure, but this is the general rule which the flowers follow.

Why do so many red flowers have long narrow tubes?

Have you ever noticed how many red flowers have their nectar hidden in deep slender pockets? If you want to suck the nectar, you must bite off the end of a tube and get it from the bottom for, of course, your tongue is too thick to get into the narrow opening. The bumble-bee's tongue is narrow but not long enough. At least a dozen red colored flowers are made this way: the trumpet flower, the coral honey-suckle, the red and yellow columbine, jewel weed, bee balm, gladiolus, canna, nasturtium, and salvia are some of them.

Red seems to be the favorite color of the humming bird. These red flowers are saving their nectar for him. His long, sharp bill is just the right size and shape to fit into their nectar tubes. They bloom later in the summer than the blue and yellow flowers as a rule, because the humming bird does not come as early as the bees. To be sure, many of the flowers wait in vain, because humming birds are not very

common. Often times not one comes to a garden in a whole season. These red flowers would not get their seeds pollinated if the bees

The humming-bird's bill is the right shape to reach the nectar of certain flowers

and butterflies did not help them out. These insects cannot get to the nectar, but they are never tired of trying, and there is plenty of pollen to reward them.

Sometimes the humming birds do come, however. If they are anywhere in the neighborhood, a garden with red flowers is sure to

attract them. Some people plant trumpet vine and coral honeysuckle just to entice them. If they do come they dash from one flower to another in a perfect frenzy of joy. Their little wings beat so fast they seem to be just a blur in the air. Their sharp little beaks find the nectar in a second and drain every drop. They do not care for pollen as the bees do, but, of course, it sticks to them anyway, and they carry it to other flowers to pollinate them.

How do plants protect themselves?

Crawling insects, like ants, usually are enemies to plants, while flying insects, like bees and wasps, are friends. A plant's problem is to make the flying insects welcome and at the same time keep out the crawlers. The crawlers are enemies because they eat the pollen and drink the nectar but do not carry the pollen to the other flowers. It is easy to see that by the time an ant crawled all the way down the stem of a rose-bush and up another stem to another rose, the little bit of pollen that had clung to him would be brushed off. A bee, on the other hand, flies in the air from one flower to another

so quickly that she cannot help but carry the pollen. It is the flower's business to see that its pollen is carried to another flower, and nature provides a means to prevent any insect that interferes with that business from taking the pollen and nectar. If ants get into the flower first, there will be no pollen left for the bees and butterflies; so the ants must be kept out.

Some flowers, like roses, have many fine hairs along their stems that keep an ant from crawling up. As she goes up the hairs keep getting thicker and thicker. They are like a forest to her; so she gives up. The hairs near the top are smeared with a gummy juice which hold her legs. It is just about impossible for an ant to get to a rose.

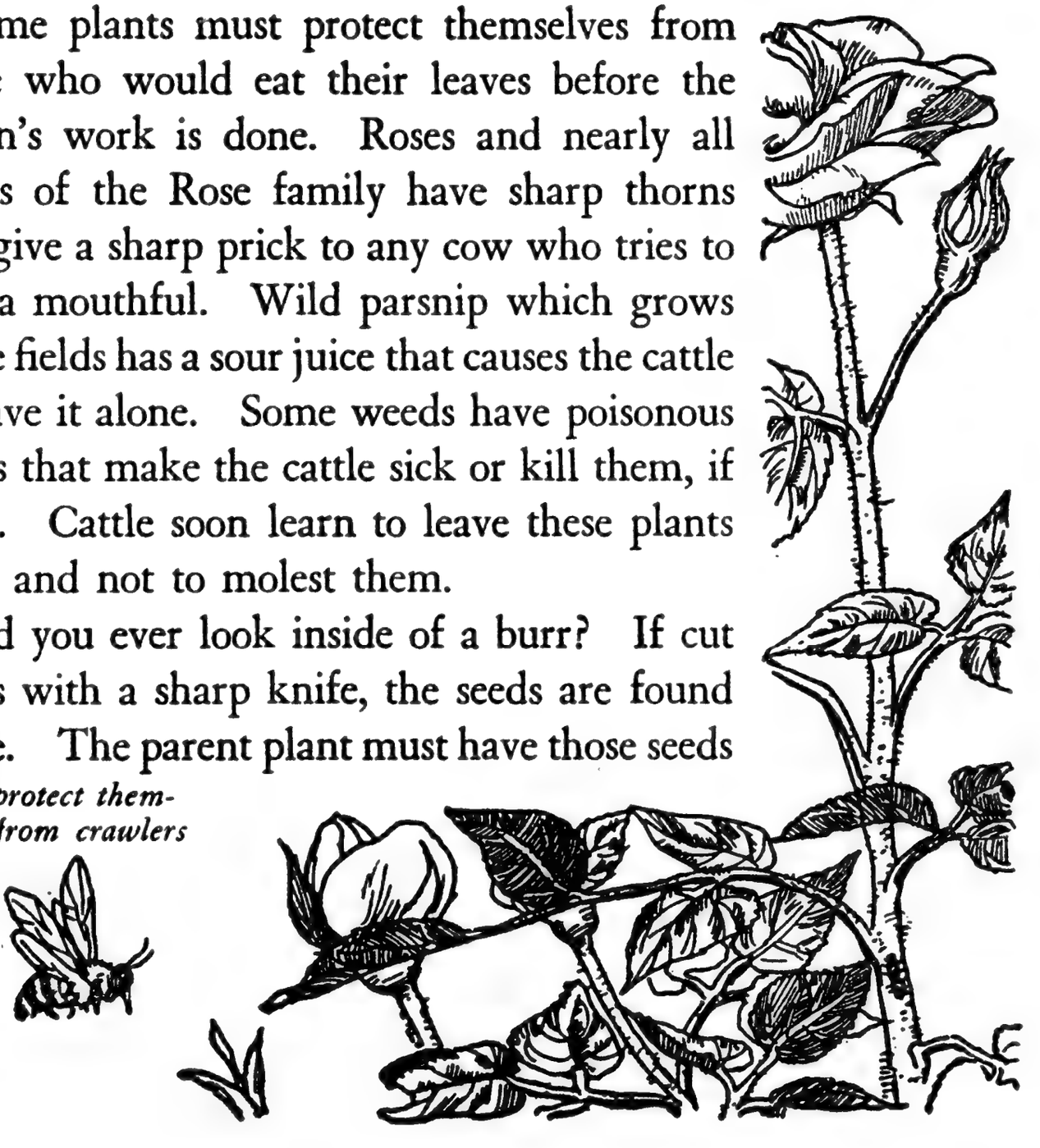
Milkweed juice is useful against ants, too. The skin of a milkweed stem is very thin. As the ant crawls up, her sharp feet cut through the thin skin and start the milky juice to flowing. Her feet become wet and tangled. If she is wise she will drop off immediately while she still can. If she keeps on trying to get up,

the juice hardens and holds her so fast that she can never get away.

The wild pink punishes crawling insects who try to steal nectar by catching them in a sticky juice smeared high on their stems. It holds them as fast as fly paper does. Perhaps you have noticed certain weeds that made your fingers sticky when you picked them. This is the reason for that stickiness.

Some plants must protect themselves from cattle who would eat their leaves before the season's work is done. Roses and nearly all plants of the Rose family have sharp thorns that give a sharp prick to any cow who tries to take a mouthful. Wild parsnip which grows in the fields has a sour juice that causes the cattle to leave it alone. Some weeds have poisonous leaves that make the cattle sick or kill them, if eaten. Cattle soon learn to leave these plants alone and not to molest them.

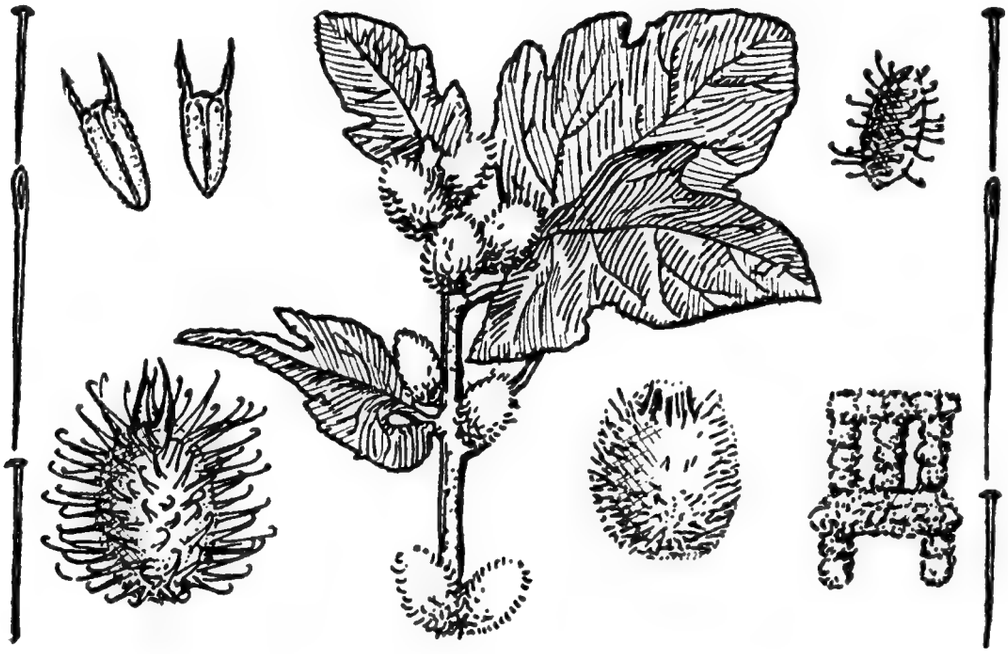
Did you ever look inside of a burr? If cut across with a sharp knife, the seeds are found inside. The parent plant must have those seeds



Roses protect themselves from crawlers

planted somewhere so that they can grow. The burdock, a plant that produces burrs, usually grows in thick patches. The space is crowded with plants, and there isn't much space for new ones. The plant provides that its offspring gets far away and starts life in a new place,

Why do burrs stick?

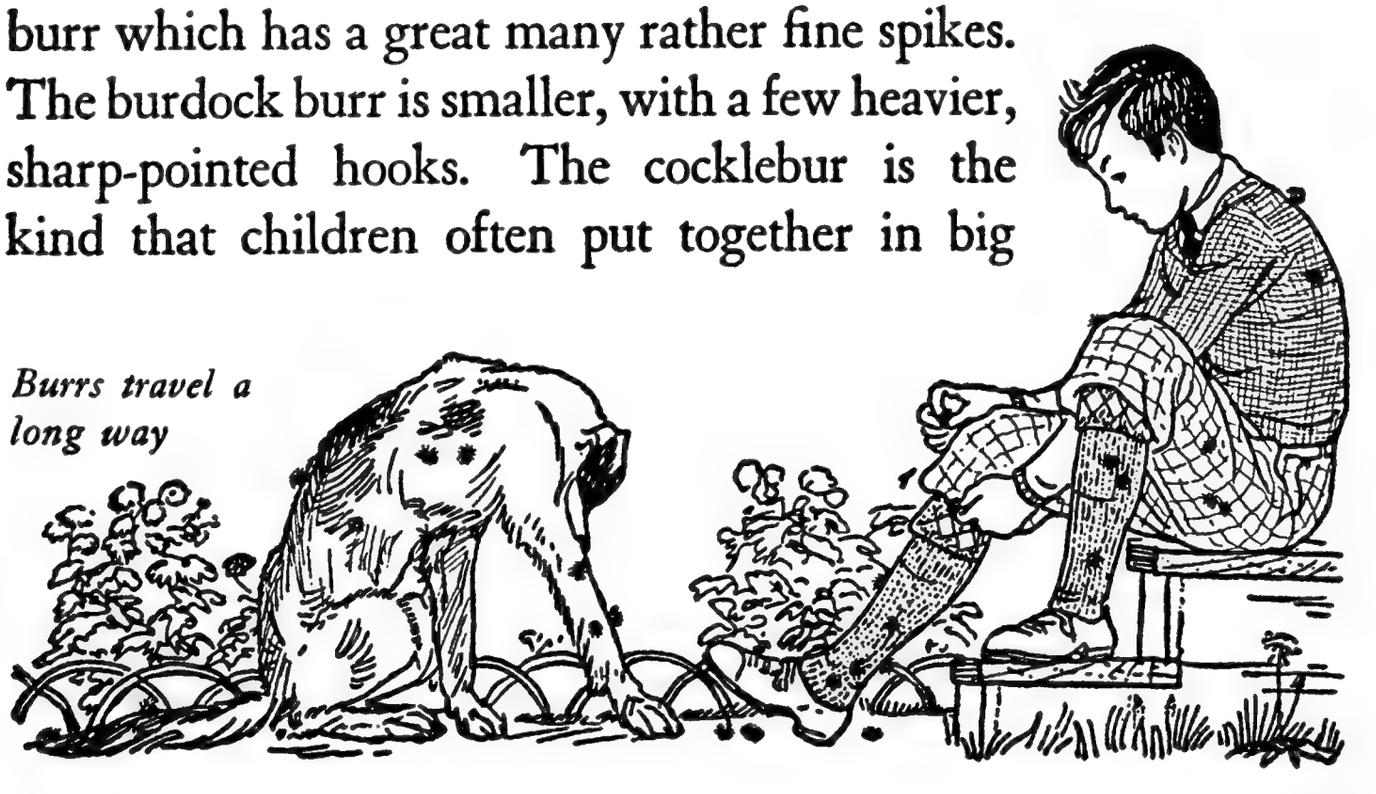


The many different kinds of burrs have just one purpose—to be carried somewhere

where there is not so much struggle for light and ground space and moisture. Its way of accomplishing this is to have little hooks on its seed pods. When a boy and his dog run through

the prairie, some of the little burrs hook onto the boy's stockings, and others catch on the dog's hair. Later on the boy pulls the burrs off. Perhaps he will pull them off the dog too. If he doesn't, the dog will have to bite them off, for they are sure to bother him. If the burrs happen to drop on the ground in a good place, they will take root and begin to grow, not right away, of course, but the next spring. If they are taken off in the house or drop on the sidewalk, they are lost. The parent plant makes provision for many of its seeds being lost; so it produces a great many more than ever can grow. That is why each burdock plant has such big bunches of burrs.

The burdock is not the only plant that sends out its seeds in this way. There is the cocklebur. That is the plant with the good-sized burr which has a great many rather fine spikes. The burdock burr is smaller, with a few heavier, sharp-pointed hooks. The cocklebur is the kind that children often put together in big



Burrs travel a long way

bunches or even use in modeling doll furniture and crude little figures. Another common plant with prickly seeds is the Spanish Needle. It has a single seed with two sharp points that are hooked. Sometimes one person will have as many as a hundred of them sticking to him at one time. The wild animals help distribute these seeds even more than people or dogs. They live in the places where these wild plants grow and they can carry an enormous number of burrs in their shaggy coats. Sometimes an animal, such as a squirrel or rabbit, or even a fox, will carry them for a long distance before he can get rid of them. In this way the new plant has a chance to find a good growing place, far from home.

And so burrs stick so that the seeds which they hold may be carried away from their parent plant to a new place which will be a good one for the new plant to make a start.

Chapter III

SUNLIGHT FACTORIES

VINES climb in order to get their leaves into a better place in the sunlight. They have many ways of getting up from the ground. Some vines twine their stems about a support such as a fence rail, a stick, a bush, or a tree. A curious thing about these twining plants is that they always twist in the same direction. The hop vine winds from right to left, or with the sun. The morning glory always goes against the sun, or from left to right.

How do plants climb?

The cucumber and grape vine have tendrils. These look like short stems, but they do not have leaves. The ends of the tendrils are hooked, and they coil when they strike a support. Sometimes a real stem acts as a tendril. It curls about a support and then continues on its way, bearing leaves as it goes. The Boston

ivy has tendrils also, but at their tips the tendrils have sensitive disks which give off a sticky juice when rubbed against a support. This juice is like glue and fastens the tendril very tightly.

Other plants—the trumpet vine, the poison ivy, and the English ivy—have aerial roots which attach themselves to the support. They like best to climb a brick or stone wall and these roots occupy the chinks or dark places of the wall or of the bark if they are climbing upon the trunk of a tree.

Some plants just scramble up. The tall blackberry has hooks and prickles all over its stems and leaves which hold fast to any support they may happen to find.

Climbers can get very high into the air without wasting effort in building strong stout trunks as trees do. They can get a great many leaves to the light and can grow very swiftly. Many of them have very long stems, from fifty to three hundred feet long. In the hot damp countries there are vines with stems as long as one thousand feet, which is nearly a fifth of a

Climbers have different methods

mile. Vines have one disadvantage. If they do not find a support, they cannot get their leaves into the light and as a result, they do not thrive so well. Climbing plants sometimes put on so many leaves that they shade the tree or bush they are leaning upon and injure it, and sometimes even kill it by keeping the sunshine away.

How do plants get their food?

Plants are like people in a great many respects, but in one way they are much more independent, for they can make their own food. Each plant, big and small, is a busy food factory, and the busiest workshop in the factory is the leaf. Whenever you see green leaves on a tree you may know that they are working hard at manufacturing food that will keep the tree alive and make it grow tall and strong. Let us take, for example, an oak leaf and see what happens in its workshop.

The first thing the leaf needs is water, and the veins which you have often noticed bring that. The water gets into the trees through the roots. It travels up the tree trunk through long narrow tubes which are connected to the veins.

Morning glories must have a support

The arrangement is something like the water pipes in a house. The water comes in at the basement, is brought upstairs through large pipes, and is passed on to many small pipes so that we may draw the water out of the faucets in several different rooms.

The next thing the leaf needs is carbon dioxide. Carbon dioxide is very familiar to you, although you may not know it by name. When you breathe you must have oxygen, but the air you breathe out is carbon dioxide. It is not good for human beings, and if there is too much in the room it makes us sick. That is why we need to have our windows opened and why we say, "We must have some fresh air." A plant, however, is just the opposite from people for it breathes *in* carbon dioxide and breathes *out* oxygen. A leaf breathes through little holes on the under side of its surface. You cannot see them without a microscope.

A green leaf has the ability to take this water and carbon dioxide and put them together. The result is sugar, because sugar is made of carbon,

oxygen, and hydrogen. Carbon dioxide is made of carbon and oxygen, and water is made of oxygen and hydrogen. You can see that there will be some oxygen left over; so the leaf breathes this out. This sugar is what the plant needs for food. It is sent all over the plant through slender tubes. We get our sugar from plants that make more than they can use—the sugar cane and sugar beets, for example.

The leaf can only make food when the sun is shining and the weather is warm. That is one reason why leaves drop off in autumn. They cannot work in winter, so the tree rests. The leaves do not work at night, either, because there is no sun. The tree must have food all winter, even if it isn't working, and it must have some stored up to use in the spring until its leaf factory has a good start. Therefore the tree stores away some food, just as the squirrels store away nuts. It wouldn't be a good idea to store the sugar because it dissolves in water and would soon be lost. Most plants have the power to change sugar into starch. The starch does

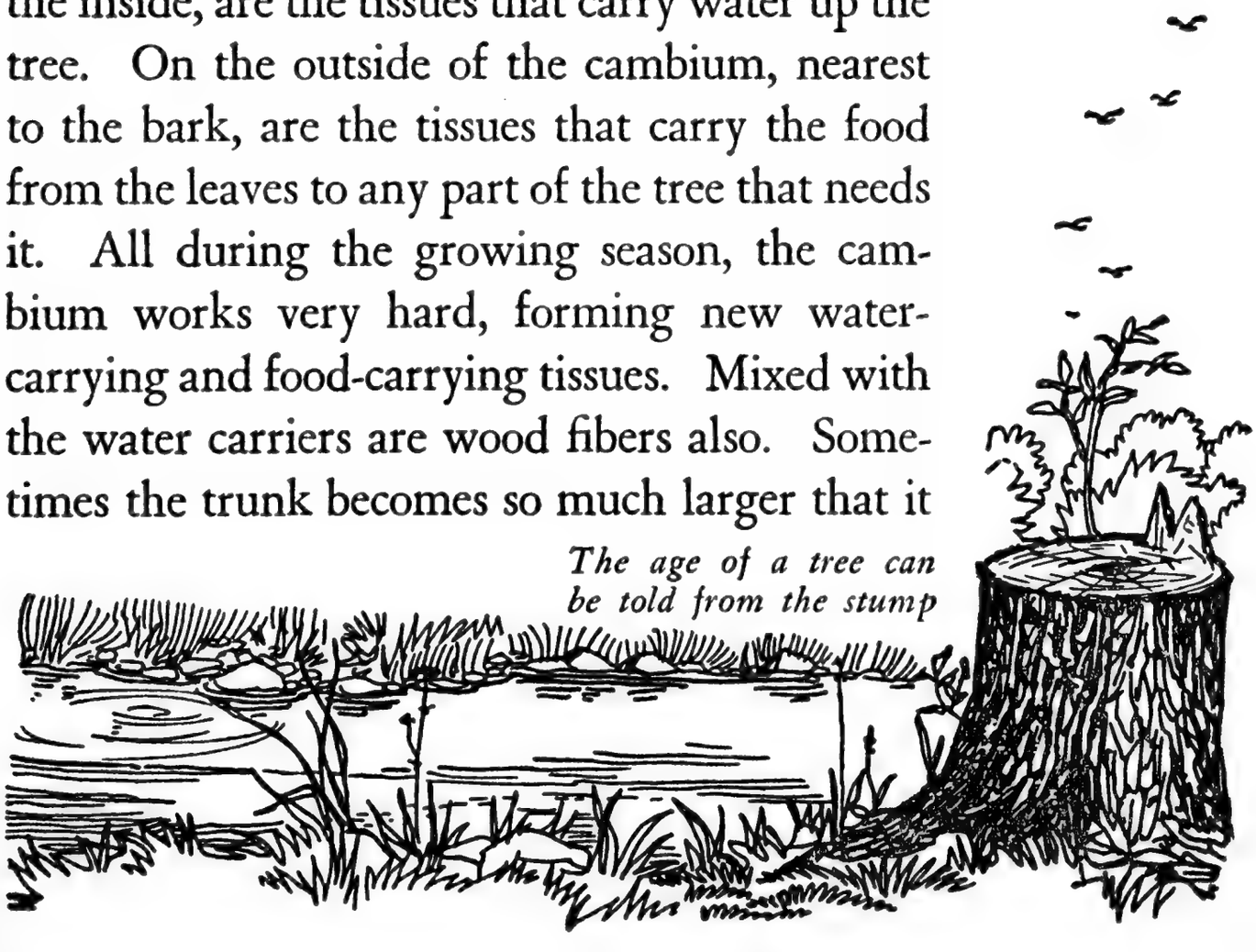
not dissolve in water so it will keep a long time. We often eat the starch that a plant has stored away. We do this when we eat potatoes, corn, and many other foods. Different plants store their winter food in different places. The trees store theirs in the roots and trunk. Potatoes are special storage rooms attached to the roots of the potato plant. Corn and wheat store their starch in the seeds because they are plants that live only one year, and the seed needs some food to start on in the spring.

The leaf factory can only work in the sunshine. That is why house plants should be near a window and why grass will not grow under a big tree which cuts off the light. Because light is needed this process of food making is called *photosynthesis* (pronounced fo'to-sin'-the-sis). Photo means light. It is the same Greek word that is found in photograph. Synthesis means "putting together." The whole word means "putting together by means of light." That is just what the leaf does. It puts water and carbon dioxide together when the sun is shining.

Leaves are factories working in the sun

Only an expert can tell the age of living trees unless they are pines or spruces. Anyone can count the circles of branches on these trees. If there are ten rows, the tree will be ten years old. But anyone with sharp eyes can tell the age of a tree that has been cut down by counting the rings in the end of the log. Each ring stands for a year's growth. The part nearest the center of the log is the oldest, and that nearest the bark is the newest. The growing part of the tree is just under the bark. It is called the cambium (pronounced kam′-bi-um). The working parts of the tree trunk are near here also. Next to the cambium, on the inside, are the tissues that carry water up the tree. On the outside of the cambium, nearest to the bark, are the tissues that carry the food from the leaves to any part of the tree that needs it. All during the growing season, the cambium works very hard, forming new water-carrying and food-carrying tissues. Mixed with the water carriers are wood fibers also. Sometimes the trunk becomes so much larger that it

How can we tell the age of trees?



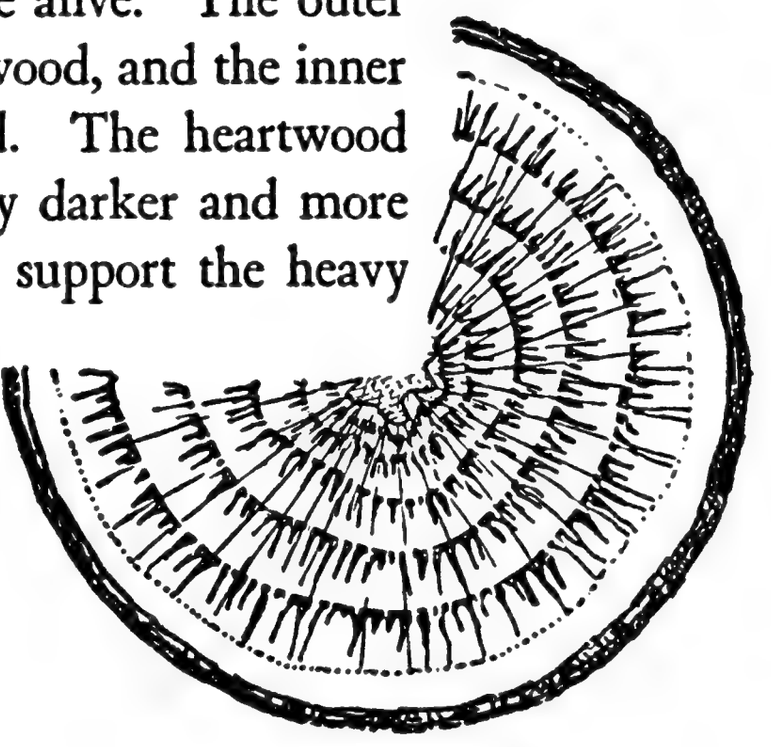
The age of a tree can be told from the stump

is too big for the bark. The bark stretches and stretches and finally cracks. That is why bark is so rough and has such deep furrows.

As the summer comes to an end, the cambium, or growing part, grows more and more slowly, and when cold weather comes it stops altogether. This slowing up is easily seen at the outer edge of the ring as the wood has a different appearance. It is that which shows clearly the end of one year's growth and the beginning of the next. The ring of wood formed during a favorable season—that is, a spring and summer with plenty of rain and sunshine—is wide. If the season was too dry, the ring is narrow. Just as each summer is different from the last one, so each ring differs from every other. Men who have had a great deal of experience in examining annual rings can tell what kind of weather there was during a certain year by looking at the rings. This is very useful when studying extremely old trees such as the big trees of California. These trees are so very old that they were growing before

any of our American history was written, or indeed, even thought of. But experts can tell something about the weather five hundred or a thousand years ago by examining the logs. A ring that is very thin means a dry season. A wide one means a rainy year. Several narrow ones close together mean there was a period of dry weather lasting for some years. Many of these huge trees have over a thousand rings, showing that they are over a thousand years old. Most of the logs cut down for lumber from the pine and oak forests have from thirty to one hundred rings. Some of these trees, however, are even younger.

As the outer rings of the tree continue to grow, the inner ones die. They do not carry sap or water any more, but they do not decay unless they are diseased. Oftentimes only the outer three or four rings are alive. The outer living part is called the sapwood, and the inner dead part is the heartwood. The heartwood changes color and is usually darker and more beautiful. It still serves to support the heavy



The rings of the tree tell its age

tree, and because of its rich color it is more desirable for lumber than the sapwood.

How do roots work?

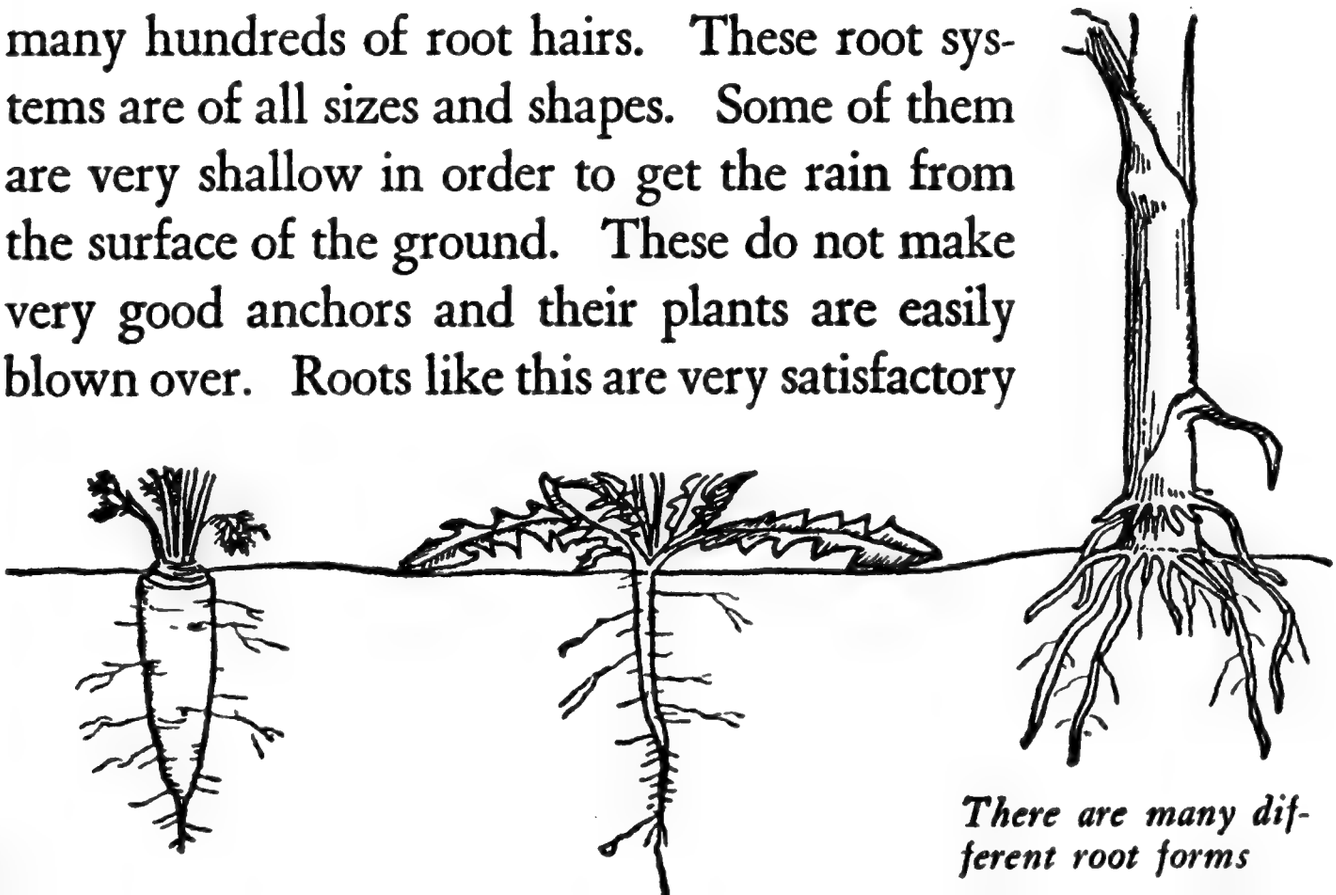
Roots have two jobs. One is to serve as an anchor and hold the plant firmly in the ground. The other is to absorb moisture and mineral substances from the soil. A plant requires a great deal of water, getting nearly all of it from the roots. The rain which falls upon the leaves is not particularly useful to it.

There are almost as many different kinds of root forms as there are kinds of plants. One reason for these different forms is the place where the plant is growing. A corn plant living in sandy soil will have deeper, longer roots than one growing in heavy black soil because the water soaks into sand more quickly and the roots must reach further to get it.

A carrot is a root. When one that has just been pulled from the ground is examined, it is easy to see the many fine hairs growing out from the sides. These are called root hairs, and they do most of the work of absorbing moisture. They soak up every drop of water they touch

and pass it back to the main root—in this case the carrot. The main root has water-carrying tissues like a stem, and it sends the water up to the leaves. A root like a carrot is called a tap root because it goes straight down into the ground and "taps" the water supply. The dandelion has this kind of root also. This is an interesting one to study because it usually has many more root hairs than the carrot. The tap root of the dandelion is much larger also. In roots of this kind the long thick part is chiefly for holding the plant in the ground and taking care of stored up food, while the root hairs absorb the water. These root hairs then pass this water back to the main root.

Most smaller plants have a crooked, branched root that looks like a stem, and each branch has many hundreds of root hairs. These root systems are of all sizes and shapes. Some of them are very shallow in order to get the rain from the surface of the ground. These do not make very good anchors and their plants are easily blown over. Roots like this are very satisfactory



There are many different root forms

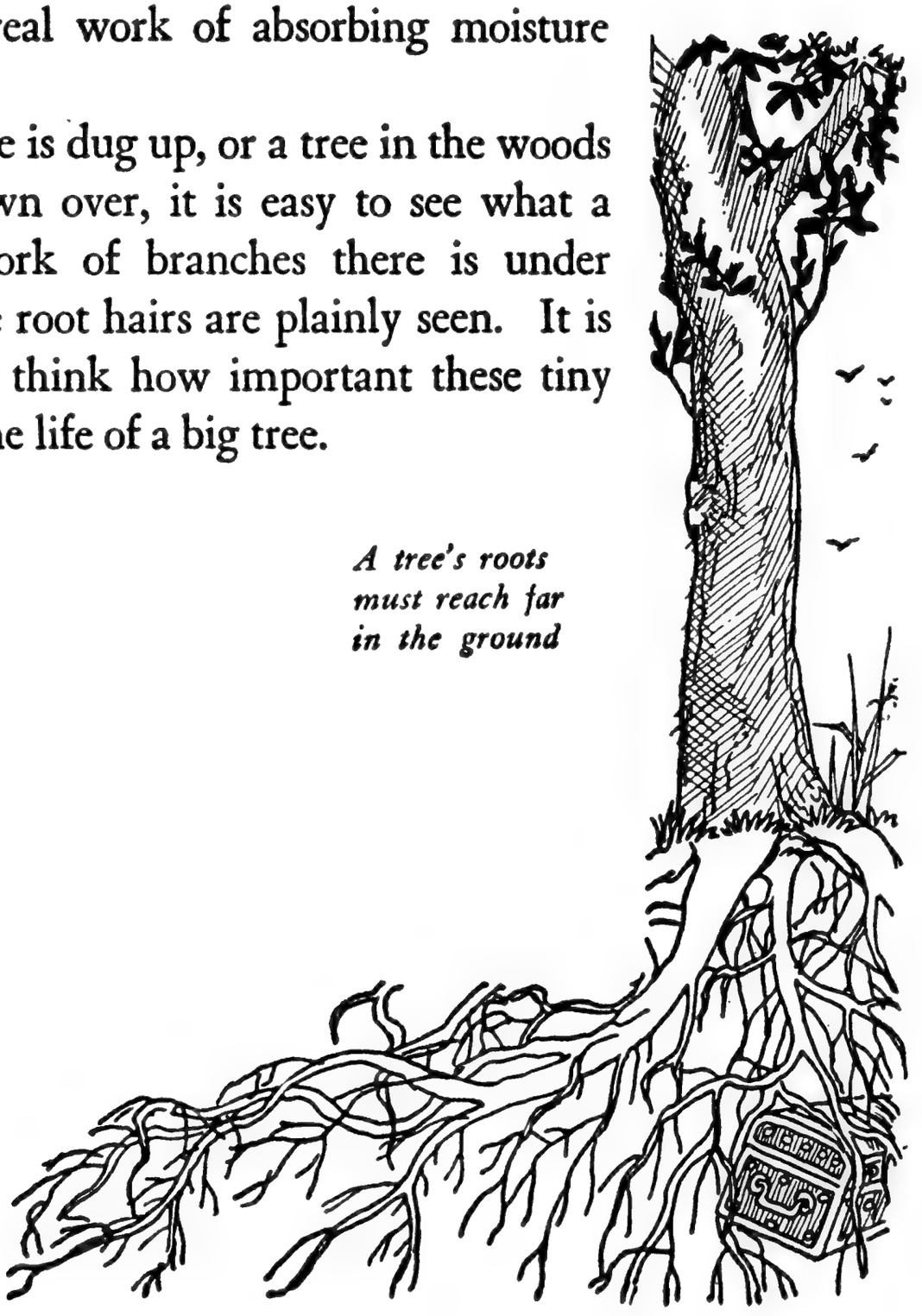
in places where the rain falls often and the surface of the earth is always moist.

Where the soil is sandy or coarse, and rain falls only occasionally, the roots must go deeper into the ground because the water does not stay on the surface but soaks in. Sometimes it goes down several feet until a bed of clay or rock holds it. There it lies until it has been used up for there is no air to make it evaporate. Plants which grow in very dry places often have root systems many times larger than the plants themselves. They branch out sideways in every direction and go deep down into the earth as well. They must be sure of getting every drop of the precious water when there is any. The prickly pear cactus, for example, often has roots that extend at least five feet on each side.

Trees, of course, must have very big roots to make a firm support for the heavy weight of the tree. A tree needs an enormous amount of water; so the roots branch out in all directions and especially go deep down into the earth to get all of the moisture possible. The big

and the smaller ones divide and redivide. All of the smaller ones are covered with root hairs. Just as with the smaller plants, it is the root hairs that do the real work of absorbing moisture from the soil.

When a tree is dug up, or a tree in the woods has been blown over, it is easy to see what a twisted network of branches there is under ground. The root hairs are plainly seen. It is interesting to think how important these tiny fibers are to the life of a big tree.



A tree's roots must reach far in the ground

Chapter IV

FOOD FOR PLANTS

Why is it hard to grow flowers in the shade of a tree?

MOST flowers will not grow well in the shade because there is not enough light for the leaves. Leaves cannot manufacture food unless there is plenty of sunlight. The leaves of the tree form such a heavy shade that no sunlight gets to the little plants underneath. But some plants come up early in the spring and get all their work done before the trees have all their leaves. That is why violets, lilies of the valley, blue phlox, and spring beauties can grow in shady places.

A second reason is because the drip of water from the branches of the trees washes away the soil from the plants that are growing below. But a third and more important reason is because the plants are likely to starve to death. All plants must have some minerals and other

plant foods which they get from the soil. A tree is such a big thing that it needs an enormous amount of food. It sends its roots out a great distance on all sides in search of nourishment. These roots are so greedy that they do not leave anything in the soil for the other plants. Smaller plants can be helped by using fertilizer. It supplies the minerals which plants need. We must use a generous amount of fertilizer in shady places because, of course, the tree will take some of that too. A good dose of bone meal once a year will do a great deal for plants that are struggling to grow in shady places.

What plants are pirates?

All honest plants make their own food and can be told by their green leaves. The plants which steal their food are pirates and have lost their green color. There are not a great many of these pirates or parasites as they are called. The mistletoe, which grows in the southern states, is one of these dishonest plants. It drops its seeds on the bark of trees and, instead of sending its roots into the ground as any honest plant would do, it sends them into the tree,

where they soak up the food the tree has made for its own use. The mistletoe, however, is not entirely a bandit for its leaves are a dull green. This means that it does make a little of its own food, but it steals the moisture which it uses from the tree instead of absorbing it from the earth as the tree does.

The most interesting of the pirate plants is the Indian Pipe. This little plant is found growing in damp, shady places in the woods where the leaf mold is very thick and black. It is only a small plant, six or eight inches tall, but it sometimes startles one because it is so white and ghostlike. It is colorless, cold-looking, and clammy to feel. It has not one speck of honest green color but it does have a ghostly charm. It has tall, straight stems and flowers that bend over at the top, giving it a shape something like the pipes the Indians used for smoking. It lives on the juices of living plants or the decaying matter of dead ones. Because it does not work, it does not need sunshine and is found in the darkest places. It is easily seen because its

whiteness is such a contrast to the black, decayed leaves that are its favorite home.

Another parasite plant is the Dodder. It is a gold colored vine, and so is often called the Golden Dodder. It is really a pretty plant with small pink flowers. Its slender stems wind themselves around tall plants and bushes like golden threads. It sends many rootlike suckers into the bark to steal food. It doesn't have a single leaf and not even a root after it has passed the seedling stage. Its little suckers look like roots, but they are not. They are just what their name says—suckers. They suck food and water from the other plant from which the Dodder is stealing its food.

There are three common plants which grow in our country—the pitcher plant, sundew, and bladderwort—which trap their food. Their victims are small insects.

The pitcher plant, which grows in bogs and swampy places, is a sturdy good-sized plant. Its leaves are shaped exactly like pitchers, except that there is no handle. They are often several

The dodder does not even have a root

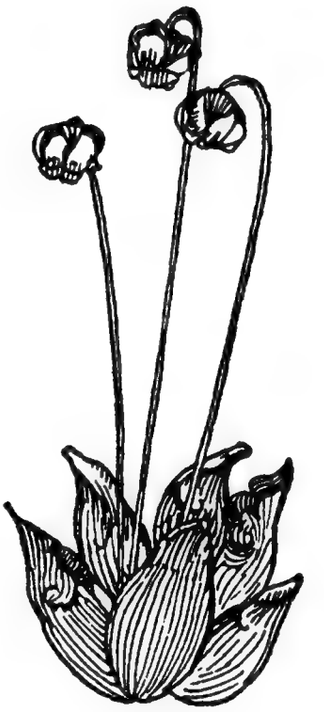
inches long. There is even a spout at the top. This pitcher is usually half full of water; some of it is rain; some is juice made by the leaves. The juice has an odor attractive to insects, and they step in to see what they can find. But they never come back! The walls of the pitcher are steep and slippery and it is impossible to crawl up them. The insect's dip into the water has made its wings so wet that it cannot fly. Even if it could fly to the top, there are strong hairs which prevent escape from the opening. There is nothing for the insect to do but drop back and drown. One of these pitchers will often contain many gnats, mosquitoes and flies, and a few beetles. In California there are pitchers large enough to drown a mouse.

What plants trap their food?

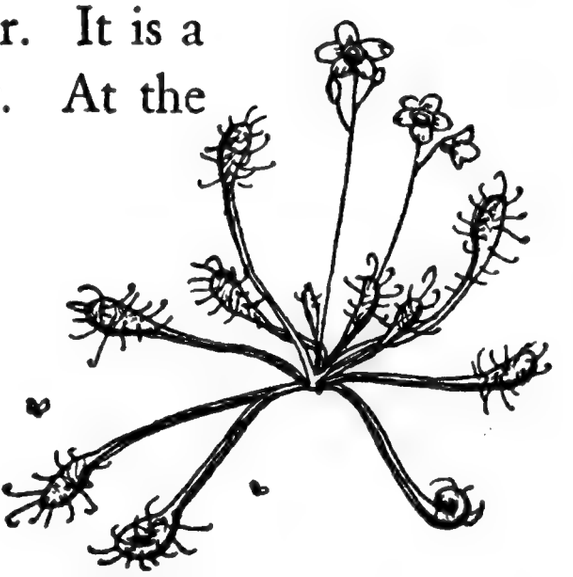
Why does this plant trap the insects? Because it needs nitrogen. All plants must have nitrogen, but most of them get it from the soil. When our garden plants are not getting enough, fertilizer must be put on the ground to help them out. Human beings need nitrogen, too, but we get it from meat and eggs. The soil

where the pitcher plant lives is very poor in nitrogen, so it has to get it in some way. Decaying animal matter contains a great deal of nitrogen and so the pitcher plant captures these small animals, waits until their bodies decay, and then uses the nitrogen.

Our second trapper is the sundew. It is a pretty, innocent-looking plant that gets its name because its leaves glisten in the sun as if they were covered with dew. Sometimes they look as if the dew had frozen on them. That shiny surface, however, is deadly to insects for it is very sticky. A fly alights on the leaf and finds his legs are caught in the glue. The more he struggles to get free, the tighter he sticks, for he becomes plastered all over with this sticky juice. It catches him just as surely as sticky fly paper does. Now the leaf rolls up around him and digests him just as if it were a little stomach. In this way the plant gets its nitrogen, as we get ours by digesting food that contains nitrogen.



The bladderwort is another trapper. It is a floating plant and lives in the water. At the



Some plants have to trap part of their food

tips of its leaves are little bladders or bags. Each bladder has a remarkable little trap door at the end of it. This door opens at a touch from the outside, but will not open at all from within. Tiny water creatures brush against the trap door and instantly find themselves inside the bladder. There is no escape possible, so they die and then decay to be used as plant food. The bladderwort catches only tiny creatures. Some of them are so small that a strong magnifying glass is needed to see them at all.

Why is clover good for the grass?

Long before anyone knew the reason, gardeners and farmers knew that clover was good for the soil. A farmer found that if he had a field of clover one year and planted corn the next year, his corn would be better in that field than in any other. The reason is interesting. Next to carbon dioxide and water, the most important element that plants need is nitrogen. Nitrogen is very plentiful in the air. It is about us all the time, but unfortunately plants cannot use it in that form. They can only get it when it is in the soil combined with other elements.

These combinations are called nitrates. Nitrates can be bought to use for fertilizer, but they are expensive. There is only one kind of plant that can use nitrogen from the air, and it is a family of bacteria that live on clover roots. When a full grown clover plant is pulled up, roots and all, many little lumps can be seen clinging to the roots. These lumps are full of bacteria, so small that a microscope is needed to see them at all.

This one kind of bacteria can take nitrogen from the air and combine it with other elements from the soil to form nitrates. They leave these nitrates in the earth, and after the clover crop is cut down, the nitrates remain there for other plants to use. These bacteria only live on the roots of clover or the roots of other plants of the clover family.

If grass is not growing well, it is a good idea to plant clover. One planting of clover will enrich the soil enough to last for several seasons. Other members of the same family that are good for the soil are peas, beans, and alfalfa. Wherever these plants have been growing, the

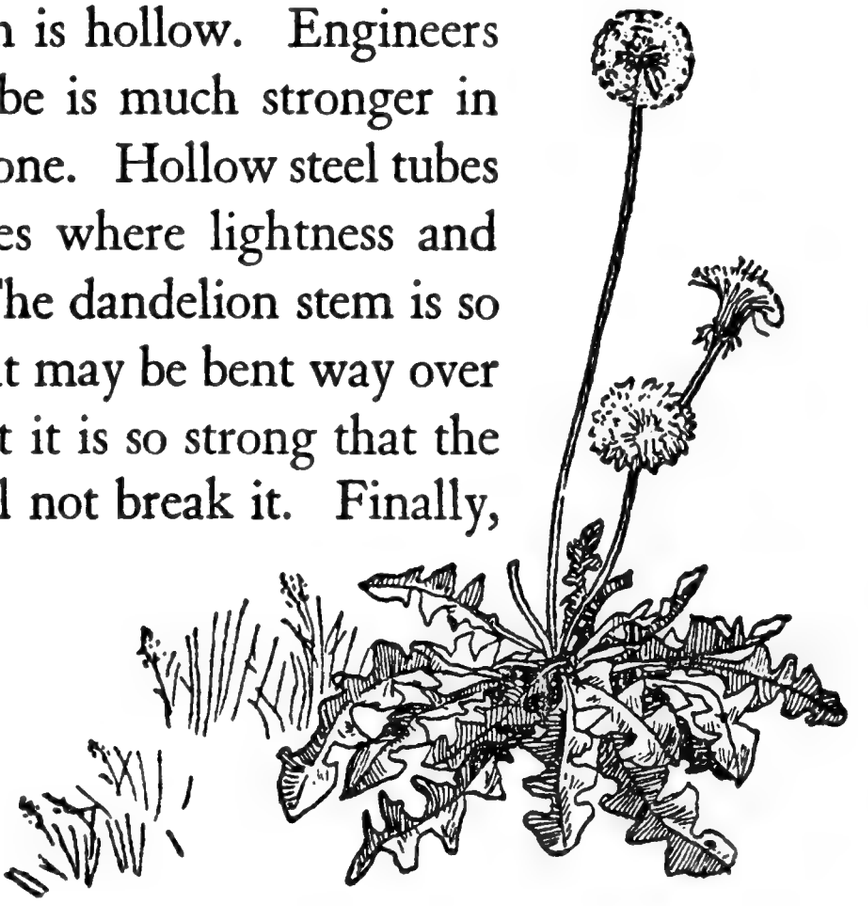
soil is much better because of the nitrates left in it by the nitrogen-using bacteria which live on the roots. Farmers should plant their fields to clover once every few years to keep the soil rich. They should do this especially if they raise corn, for corn is hard on the soil, and if grown too many years in succession, will not give a good crop. All up-to-date farmers alternate clover with corn or wheat. This method of keeping the soil rich is called "rotation of crops."

Why do dandelions kill the grass?

The dandelion is a great nuisance to the gardener. He fights it all summer long, and usually he finds at the end that the dandelion has won the battle for it is a very good fighter. If beaten in one way, it will come back in another. Cut off its leaves; it sends up some new ones. Cut off the root; it starts growing at the cut place. Pull it up by the roots; and if every bit of it comes up, which hardly ever happens, this one is conquered. But by this time it has sent out hundreds of seeds; so next year it will be even harder.

The dandelion has many good weapons with

which to fight. First, it has a long strong root which goes so deep into the ground that the frost cannot hurt it. It is too deep for rabbits and moles to chew, and too strong for insects to bother. It has a circle of strong green leaves. These are arranged in a rosette so that they get the most possible sunlight. Notice how the dandelion leaves lie flat and are arranged so that none of them shades any other. The leaves are so close to the ground that no plant can get underneath and steal food from the soil. They make it so dark under them that any grass which was there before has to die for lack of sunshine. If the rosette of leaves begins to get too tall, the root pulls it down closer to the earth. The flower stem is hollow. Engineers know that a hollow tube is much stronger in many ways than a solid one. Hollow steel tubes are used in many places where lightness and strength are needed. The dandelion stem is so light and yielding that it may be bent way over without hurting it. Yet it is so strong that the hardest wind storm will not break it. Finally,



The dandelion has many weapons

it has the best system in the world for raising flowers. Each dandelion blossom is composed of many tiny flowers and each one produces a seed. After a dandelion has gone to seed it grows taller. This is so the breeze will be sure to get to the seeds and blow them far away to begin new homes.

Is it any wonder that we cannot get rid of dandelions? From the point of view of man this little yellow flower is a pest, but from the point of view of plants it is most successful. Its roots, stem, leaves and flowers all work together to see that the dandelion has the best of everything. We call such working together, efficiency, and the dandelion is the most efficient plant in the whole plant kingdom.

Chapter V

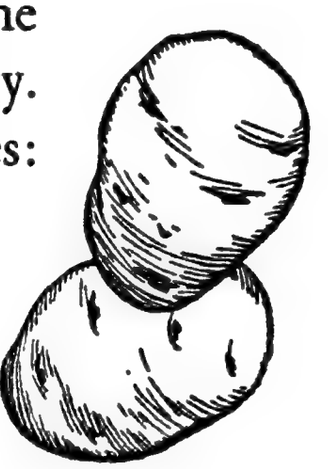
STORAGE ROOMS

VEGETABLES are really any part of the plant that is eaten, but the word usually means parts that are not sweet. Oranges, apples, and bananas are sweet and so are not called vegetables. Some fruits are vegetables, but all vegetables are not fruits. The difference will be seen later. Vegetables are good to eat because the plants have stored up food in them. Different plants choose different places to store food; vegetables, therefore, come from six parts of the plant.

What are vegetables?

1. *Tubers* are thickened branches of an underground stem. The most common example is the white potato. It is good to eat because it is full of starch, which is one of the substances needed to give us heat and energy.

2. *Roots* give us many of our vegetables:



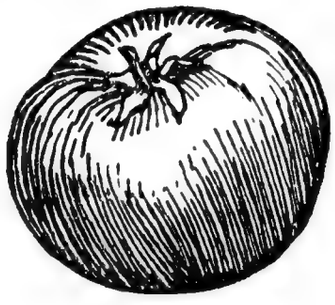
Potatoes are tubers

radishes, turnips, beets, sweet potatoes, parsnips, and carrots. Root vegetables do not have as much starch as tubers, but they contain many mineral salts which people must have, and they are coarse and rough. We cannot get along with only soft, tender food.

3. *Bulbs* give us only one common vegetable —the onion. A bulb is an underground bud that is full of food to help the young plant to grow quickly. The food is just as good for human beings as for the young plant.

4. *Leaves* give us some of our most healthful vegetables, for although they do not contain much starch, they are full of minerals, vitamins, and supply the coarseness which we need. Spinach is the most common leaf food. Cabbage, lettuce, and celery are also leaf foods, although most of the stalk is eaten too.

5. *Fruits* which are not especially sweet are also called vegetables. Tomatoes, pumpkins, cucumbers, and squash are all fruits. They are good food because of the water and minerals stored in them.

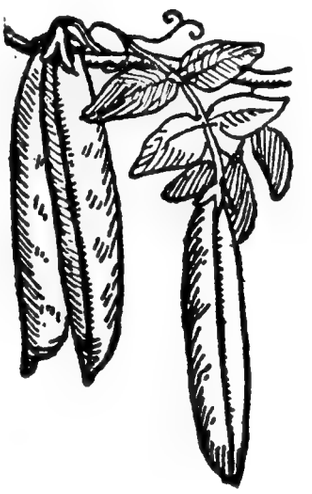


A common bulb, leaf, and fruit

6. *Seeds* give us three of our most useful vegetables: peas, beans, and sweet corn. They supply starch and some fats. The peas and beans also have proteins, the substance needed for growing. They can take the place of meat because protein is the substance supplied to our bodies by meat.

Why do leaves drop in the autumn?

Leaves are the workshops of the plant. A peculiar green substance, *chlorophyll,* makes it possible for them to manufacture food. They absorb water from the roots and carbon dioxide from the air. Water is very necessary to the making of food. But, in addition, more water is needed by the leaves than is used in photosynthesis. In order to work properly the cells of the leaf must be full of water. When a leaf wilts, it is because the cells are nearly dry. Water is also needed to carry the finished food from place to place in the plant. Therefore, the leaves are constantly calling for more water. They draw up more than they need. There are tiny openings in the under side of the leaves where the extra water may escape. The mois-



Many seeds are good to eat

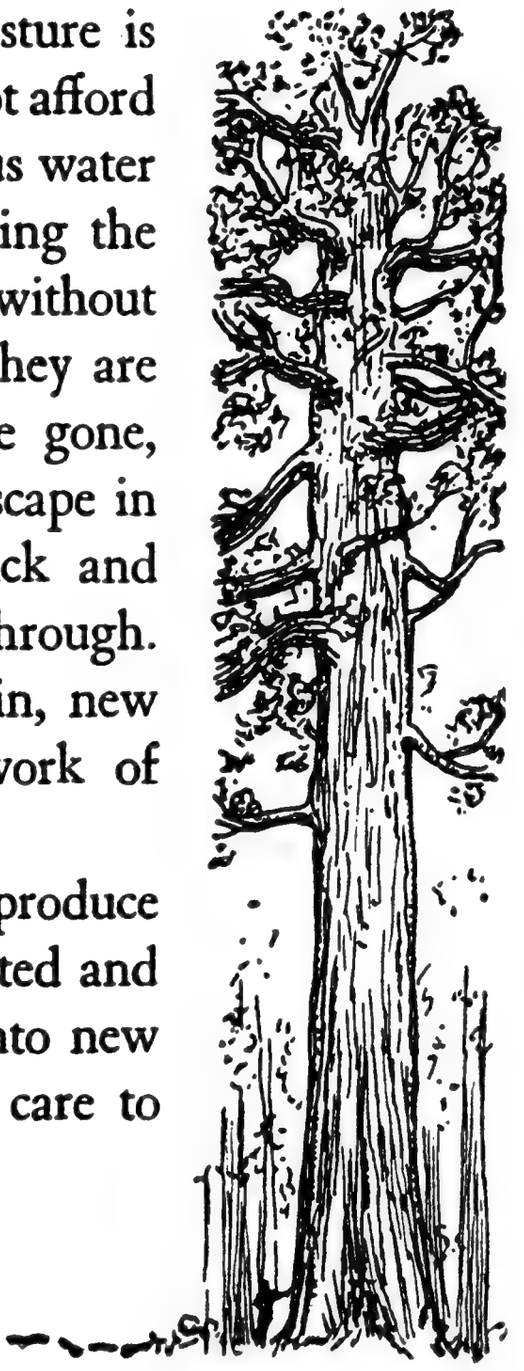
ture evaporates into the air just as the dampness evaporates from a wet rag that is hung on a clothesline. This process of giving off moisture is called *transpiration*. It is very like perspiration. It keeps the leaves cool, just as perspiration keeps human skins cool on a hot day in summer.

Now, leaves, of course, cannot think and do not know anything about outside conditions. Their job is to bring up water for food making and get rid of what is left over. They are not able to know whether water is plentiful or scarce; the small pores open and pass off the moisture just the same. This is very hard on the plant during the dry season, for often it cannot get any moisture and the whole plant wilts. All the cells of the plant must be full of water, not just the leaf cells only. It is not at all unusual for delicate plants to die during a drought because the leaves transpire too much of the water the plant must have.

Trees must be very careful of their water supply because they are so large that they use a

great deal. They have a special arrangement to prevent too much transpiration. The leaves can make food only during the warm sunny months. As the weather gets colder, they work more and more slowly, and at last stop altogether. Even though they are not working they continue to send off water. Moisture is scarce in cold weather and the tree cannot afford to lose any. In order to save its precious water supply, the tree drops its leaves. During the winter the tree can get along better without them because they do not work, and they are wasteful of moisture. When they are gone, most of the water is safe. It cannot escape in any other way. The bark is too thick and rough to allow any moisture to pass through. When spring comes again with its rain, new leaves come out and carry on the work of making and transpiring moisture.

The chief business of a flower is to produce seeds, to see that they are safely pollinated and ripened in order that they can grow into new plants. The parent plant takes great care to



Trees drop their leaves to save water

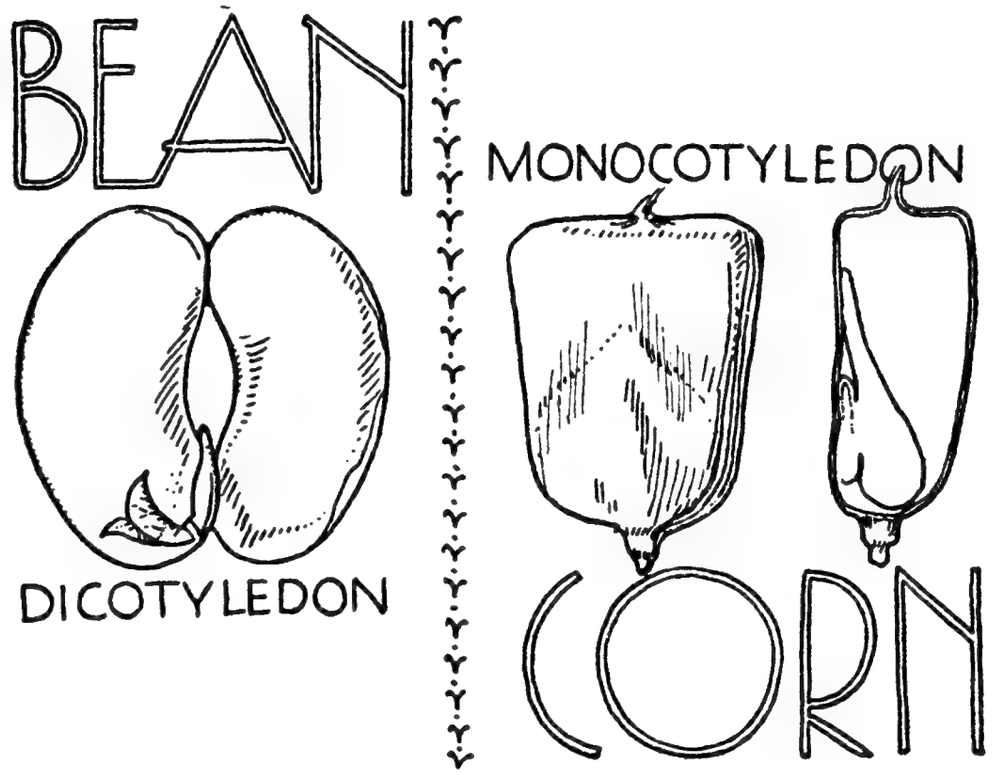
What is a seed?

see that the seed is given a good start in life. First of all, the seed has a hard outside coat. This is strong enough to protect it from heat, frost, dryness, or too much moisture. Secondly, it has a supply of food which the seed uses when it begins to sprout. It takes quite a while for the baby plant to push through the earth to the light. As soon as it reaches the light and gets some green color in the stems and leaves, it can make its own food. Before then, it must use that which was stored in the seed.

Every seed has two inside parts, the food supply, and the baby plant, which is called the *embryo* (pronounced em′bri-o). In many seeds the embryo is too small to be seen without a microscope, but in others it can be seen very clearly. If a peanut is split into its two halves the little embryo can clearly be seen up in one corner. Looking closely, a little stem and the beginning of leaves can be seen. The two halves are the storage places for food.

There are two kinds of seeds: those whose storage rooms are split in two, like peanuts,

beans, and peas; and those which are all in one piece. The ones which split in two are the most interesting because you can see the embryo



The storage room of some seeds is split in two, others are all in one piece

so plainly. In the one-piece seeds, the baby plant is curled up in a mass of starchy matter and the whole is covered with the seed coat. The storage part of the seed is called a *cotyledon* (pronounced kot′i-li′don) and if it is all in one

piece it is a *monocotyledon* (mono meaning one). If it has two parts it is called a *dicotyledon*. Sometimes the names are shortened and they are called monocots and dicots. As the little plant begins to grow, it uses up the food. One of the first things it must do is break through the seed coat. Then it continues growing and growing. The more it grows, the more food it needs. By the time it gets to the sunlight, the food is all gone. Nothing is left but the empty seed coat, and it is torn and broken. However, that doesn't matter, for the plant can take care of itself now it is in the sunlight. As fast as it grows, it works making food for itself from the air, water and soil.

Seeds are of all sizes and shapes. Mustard seeds are famous because of their small size; many flower seeds are also very small. Nuts are good sized seeds. Often a single large seed or many small seeds are enclosed in a large juicy covering. Examples of this kind are tomatoes, apples, oranges, pears, plums, berries, and dozens more. Every seed, no matter how

it is born on the plant, has these three important parts, a seed coat, an embryo, and some stored food to give it a start in life.

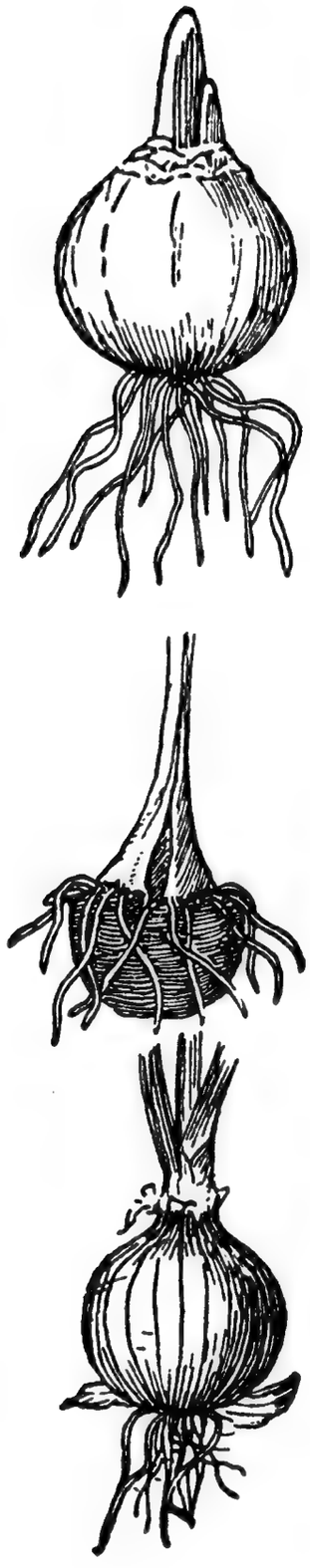
People eat a great many seeds because they can use the stored food also. We eat nuts, corn, wheat, beans, and peas, and many others. Of course we also eat the fruit that covers the seeds of apples and pears and similar fruits, but that is not quite the same as eating the seeds. An apple seed can still grow after the stored pulp around it is eaten away, but a peanut is finished. All plants provide many more seeds than could possibly grow so that we are not doing any damage when we eat the seeds.

What are bulbs?

When people want to raise carrots or daisies, they plant seeds, but when onions or tulips are wanted, bulbs are set in the ground. A seed is very hard and dry. Before it can grow, the rain must soak through its hard coat and soften the baby plant inside. That baby plant or embryo is so tiny that it takes a good while for it to push through the earth to the light. When it does get through, it has to start making food

in order to grow further. On the whole, it is a long performance. It takes quite a long time for carrots or daisies to grow to full size.

A bulb, on the other hand, is juicy and fat. It is stuffed full of food and is all ready to grow. It doesn't need much soaking. The tulip bulb has enough food for the use of the new plant. Consequently, as soon as warm weather comes, the tulip just shoots up. Before long there is a tulip blossom. Growing plants from bulbs is very much quicker than growing from seeds. But only a few plants have bulbs Most of these belong to the lily family. Tulips, daffodils, hyacinths, and all lilies have them. The onion belongs to this family too. Some flowers are especially fortunate to have bulbs. These are the early spring flowers that grow low on the ground in a deep forest. Because of their fast-growing bulbs they get an early start in the spring. By the time the leaves are on the trees, they are all through making and storing food for the next season. If they did not get through by this time, the forest would soon

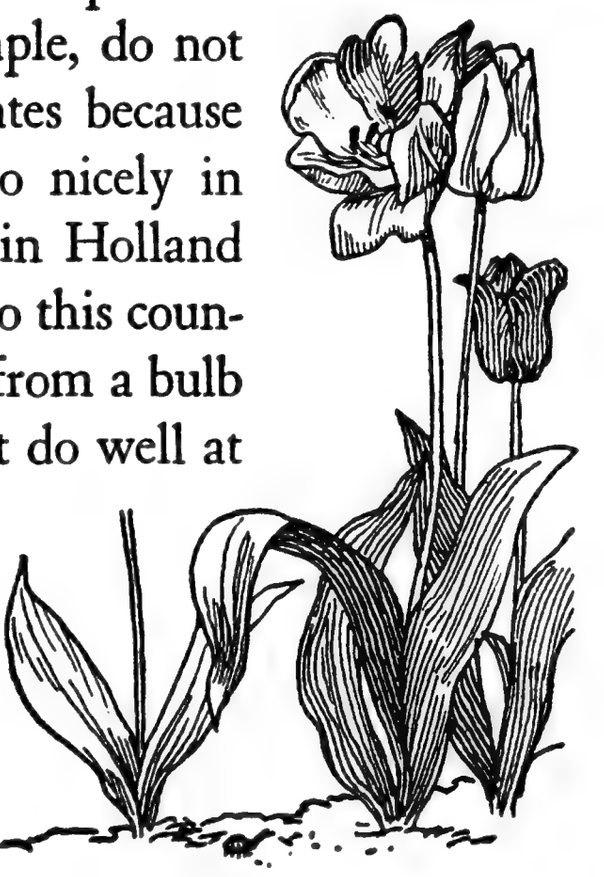


Bulbs are stuffed with plant food

become so shady that they could not get any light for their work. A familiar flower that uses its bulb to help it grow in this way is the dogtooth violet.

A bulb is really an underground bud. It is made of thick overlapping scales. It can send up a shoot that becomes the new plant, and it can also produce new bulbs that grow out of the sides of the old one. Late in the summer these side bulbs can be pulled off and planted. The old one can also be used again. Some kinds of onions form bulbs above the ground. They have little bulblets in place of flowers. These are the "onion sets" that are bought for vegetable gardens.

There is another reason why bulbs are planted instead of seeds. Tulips, for example, do not grow from seed in the United States because the climate is not right. They do nicely in Holland; therefore, the gardeners in Holland raise the plants and send the bulbs to this country. Very often a plant will grow from a bulb in a climate where the seed will not do well at



Tulips grow best from bulbs

all. This is because the bulb has so much food stored away that the plant can disregard climate. Bulbs do well in places where the summer is very dry, also. The plant grows so quickly that it is finished with its work when the dry season comes. If seeds had been used, the work would be just beginning and of course, would have to stop, because moisture is necessary for food-making.

Why are there laws against picking wild flowers?

In nearly every wood or forest preserve, especially near large cities, there are signs which say, "Don't pick the wild flowers." People who do not think seriously are sometimes angered by these signs. They say the guardians of the forest do not want people to enjoy themselves. Many of them disobey the signs and pick the flowers anyway. Other people, who really think about the matter, realize that such a law adds to their pleasure because if visitors continue to pick the flowers, they will soon disappear entirely. Many of our most beautiful spring flowers have vanished because of careless picking. The glorious white trillium which

used to be very abundant, has become so rare that many people have never seen one. The trailing arbutus, one of the most exquisite and dainty of all spring flowers, has been torn up so carelessly that it now grows only in a few hidden spots. Flower lovers who know where it grows will not tell because they want to preserve it from the thoughtless crowds who would quickly pick it.

Wild flowers are not like garden flowers which should be picked. Many of them produce only one flower. The flower is at its prettiest before it has been pollinated. After pollination, it fades because its purpose in life has been completed. If it is picked before pollination, there will be no seeds this year. If it is an annual plant, one that dies down every season and has to start each spring from seeds, that is the end of its life. By picking one bunch of buttercups a thoughtless visitor may destroy a whole patch.

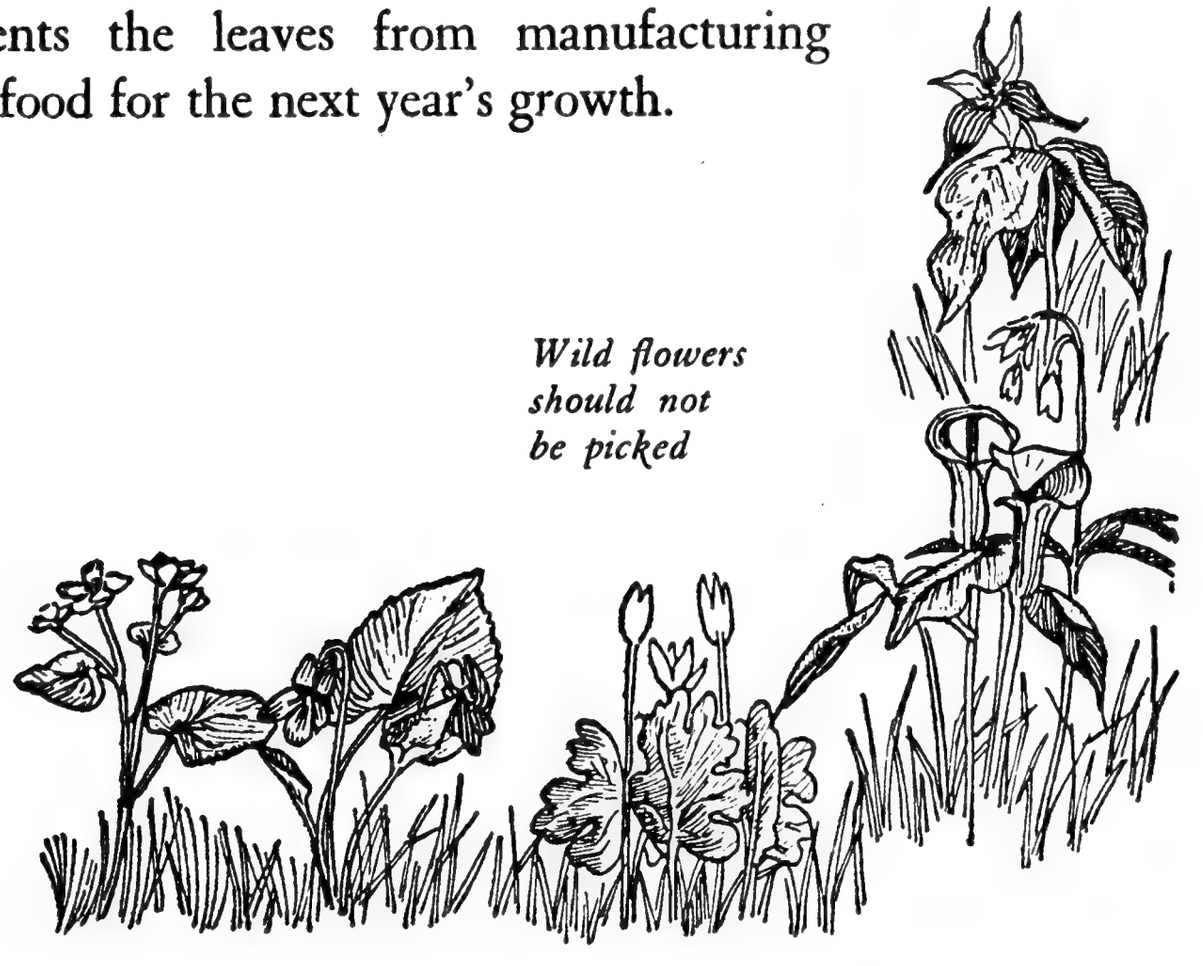
A great many of our wild flowers, especially early spring ones, are perennials. That is, they

have a bulb or a tuber or an underground stem that keeps alive all winter, sending up new shoots in the spring. Trillium, spring beauties, anemones, and violets are some of the prettiest flowers that are perennial. Such plants grow almost entirely in shady, moist places under the trees. The soil where they grow is so moist that it is impossible to pick a flower without pulling up the underground part as well. No matter how carefully people try, they are sure to injure that important part which means life to the plant. That is the reason why the delicate white trillium has disappeared. The red or purple trillium is not so attractive. People have left it alone, and it is still plentiful.

Even though the valuable underground stem of the flower is uninjured, picking may do further damage. This bulb or stem, whichever it happens to be, can stay alive all winter, but it cannot do so unless it receives a fresh supply of food. The leaves are working busily making this food. The leaves of spring flowers, in particular, must work very fast, because as soon as

the trees are covered with leaves they cut off the necessary sunlight. An early spring plant cannot spare one day of sunlight because its working season is so short, but if a careless visitor to the woods picks the flowers and the leaves with them, the work of making food is ended. The bulb will not have enough stored away to start the plant next year; therefore another spring flower has been destroyed. The place where spring beauties were growing this year will be bare or covered with weeds next spring.

Communities have three good reasons for saying, "Don't pick the wild flowers:" picking flowers destroys the chance for seeds; it is more than likely to kill the roots of perennial flowers; it prevents the leaves from manufacturing enough food for the next year's growth.



Wild flowers should not be picked

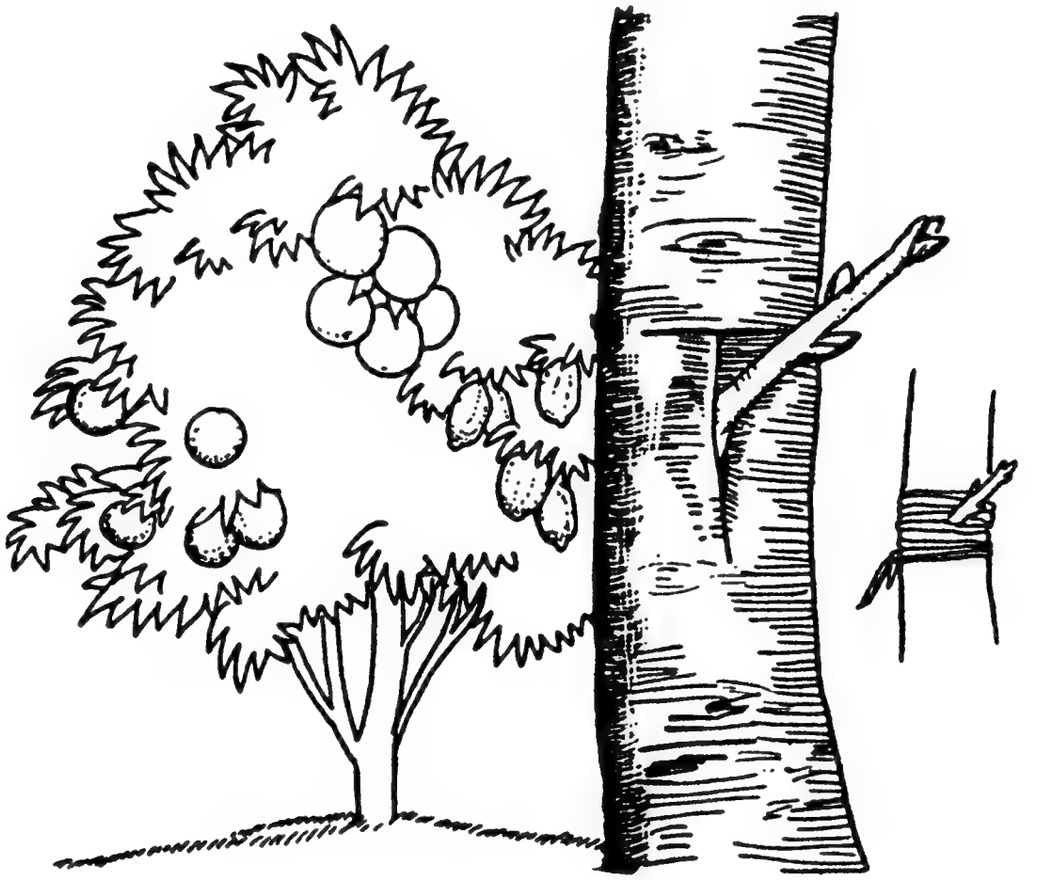
Chapter VI

MAN-MADE PLANTS

Will oranges grow on lemon trees?

ORANGES sometimes grow on lemon trees, but it does not happen naturally. An orange grower often puts oranges on his lemon trees by grafting or budding. A man might buy some land to use for an orange grove and then find that the soil was not good for orange trees, but excellent for lemons. He does not become discouraged and sell his farm but instead lets some lemon trees get a good start. When he is sure the trees are strong and healthy, he goes to someone who has orange trees and gets some buds. He is careful to cut buds only from the very best trees. The bud is the growing part of any plant. We usually think of buds as growing into flowers or leaves, but branches come from them also. This man will cut a bud from the orange tree in such a way

that there will be a small oval shaped piece of barking clinging to it. Then he quickly cuts a T-shaped slit in the bark of the lemon tree and



The bud from another tree will grow and bear its own kind of fruit

slips the orange bud underneath. He covers the cuts with wax to keep the moisture from drying out and sometimes winds raffia or twine about the stem to hold the bud in place.

If he has done a good job, the bud will begin to grow into a branch. That branch will bear *oranges,* not *lemons.* After the branch has had a good start and has produced enough leaves to make food for the tree, he may cut off all the lemon branches. Then he has an orange tree, but the roots are still those of the lemon tree. He can do this to his whole grove. It is not hard to do. The workman must be careful of just one thing. The growing part of a tree is just under the bark. He must make his cuts so that the growing part of the orange tree and the growing part of the lemon tree fit into each other exactly. If he cuts too deep or not deep enough, the bud will not be able to grow.

Budding has made it possible to grow oranges in many places where they did not grow before. One kind of orange can be budded onto the roots of another kind. For example, Florida oranges are very sweet and juicy, but they will not grow except in very warm climates. A certain kind of Japanese orange will stand much colder weather, but its fruit is sour and bitter.

Someone thought of putting the Florida buds onto the Japanese trees, and now it is possible to raise Florida oranges much farther north than formerly. You can see that there is a great advantage in being able to do this.

Often people who do not raise fruit to sell have fun making experiments with budding. A family may have room for just one tree in its yard. They probably will plant a lemon tree, for it is very hardy. Later they can bud onto that tree, oranges, grapefruit, and tangerines. Maybe they will have several different kinds of oranges. It is not at all unusual in California to see four kinds of fruit growing on one single tree.

The different kinds of fruit must be closely related as oranges and lemons are. You cannot put apples on lemon trees, but you can grow apples on pear trees. There is a grove of prune trees in California now whose roots are the roots of almond trees. It is fairly easy to tell which trees will exchange this way by looking at the seeds. Orange and lemon seeds are alike, so

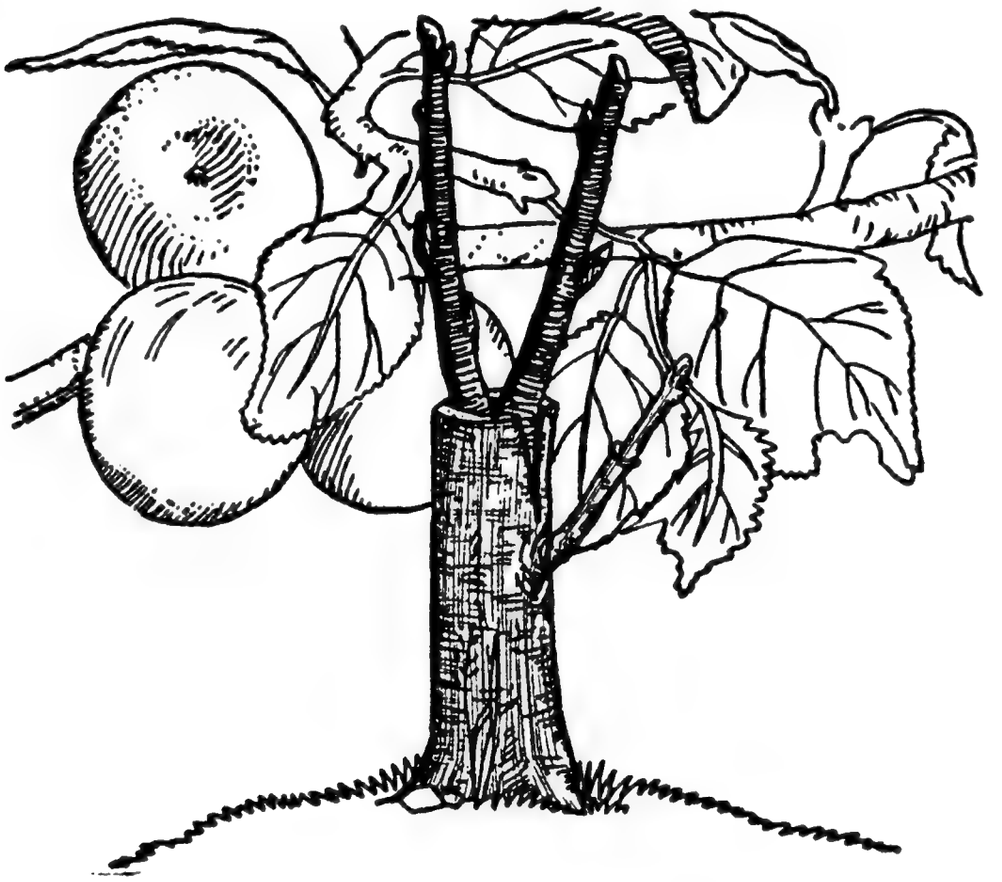
are apple and pear, and prune pits are like almond pits.

How do farmers get better apples?

It is a curious fact that apple trees grown from seeds never have as good fruit as the apple which produced the seed. The seeds from a big juicy apple might be planted and develop into trees which bear small, sour fruit. Because this is true, farmers do not raise apple trees from seed but buy little trees from the nursery man. However, if a farmer wanted to take the time and trouble, he could get good trees by grafting, which is what the nursery man does. Grafting is very like budding, but is a little harder to do. It means attaching the twigs of one tree to a branch of another.

This is what often happens: A farmer has one fine apple tree. The apples are big, juicy, mellow, and of a lovely red color. Around his orchard are several little seedlings from these same apples. They are strong and healthy, but he knows the apples they bear will not be so good as those of the parent tree. He cuts off one of these seedlings just above the ground

and makes a notch. Then he cuts, from his good tree, two twigs that have several buds, and he shapes their ends like a wedge. He fits these



By means of grafting the fruit grower can improve the fruit the tree will bear

into the notch, one on each side, taking great care that the growing parts of the stem and the twigs come together. Then he ties the twigs in place with raffia and covers the cuts with

wax to keep out rain and bugs. If he has done his work carefully, the twigs will grow just as well as on their own tree, and in a few years he will have delicious fruit.

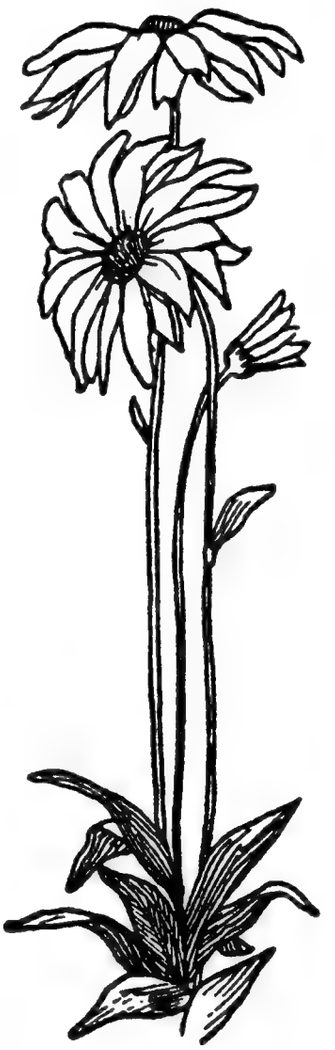
The seedling to which the twigs are grafted is called the *stock,* and the twigs which are grafted on are called *cions* (pronounced si'ons). There are several ways of grafting—that is of cutting and fitting—but the principle is always the same. The growing part of the stock and the cion must fit together. The growing part of the tree is just under the bark.

Sometimes grafting is used for another purpose. In France, the largest industry is making wine from grapes. Some years ago all the grape vines began to die. It was found that some plant disease had attacked the roots. For a time it seemed that all the vineyards would be lost. It was a very serious situation but at last somebody discovered that American grape vines could not catch this disease. They were immune to it. No matter how close they were placed to the diseased plants they grew and

thrived. The French began immediately to plant American grapes. However, these grapes are not sweet enough to make good wine. Therefore they grafted their French vines to the American roots. Now these grapes are just as they were before the disease attacked them. You could not tell the difference in the fruit, but the roots are strong and healthy. Grafting saved the French vineyards.

How did Burbank produce the shasta daisy?

The big, brilliantly white shasta daisy is not a natural flower, but one that was created from three less attractive daisies. Luther Burbank, a world-famous experimenter with plants, improved and changed many plants in a way that seems almost like magic by using a method called "crossing." He had always been fond of daisies, but the American field daisy is not a very beautiful flower. It is strong and hardy and has a great many blossoms, but they are small and straggly. The stems are crooked and not very tall. In England there was a daisy much larger than ours with coarser stems and flowers. In Japan, there was a small daisy



Burbank created the Shasta Daisy

whose petals were so white they were almost dazzling. Mr. Burbank thought how wonderful it would be to have a daisy large and tall like the English one, strong and full of blossoms like the American, and a brilliant white like the Japanese. The shasta daisy has all these good qualities and this is how Mr. Burbank did it:

He got the very best seeds he could find from the three different kinds of daisies and planted them. When they bloomed, he *cross-pollinated* them. That means that instead of allowing the pollen from one kind of flower, say the American, fall upon the pistils of the same kind, he took the pollen and with a small brush sprinkled it carefully on another kind, either the English or the Japanese. He saw to it that each flower received pollen from a different kind of daisy. He did not know which combination would be the best, so he tried a great many different ones. After the daisies had all been pollinated, he tied little bags over them to protect them from any wandering bee with pollen on his legs that might come along and spoil the

experiment. When the seeds formed from these flowers, he saved and planted them. Later, when the flowers came from these seeds, he studied them carefully. Just as a little girl may have curly hair like her mother and blue eyes like her father, so some of these flowers were large and tall like the English daisy and a beautiful white like the Japanese. Whenever a flower had a good quality that he wanted to keep, he crossed the pollen from it with another good flower and saved the seed. When the plants grew from this seed, he saved only the best ones. Those that were tall, straight, white, large, strong, and many blossomed were chosen and he burned the rest. He selected the seed and planted it every year for eight years, destroying always those flowers that were not just right. All of this time was necessary because plants inherit bad traits from their ancestors just as people do. He wanted to be sure that none of the seeds would produce flowers that were small, straggly, or a dirty white color.

At the end of eight years he was sure that the

seeds would produce only beautiful flowers. Then he gave the seed to others, and soon there were shasta daisies growing in gardens all over the country. He named the flower for Mt. Shasta, a beautiful mountain peak in California, which is covered with shining white snow all through the year.

Botanists call a flower like the shasta daisy a *hybrid* because it is produced by crossing the pollen of different kinds of plants, and it inherits the best points of each. Most hybrids are formed only by two kinds of plants. The shasta daisy is unusual because it comes from three.

Chapter VII

A WORLD OF GARDENS

WATER lilies are not so different from other plants as might be thought. Like all plants, they need air and sunlight, food and water. There are air chambers in the leaves floating on the top of the water. Therefore the plant can get plenty of air and sunlight. They live in the water so they never have any trouble in getting enough moisture, and they do not have to provide against drying out as land plants do. In Italy, where the summers are hot and dry, the leaves of ordinary plants must have an extra thick skin to keep the water from evaporating too fast. The water lily does not need any such help. The skin on its leaves is soft and tender.

How do water lilies grow?

A water lily could not live in water alone. It has roots which go down to the soil under-

neath the pond, for it must have nitrogen and other minerals which only the soil can supply. The biggest and best water lilies are found in ponds where the soil underneath is rich and black. If the pond has a sandy bottom, the lilies will not do so well there.

Water plants have one advantage over land plants; they do not need strong woody stems to support them. They can save the energy other plants use in growing strong stems for building big leaves to make food and for beautiful flowers. They do not need long tubes in their stems and leaves to carry water because the water is near to all parts of the plant.

Some water plants like bulrushes and cat-tails have strong stems. They are then able to grow on land as well as in the water. This is very useful to them in case their pond or stream should dry up.

Some other water plants grow completely under water. They do not need strong stems, but they are at a disadvantage when making food, for the sunlight has to pass through the

water, which weakens it. The only air they get is that which has been absorbed by the water.

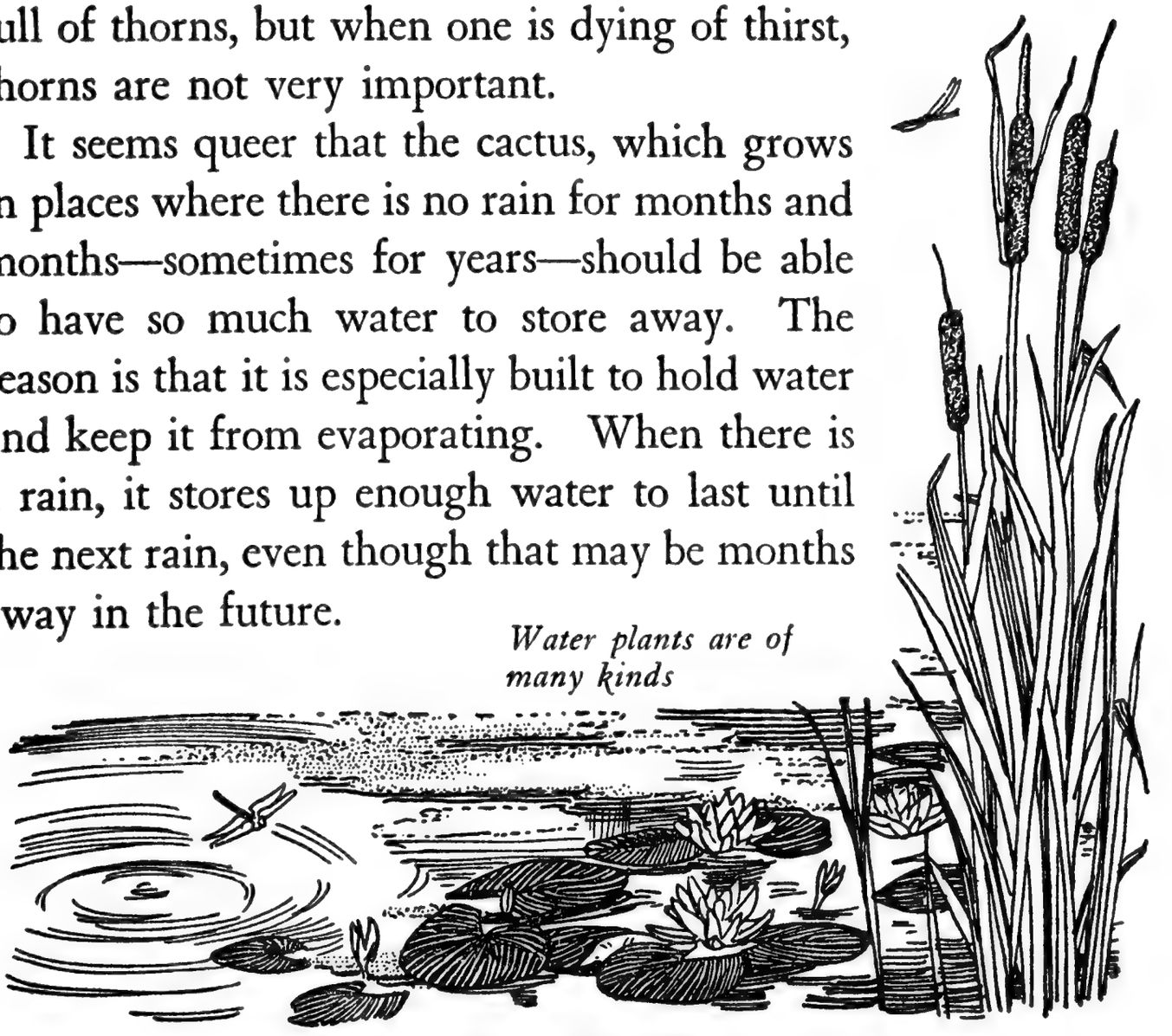
On the whole, water plants do not get along as well as land plants. The nearness of water is a great help, but there are disadvantages.

Why is a cactus full of water?

Many a prospector, looking for gold in the desert country of Arizona or California, would have died of thirst if it had not been for the cactus plant. All he had to do was chop off the top of the cactus with his ax, and he would find sweet water stored in its barrel-like stem. Of course, he took a chance of getting his hands full of thorns, but when one is dying of thirst, thorns are not very important.

It seems queer that the cactus, which grows in places where there is no rain for months and months—sometimes for years—should be able to have so much water to store away. The reason is that it is especially built to hold water and keep it from evaporating. When there is a rain, it stores up enough water to last until the next rain, even though that may be months away in the future.

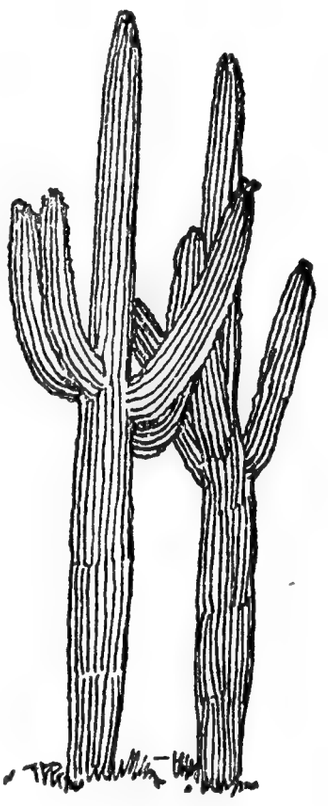
Water plants are of many kinds



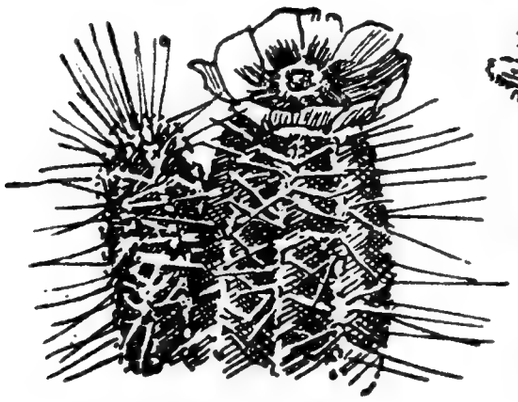
Leaves make food from water and carbon dioxide. The leaves also give off water which evaporates into the air, a process called *Transpiration*. Trees drop their leaves in winter so they will not lose too much moisture. The cactus plant prevents the transpiration of water by *not having any leaves*. The stems have some green coloring, and they do the work of making food. Naturally they do not make it very fast, and for that reason the cactus grows slowly. The water is stored in the stem, which is very thick, sometimes over a foot across. All over the stem is a heavy skin which prevents evaporation. There are also hairs and thorns which keep the moisture inside. They serve to keep away prowling animals who might break the stem and so let some of the precious water escape. The skin, in addition to being thick, is rather waxy. Wax prevents evaporation. That is why we wrap food in wax paper to keep it fresh. The only way water can get out of this armored plant is when some outside agent like the prospector with his ax, breaks through.

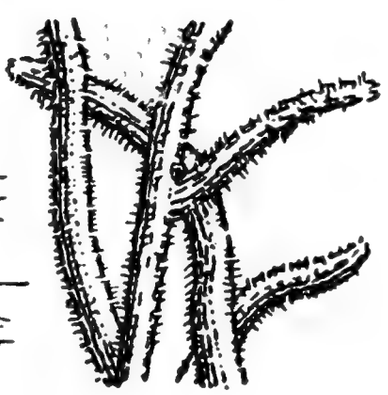
The cactus has many forms. Although some may grow to a height of fifty feet and have many branches, like the giant cactus, most of them are much smaller. A common kind is the barrel cactus which is something less than a foot across and from a foot to six feet tall. It has deep furrows and many sharp thorns. Another common variety is the prickly pear, which has flat, jointed stems shaped something like the sole of a big shoe. It has prickles instead of thorns. Because of their ability to store large amounts of water, the members of the cactus family are found in dry regions where very few other plants can grow. Such places are Mexico, Arizona, New Mexico, and Southern California where the climate is dry.

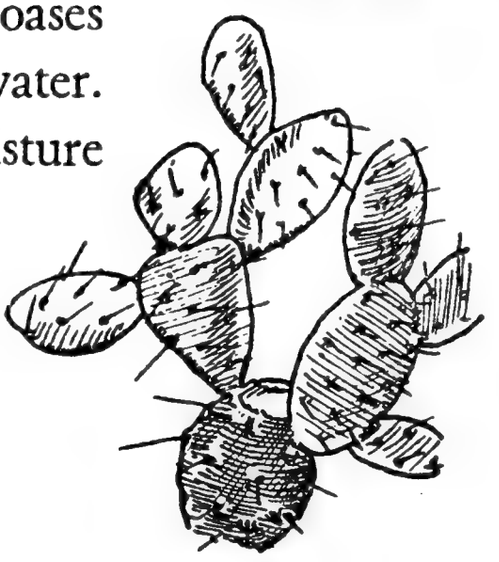
Cacti are found in dry places



The Arabs, who know all about dates because they depend upon them for food, have an old saying that the date palm must have its feet in the water and its head in the furnace. As a matter of fact, date palms only grow in the oases or parts of the desert where there is some water. Nothing can grow where there is no moisture







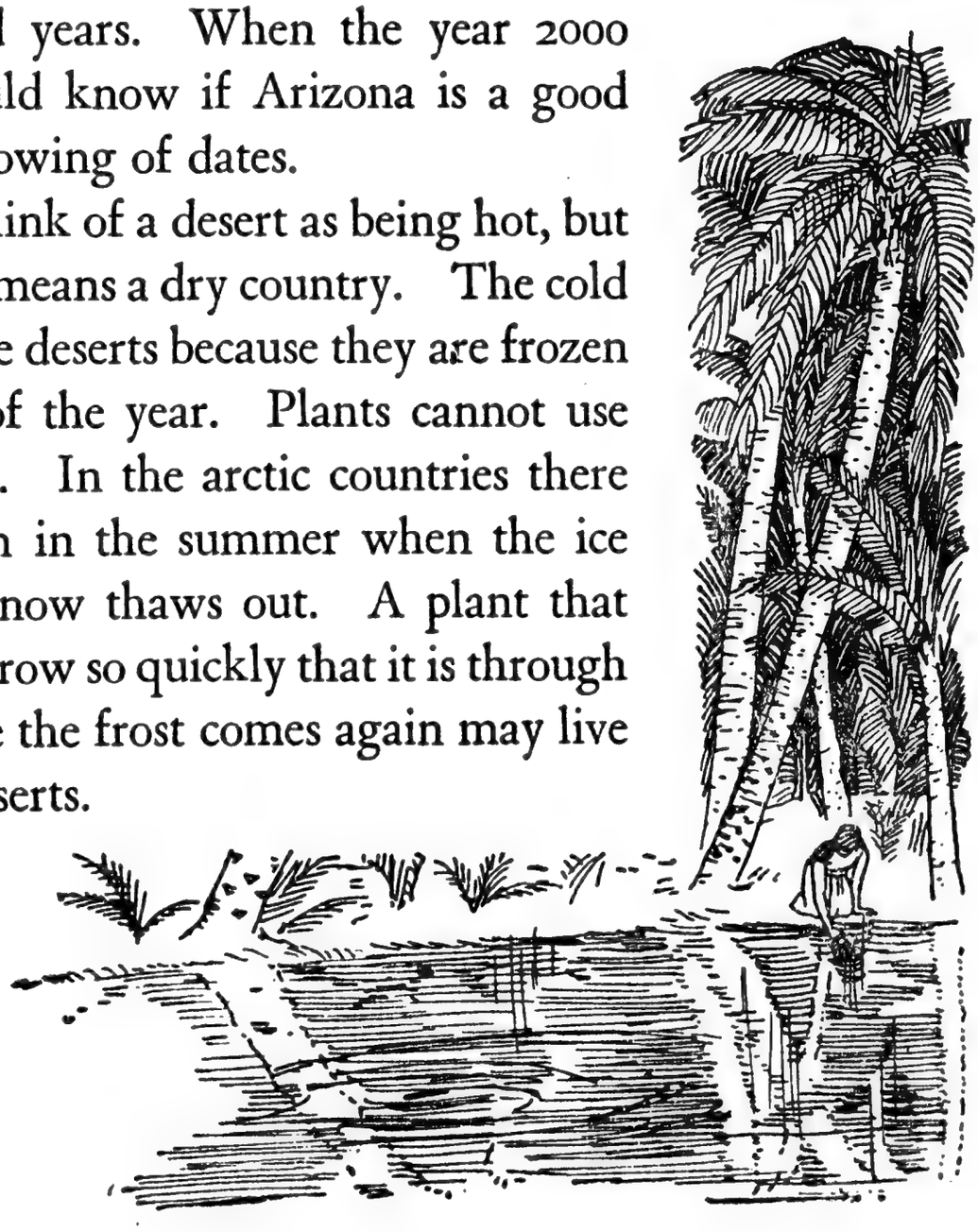
Why do dates grow in the desert?

at all. The old Arab saying means that the date palm must get all the moisture that it needs through its roots. If its leaves or stems are wet by rain, it does not do so well, and may even die. In a desert, such as the great Sahara, this condition is possible. The water is brought to an oasis by underground streams, not by rain. It so seldom rains in this desert that we can almost say never. While the date tree's roots are absorbing this underground water, the great feathery crown of the tree is hot and dry under the sun. The hotter the sun the better the tree thrives and the bigger it grows.

A single oasis may have many thousands of date trees growing there. There are some oases which have as many as half a million trees. A single bunch of dates from one of these trees may weigh from one hundred to five hundred pounds. Each of these date palms bears an enormous bunch of fruit every year, so it is not surprising that dates are the chief food of the desert dweller. He can live many days, and often has done so, on dates alone.

Farmers have tried to raise dates in many places in the United States but have not been very successful. We have very few places where there is underground water, no rainfall, and plenty of hot sunshine. The best place seems to be in Arizona, near Phoenix, and many trees have been planted there, and have been growing for a number of years. It is too soon, however, to tell whether they will be perfectly successful, for a date palm should live for at least a hundred years. When the year 2000 comes, we should know if Arizona is a good place for the growing of dates.

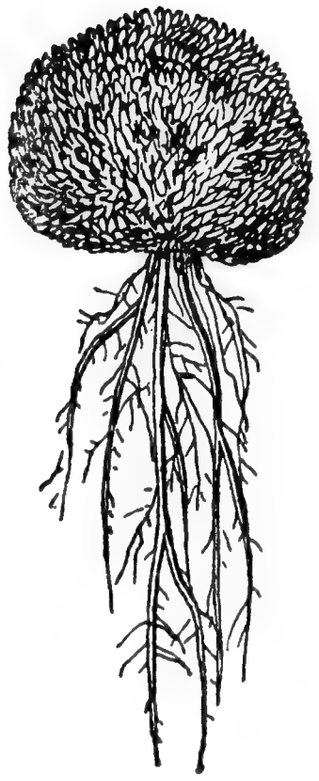
Usually we think of a desert as being hot, but the word really means a dry country. The cold arctic regions are deserts because they are frozen for two-thirds of the year. Plants cannot use frozen moisture. In the arctic countries there is a short season in the summer when the ice melts and the snow thaws out. A plant that can manage to grow so quickly that it is through flowering before the frost comes again may live in these cold deserts.



Some oases have thousands of date palms

What plants grow in the cold deserts?

There are only a few plants that are able to work so fast. The only common plant in the frozen north is the reindeer moss. There are also some little flowering plants that have small bright flowers. Some of them even have berries. Trees grow there, too, but would not be recognized as trees. The summer is so short that the tree can grow only a tiny bit each year. A larch tree that is fifteen years old may be only a few inches high.



In the extremely cold deserts of the antarctic there are practically no plants at all.

High mountains are sometimes cold deserts also. Traveling from the base of a high mountain to the peak is something like traveling from the equator to the north pole. At the base are the luxurious plants of the warm climate. Farther up the weather becomes colder and the season of winter lasts longer. First the hard wood trees give up, and only the conifers are left. Conifers or cone-bearing trees, like the pines and firs, can grow in quite severely cold climates. At length, however, the climate be-

Alpine plants must grow quickly

comes too severe for them. The highest place where trees can grow is called "timber line." Above this point there are no trees. From here to the peak of the mountain the plants become smaller and smaller and more like the plants of the arctic regions. If the mountain is very high and the peak covered with snow all the year around, there will be no plants at all, as in the antarctic where there is always snow.

What is the most important family in the plant kingdom?

The grasses are the most important family in the plant kingdom. They cover the earth. There are over one thousand different kinds of grasses and they grow in every climate where anything can grow at all. The largest grasses are the bamboos, which grow in hot countries; and the smallest are tiny plants no taller than moss which grows in very cold climates like Iceland and Siberia. The world would be a much poorer place if it were not for grass. Indeed, it would be impossible for men to live at all.

In the first place, the roots of grass form a network which binds the soil together. If they did not, the wind would be constantly blowing

the sand and earth from one place to another. Larger plants, like trees, could not grow because the soil would not stay in one place long enough. Grass roots hold the soil in one place. They also keep rain from washing it away.

In the second place, grasses are the most important food materials in the whole world. Farm animals—horses, cows, sheep—live on grass. Dried grass, in the form of hay, supplies them with food all winter. Grasses supply man with most of his food. Corn, wheat, rye, barley, rice, and oats are all grasses. All of these plants, except corn, have been grown to feed men since long before history was written. In Bible times the raising of wheat was an old profession. In China and India the people live almost entirely on rice and have done so for thousands of years. White men did not have corn till America was discovered, but the Indians had probably eaten it for hundreds of years before that time.

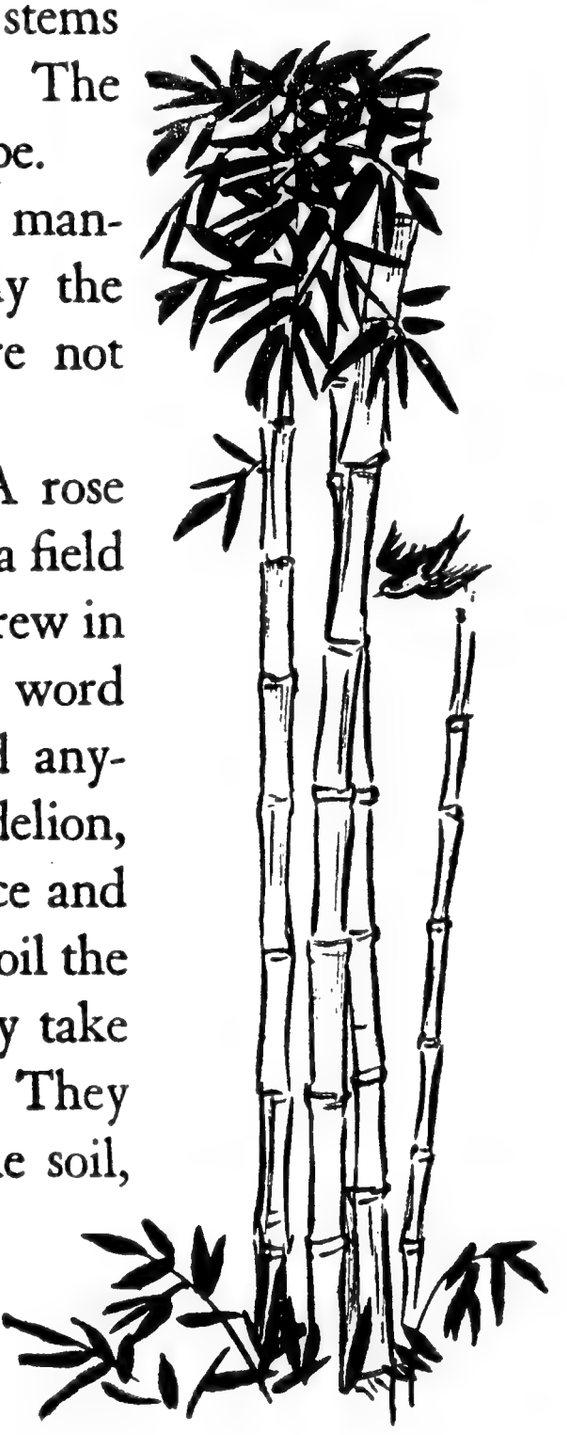
Sugar cane is another grass. How we should miss its sweetness if it should suddenly vanish from the earth.

Corn is one of the grasses

In some hot countries bamboos supply food, clothing, and shelter. In some islands in the South Seas, boys and girls wear jackets of bamboo, live in bamboo houses, and gather tender young bamboo shoots to eat for vegetables. They use sections of the smaller bamboo stems for cups and the larger ones for pails. The fiber is also used in making paper and rope.

Not the least of the grasses' service to mankind is in supplying beauty. How ugly the fields and yards would be if they were not covered with a soft green carpet of grass.

A weed is any plant out of place. A rose bush might be called a weed if it grew in a field of wheat, and so might a corn stalk if it grew in a flower garden. Usually, however, the word weed means a plant that is not wanted anywhere. The ragweed, cockle-bur, dandelion, thistle, and plantain are always a nuisance and are not welcome in any place. Weeds spoil the appearance of lawns and gardens. They take up light and space that other plants need. They steal moisture and nourishment from the soil,



Bamboo is the tallest grass

preventing the garden flowers or grass from growing well. If they grow in the grain fields, their seeds are mixed with the grain at harvest time and lower the price the farmer can get for his crop. The weeds are not good for cattle and spoil the milk if a cow has eaten them. The pollen from ragweed gives hay fever to many people.

What are the most troublesome plants?

That is what people think about weeds. From the plant point of view, a weed is among the most successful of plants. It can do all of the things that a plant most needs to do. It grows in almost any soil or in nearly any climate. It crowds out any plants that are in its way and it produces an enormous number of seeds. That last fact is the most important. Consider how many seeds are sure to be lost every year. The plant which has the most to begin with is the one which will produce the most new plants the next season.

The best way to prevent weeds from growing in our fields and gardens is to keep them from going to seed. Most of them are the kind of

plants that are known as annuals. That means they live only one season and must start anew from seeds the next year. If this year's plants are kept from forming seeds there will not be any plants next year. If everyone would be careful to cut away every weed he saw before the blossoms had turned to seed, we could be entirely rid of many kinds of weeds. That would mean quite a great deal of work, but it would surely be worth it.

There are some weeds which could continue growing even though they did not produce any seeds. These belong to the kind of plants known as perennials. That means that the undergound part of the plant stays alive from year to year in spite of the fact that the top dies. Each spring this underground stem sends up new green shoots. If we could keep these shoots from growing, the plant would die finally, because the green leaves above the ground would be unable to manufacture food and so the undergound stem would die. Whenever you see a weed starting to grow, cut it off

down to the ground. Cut it every time it starts, and at last it will be too weak to try again because it will have used up all its stored-up food without being able to make any new.

We could do a great deal toward freeing the country of troublesome weeds if everyone would do these two things: cut all weeds before they go to seed, and cut all young shoots before they can make food.

Why do forests need protection?

When the first settlers came to America, they found the new country covered with forests and prairies. For hundreds of years no one had disturbed the plants which grew here and they had been progressing in the natural way. In the natural way the prairies come first. Grasses and flowering herbs like daisies grow in the prairies. After many years the soil becomes much richer, because the leaves from these plants have dropped every year and decayed. The decayed leaf mold, or humus, as it is called, makes a rich soil that is suited to trees. Also it holds water better than the light soil of the original prairie. Gradually trees begin to grow

and in time the prairie disappears to be replaced by a forest.

When trees and prairies are allowed to grow by themselves, they still follow this succession. The thousands of new settlers coming to America, however, changed all this. First of all, they needed homes and fire; so they chopped down trees to build log cabins. Later they built board houses. They burned wood to heat their homes and to cook their food. The next thing they needed was food; so they plowed up the prairies for farms. Often times a forest would interfere with a man's farm, and he would kill the trees to get them out of the way.

At first no one realized what a serious mistake these people were making. Only about fifty years ago, the citizens began to wake up. They discovered that their fine forests were disappearing. The forests in the eastern United States are about gone. Wood has become very expensive, although we need it more than ever. Trees cannot be replaced in a year like corn or wheat. It takes fifty to a hundred years, at

least, to produce a tree large enough for lumber.

After our trees were gone, we discovered another service that forests do for man. They prevent floods. The roots of trees hold the moisture and let it go very slowly. When the trees are gone, the fast melting snow or heavy spring rains carry the soil away because there is nothing to hold it. Many hillsides have been washed bare of soil when the trees were either cut down or uprooted.

The United States government is trying very hard to save the forests which are left and to plant new forests to replace the old ones. The government hires forest rangers to watch for forest fires, as many hundreds of trees are lost by fire each year. The government also tries to persuade lumber companies to plant a new tree every time an old one is cut down.

All trees are beautiful, and most of them are useful. They grow usually in family groups. The northern forests are made up of conifers or soft wood trees. They are called conifers because they have cones which hold the seeds.

Most of the conifers are evergreen and have needle-like leaves. Pines, cedars, firs, and spruces are well-known examples of the conifers. They can stand long cold winters and dry summers. Besides growing in the northern forest, they are also found in the south along the mountain ranges which have a colder climate than the lowlands.

The hardwood trees, which drop their leaves in the autumn, require a rainy spring, a warm summer, and rich soil. They grow in the central parts of our country where these conditions can be found. The oak, beech, and maple trees form most of our hardwood forests.

And so, it is no wonder that our world is full of gardens, that it is a world of plants, growing not only on the land, but in water, in the hot and cold deserts, and even on the mountains. Wherever there is sunlight and moisture, there we find plants at work, running their factories so that the world will never be without its gardens.