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San Francisco, California
2007

THE FIRST BOOK OF
PLANTS



LILY of the VALLEY



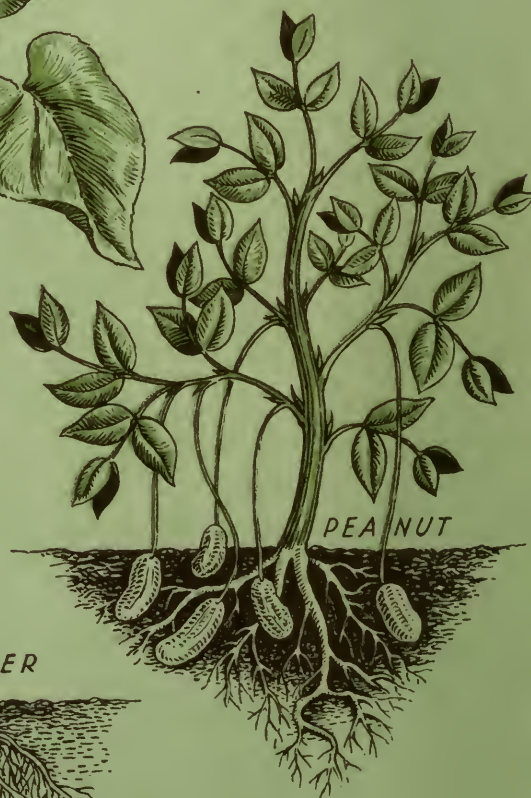
SUN FLOWER



TULIP



POTATO



PEANUT



TURNIP



MUSHROOM



PEA



CORN



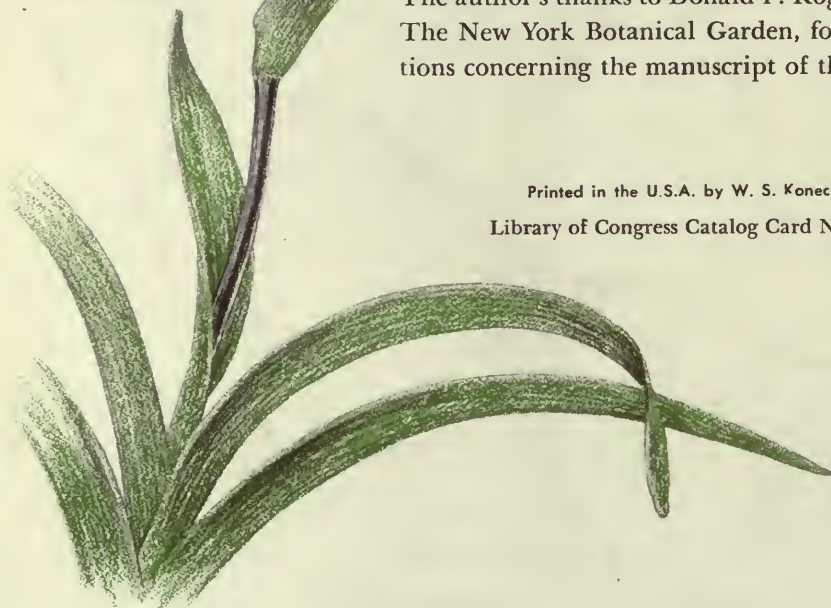
WATER LILY



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THE FIRST BOOK OF PLANTS

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Pictures by PAUL WENCK



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PLANTS—LIVING AND GROWING

Plants grow almost everywhere in the world around us—in all sizes and shapes. Some are so small that they can be seen only with a microscope. Others, like the redwood trees of California, tower high in the sky. Plants grow not only in well-watered soil, but in oceans, rivers, lakes and swamps, in deserts, on rocks, far above the ground on branches of trees, on old pieces of wood, even on such unlikely things as crusts of bread, old shoes, or on top of arctic snow. Some strange plants eat insects, and others steal food from their neighbors.

Plants and animals are the living, growing things of the earth. Most animals move around, and many of them have sound apparatuses, for making noises. Most plants spend their whole lives silently in one place. Because they live so quietly, we sometimes forget that during their growing seasons they work hard all day long. For plants are just as alive as animals, and they have the same problems: finding and keeping a place to live, getting food, fighting animal enemies and plant rivals,





and having young, so that new plants will grow each year.

Scientists, taking hourly moving pictures of plants, then running them off quickly, have shown how active plants really are—always twisting their stems and turning their leaves toward the sun, stretching out longer, growing new buds, then flowers, and finally seeds. Watch a sunflower as the sun moves across the sky, and see for yourself what happens.

People often think of plants' leaves and flowers as only decorative, and of their fruits as solely for human beings and animals to eat. But for plants themselves, their green leaves, their many-colored flowers, their great variety of fruits—all the things about them—are strictly business, part of the job of keeping alive and providing for new plants.

Plants are fierce rivals. Anyone who has ever weeded a garden knows that often several different kinds of plants are fighting for quarters on the same piece of ground. Each plant has its own special equipment to help it in the hard business of living. Part of the fun of knowing plants is discovering each kind's way of getting along in the world.



WHY PLANTS ARE IMPORTANT

Getting food is one of the most important jobs of both plants and animals. Most animals can find food best by moving around after the plants or other animals they eat. That is the way they keep alive.

Plants have a different way of getting food. They can stay in one place and still eat. They do not need to dash around.

A green plant's way of getting its food is just as important to every animal and every person on the earth as it is to the plant itself. For green plants do not eat other plants or animals as food. So far, green plants are the only things in the world that can make food from its raw materials—water, a few minerals, and a gas called carbon dioxide, which is all around us in the air. No animal can do this food-making. And no animal can live without plants for food.

To be sure, some animals eat only other animals. But those other animals probably eat plants, or else they feed, in turn, upon still other creatures who do. Without plants, there would be no animals — and no meat. Green plants are the wonderfully designed, self-running machines upon which every living thing in the world really depends for food.



FOOD-MAKING LABORATORIES

For years, scientists have been trying to solve the mystery: how do plants make food? Although a few links are still missing, here are the chief clues:

1. Only *green* plants can make food. This is because they have an important, almost magic, green substance called chlorophyll from two Greek words meaning *leaf* and *green*. Place a green leaf in a small jar and cover it with alcohol. After some hours, the leaf will be yellowish, but the alcohol will be green. This green is chlorophyll, the plant's green coloring matter, which the alcohol has taken from the leaf.



2. Green plants can make food only if they can get the raw materials, carbon dioxide and water.

3. Green plants cannot make food unless they have light. Without light, they lose their chlorophyll. Plants growing in nature depend on sunlight.

Plant food-making works like this: Carbon dioxide and water are both made of simple chemicals, put together in special ways. Green plants act as chemical laboratories, separating carbon dioxide and water into blocks of the simple chemicals of which the gas and water are made. Then the plants rebuild the blocks in another way so that they make sugars. The plants use these sugars as food.

Chemists, trying to separate water and carbon dioxide into simple chemicals in their laboratories, have found that it takes a great deal of energy, or force. Plants are able to use the greatest energy-maker there is—one that people have not yet learned how to use. That is the sun. The chlorophyll in green plants acts somehow as a screen to trap this energy, sunlight, and use it in making food. The process of food-making by plants is called photosynthesis, which comes from two Greek words, and means “putting together with the help of light.”

Besides furnishing food, plants do another thing for animals. Carbon dioxide and water both have oxygen in them. In separating carbon dioxide and water into simple chemicals, plants are left with more oxygen than they need for staying alive. They return this extra oxygen to the air. Air contains oxygen, nitrogen and other gases. But oxygen is the part of air which all living things need. Plants help keep animals supplied with oxygen. If they did not do this, our supply of oxygen would soon run short.

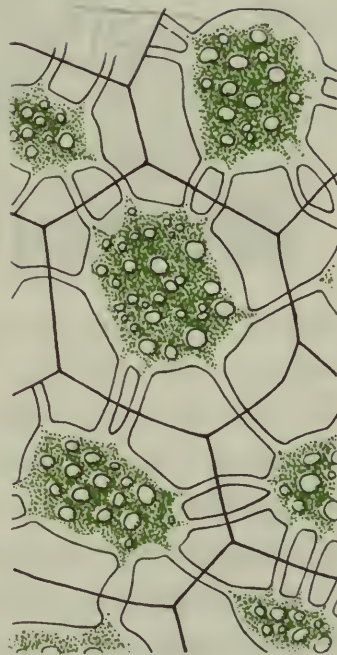


HOW PLANTS ARE BUILT

Green plants are built so that they can be sure of having a steady supply of raw materials for food-making. Every plant and every animal is made up of very tiny units or parts, like building blocks. These units, called cells, can be seen only with a powerful microscope. Each plant cell has thin walls surrounding a living, jelly-like substance and some liquid cell sap. Some of the cells also have little spots of the green coloring matter called chlorophyll.

A very simple green plant may be only one single cell large. It has no trouble in making food from the water and carbon dioxide that come to it directly through its cell walls.

A more complicated plant, like a daisy, has many cells of different kinds. The plant's work is divided among these cells, which form roots, stems, leaves, flowers and seeds. Getting raw materials is not as simple for a plant like this as for a one-celled plant. Plants with roots, stems, leaves, flowers and seeds use their leaves as food-making laboratories.





Leaves are well fitted for their jobs. Look at a houseplant that has been sitting in the same position in a sunny window for a week or so. Its stems have spread the leaves out to face the sunlight, so that each gets as much sun as possible. Turn the plant around so that the leaves are away from the light. After several days you can see that the stems are turning the leaves back to face the sunlight. Notice an outdoor plant. The stems are doing the same thing there—spreading the leaves out to get sunlight.

Now notice how thin through leaves are. This is so that the sunlight can reach as many of their cells as possible. If leaves were as thick as branches, sunlight could reach only their top-most layers. The inner cells would be useless as food laboratories.

Next, look at the waxy coating on the outside of many leaves, especially on the side nearest the sun. This coating is waterproof—but it's waterproof to keep the moisture *inside* the leaf from escaping too much into the air outside, and so allowing the leaf to dry out. At the same time, this waxy coating is transparent—the sunlight shines right through it.

The lines on a leaf are its veins and midribs. They help to strengthen the whole leaf, and are part of its supply line in food-making. For the leaf would be useless if it could not get its work supplies, carbon dioxide and water.



STOMATA



VIEW OF LOWER SURFACE

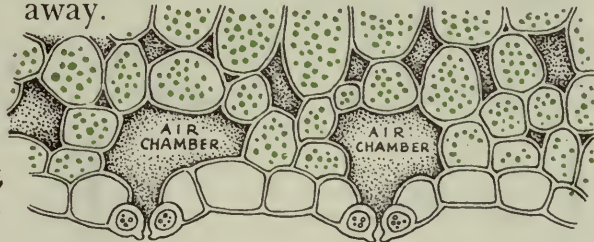
STOMA



CROSS SECTION

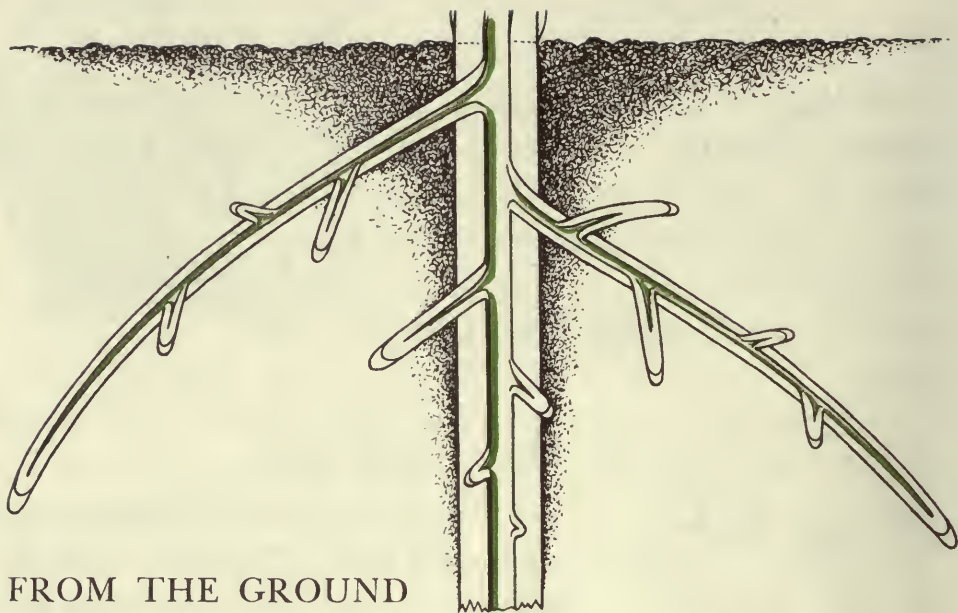
One single opening of the stomata is called a "stoma."

CROSS SECTION OF A LEAF,
LOWER SURFACE →



FROM THE AIR

Leaves get carbon dioxide from the air around them. They are full of tiny openings, so small that an average leaf has 125,000 of them in each square inch of its surface. These openings are called stomata, from a Greek word meaning "mouth." Through these stomata, gases come in and go out of the leaves. Inside the leaves are air spaces like little hallways, through which carbon dioxide goes to the food-making cells and extra oxygen comes away.



FROM THE GROUND

The water that the leaves need cannot come to them through their stomata. It has to come from farther away. Roots are the plants' specialists in charge of water supply. Their tips are always reaching out to tap new moisture in the soil—for it is the root *tips* that count, in water collecting.

Root tips are built like this: At the very end of each tiny root is a tough little cap. This is the root's protective armor as it pushes between the small bits of soil that are as rough as sandpaper. Often the cap has a slippery coating, to help it slide through the ground.

In back of the armored point is the growing part—the tiny section where the root's whole business of stretching longer is



carried on—for roots grow longer only at their tips.

Directly behind this lengthening part is the small root-hair section, covered with tiny hairlike growths. These reach out, firmly grasp the damp bits of soil, and soak up moisture through their thin walls. These root hairs live only a few weeks or months. As the root tip moves forward into new territory, new root hairs keep growing and the older ones die. The bigger parts of the roots, nearer the stem, become thicker and covered with a layer through which water cannot pass. But the growing tips keep collecting moisture steadily.

If you pull up a plant you probably will not see all the root tips. They are so delicate and grasp the bits of soil so firmly that many of them break off and remain in the ground when the plant is yanked up. You can see exactly what root tips look like, though, by growing some yourself.

Put layers of blotting paper between two panes of glass. Place radish seeds between the blotting paper and the glass so that you can see the seeds. Now fasten the panes together with rubber bands, and stand them upright in a shallow tray of water. In a few days the seeds will sprout.

Now you have a showcase view of some root tips. Imagine a full-grown plant with its hundreds of thousands of root tips with their root hairs, all soaking up moisture. Root tips are tiny, but all of them, working together, keep a plant well supplied with the water it must have to stay alive.



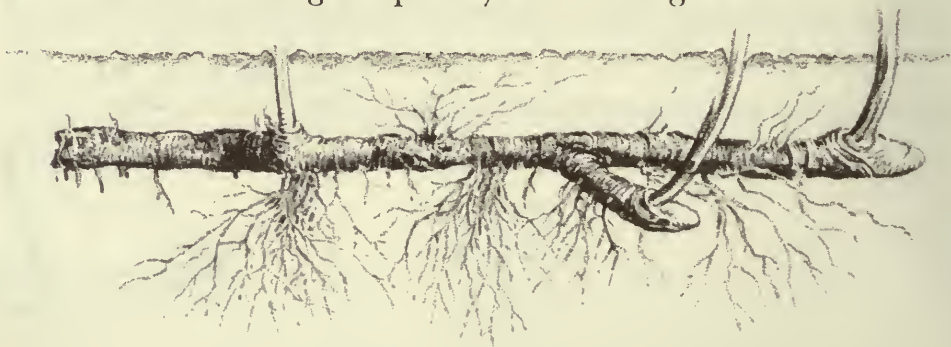
PLANT PIPELINES

Even after water has soaked into the roots of a plant, it still has to get to the leaves. Plants have pipelines, made of rows of long, slender cells. These stretch from every root tip, along the roots, through the stalks and stems, out through the veins, to every part of every leaf. Water coming into the root passes steadily through the plant, until it comes out into the food-making cells of the leaves.

Usually these cells are so soaked with water that some of it escapes from their moist walls as a gas called water vapor, and goes out into the air passages of the leaves. From there, it passes through the open stomata into the air around the plants.

So, during the business of food-making, plants do air-conditioning, too. They help keep the atmosphere moist with escaping water vapor, and fresh with the extra oxygen they give off.

And roots do much more than merely collect water. They anchor the plants to the ground. The hundreds of thousands of roots, branching through the soil and clinging to it, help bind it together so that it does not wash away. Roots help break apart the soil and keep it full of air spaces, too, so that rain soaks into it, instead of running off quickly and causing floods.



USING THE FOOD

All day long, while the sun is shining, leaves make sugars from carbon dioxide and water. They must have a way of distributing the food they make. So plants have another set of pipelines, leading away from the leaves and carrying the dissolved food all over the plant, to wherever it is needed.

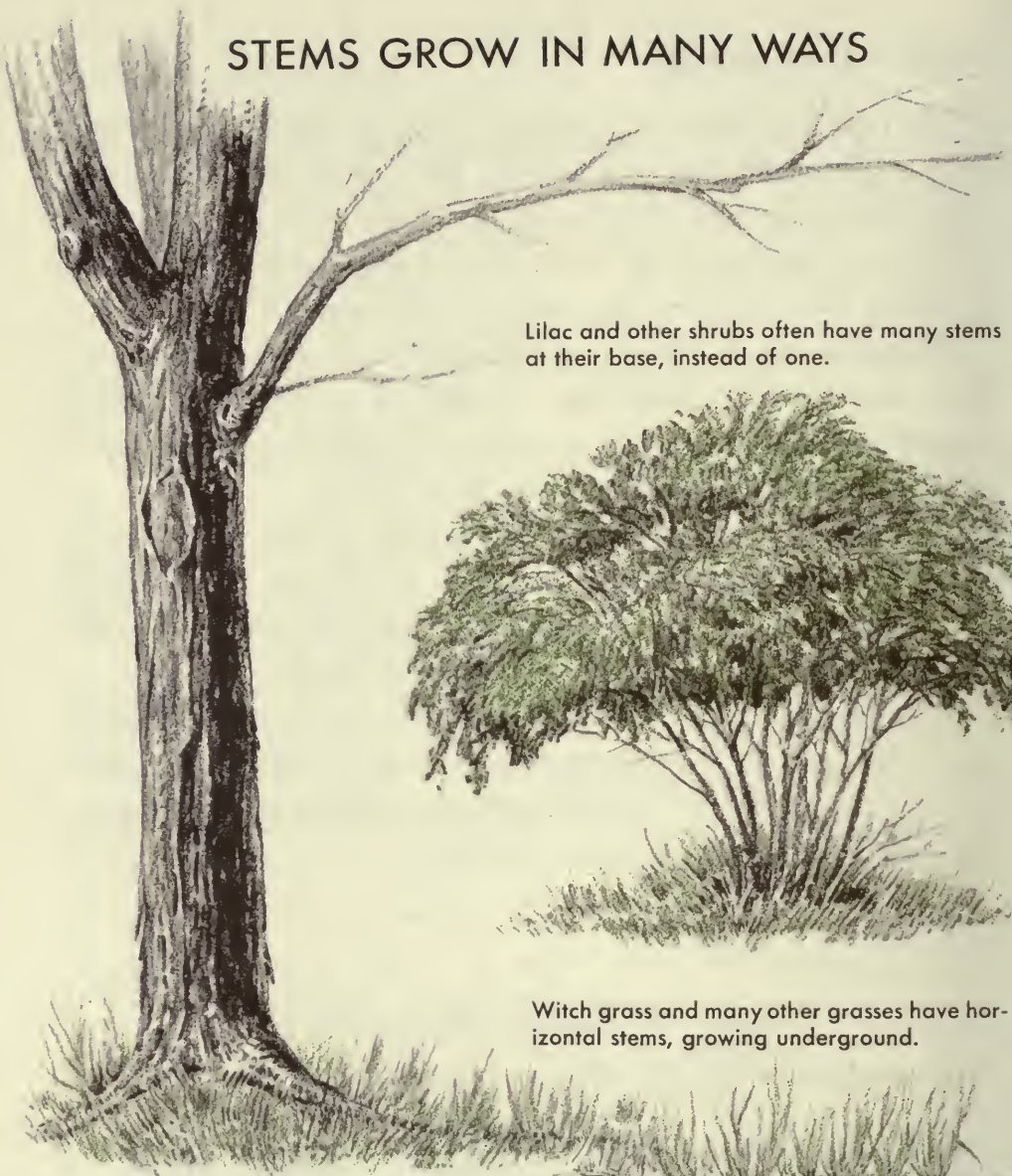
Of course, some of the food is used at once, to keep the plants alive and growing. And just as some of an animal's food is turned into flesh and bone, so some of a plant's food is turned into stems and leaves and all its other parts.

From the first simple sugars that a plant makes, it goes on to make fats, starches and more complicated things. To do this, it must have minerals. Roots soak up these with water, and the pipelines carry them to where they are needed.

Most plants make more food than they need at the time, so they store it in their roots, stems and seeds. People and animals use this stored food. Potatoes, carrots, turnips and onions are only a few of the stored plant supplies.



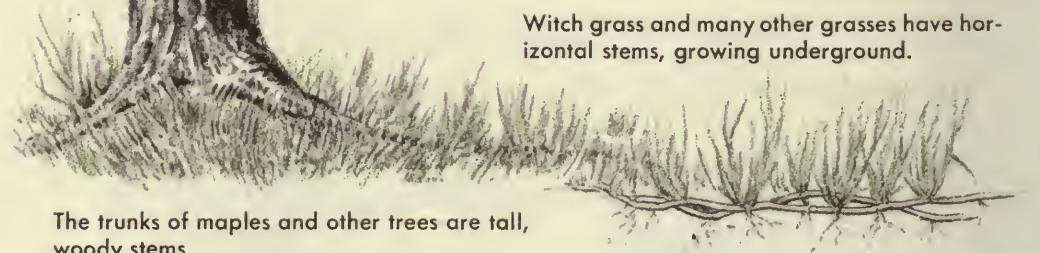
STEMS GROW IN MANY WAYS



Lilac and other shrubs often have many stems at their base, instead of one.

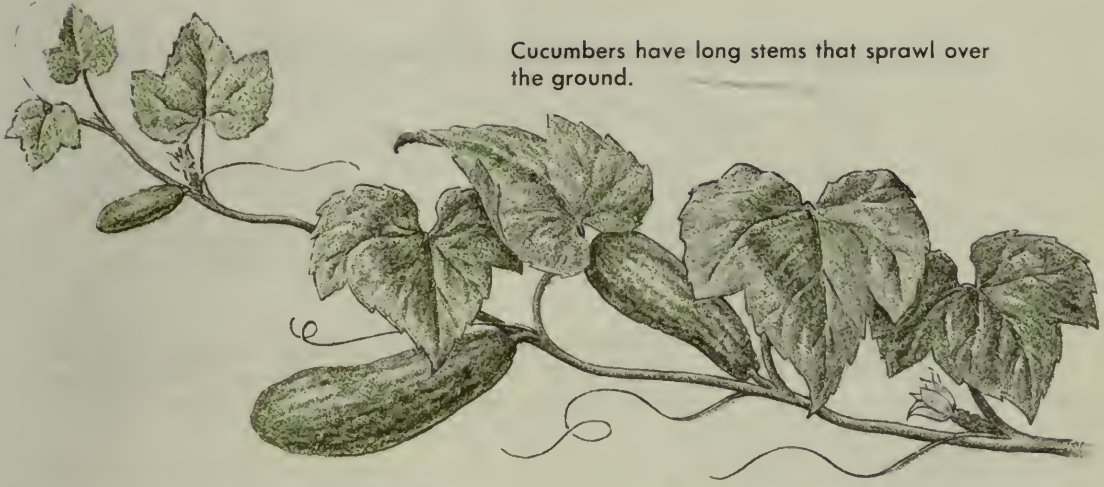


Witch grass and many other grasses have horizontal stems, growing underground.



The trunks of maples and other trees are tall, woody stems.

Cucumbers have long stems that sprawl over the ground.

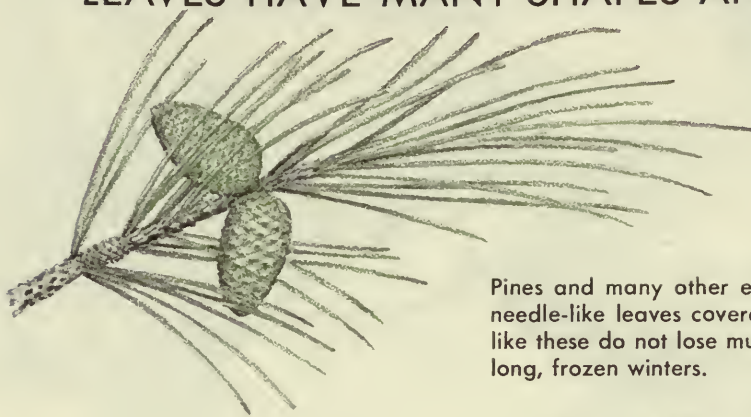


Grapevines have long, climbing stems with tendrils that cling to supports.



Prickly pear and barrel cactus are two of the many cactuses whose stems store water and make food. Spines replace their leaves.

LEAVES HAVE MANY SHAPES AND SIZES



Pines and many other evergreen trees have needle-like leaves covered with wax. Leaves like these do not lose much water during the long, frozen winters.

Staghorn ferns grow on the trunks of tropical trees. Round leaves at their bases are fitted for collecting soil and water.

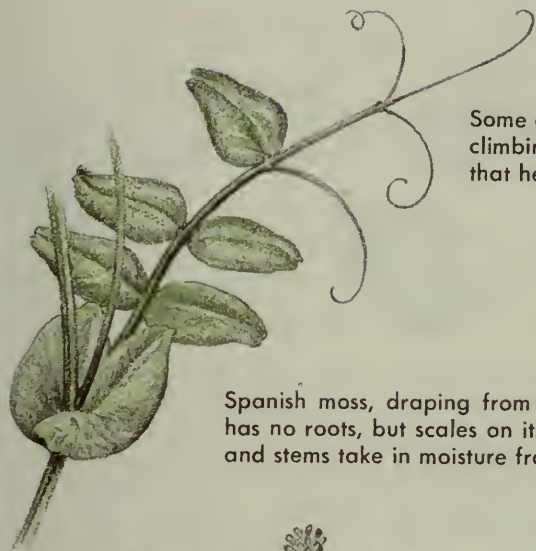


Cactus leaves have been replaced by spines that protect the plants from browsing animals.



Water hyacinth leaves grow from stalks like buoys, which keep the plants afloat.





Some of the leaves of garden peas and other climbing plants have changed into tendrils that help fasten the plants to their supports.

Spanish moss, draping from Southern trees, has no roots, but scales on its slender leaves and stems take in moisture from the air.

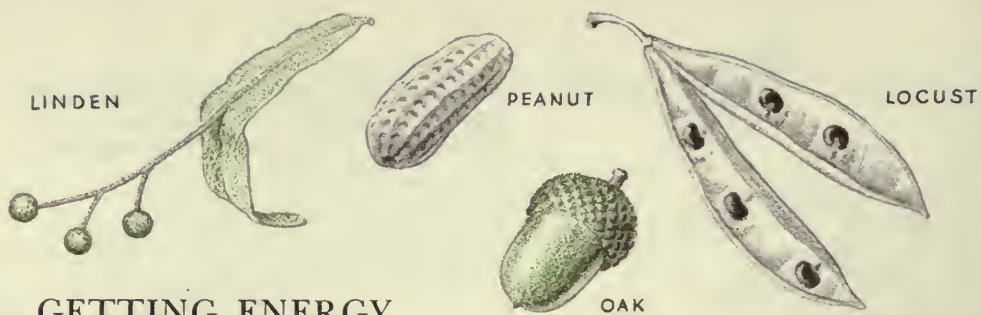


Stone-crop, sea fig, and some other plants that live in dry places have thick leaves that store water for use during droughts. These plants are called succulents.



Leaves of water lilies float like rafts on the surface of the water.





GETTING ENERGY

In order to keep alive, all plants and animals need energy. The sun is the Number One maker of energy, but only plants can capture the energy in sunlight and keep it for future use. While plants are making food, they are also storing the sun's energy inside themselves. Food has sun energy locked up in it. Every living thing in the world uses this energy. Animals and people use the sun energy in their food for heat, and to help them move around. Plants also use sun energy for their activities.

But to use energy, plants and animals must first set it free from the food where it is locked. Every living thing does this in the same way—by taking in oxygen. This is what happens: The oxygen joins together with food stored in the plants' or animals' cells and changes it, so that it gradually stops being food and turns back to carbon dioxide and water. When it changes to gas and water, the energy locked up in it is let loose, to be used by the plants and animals.





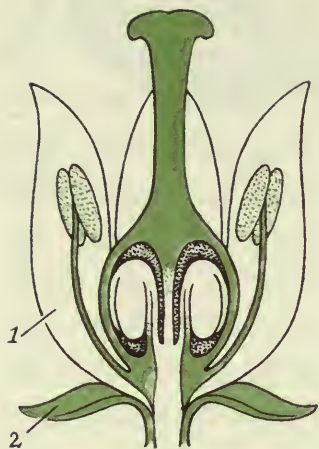
The business of setting energy free by joining food and oxygen is called respiration. Respiration is just the opposite of photosynthesis. Photosynthesis is using the sun's energy for *putting together* carbon dioxide and water to make food. Respiration is *taking apart* food to make carbon dioxide and water and set free energy. Respiration goes on all the time in all living things. A certain amount of food is always being used to set free energy.

Plants need to take in oxygen just as animals do, in order to get energy. But they use this oxygen very slowly. Plants do not walk around from place to place, so they do not need nearly as much energy as animals do.

MAKING NEW PLANTS

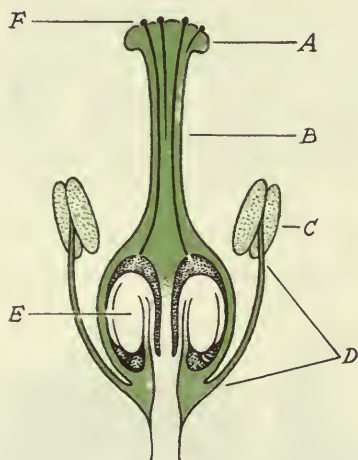
Roots, leaves and stems are the plants' food-making equipment. But besides making food, plants must grow new young ones, so that their very special kind, called their species, will not die out. The greatest number of land plants grow their young by means of seeds.





Flowers are plants' seed-making machines. A simple flower is built like this: Green, leaflike parts, called sepals, are like a cup, holding the rest of the flower. Inside this cup is a colored ring of petals. These enclose a ring of often club-shaped growths, called stamens. And, in the very center of the flower, is another part called a pistil.

The stamens and the pistil are very important in seed-making, for the stamen is the male part of the flower and the pistil is the female part. Unless these two parts work together, seeds cannot be made. Each plant seed must have two parents, just as each animal must.



The female pistil broadens out at its base into a sort of chamber, called an ovary. In this are tiny pockets containing eggs. These will develop into seeds if they join with little dustlike particles grown by the male stamens.

1. Petal. 2. Sepal. A. Stigma. B. Style. C. Anther. D. Filament. E. Ovary. F. Pollen.

But the eggs cannot move from the ovaries, and the stamens cannot move from their place on the flower to take the particles to the ovaries. This is what happens: Stamens grow a yellow powder called pollen. When the pollen is ripe it is carried to the tops of the pistils by the wind or by insects or birds. From there, the pollen grains grow tubes down the pistils into the ovaries. These tubes carry the male cells, join them with the eggs, and so start seeds.

Plants cannot make seeds unless pollen from the stamens reaches the pistils and grows tubes down into the ovaries.

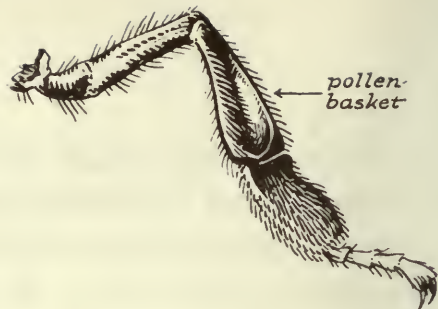
HOW BEES HELP

Not all flowers are simply made. Some are very complicated. Some have stamens and pistils in one flower. Some have stamens and pistils in different flowers on the same plant, and some even have female flowers on one plant and male flowers on another.

Pollen from the stamens of all these flowers must reach the pistils of other flowers of the same kind. Since they are anchored in one place, flowers must have outside help with this.

Many plants depend on insects to carry their pollen. Of these, bees are the greatest helpers. For bees, to make honey, need the sweet liquid called nectar, which many flowers have. Bees also mix some pollen with nectar to make “bee bread” as food for young bees.





But flowers don't furnish these things free. Bees must work for what they get, although of course they don't think this out. They are merely collecting nectar for food. But the nectar of flowers is always placed so that bees must crowd by the pistil and stamens to reach it. As the bees do this, pollen brushes off the stamens onto their hairy bodies and legs. As they fly from blossom to blossom, some of the pollen from one flower's stamens brushes off onto the pistil of the next flower they visit. In this way, bees help spread pollen while they are collecting nectar.

Besides their nectar, flowers have other ways of drawing bees to them. Their colored petals are like advertising signs, hung out to attract the bees' attention. Many flowers even have little lines on their petals, like guidelines. They help lead the bees to the nectar.

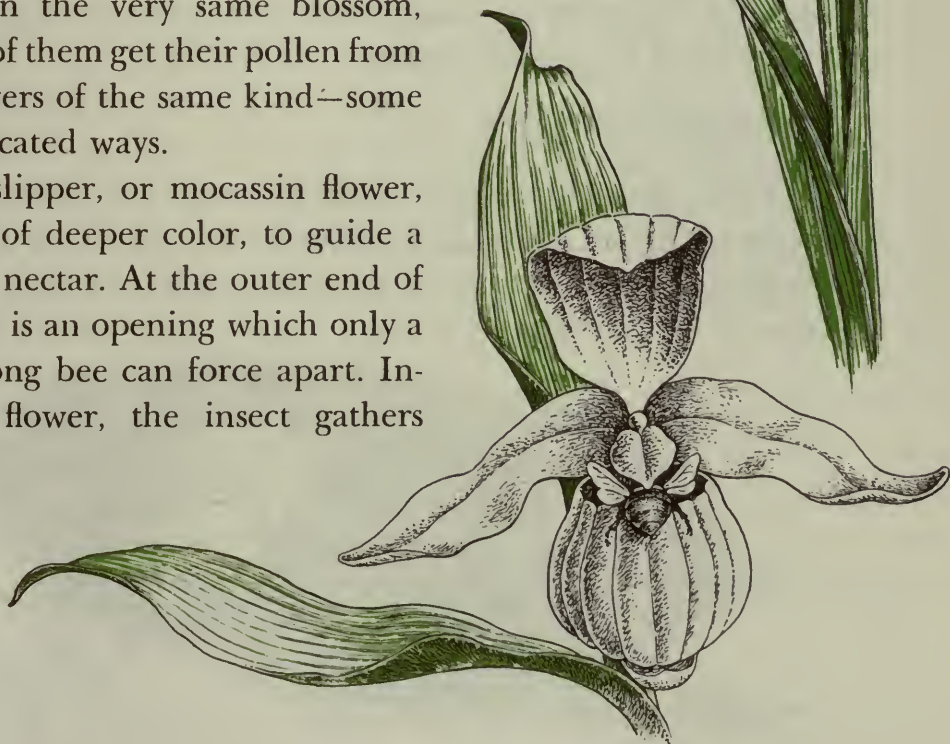




Flowers advertise in another way—by their smells, which attract bees to them. And many flowers have petals arranged like landing fields for the bees. A daffodil has a very fine landing field. It always keeps this field in the best position for the bees' use. Even if you should tie the stem of a growing daffodil so that its landing field is straight up and down, the flower will soon tip back to its old position.

A few pistils receive pollen from the stamens in the very same blossom, but most of them get their pollen from other flowers of the same kind—some in complicated ways.

A ladyslipper, or mocassin flower, has veins of deeper color, to guide a bee to its nectar. At the outer end of the flower is an opening which only a large, strong bee can force apart. Inside the flower, the insect gathers nectar.





But the door by which it entered cannot be opened from the inside. The bee must work its way through a narrow passage to two little openings at the inner end of the flower. Over the passage hangs the pistil. It has combs that rake the bee's back as it goes underneath, and gather the pollen that the bee brought from another flower. Just before the bee squeezes out of one of the openings at the end of the flower, a stamen is jiggled out of place and plasters the bee's back with more pollen. The bee carries this to another flower.

OTHER HELPERS

Flies, gnats, butterflies or moths carry the pollen of some plants. Flowers like evening primroses, which are pollinated by night-flying moths, have light-colored petals that the insects can see in the dark.





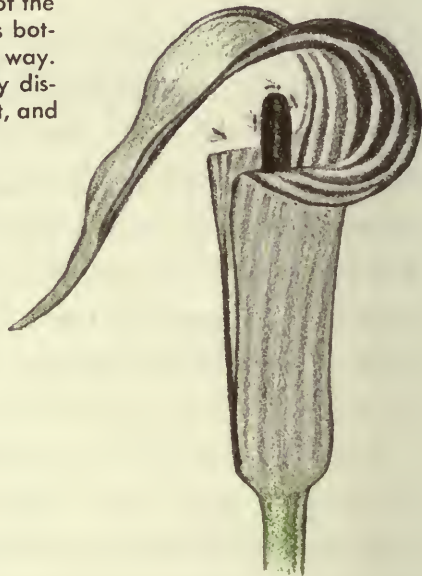
Hummingbirds spread the pollen of some flowers. These flowers have their nectar in long, tubelike blossoms. Bees cannot reach into these, but hummingbirds' long beaks just fit. Flowers pollinated by hummingbirds have no landing fields or nectar guides. Hummingbirds do not land as they sip nectar. They stay still in one place in the air, beating their wings to keep themselves up. The stamens grow so that they touch the birds as they hover. Many of the hummingbird flowers are red. This seems to be a favorite color with these birds.

Many flowers which depend on flying insects protect themselves from those that might crawl up from the ground and steal nectar without carrying pollen to other flowers. These plants have stems that trap insects with sticky "flypaper" juices, or hairs like barbed wire. Or they have growths that detour the invaders onto the leaves, away from the flowers.



SOME WAYS OF SPREADING POLLEN

The jack-in-the-pulpit's flowers are clustered near the bottom of a thick column, which is the "jack." Its pulpit is an overhanging shield, called a spathe. Tiny gnats coast down the slippery inside walls and column of the jack-in-the-pulpit to the flowers and pollen at its bottom. A ledge prevents their going back the same way. After the gnats crawl around in the pollen, they discover a gap in the overlapping front of the pulpit, and leave to carry pollen to other flowers.



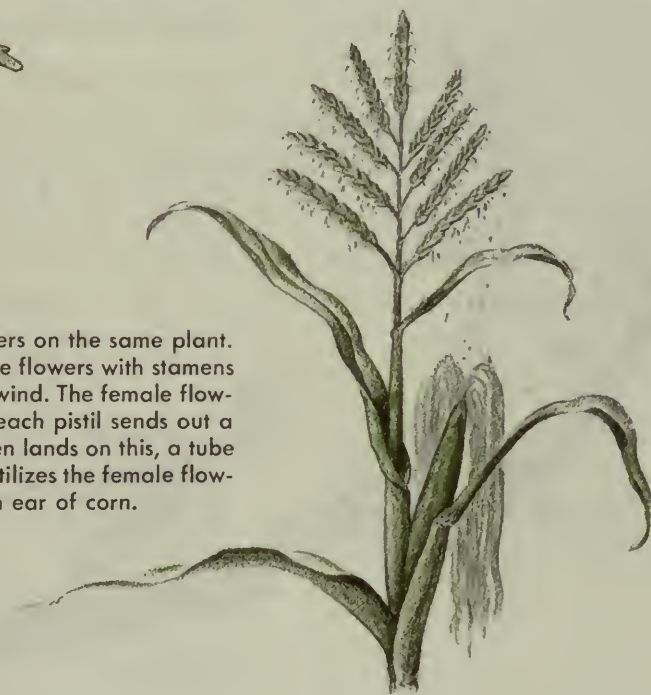
Purplish Dutchman's pipe flowers are hidden under large leaves where they cannot be seen by high-flying bees and butterflies. Low-flying gnats and flies enter the flower and are trapped by hairs that point in and down but act like a fence when the visitors try to leave. They are prisoners while the pollen they brought with them reaches the eggs of the flower they are in. Only after this does the flower's own pollen ripen, and powder the backs of the insects. Then the fence of hairs becomes limp and the flies and gnats escape, to visit other flowers and repeat the same experience.

Bunchberry has a cluster of tiny, inconspicuous greenish flowers, but it calls attention to them by large, showy, whitish growths called "bracts," directly beneath them. Many people mistake these for petals.



The white daisy is not a single flower, but a cluster of many tiny flowers, grouped together. The yellow center flowers, shaped like tubes, are called disk flowers. The white flowers around the edge—each a separate flower although it looks like a petal—are called ray flowers. By putting many tiny flowers together, the daisy attracts insects' attention and furnishes plenty of pollen to visitors.

Corn has male and female flowers on the same plant. The corn "tassel" is made of male flowers with stamens that shed pollen, carried by the wind. The female flowers are enclosed in a husk, but each pistil sends out a thread, the corn "silk." The pollen lands on this, a tube grows down each thread and fertilizes the female flowers, and seeds grow, forming an ear of corn.



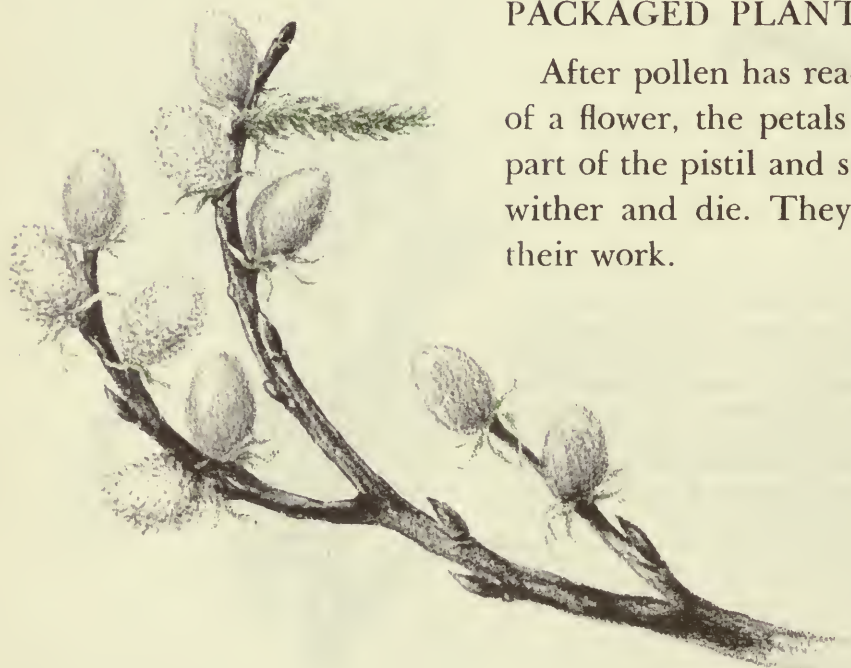


WHEN THE WIND BLOWS

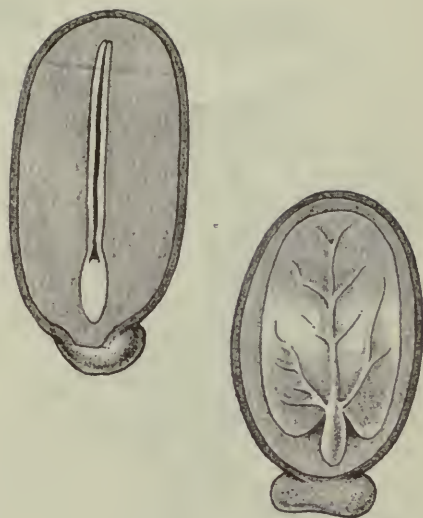
The flowers of grasses and many trees depend on the wind to spread their pollen. These blossoms are likely to be feathery or plumelike so that they spread nets to catch the pollen drifting through the air. Wind-pollinated flowers do not have odors or bright petals, as they do not need to attract insects. They are usually small and inconspicuous, like the flowers of grasses.

PACKAGED PLANTS

After pollen has reached the ovary of a flower, the petals and the outer part of the pistil and stamens usually wither and die. They have finished their work.



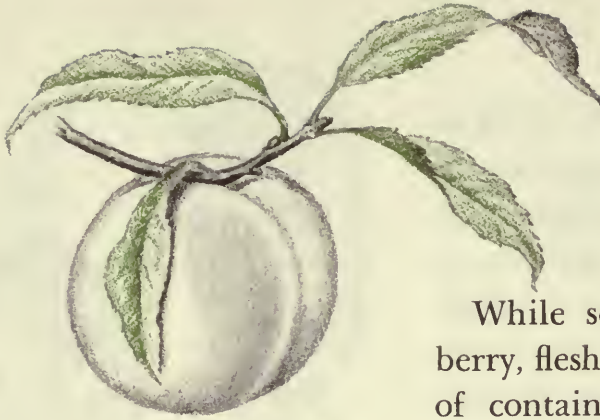
Now seeds start to form. This is what happens: Within the ovary of the flower, very, very tiny plants, with roots, stems and leaves, begin to develop. They are so small and young that they cannot yet shift for themselves. They will need food to keep them alive from the time they first start growing in the earth until their leaves are big enough to make sugars. So the parent plant helps them by making seeds.



A seed is really a handy package made up of a little plant with enough food packed around it to last it through its early days. This package is done up in a heavy outside wrapper—the seed coat. If you soak a dry lima bean overnight, then split it open, you can see the tiny plant and its food, inside the wrapper.

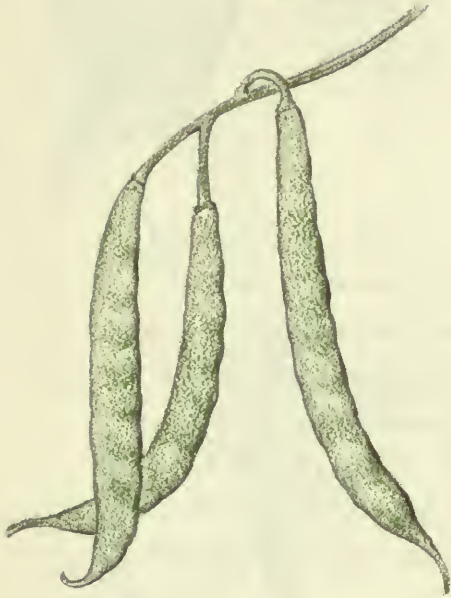
Seeds grow inside an ovary only until the little plants have reached a certain size and until their food supply is provided. Then the seeds stop growing and often go into a resting period before they are ready to sprout.





While seeds are forming, a pod, berry, fleshy fruit, or some other kind of container is developing around them. Very often this container has some shape that helps the seeds to travel away from their parent plant when they are ripe.

For seeds must have some way of setting out on their own. If they all dropped to the ground under their parent plants, there would be too many plants in one place for the amount of sunlight, water and soil there. The contest among the young plants for these things would be so great that most of the plants would die.

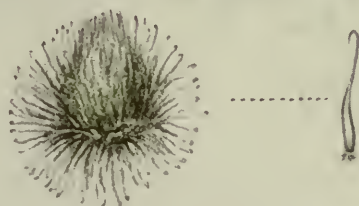


TRAVELERS

Seeds have many ways of traveling. Some drift with the wind. Two short wings help maple seeds. Instead of falling from the maple branches directly to the ground, the seeds spiral slowly on their wings through the air, and the slightest breeze carries them away to a new spot. Elms, ashes and pines also have winged seeds.

Dandelion seeds have silky parachutes, for drifting away. Milkweed, cottonwood and clematis seeds also sail through the air on tufts of down.

Other seeds are hitch-hikers. Beggar ticks and burdocks hook themselves firmly to passers-by—animals or people—and ride as far as they are allowed. Mistletoe seeds are sticky and cling to the claws of birds, to be wiped off some distance from their starting point.



SOME OF THE WAYS SEEDS TRAVEL

Linden, or basswood, trees have seeds with gliders to carry them through the air.

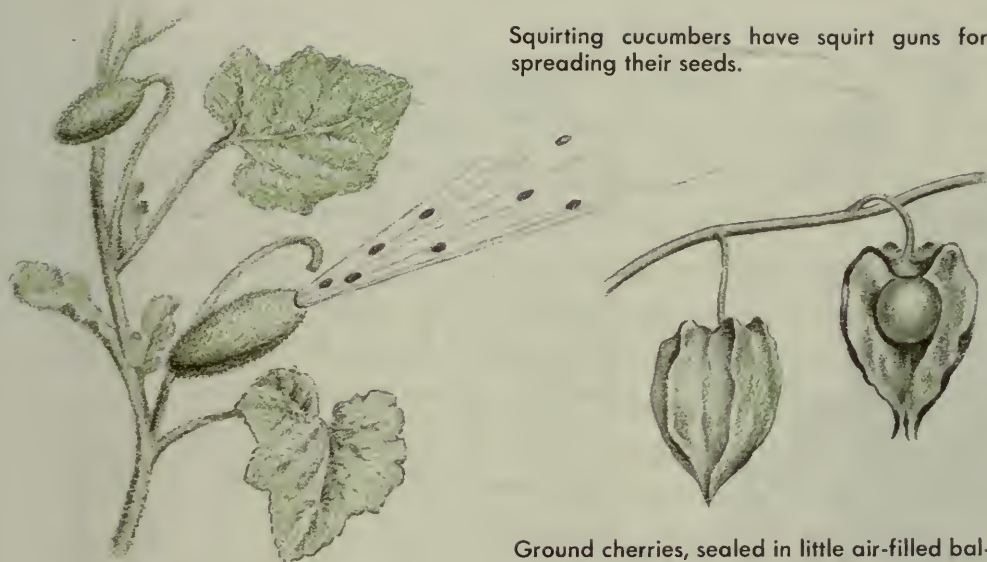


Jewel weeds, or touch-me-nots, have built-in slingshots. When the seeds are ripe, the capsules containing them explode, and snap! out shoot the seeds.

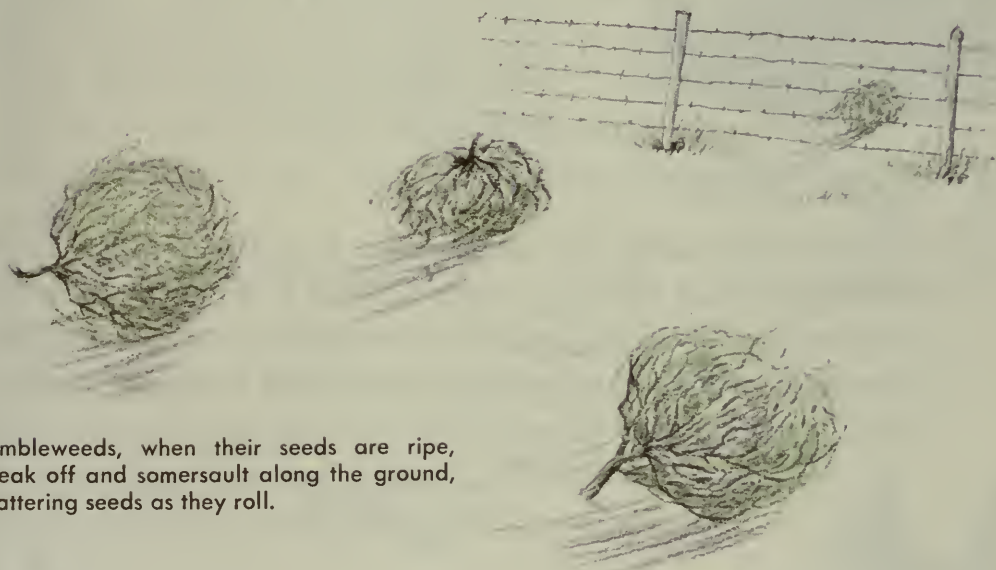


Coconuts, which often grow by the seashore, have thick, waterproof rinds and will float for long distances.

Squirting cucumbers have squirt guns for spreading their seeds.



Ground cherries, sealed in little air-filled balloons, are easily scattered by the wind.



Tumbleweeds, when their seeds are ripe, break off and somersault along the ground, scattering seeds as they roll.

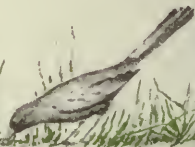


Animals are great seed spreaders. Squirrels, preparing for winter, hide great quantities of nuts—often more than they use. Some of these sprout and grow. Birds and animals eat berries and fruits. The seeds, unharmed by digestive juices, finally drop to the ground. Many of them grow.

Many seeds of wild plants never reach spots where conditions are right for growing. Or, if they do, they are crowded out by other plants or die for one reason or another. Wild plants, to be sure of new young plants each year, form and spread millions more seeds than will ever take root.

SPRINGTIME

Even before seeds go traveling, the tiny plants inside them have begun their resting periods. Several months may pass before they start growing again. Then they can start only if they have water, air, and the right temperature. In northern climates, this is usually in the spring.



Seeds are dry, tightly crammed packages until the moisture of the damp earth soaks through their heavy wrappings. Then the little plants and their food swell and burst the seed coats, which water has softened.

The little plants start growing and making special digestive juices. These juices change the food stored in the cells from dry starches, fats and proteins to dissolved form. Water carries this dissolved food to the important growing points of the young plants—the tip of the root and the tip of the stem. There the food is made into new living cells that build up the plant.

At the same time, oxygen from the air, taken in by the plant, helps let loose the energy of some of the food. This energy is used in the work of building cells. Young plants have tremendous force. Water added to a jar packed full of seeds makes them swell and sprout. Enough energy is let loose so that they can break a closed jar.

ROOTS DOWN, STEMS UP

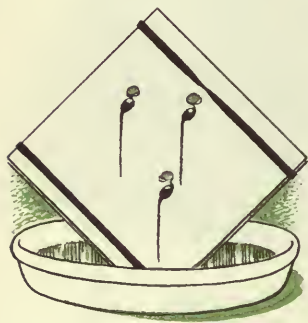
When the plant has water, air and its favorite temperature, its root starts reaching down into the earth and its stem starts growing upward. Young roots grow down and stems up, no matter in what position the seeds are planted. An experiment will show this:





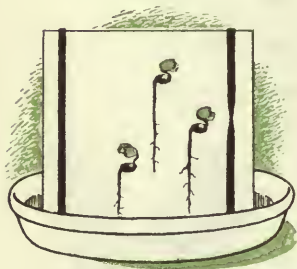
Put radish seeds between blotting paper and panes of glass, and place the glass in a shallow dish of water, as was described on page 15. When the roots start growing downward, give the glass a quarter turn, so that the roots and stems are reaching out sideways. Wait and watch—soon they will begin pointing up and down again. Each time they do this, turn the glass. Each time, the roots and stems will turn, too—to grow up and down.

YOUNG PLANTS



While plants are still pushing upward through the earth to reach the light, they are unable to make food. They depend entirely on the food stored in the seed. If they are planted too deeply and use up their food before they break through the ground, they die.

The plants' temporary seed leaves, which grew with them in their seeds, help in feeding them. Some plants, like common beans, have their seed food stored in their two fleshy temporary leaves. These grow with the plant up to the light. They even become green and do some food-making for a while. But as the food stored in them is used up, they shrivel. By this time, however, the bean



plant has grown other green leaves, and roots that spread out through the earth. It has become an independent plant, able to feed itself.

Other plants, like corn, have single temporary seed leaves that stay within the seeds, underground. There they act as the plants' supply line, sending food to the root and stem tips, until the plants grow green leaves, are fully rooted and are able to shift for themselves.

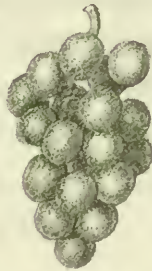
SEEDS ARE IMPORTANT

Each green, seed-producing plant's whole life, from the moment its first little root plunges into the ground, is aimed at making seeds and more seeds so that new young plants will keep growing each year.

We are fortunate that this is so, for seeds are very important to us. Not only do we use them in growing new crops each year, but wheat and rice seeds are the principal foods for hundreds of millions of people all over the world. Corn, rye, oats and beans are only a few of the many other seeds that we eat. Oil from cotton, coconut and peanut seeds is used in making food products and many other things. Linseed oil, from flax seeds, goes into the making of paints, varnishes, linoleum and oilcloth. Scientists are still discovering countless ways in which seeds help us.

PLANTS HAVE MANY KINDS OF FRUIT

Scientists say that fruits are containers with the enclosed seeds of plants. A bean pod is one kind of fruit.



Some seeds surrounded by a soft, fleshy wall are called berries. Tomatoes are berries, and so are grapes.



Cucumbers are berries with a hard rind.



A blackberry has many tiny fruitlets joined together to make a larger fruit.



A nut is a hard, one-seeded fruit.



Poppy fruits are dry capsules that split to sprinkle their seeds on the ground when the wind shakes them.



Apples, pears and quinces are fleshy fruits called pomes.



Oranges are berries with a leathery rind.

OTHER WAYS THAT NEW PLANTS GROW



The life plant has a scientific name that means "sprouting leaf." Along the edges of its leaves, young plants form. If the wind or a passing animal knocks them off onto good soil, they take root and grow.

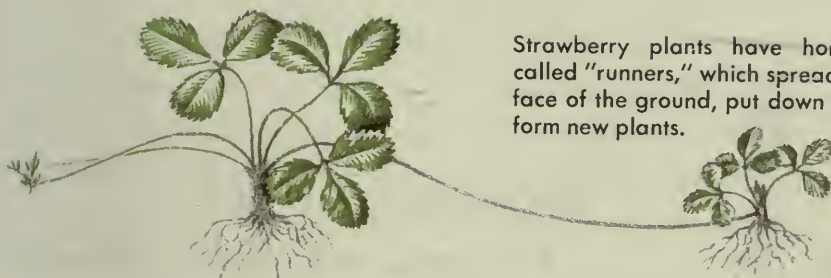
White potatoes are underground stems, called "tubers," used by the plants for storing food. Each "eye" is a bud. Bury potato tubers and the buds will sprout into new plants. Potatoes are almost always grown in this way.



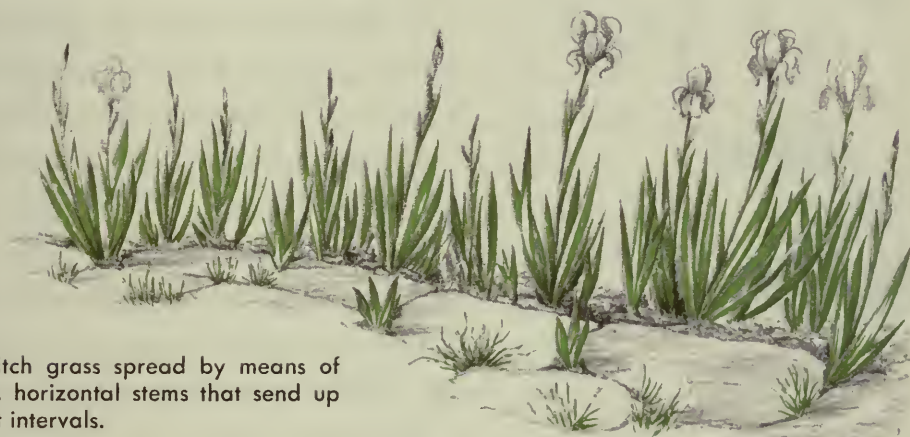
Many plants—lilies and onions among them—have underground "bulbs," which are really shortened stems, wrapped in fleshy leaf bases into which the plants pack stored food. Bulbs will grow into new plants, and may also produce many smaller bulbs.

Gladiolus and crocus plants have "corms," which are underground stems where plant food is stored. These grow into plants and also divide into new corms.

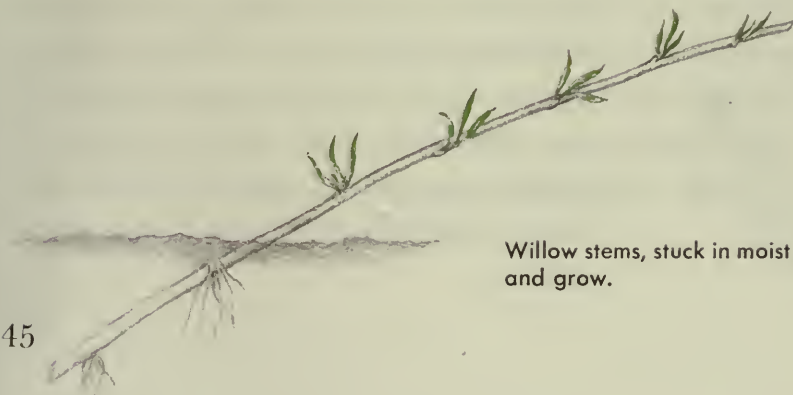




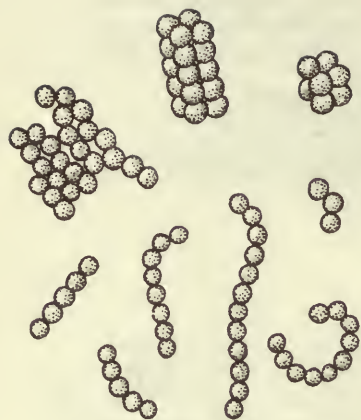
Strawberry plants have horizontal stems, called "runners," which spread along the surface of the ground, put down new roots, and form new plants.



Irises and witch grass spread by means of underground, horizontal stems that send up new shoots at intervals.



Willow stems, stuck in moist soil, will take root and grow.

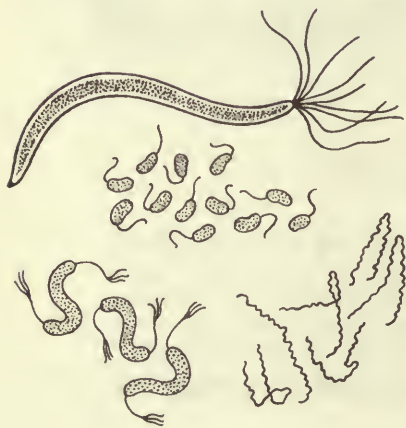


TOO SMALL TO SEE

The green, seed-growing plants of the world are very valuable, but they could not live at all without the help of some other strange plants so small they can be seen only with a microscope. These are the bacteria. One single plant is called a bacterium.

Bacteria are the world's smallest living things. Placed end to end, 250,000 of the tiniest ones—250 of the largest—would measure one inch.

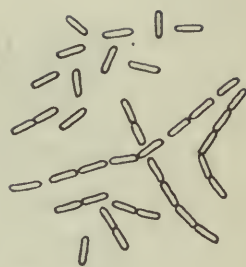
Each bacterium plant is made of only one single cell. Sometimes these cells live in colonies, strung along like beads, or growing in clusters. Sometimes each plant cell lives alone. There are several thousand species of bacteria, but only three shapes — spheres (round), rods (longish and thin), and spirals (twisted like corkscrews).



Bacteria are plants with a difference. They are colorless, with no green chlorophyll. Some that live in liquids can move around, using little hairs attached to them like propellers. When they lash these hairs back and forth, off they go, scooting around like tiny speedboats.

Bacteria have no seeds. They produce new plants in just about the simplest way there is. They merely split in two! Every so often, each tiny, single-celled plant gets thinner and thinner around the middle, until suddenly two new bacteria are growing in the place of one old one. When bacteria have plenty of food and space and a temperature they like, they split rapidly—about three times an hour. One scientist has figured that in two days one bacterium would have 281 billion relatives, even if each one split only once every hour — quite a family!

There are more trillions of bacteria in the world than anyone can imagine — and they are everywhere. They ride on little specks of dust far above the earth. They swarm underground. They live in hot springs and on snowdrifts. Everything you touch has bacteria on it unless it has been cleaned with a disinfectant that kills them.



THE HARMFUL BACTERIA

Most bacteria cannot make their own food because they do not have chlorophyll. They must get their food from other living or dead plants or from animals. Those that depend on *living* plants or animals are called parasites. Some of our worst illnesses — tuberculosis, typhoid fever, diphtheria, cholera, meningitis—are caused by bacteria parasites that find their way into our bodies and, in living there, cause infection and disease. Scientists are always working to discover new ways of fighting and controlling disease bacteria. Each of us can help keep them away by eating the foods that make us healthy and by being clean ourselves and living in clean surroundings. Good health and cleanliness are safeguards against disease bacteria.

MORE HELPFUL THAN HARMFUL

Although disease bacteria do great harm, by far the greater number of bacteria are not only helpful, but some are necessary to keep living things growing.

Some of the most important of all are those that live in the ground. When you pick up a handful of earth, it looks unexciting. Nothing seems to be happening in it. Actually, you are holding a living, rampaging little world in which millions of soil bacteria are busily working.

Some of them act as part of the earth's clean-up squad. In the earth are many dead roots, tree stumps and dead insects. On top of the ground are twigs, logs, and the remains of plants and animals no longer living. If these never decayed, they would pile up and up and the world would be one vast clutter.

Decay doesn't just happen. It is the work of little plants, some of them called decay bacteria, which get their food and energy from all these once-living things. No sooner are they dead than the little plants, which are scattered all around them, start working, using special juices to break down the complicated bark and leaf and flesh and bone into simpler forms. The little plants work them into simpler and simpler chemicals—until finally the dead plants and animals are back to the carbon dioxide and other substances from which they started long before as raw material for plant food.

Decay bacteria help keep the world tidied up. They also keep green plants supplied with fresh raw materials for food-making. Carbon dioxide in the air is absolutely necessary for making plant food. Yet there is very little of it in the atmosphere at any one time. If bacteria did not keep busy decaying dead plants and animals and freeing carbon dioxide so that it could be used again and again, all the carbon dioxide in the world would be used up in thirty or forty years.



NITRATE MAKERS

Besides carbon dioxide, green plants must use plenty of nitrogen, for changing some of their sugars to other kinds of foods. Air has the gas, nitrogen, in it, but most plants cannot get nitrogen through their leaves from the air. They must take it in through their roots in the chemical form of nitrates. Some soil bacteria help green plants by making nitrates.

Some of them can do this by using ammonia that is produced during the work of decaying dead plant and animal matter. Some can join nitrogen in the air of the soil with other chemicals and build up nitrogen substances.

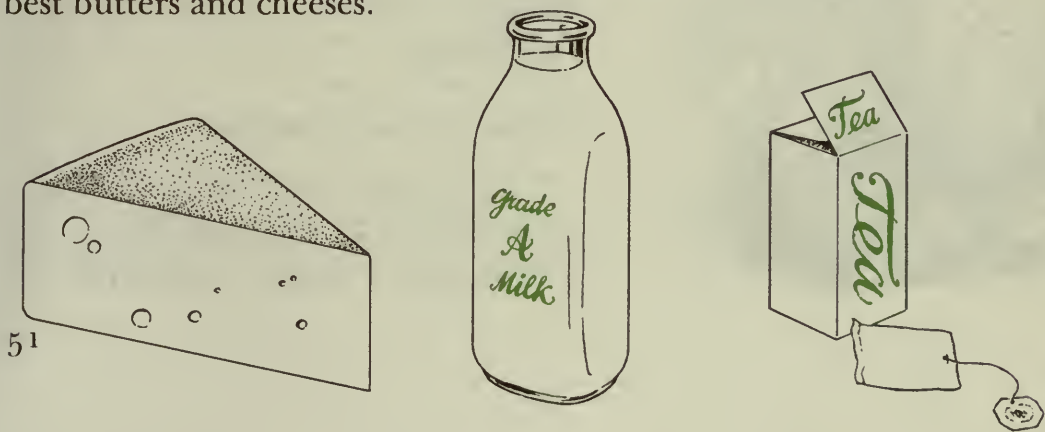
Other kinds of bacteria form partnerships with certain green plants, such as clover, peas or alfalfa. They enter the roots of these plants and make little colonies that produce lumps on the roots. The bacteria take their food from the green plants, but they get the nitrogen they need from the air in the soil. In turn, the green plants on which the bacteria live use this nitrogen. Even after the plants die or are har-

vested, their roots full of nitrogen products help enrich the soil. Farmers often plant clover or alfalfa and plow it under when the soil is poor. The nitrogen products collected by the root bacteria return to the soil and make it better for farming. Without bacteria to help furnish fresh supplies, the nitrates of the soil would soon be used up.

Soil and decay bacteria help keep the green plants going by continually putting back minerals into the soil and carbon dioxide into the air. Without the bacteria, everything in the world would die in time because there would no longer be fresh raw materials for food-making.

MORE HELPERS

Still other bacteria help people with their work. The action of these little plants makes it possible to tan leather, cure tobacco and tea, manufacture indigo blue dye, make vinegar from cider, and linen thread from flax. The working of bacteria on milk and cream makes the fine flavor of some of our best butters and cheeses.





LIVING ALMOST ANYWHERE

Molds, mildews, yeasts, mushrooms, and the shelflike growths that jut from tree trunks are all plants called fungi. Fungi, like bacteria, have no chlorophyll. They have much more variety than bacteria, but they are all alike in two ways. They have no stems, leaves, roots or flowers. And, having no chlorophyll, they cannot use sunlight to make food. They must take it ready made, from dead or living things.

Fungi can live almost anywhere except on metal, so long as they have moisture, a warm temperature, and not much sunlight. In hot, damp climates, molds and mildews grow on things as different as leather, food, and animals.



HOW FUNGI GROW

One single plant of the fungi is called a fungus. The food-getting part of a fungus is a white, threadlike net

that grows through the material on which the fungus is living. This material on which a fungus lives is called its "host." A fungus plant makes digestive substances that spread out into the host and change its material into simple foods. In taking in food, the fungus gradually destroys its host.

A fungus' food-getting often goes on inside the host. No one even guesses that fungi are there until they are ready to make new plants. Then they send growths above the surface of the host. On these growths are millions of tiny, dustlike cells, called spores. The faintest breeze sets these spores flying through the air in great, invisible clouds. If a spore lands in a favorable spot, it starts growing more cells, and becomes a new fungus plant. The mushrooms that grow aboveground are only the spore-making parts of great underground fungus networks. One mushroom can free millions of spores in one night.





A FUNGUS YOU KNOW

A fungus that everyone knows is mold. Take some cooked corn meal and leave it uncovered for an hour or so, so that floating spores will fall on it. Then keep it in a closed dish for several days at a warmish temperature, before uncovering it. Usually mold will grow. You can see its network spreading over and through the corn meal, taking in food. Soon stalks grow up, each ending in a little black sac of spores. Soon these drift off through the air, to grow into more mold if they land in a good spot.

THE GREEN PLANTS' ENEMIES

Fungi grow so easily, it's a pity that many of them are the villains of the plant world. Many fungi are parasites, stealing their food from other living plants. They are among the worst

enemies that the green plants have.

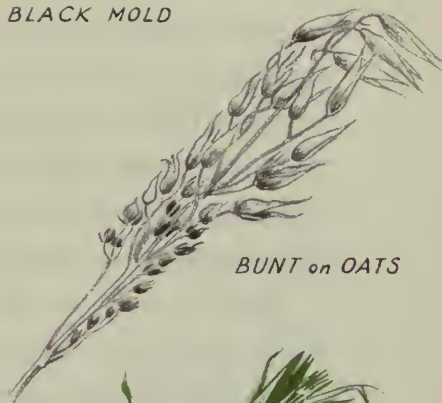
For every three kinds of green plant, there is at least one fungus parasite. Molds, mildews, rusts, blights, rots and smuts send their fungus nets into living plants. They rob them of their food and gradually disease or kill them. Later, spores appear, and the wind carries them in great clouds to other areas, where they grow and harm more plants.

Many fungi are specialists. They live on one kind of plant and usually leave other kinds alone. Some of our most dangerous fungi are those that ruin wheat, rye and other grain and food crops.

Scientists are always searching for ways to fight the green plants' fungus enemies. They are working on new sprays and are growing varieties of plants strong enough to resist the fungus killers. Although much has been done, the battle against the harmful fungi never ends.



BLACK MOLD



BUNT on OATS



SMUT on CORN

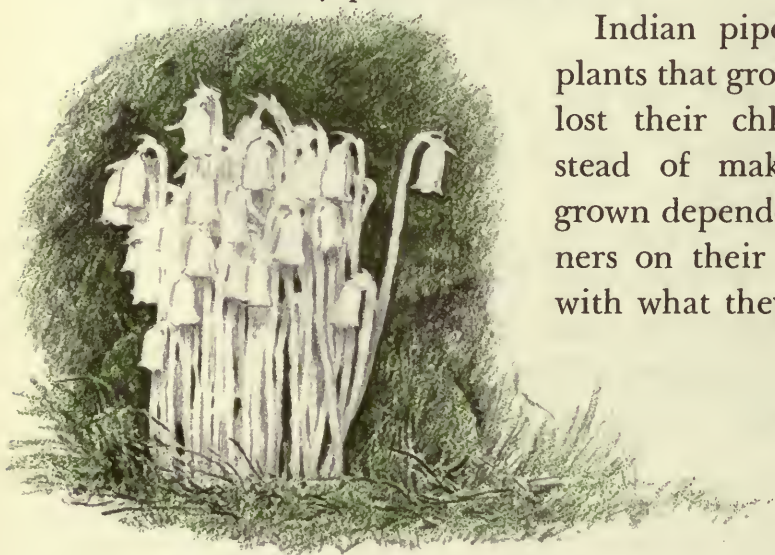
SOME THAT ARE PARTNERS

Not all fungi are harmful, however. Some of them, while getting their foods, help the bacteria in decaying dead plants and animals. Fungi break up more plant remains than bacteria do, while bacteria break up more animal remains.

Some fungi are partners of green plants. Many forest trees, especially pines, have roots closely covered with fungus networks. These threadlike nets do some of the work usually done by roots. They take in minerals and water for the trees. Plant scientists are finding that these fungus partners are very important in helping some trees to grow.

Many kinds of orchid seeds will not even sprout unless their particular kind of fungus partner is in the soil where they are planted. Often florists add this fungus to the soil when they plant orchid seeds.

Indian pipes, the pale, ghostlike plants that grow in many forests, have lost their chlorophyll entirely. Instead of making food, they have grown dependent on the fungus partners on their roots to furnish them with what they need.



FUNGI AND FOOD

Offhand, we would not think of yeast cakes as plants—yet they are tiny, one-celled fungi packed together with food to keep them alive. Yeast plants change sugar into alcohol and carbon dioxide. When a yeast cake starts working on the sugar in bread dough, the gas, carbon dioxide, puffs bubbles in the dough. We say the dough has risen. Baking drives off the alcohol in it and turns the dough into light, tasty bread.

Cheesemakers in Europe, long ago, discovered that some kinds of fungus molds added to cheese make delicious flavors. Roquefort, Camembert and Brie cheeses are made in this way.

WONDER DRUGS

One of the most thrilling discoveries in modern medicine was made when Alexander Fleming, working in his laboratory, noticed that a fungus mold was growing in a plate of harmful disease bacteria—and was killing the bacteria!

Scientists found that this mold, when grown in a broth—or liquid food—made a substance, penicillin, that killed many disease bacteria. It is one of our wonder drugs, a treatment for pneumonia and some other illnesses caused by bacteria.

Another wonder drug, streptomycin, is made from a mold that grows in the soil. Other medicines from fungi are being discovered. These drugs from fungi are called “antibiotics.”

THE SIMPLEST GREEN PLANTS

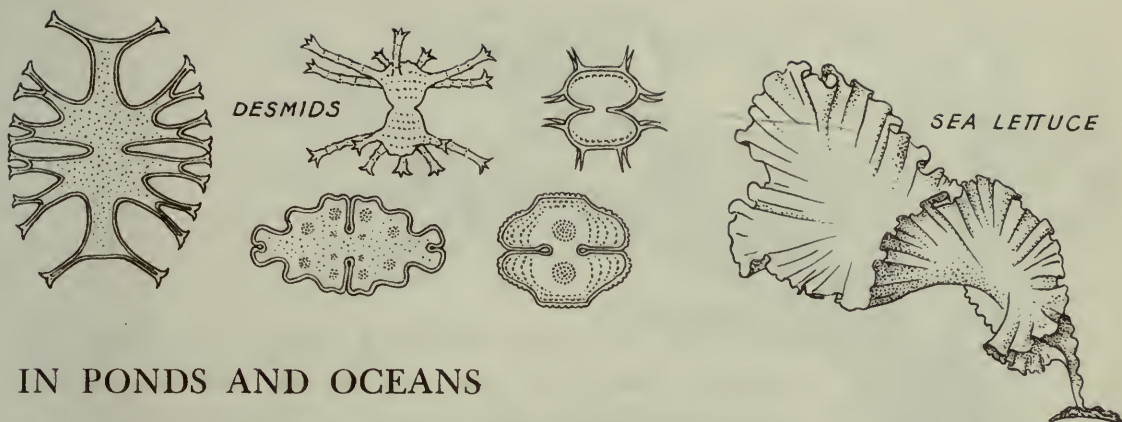
Everyone has seen the plants called algae (pronounced al'-jee) . They are the green scum on the sides of an aquarium, the thin, green coatings on damp tree trunks, and the many kinds of seaweeds. Some red algae even live on arctic snows.

Algae have chlorophyll, though some are not green in color. They use sunlight in food-making. Some are only as large as a single cell. Other algae are giant seaweeds.

None of these algae have roots, stems or leaves. Roots, stems and leaves are useful for green plants that must take carbon dioxide from the air and water from the soil. But algae live either in water or in very damp places, surrounded by raw materials for food-making. They are single cells or thin sheets of cells, each one of which has chlorophyll. Each cell can take in raw materials through its walls and make its own food. It has no use for roots or leaves.

Algae don't have flowers or seeds, either. Some tiny algae make new plants as the bacteria do—by splitting. Others make the tiny cells called spores, which grow into new algae. Many spores that grow in water can swim, with the help of little lashing hairs. These spores go scuttling around until they wear themselves out. Then they settle in choice spots and grow into new plants. Other algae have eggs that join with male cells and form new plants.





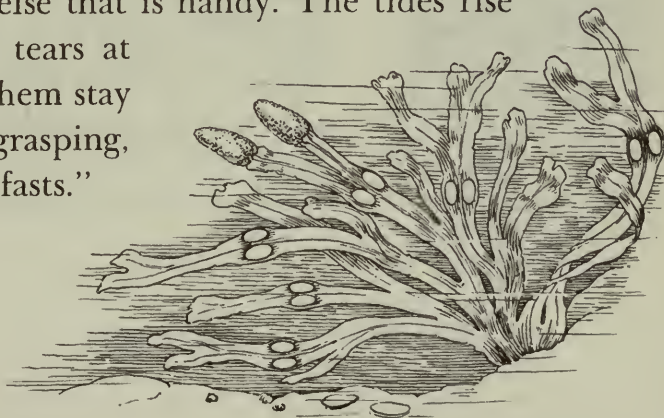
IN PONDS AND OCEANS

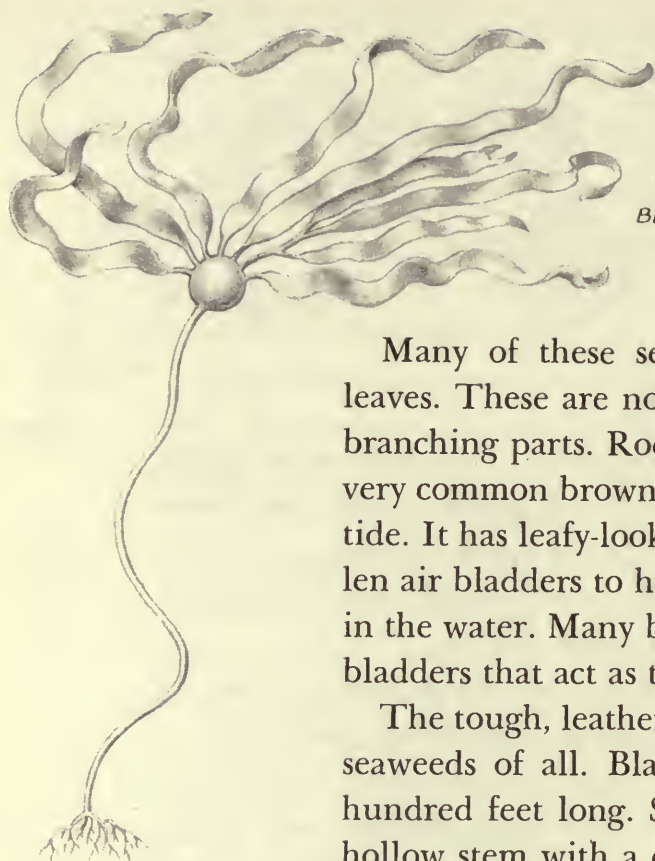
Algae grow in a surprising number of shapes. The one-celled desmids, which grow in swamps and ponds, can be seen only with a microscope. But scientists who study them say they are beautiful. Some look like very small snowflakes. Others are scalloped, or have half-moon or star shapes.

Many algae live in fresh water, growing as scums on top of lakes and ponds or as green garlands streaming underwater.

To most people, however, the seaweeds are more interesting. Seaweeds all have chlorophyll and some of them are bright green. Sea lettuce is one of the green algae that is often cast up on beaches by the tides.

Some seaweeds have brown coloring material besides their chlorophyll. Many of these live along the seashore, clinging to rocks, wharves, or anything else that is handy. The tides rise and fall, and surf tugs and tears at these seaweeds, but most of them stay firmly in place, anchored by grasping, rootlike growths called "holdfasts."





BLADDER KELP

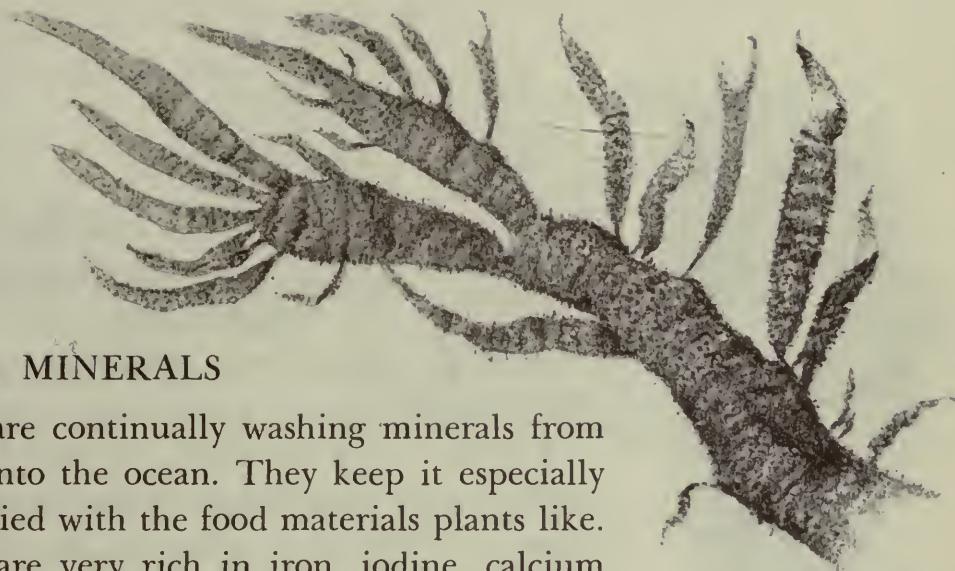
Many of these seaweeds look as if they had leaves. These are not true leaves, but are merely branching parts. Rockweed, or bladderwrack, is a very common brown seaweed seen on rocks at low tide. It has leafy-looking branches, and little swollen air bladders to help keep it afloat and upright in the water. Many brown seaweeds have these air bladders that act as tiny waterwings.

The tough, leathery kelps are the biggest brown seaweeds of all. Bladder kelp is often over one hundred feet long. Sea palm, a small kelp, has a hollow stem with a cluster of leaflike branches at its top. Kelps form great sea forests, especially on the underwater reefs off our Pacific coast.

Farther out, in the quiet, deeper water, the delicate red algae grow. They not only have chlorophyll, but other coloring matter which makes them lovely shades of red, pink and violet. *Dasya* is a silky red seaweed, while red *gigartina* has a flattened shape.



SEA PALM



GIGARTINA

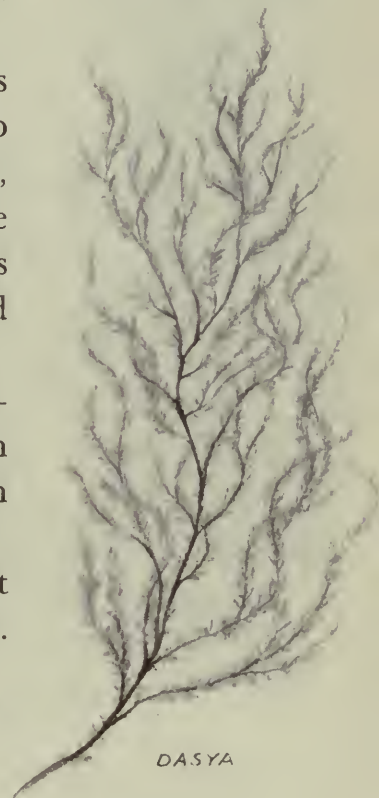
RICH IN MINERALS

Rivers are continually washing minerals from the land into the ocean. They keep it especially well supplied with the food materials plants like. Seaweeds are very rich in iron, iodine, calcium and other substances which they take from the sea water. They are crammed full of vitamins.

The Japanese gather kelps to use as vegetables in soups and with fish. They make them into flour, relishes, and even sweet cakes. In Ireland, Wales, Scotland, Iceland, Hawaii and Japan, some of the red algae are eaten as vegetables. In this country, fishermen gather Irish moss, a seaweed rich in gelatin, for use in various ways.

Besides being used as food, seaweeds are harvested for the minerals they contain. Potassium and iodine are taken from them. Some of them are made into fertilizers.

Many of the tiniest algae are among the most valuable. They are food for fish and sea animals.



DASYA



CRUST LICHEN



ROCK TRIPE

A PLANT PARTNERSHIP

The next time you take a walk in the country, look for flat, gray-green crusts clinging tightly to rocks. They are lichens (pronounced li'-kens), some of the world's most interesting plants—and the only ones that can grow on bare rock.

A lichen is not one plant, but two. It is a partnership of algae and fungi, which, joined together, make a third kind of plant not like either of its two members. These algae and fungi partners have a fine arrangement. They divide their work, and each has something to give the other.

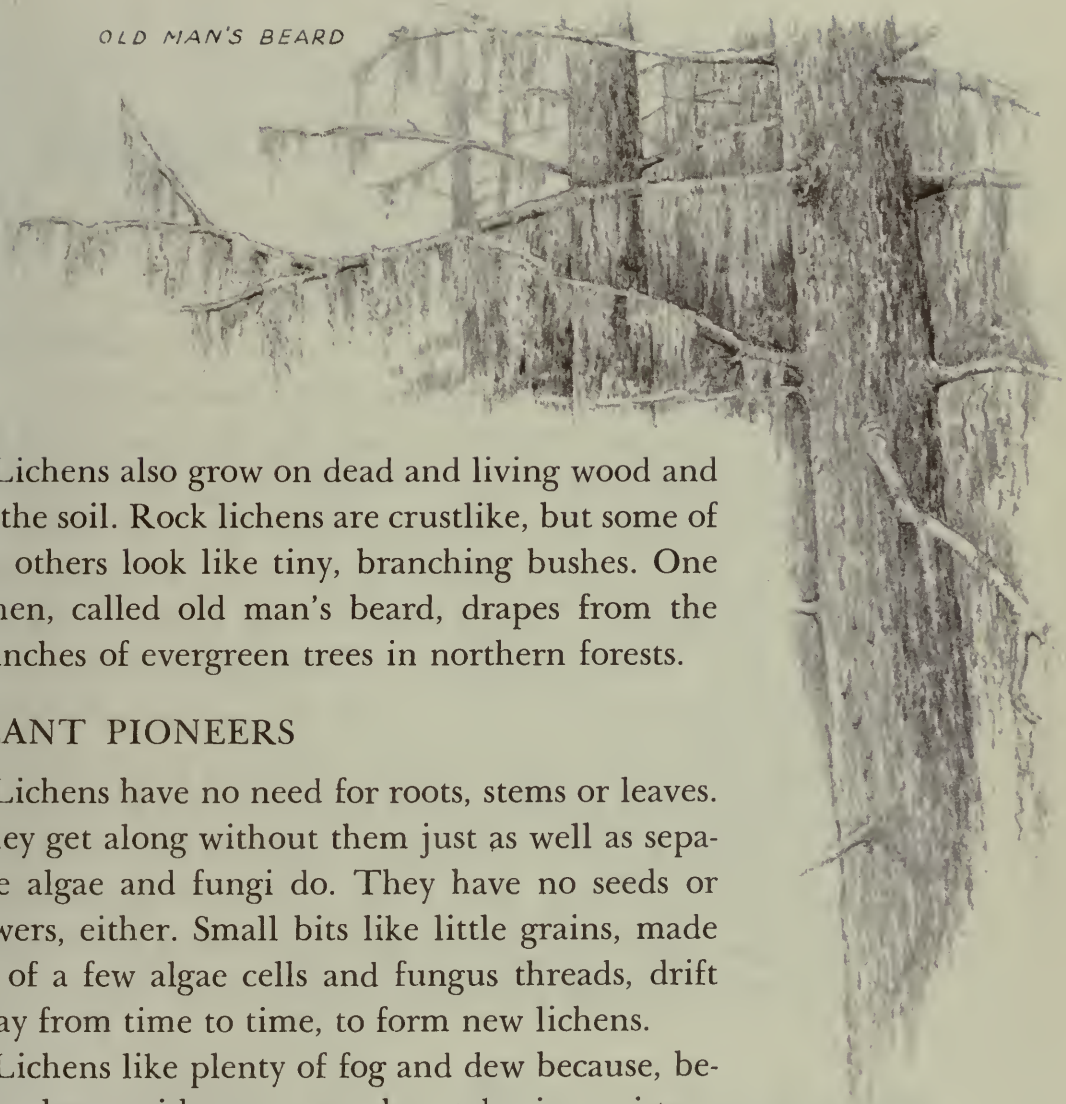
This is how a rock lichen is made: The fungus part forms its usual threadlike network. By making a weak acid, its threads can break down hard rock, and anchor there. The top of the rock lichen is crusty, and made of fungus threads, also. In between, all through the fungus network, grow little one-celled algae. They take in carbon dioxide and moisture from the air. With their chlorophyll, they can manufacture food enough for themselves and for their fungus partner. The fungus stores water and helps keep the algae from drying out. It anchors the lichen to the rock, too.

Lichens also grow on dead and living wood and on the soil. Rock lichens are crustlike, but some of the others look like tiny, branching bushes. One lichen, called old man's beard, drapes from the branches of evergreen trees in northern forests.

PLANT PIONEERS

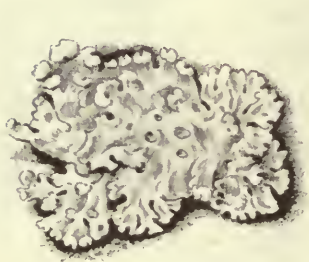
Lichens have no need for roots, stems or leaves. They get along without them just as well as separate algae and fungi do. They have no seeds or flowers, either. Small bits like little grains, made up of a few algae cells and fungus threads, drift away from time to time, to form new lichens.

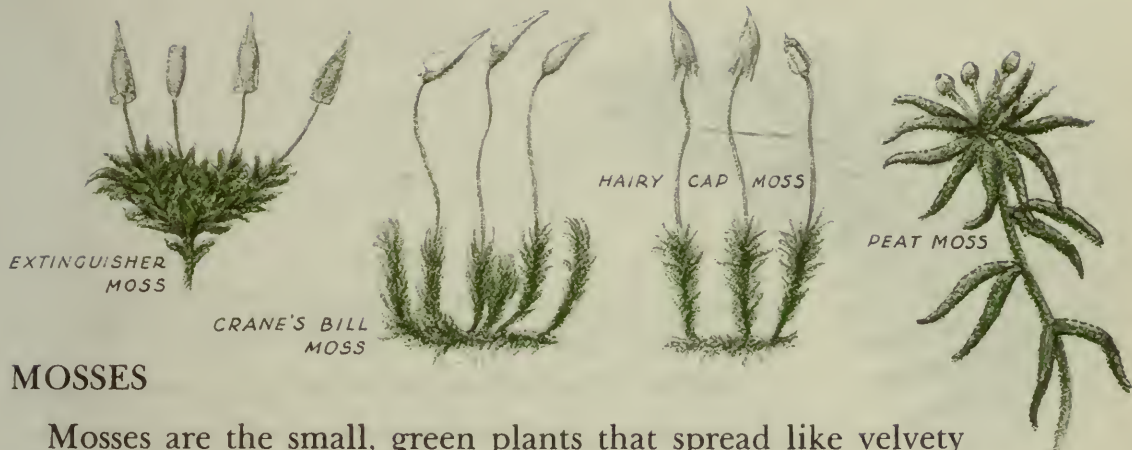
Lichens like plenty of fog and dew because, being plants without roots, they take in moisture from the air. They like fresh air, too. They cannot grow in the dust and smoke of cities.



They are tough plants that can endure great cold and long periods of dryness, if they have to. Without water, they become brittle. But when moisture comes, they take it in, perk up, become greener and more spongy, and start growing again. They can live on frigid mountain tops and in arctic regions where almost no other plant will survive. Reindeer moss—not a moss, really, but a lichen—is a very valuable food for caribou, reindeer, lemmings, muskox and other cold-climate animals.

Lichens are important because they are the pioneers of the plant world. Only they can grow in bare, rocky places without soil or other plants. They move into these spots, attach themselves to rocks, and slowly break them down with their acids. After a long, long time, the little, broken-up pieces of rock and tiny bits of dead lichens form a very thin layer of soil. Then grasses or mosses move in. They grow and, as their dead parts break up, more soil is formed. Gradually, over many years, larger plants arrive. At last, after hundreds and hundreds of years, a forest may grow where once there was only bare rock. It never could have been there if lichens had not pioneered the way by making the first thin layer of soil. Many fertile farmlands may owe their beginnings to modest little lichens.





MOSESSES

Mosses are the small, green plants that spread like velvety carpets over damp, shady places. They never grow more than a few inches tall because they don't have real roots. Instead, they have flat networks that spread over the surface of the ground and soak up water. Mosses don't have real leaves, either—merely little green leaflike branches. They are able to make food enough to support only small plants.

Mosses don't have flowers or seeds, but have a very complicated system of making dustlike spores, which drift away and form new plants. The cases that hold these spores grow on little stalks. They give mosses their unusual appearance and many of their names. Crane's-bill moss has spore cases that look like small, inquisitive cranes' heads, poking into the air. Extinguisher moss has a capped spore case that looks like an old-fashioned candle extinguisher.

Because mosses are small, people don't always notice what great variety they have. By looking, you can find many mosses, each with its own special appearance.

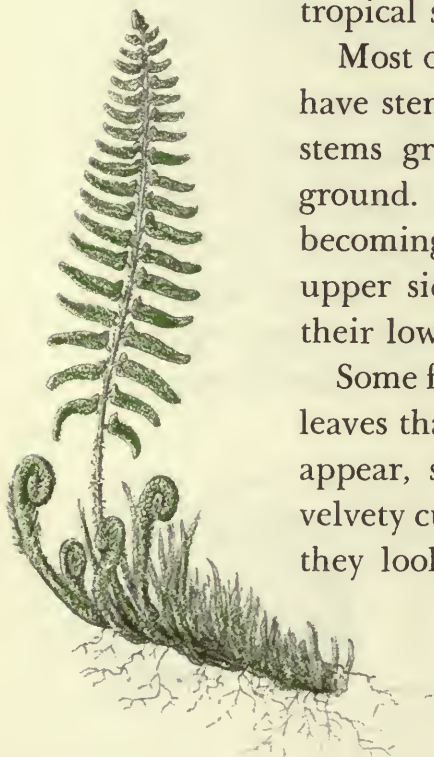


MORE PLANTS FOR SHADY PLACES

Ferns, like mosses, almost always grow in shady places with plenty of moisture. But ferns have true roots spreading down into the soil, stems fitted for carrying plentiful water and minerals from the earth, and real leaves, for making food. They are able to grow much bigger than mosses. In some tropical spots, tree ferns are forty feet high.

Most of the common ferns in this country don't have stems that tower in the air, however. Their stems grow flat, just below the surface of the ground. These stems live on from year to year, becoming a little longer each season. From their upper sides, leaves shoot into the air, and from their lower sides, roots plunge downward.

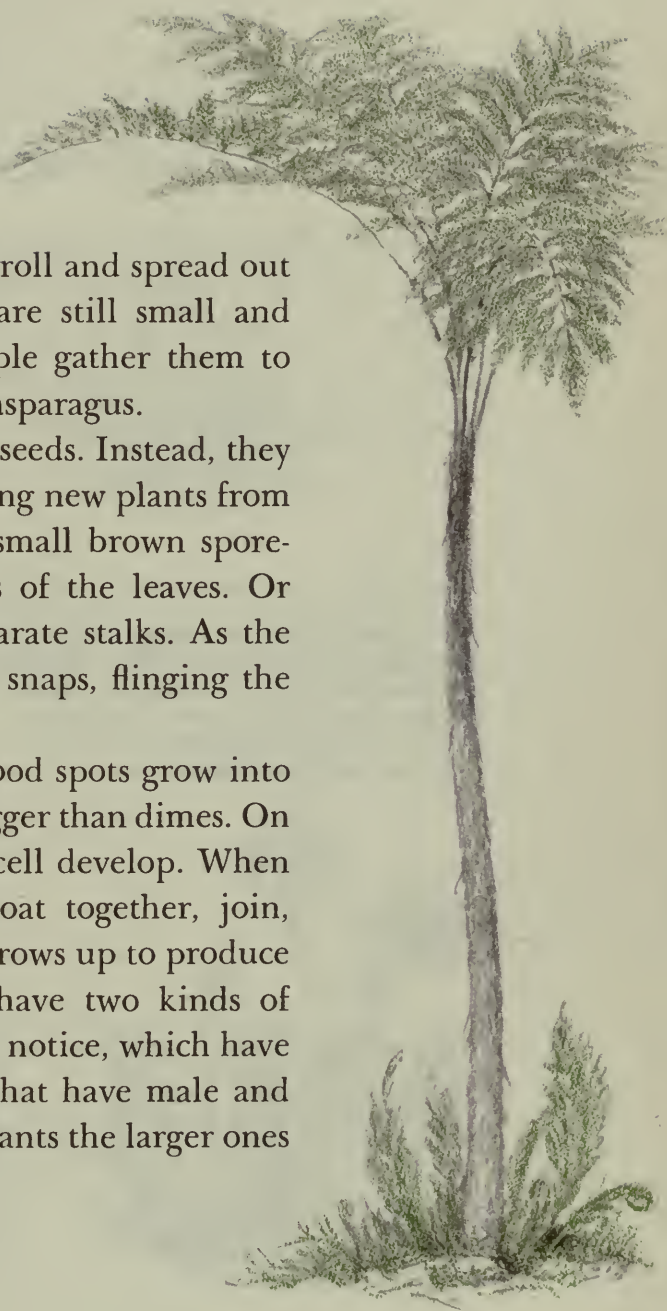
Some ferns are evergreen, but most of them have leaves that die each fall. In the spring, new leaves appear, starting up from underground in tight, velvety curls. These are called fiddleheads because they look like the scroll at the end of a fiddle.



Gradually these fiddleheads unroll and spread out into fern leaves. While they are still small and curled up, many country people gather them to cook and eat as they would asparagus.

Ferns do not have flowers or seeds. Instead, they have a very special way of making new plants from spores. These spores grow in small brown spore-cases, often on the undersides of the leaves. Or sometimes they cluster on separate stalks. As the spores ripen, part of each case snaps, flinging the spores out into the air.

Those spores that land in good spots grow into little heart-shaped plants no bigger than dimes. On each plant an egg and a male cell develop. When water wets the plant, these float together, join, and make a new plant, which grows up to produce more spores. So ferns really have two kinds of plants—the showy ones that we notice, which have spores, and the tiny flat ones that have male and female cells. From these tiny plants the larger ones grow.



CARNIVOROUS PLANTS

A few plants, called carnivorous — “flesh-eating” — plants, while able to manufacture food, have traps for capturing insects, also. More than that, they actually have digestive juices that act on the soft parts of the insects so that the plants absorb them into their systems as food.

The showy, pitcher-like leaves of pitcher plants contain pools of liquid. Their color and sometimes their smell attract insects, who toboggan along slippery hairs pointing downward into the pools. They drown and are absorbed by the plants' digestive juices.



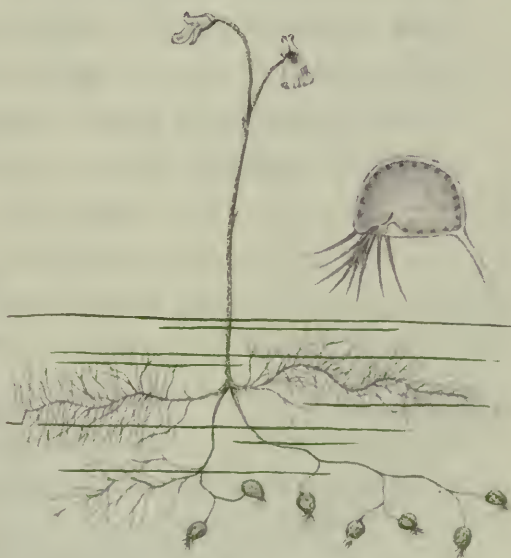
The end of each leaf of a Venus fly trap has hinged halves that can snap shut like a book. Each leaf half has trigger hairs. Insects, landing on them, spring the trigger, and the leaf snaps shut, trapping the insect. Interlocking teeth on the edges keep the leaf halves shut while juices digest the insect.

Sundews' round leaves are covered with hairy glands that make a gluey liquid. Insects, alighting, are stuck fast. Surrounding hairs, bending over, hold the insect down. Acid juices then digest it.



Butterwort's slender leaves are slightly hollowed like a trough, and covered with hair-like, sticky glands. Insects, alighting, are caught as if by flypaper. The plant then uses its digestive juices.

Bladderwort, a water plant, has underwater bladders, each with a small opening at its bottom, surrounded by bristles. Tiny insects, escaping from enemies, swim along the bristles. A trap door lets them into the bladder, but they cannot escape—the door does not open from the inside. Digestive cells then absorb them.





PLANT COMMUNITIES

The plants of the earth are divided into big groups: the green, seed-making plants, the bacteria, fungi, algae, lichens, mosses and ferns. Many of the algae live in water, but no group grows in a closed-off neighborhood by itself. The plant groups live all jumbled together. Walking through a northern forest, you might see evergreen trees and birches—green, seed-making plants—ferns, mosses, lichens, fungi and algae, all growing in a few square rods of woodland. Bacteria would be there, too, although you could not see them.

In the southwest desert region, a different group of plants would be growing. There might be cactuses, mesquites, desert ironwoods and palo verde trees.

A small pond and its shores might have pond lilies, cattails, sedges, irises, ferns, mosses, and some algae and fungi.

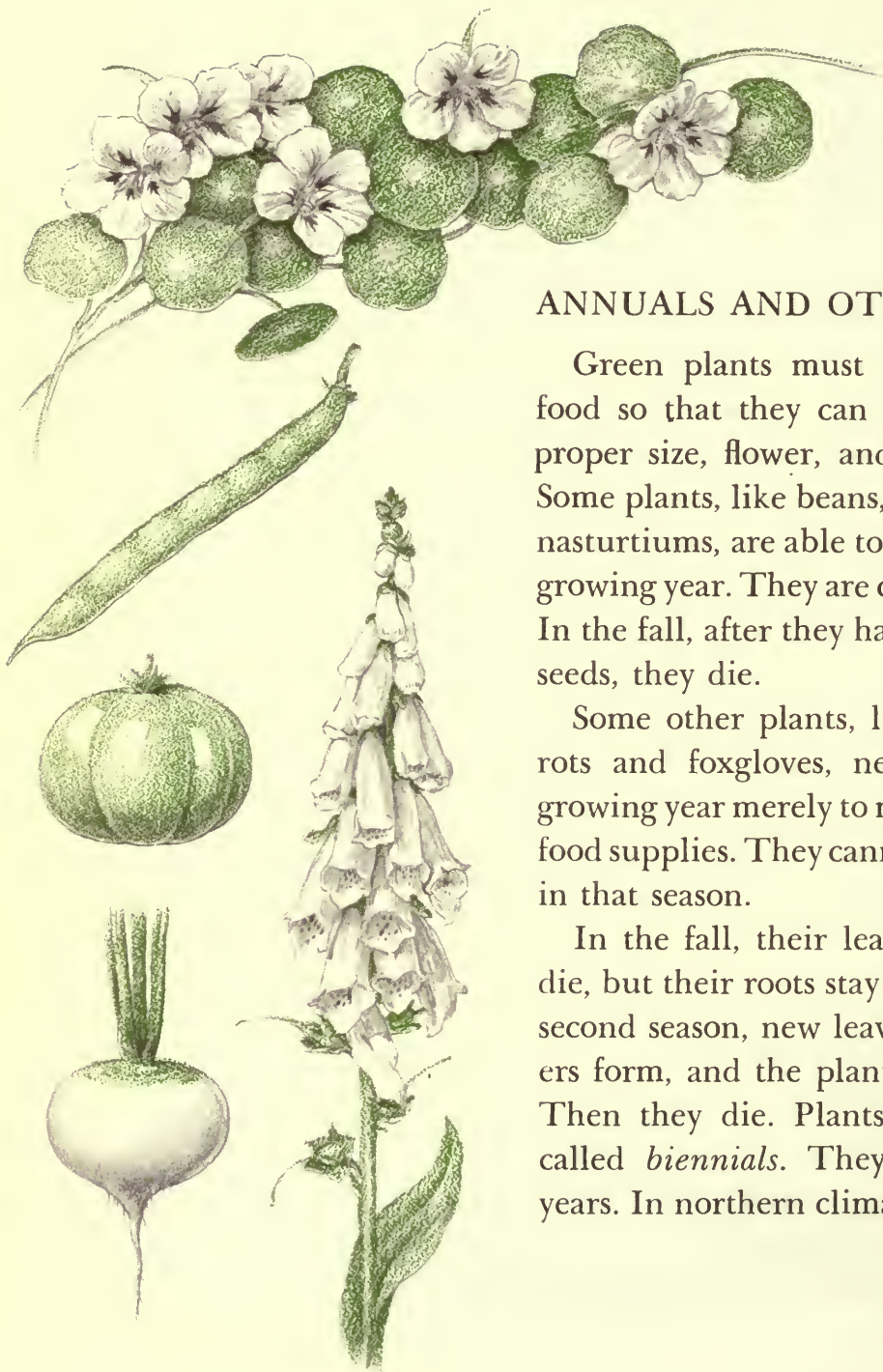
Wild plants live where the growing conditions suit them best. These important things must be right, for plants to stay alive: temperature, moisture, soil and light. Not all plants like the same things. Some do best in sandy soil, some in swampy

ground, and some in good garden earth. Some need a great deal of water, others do well with very little. But many plants from different groups like almost the same growing conditions.

These plants with the same needs live together in what are called "plant communities." There are desert communities, swamp communities, prairie communities, and plant communities for each section of the country. The next time you visit far from home, compare the wild plants you see there with those in your own neighborhood. You may see many strangers.

Plants have many ways of keeping alive in their special surroundings. In climates with cold winters, many trees, called "deciduous" trees, lose their leaves in the fall and grow new ones each spring. In this way they save moisture during the frozen, cold-weather months when water is hard to get. In deserts, cactuses have no leaves at all. Their stems are green and make food for them. These stems are coated with a thick wax that prevents them from giving off too much moisture into the hot desert air. Often a cactus plant's stem stores water like a reservoir.





ANNUALS AND OTHERS

Green plants must make enough food so that they can grow to their proper size, flower, and make seeds. Some plants, like beans, tomatoes and nasturtiums, are able to do this in one growing year. They are called *annuals*. In the fall, after they have made their seeds, they die.

Some other plants, like beets, carrots and foxgloves, need their first growing year merely to make and store food supplies. They cannot make seeds in that season.

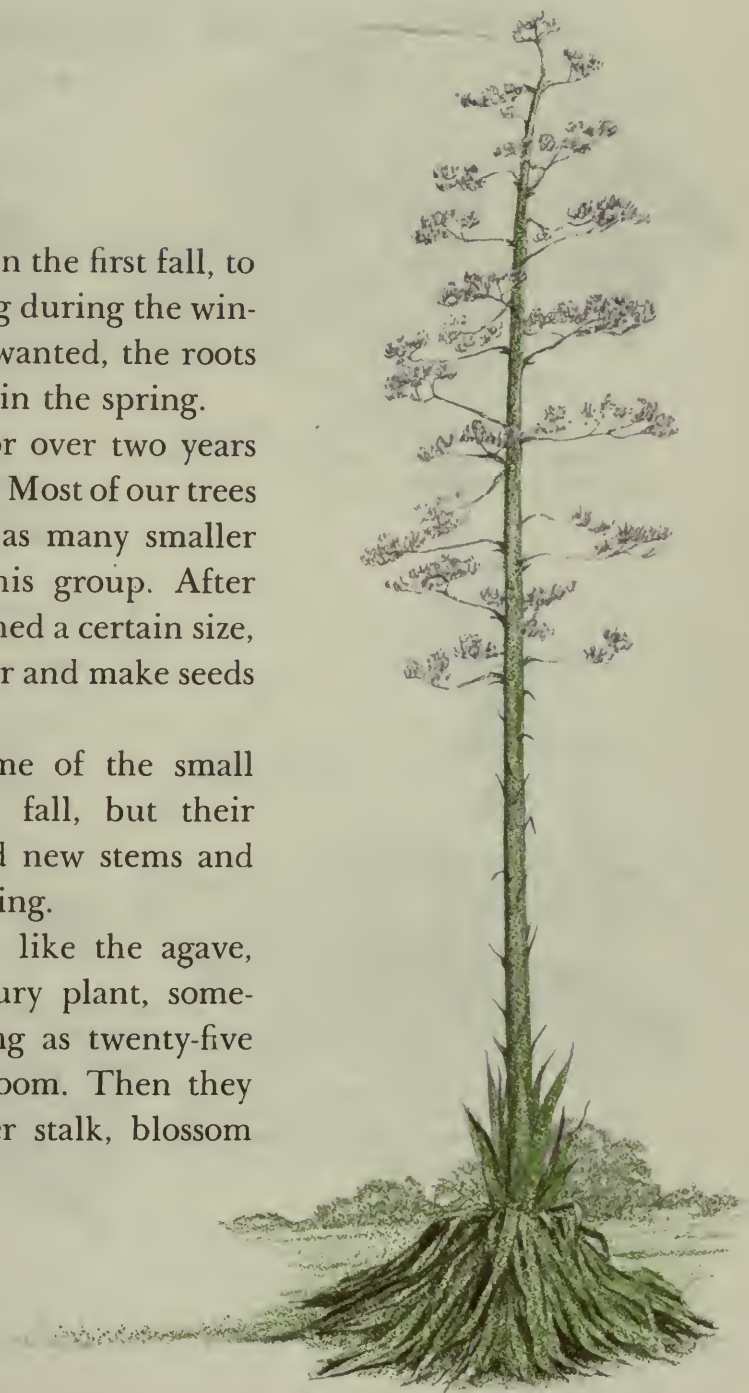
In the fall, their leaves and stems die, but their roots stay alive. In their second season, new leaves grow, flowers form, and the plants make seeds. Then they die. Plants like this are called *biennials*. They live for two years. In northern climates, beets and

carrots must be dug in the first fall, to prevent their freezing during the winter, but if seeds are wanted, the roots can be set out again in the spring.

Plants that live for over two years are called *perennials*. Most of our trees and shrubs, as well as many smaller plants, belong in this group. After perennials have reached a certain size, they are able to flower and make seeds year after year.

The stems of some of the small perennials die each fall, but their roots keep alive, and new stems and leaves grow each spring.

A few perennials, like the agave, also called the century plant, sometimes live for as long as twenty-five years before they bloom. Then they send up a tall flower stalk, blossom just once, and die.



TREES ARE AMONG OUR LARGEST PLANTS



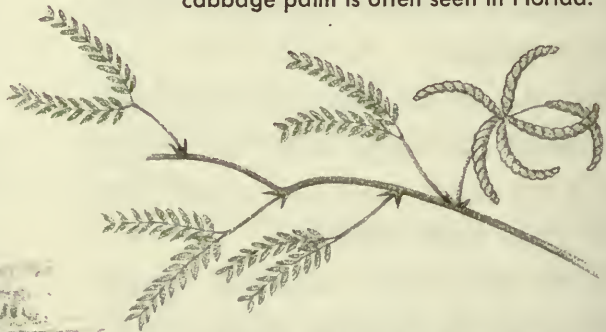
Horse chestnut trees have showy white spikes of flowers in the spring, and, in the fall, burs containing glossy brown seeds.



Palm trees have unbranched trunks, each topped by a cluster of large leaves. The wild cabbage palm is often seen in Florida.



The lodgepole pine is a tall tree of our Western mountains. The Indians used it in building their lodges and tepees.

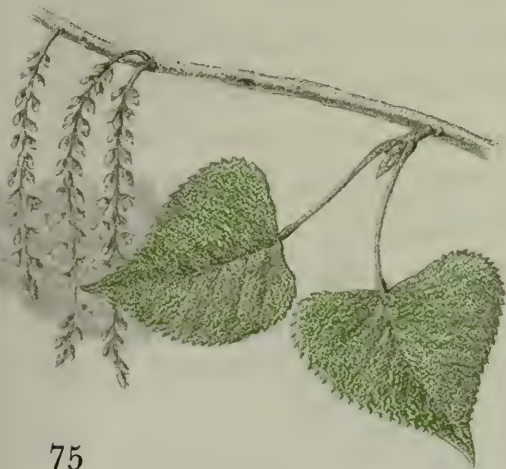


Mesquites are small trees that grow in the Southwestern deserts. Animals like their seed pods for fodder.

The canoe or paper birch is one of our loveliest trees, with its gleaming white bark, which the Indians used for making canoes.



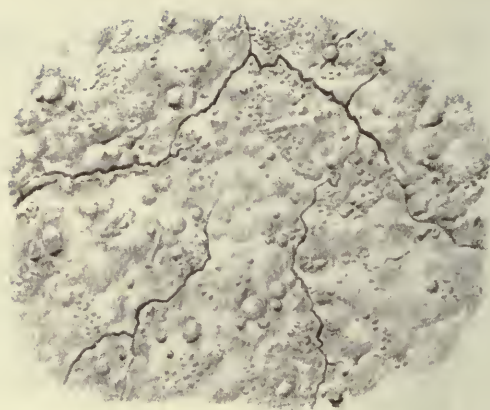
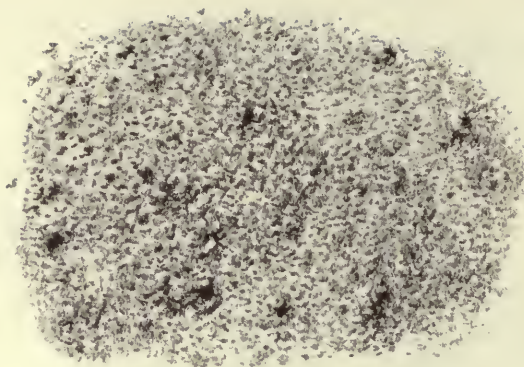
Cottonwoods are named for the cottony fuzz attached to their seeds. They are common trees along the streambeds of the Great Plains.



In New England especially, the graceful elm is a favorite tree.



Live oak is a beautiful, spreading evergreen tree of the Southern states.



BETTER SOIL

Because plants are as valuable as anything in the world, scientists are always experimenting to learn more about them. One whole group of scientists studies the soil alone.

Soil is very important to plants. Many of them grow rooted in it and take minerals and water from it. Others—bacteria and fungi—live buried in it. Even seaweeds use minerals washed from the soil by rivers. If the soil does not give plants what they need, they cannot grow well, and may even die.

The best soils are those with plenty of decaying material in them. About twenty million bacteria and one million fungi may grow in an ounce of good top soil. At the same time that they are decaying the dead plant and animal material in the earth, they are keeping it in good condition.

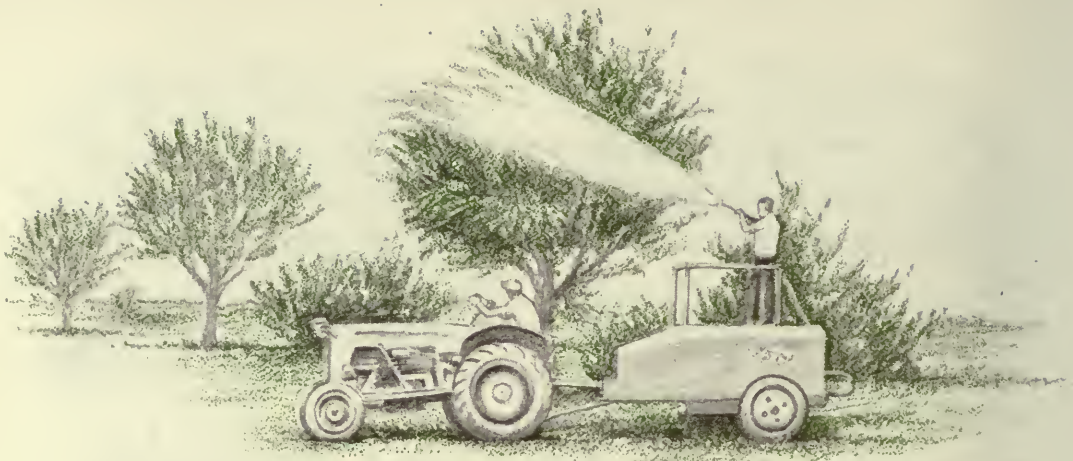
As things decay in the earth, there is a stage when they form gums. These gums glue together the soil's fine grains of clay so that they form larger lumps of earth. Good soil has lumps

that vary from the size of a pinhead to that of a pea. Soil formed in these lumps has plenty of air spaces. It does not make a hard crust on top and can take in plenty of water, which all plants need.

Soils in some places have so much clay and so little decaying material that they pack solid, with very few air spaces. They become crusted on top and dry out quickly. Plants do not grow well in them. A great deal of dead material would have to be added before gums could be formed in these soils. Even then, it might be years before the bacteria and fungi could do all the necessary work of decay.

Scientists have invented a new chemical powder that can do this same work very quickly—in one season. Sprinkled on the ground, then spaded in, this powder forms gums. They make the soil into just the right kinds of larger lumps. Out of a heavy, crusty soil, a good, well-aired, moist one can be made. Some cornfields where this powder has been used produce five times as much corn as they ever did before.





PLANTS AND CHEMISTRY

Some chemists are experimenting with all kinds of new sprays to kill insects, worms, plant diseases, weeds, and even rodents that burrow in the gardens. Other chemists are working on liquid plant foods. These have the nitrates and other minerals that plants need, already dissolved in them. When these foods are poured around roots, they can be taken into plants very quickly.

In using these liquid plant foods, scientists have made an important discovery. They have found that plants can take in many minerals through their leaves, when these minerals are sprayed on. Scientists formerly thought that plants took in minerals only through their roots.

Orchard men and some gardeners are using mineral leaf sprays to help their plants grow better. However, most minerals still come through the roots of plants.

PLANTS MADE TO ORDER

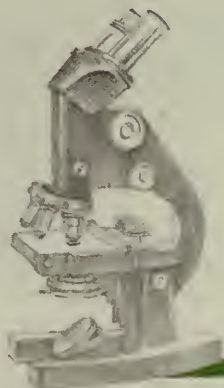
Scientists called plant breeders can even make new varieties of plants. Instead of waiting for insects to carry pollen from one flower to another to make seeds just hit or miss, plant breeders do this work in a planned way.



They choose two especially good plants of the same species, each of which has qualities they like. With a brush, they carry pollen from the stamens of one plant to the pistil of the other plant. Then they cover the blossoms with little bags so that no other pollen will reach them.

The seeds that develop may grow into plants that have all the good points of both their parents. If they don't, the plant breeders try again, growing and pollinating plants each season until finally they have just the kind they want.

Plant breeders have made our wheat just about to order. American farmers needed a wheat that would produce large crops and whose grain would make a flour that baked well.





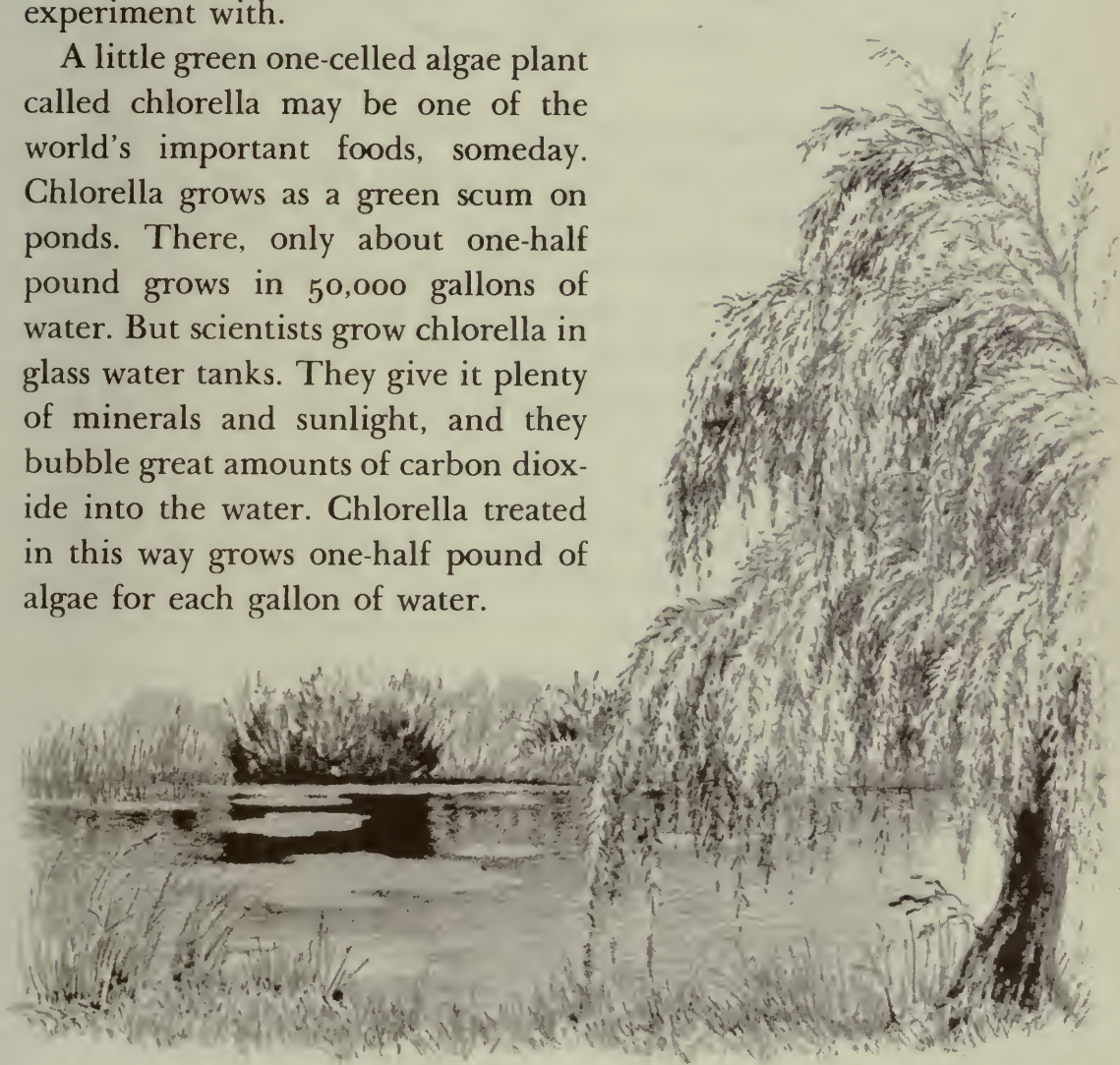
Besides that, this wheat must be able to remain healthy against rust and all other wheat diseases. It must not be damaged by wheat insects. It must be able to endure cold, heat and dry weather. It must have many other qualities that would make it easy to harvest.

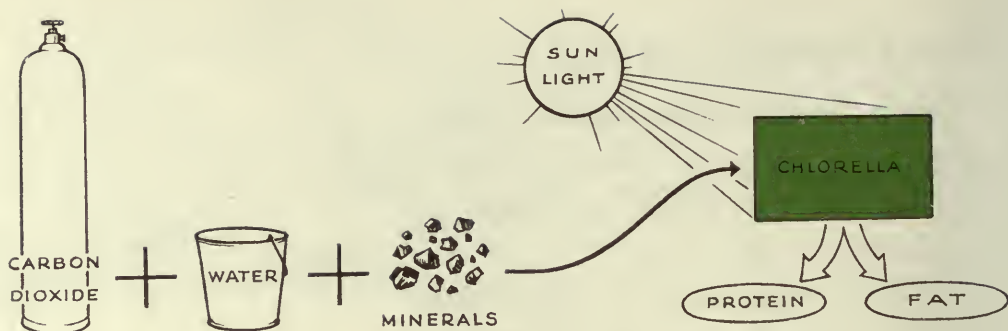
Gradually, by choosing, pollinating, and planting, over and over again, plant breeders made just the wheat seeds the farmers needed. There are no longer the terrible epidemics of wheat rust and other fungus diseases that used to ruin our wheat crops. Our new wheats do not catch diseases easily.

THE OBLIGING ALGAE

Algae are favorites with plant scientists. They grow easily and quickly in tanks of water, and they are simple to experiment with.

A little green one-celled algae plant called chlorella may be one of the world's important foods, someday. Chlorella grows as a green scum on ponds. There, only about one-half pound grows in 50,000 gallons of water. But scientists grow chlorella in glass water tanks. They give it plenty of minerals and sunlight, and they bubble great amounts of carbon dioxide into the water. Chlorella treated in this way grows one-half pound of algae for each gallon of water.





Chlorella is an obliging plant. It will change, depending on how it is treated. If a scientist wants a plant rich in fats, he gives chlorella very little nitrogen. When he has scooped the plants from the top of the tank and dried them, he gets a light-yellow powder that can be made into fats and oils. If he wants a plant rich in protein, he gives chlorella a great deal of nitrogen. He gets a green powder that can be made into animal and chicken feed.

Most crops planted in soil produce only from one to three tons an acre. Chlorella produces fifty tons an acre and could possibly produce as much as two hundred tons an acre. It has no stalks or roots or other waste. Every bit of it is usable.

Already there are factories where chlorella is being raised in huge covered tanks. Scientists are still working with it, finding new uses for it. They look forward to a day when great factories will produce algae foods. Then people will no longer depend entirely on crops that may be ruined by weather or diseases. Possibly algae will some day prevent famine in many parts of the world.

PLANTS ARE EXCITING

There are many plant discoveries yet to be made. Scientists are only beginning to realize the uses of molds. Recently they found that when penicillin, terramycin or other drugs made from molds were fed to young chickens and pigs, these animals grew faster than ever before.

Japanese scientists have found that some algae can make nitrates just as some bacteria can. By planting these algae in the flooded rice fields, these scientists have grown much larger rice crops. Algae will mean more food for Japan.

For many years people have realized how important the green, seed-producing plants are. Now, more and more, they are finding new uses for the algae, fungi and other groups.

The world of plant life is an exciting one, in which anything might happen—and probably will. It's a world still full of discovery. And it's well worth watching—for its everyday wonders as well as for its scientific miracles.



ROOTS THAT ARE DIFFERENT



Each slender leaf of the walking fern may bend over, and, upon touching the ground, grow roots at its tip. A tiny plant forms, and finally separates from the older fern.



Cornstalks grow sturdy prop roots aboveground, to brace the tall plants.



Some tropical orchids grow perched on trees. Their roots do not grow in soil, but dangle in the air and take moisture from it.



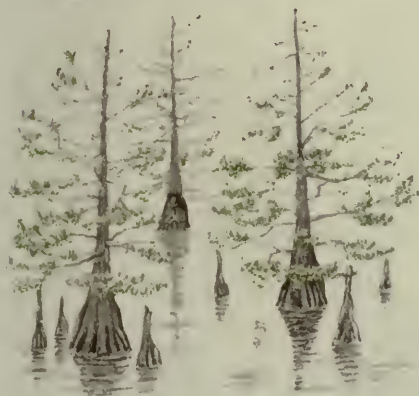
Pickerel weed grows in the shallows of ponds and streams, its roots in underwater mud.



The branches of an Indian banyan tree send down roots that grow into the soil and are both props and food-getters.



A young strangler fig starts high in a tree, often a palm. It sends down encircling, "strangling," roots, which grow into the ground. Finally the host tree dies as the strangler fig becomes larger and larger.



Bald cypress trees grow in swamps of the southern United States. Their roots are often underwater. They send up curious "knees" that help support the trees and probably take in air.



English ivy is a vine with long stems from which grow little roots. They cling to wood and stone as the plant climbs.

SOME SEED-GROWING PARASITE PLANTS



Dodder is a leafless, orange-yellow vine with little roots that take food from the stems of green plants.



Cancer root has white or violet flowers, but no leaves. It takes its food from the roots of green forest plants.



Mistletoe is partly a parasite. It grows on tree branches and has green leaves that manufacture food, but its roots pierce the bark and take their water supply from the tree.



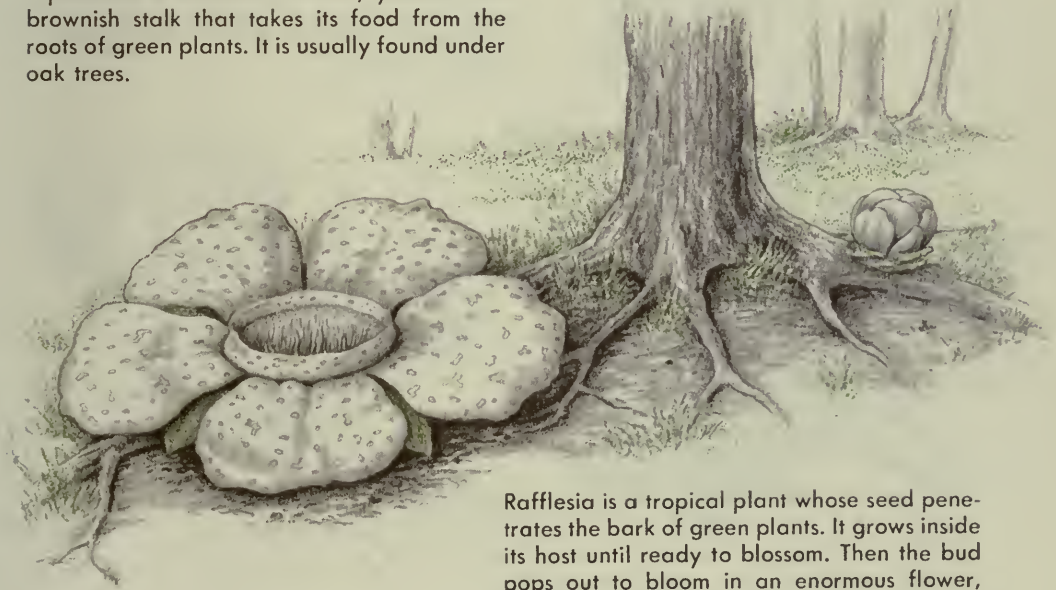


Beechdrops are brownish in color. They get food from the roots of beech trees.



Broom rape is a small, leafless plant, yellowish or purple in color. It is a parasite on the roots of green plants of fields or meadows.

Squawroot is leafless—a stout, yellowish or brownish stalk that takes its food from the roots of green plants. It is usually found under oak trees.



Rafflesia is a tropical plant whose seed penetrates the bark of green plants. It grows inside its host until ready to blossom. Then the bud pops out to bloom in an enormous flower, three feet across.

WILD PLANTS THE INDIANS ATE



The tender spring leaves of marsh marigold, or cowslip, were boiled as greens.



The acorns of the white oak were boiled and made into meal.



Bracken fern's bark-covered underground stems were peeled and roasted.



Spring beauty's starchy underground tuber was eaten raw or boiled.



The underground stems of Solomon's seal were boiled.



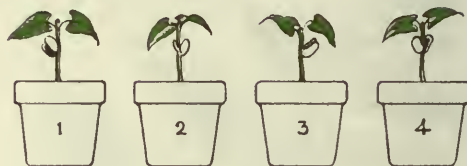
Water chinquapin, or duck acorn, has large seeds which were roasted and ground into meal.



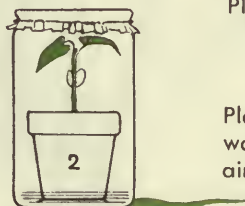
Cattail roots were ground into flour; the young stems were peeled and eaten; and the flower spikes, when small, were boiled into soup.

PLANT EXPERIMENTS THAT YOU CAN DO

Grow bean plants in small pots. When they are two or three inches high, select four as nearly alike as possible.



Place one in the dark but give it water.



Place the second in a glass jar with a little water in the bottom. Seal the jar to keep out air.



Give the third plant air and sunlight, but do not water it.



Give the fourth plant air, sunlight and water.

Keep all the plants at the same temperature. Which plant grows best? Green plants need air, sunlight and water.



Take a small, well-watered potted plant and place a heavy piece of aluminum foil around its stem and over the top of the pot, so that no moisture can escape.



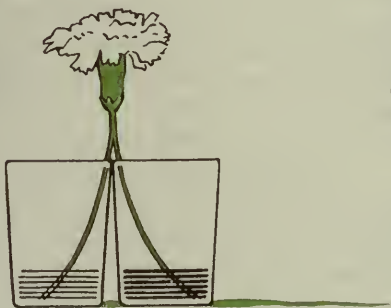
Now place a large jar over the plant.



In a few hours, beads of water will appear inside the jar. The leaves are giving off moisture.



Take a white carnation with a stem about four inches long. Split the stem up the middle for about two inches. Put one half in a small glass of blue ink, the other in a small glass of red ink, placed side by side. Soon the ink will rise and color the flower—one half red, one half blue.



Place a stalk of white celery in a glass of red ink. Soon you can see the ink rising through the plant's pipelines. In a few hours, cut the celery stalk crosswise. You can see the pipelines, stained red.

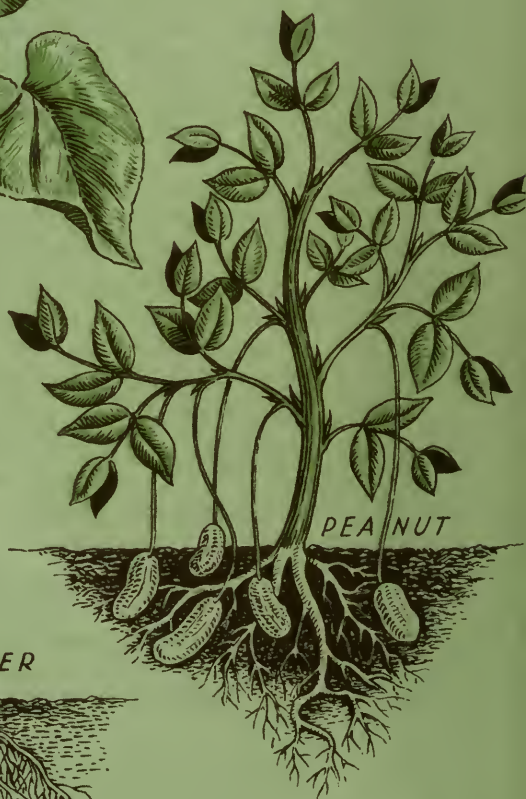
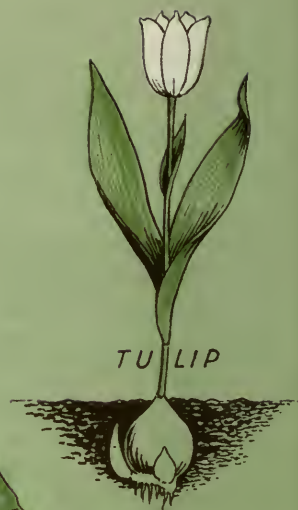


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TURNIP



MUSHROOM



PEA



CORN



WATER LILY

