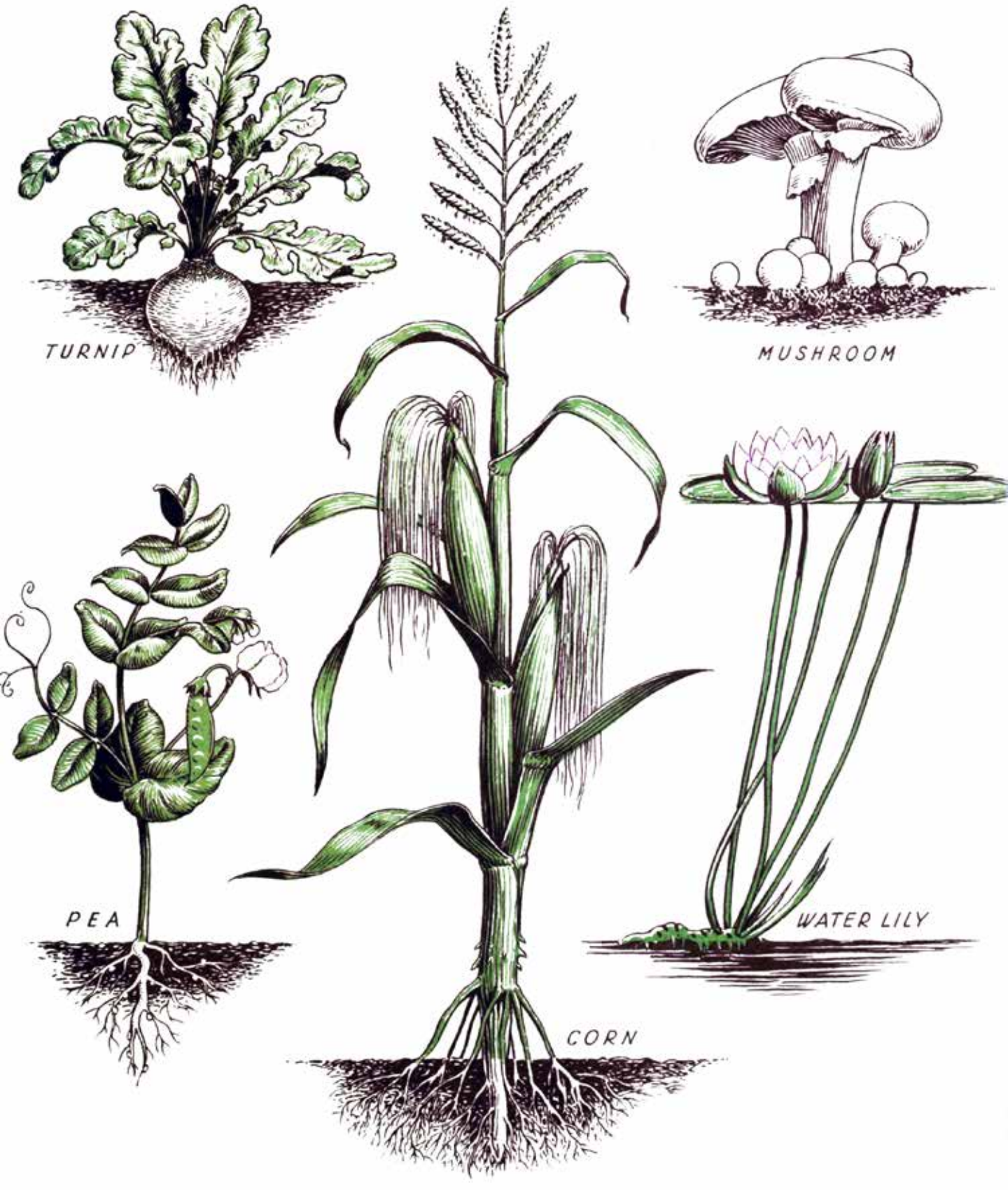
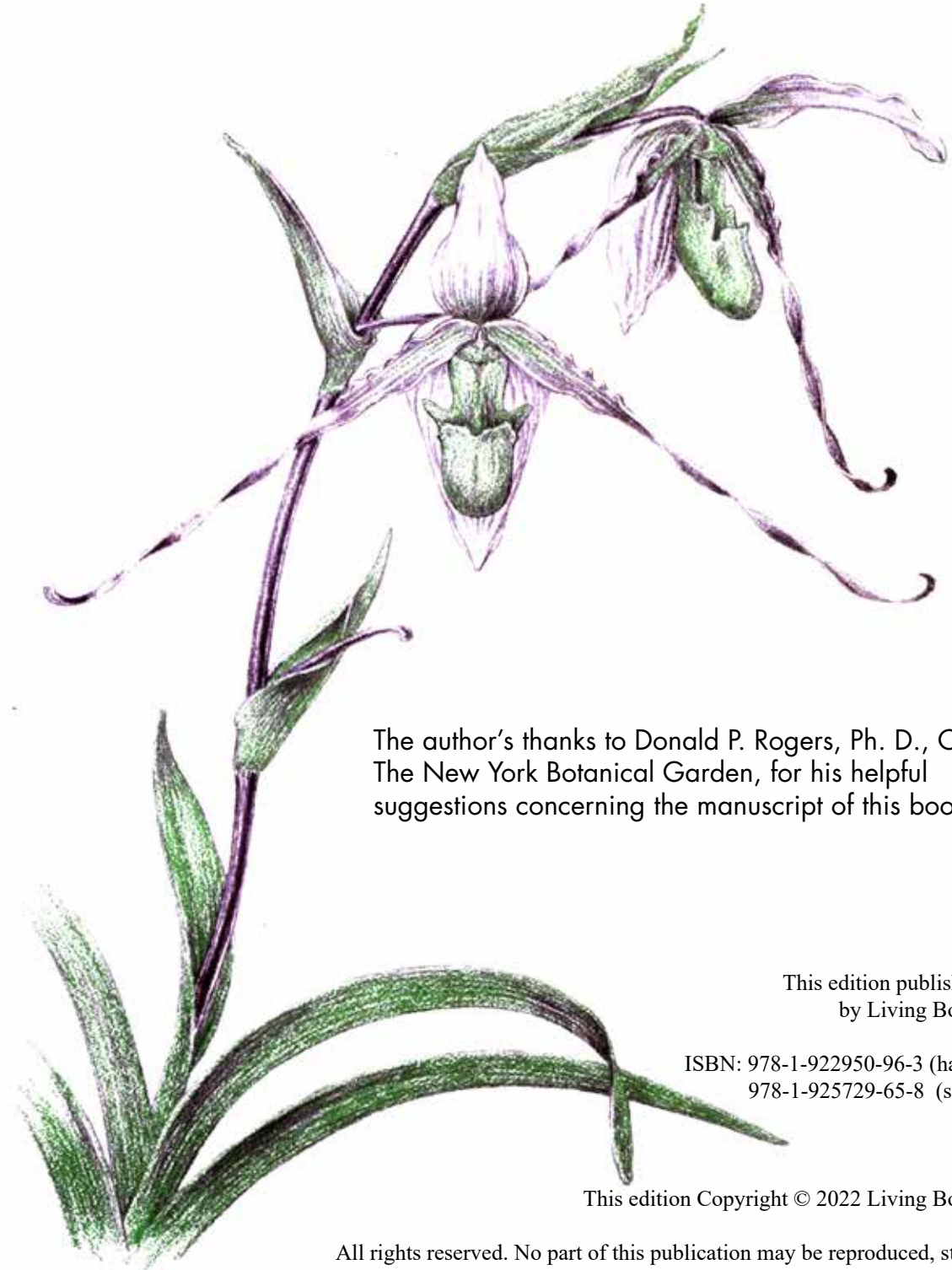
THE FIRST BOOK OF PLANTS

by Alice Dickinson

pictures by Paul Wenck


LILY of the VALLEY
TULIP
POTATO
SUN FLOWER
PEA NUT


TURNIP
MUSHROOM
PEA
WATER LILY
CORN



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THE FIRST BOOK OF PLANTS

By ALICE DICKINSON
Pictures by PAUL WENCK

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.

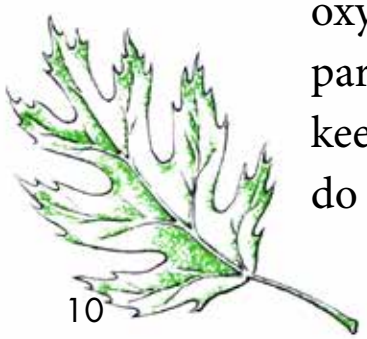
2. Green plants can make food only if they can get the raw materials, carbon dioxide and water.

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

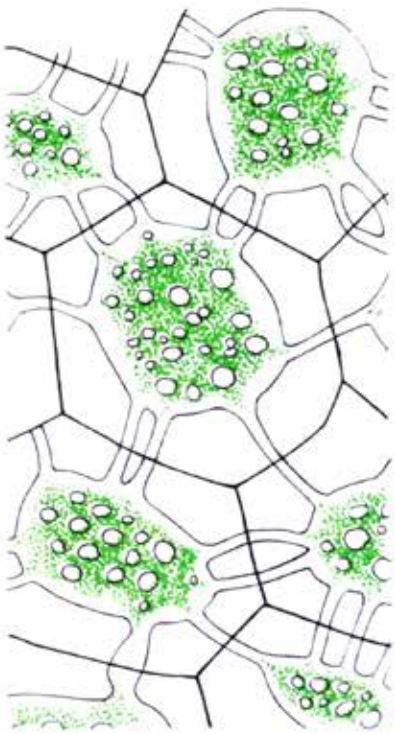
Plant food-making works like this: Carbon dioxide and water are both made of simple chemicals, put together in special ways. Green plants act as chemical laboratories, separating carbon dioxide and water into blocks of the simple chemicals of which the gas and water are made. Then the plants rebuild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



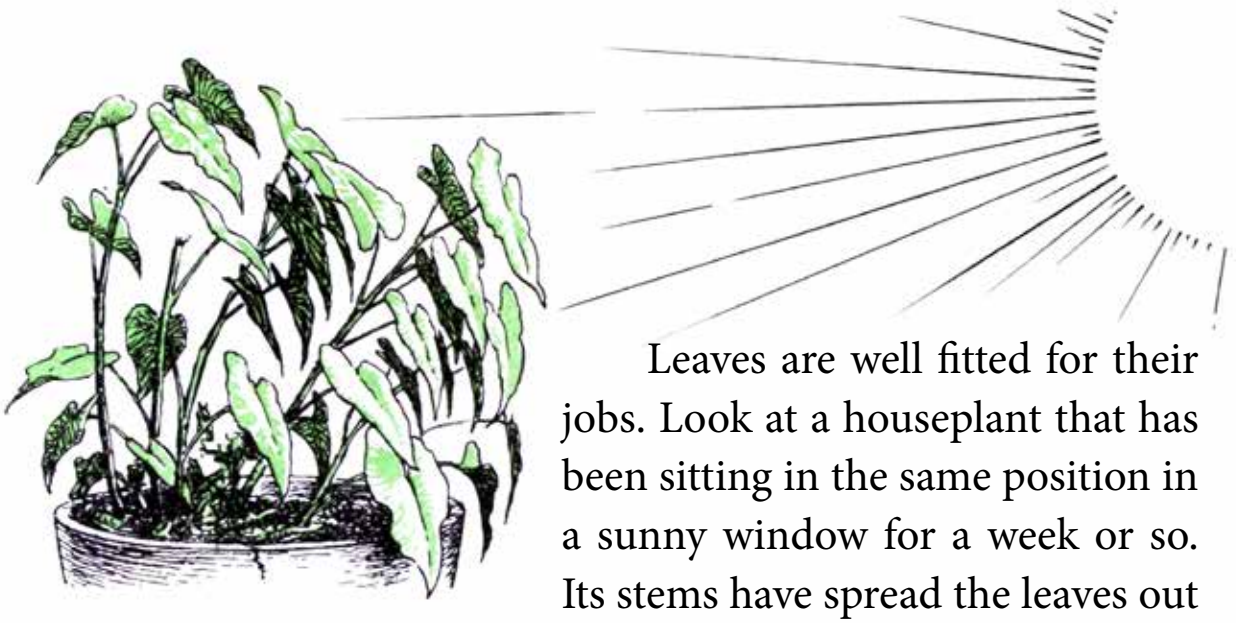
HOW PLANTS ARE BUILT



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.

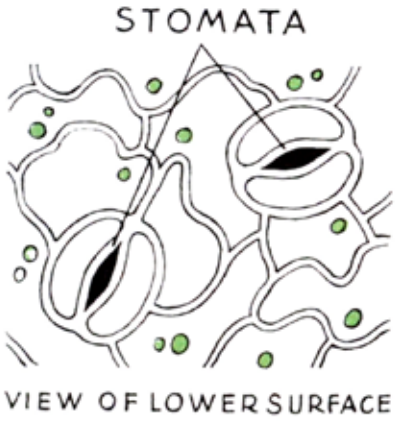
Now notice how thin through leaves are. This is so that the sunlight can reach as many of their cells as possible. If leaves were as thick as branches, sunlight could reach only their top-most layers. The inner cells would be useless as food laboratories.

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.

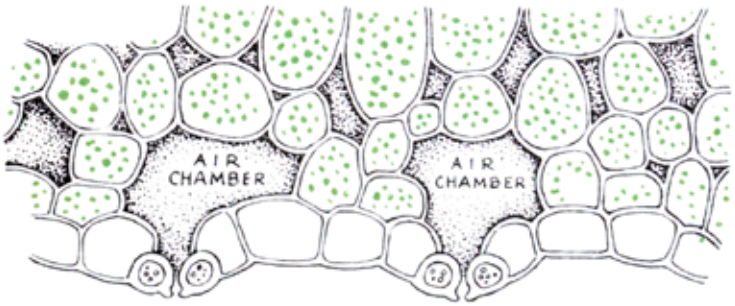
The lines on a leaf are its veins and midribs. They help to strengthen the whole leaf, and are part of its supply line in food-making. For the leaf would be useless if it could not get its work supplies, carbon dioxide and water.

FROM THE AIR

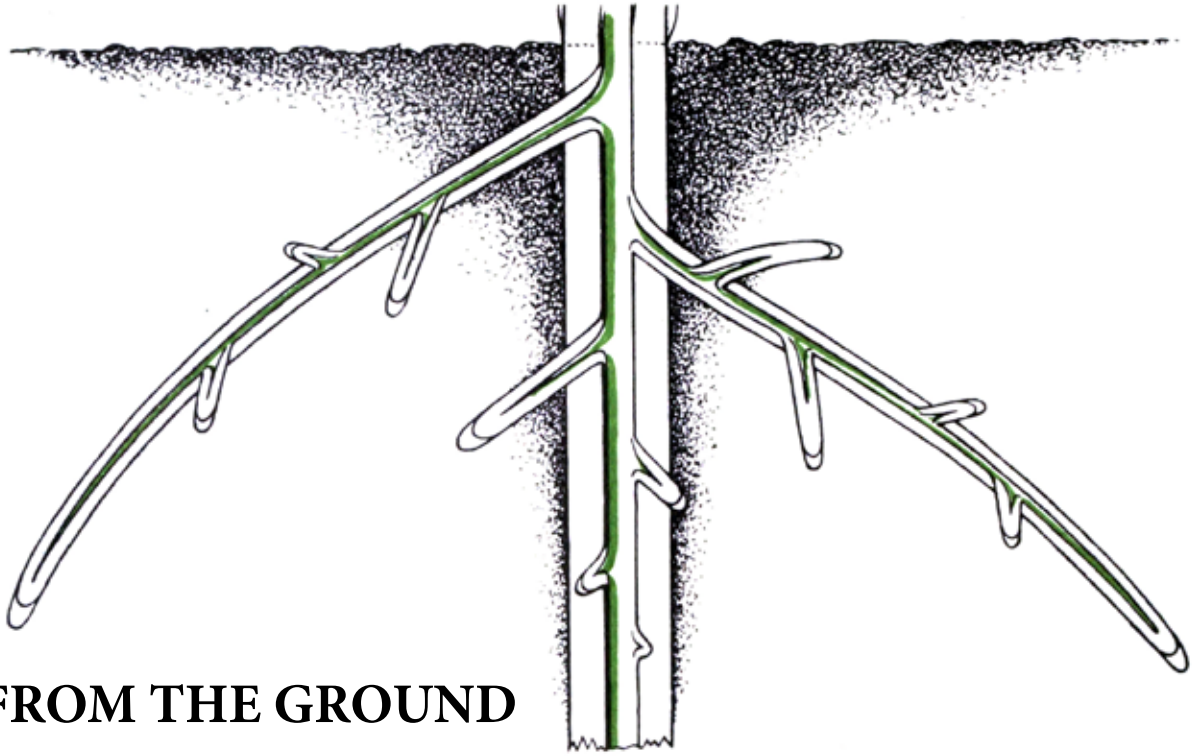
Leaves get carbon dioxide from the air around them. They are full of tiny openings, so small that an average leaf has 125,000 of them in each square inch of its surface. These openings are called stomata, from a Greek word meaning "mouth." Through these stomata, gases come in and go out of the leaves.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



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



CROSS SECTION OF A LEAF, LOWER SURFACE →



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.

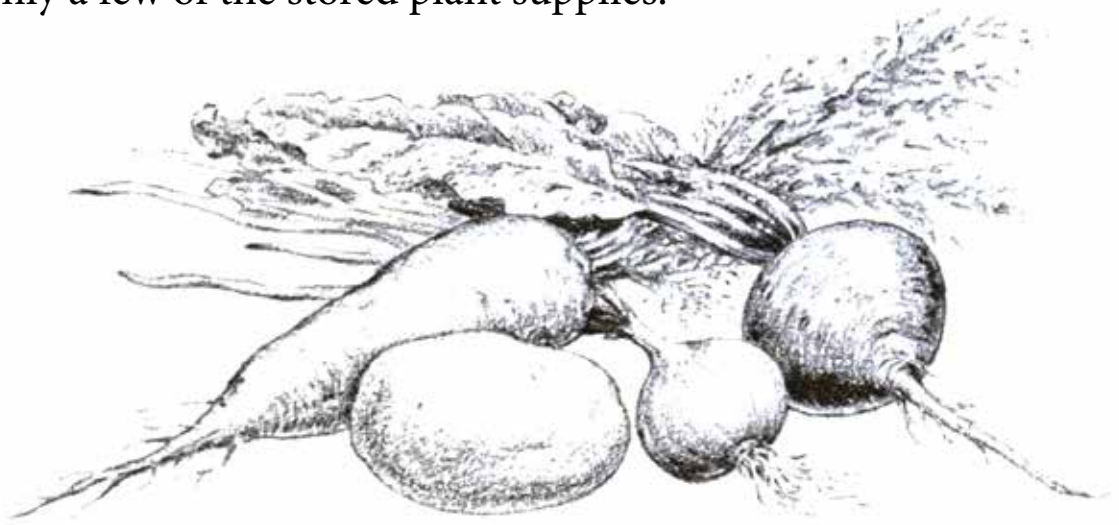
USING THE FOOD

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.

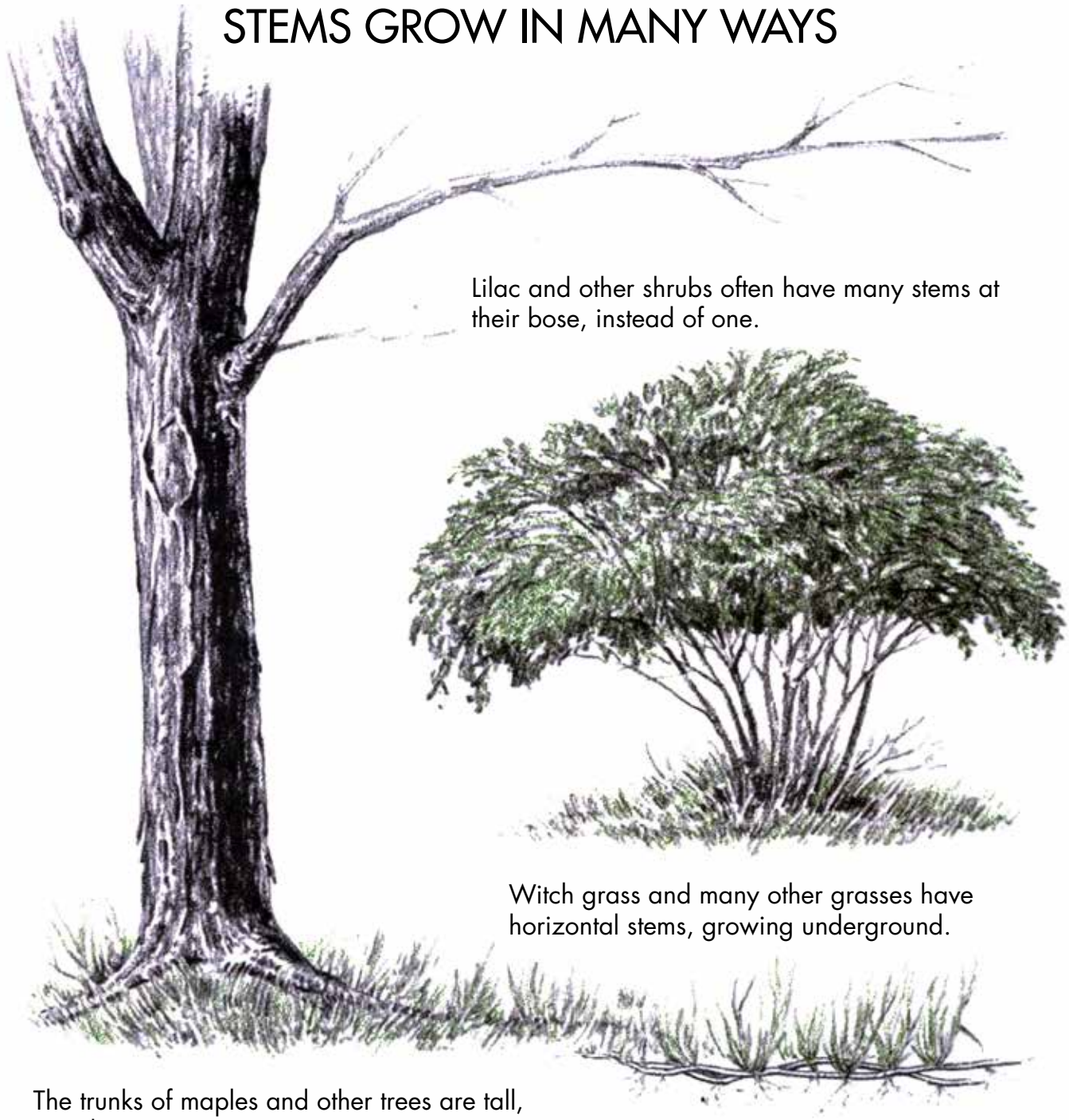
Of course, some of the food is used at once, to keep the plants alive and growing. And just as some of an animal's food is turned into flesh and bone, so some of a plant's food is turned into stems and leaves and all its other parts.

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

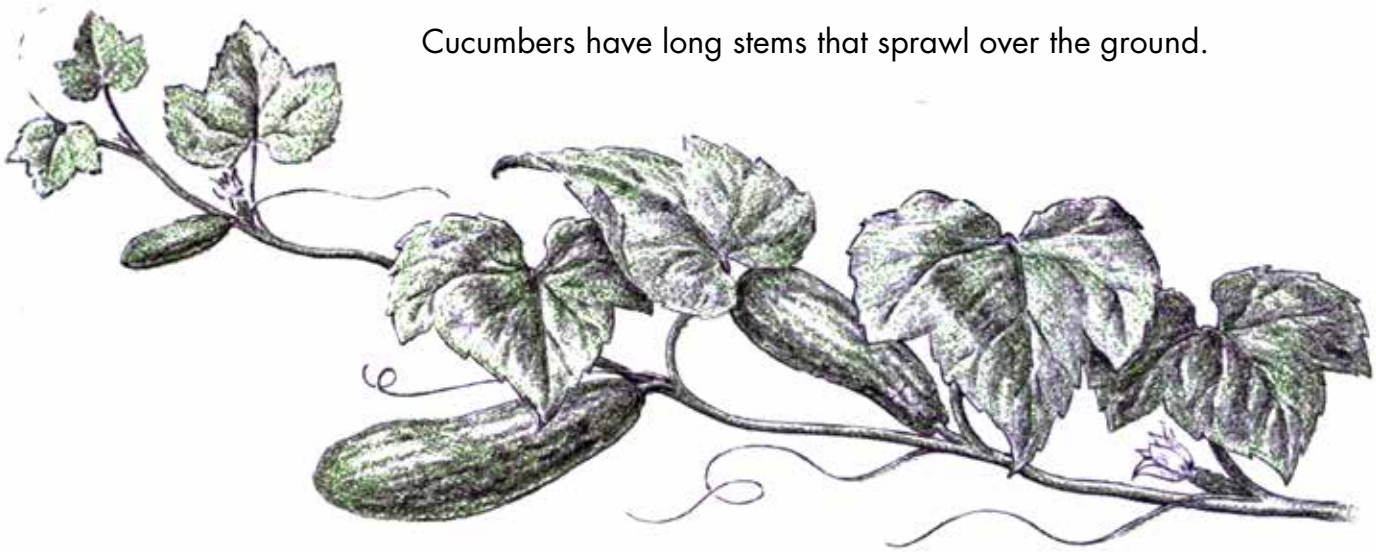


Lilac and other shrubs often have many stems at their bose, instead of one.

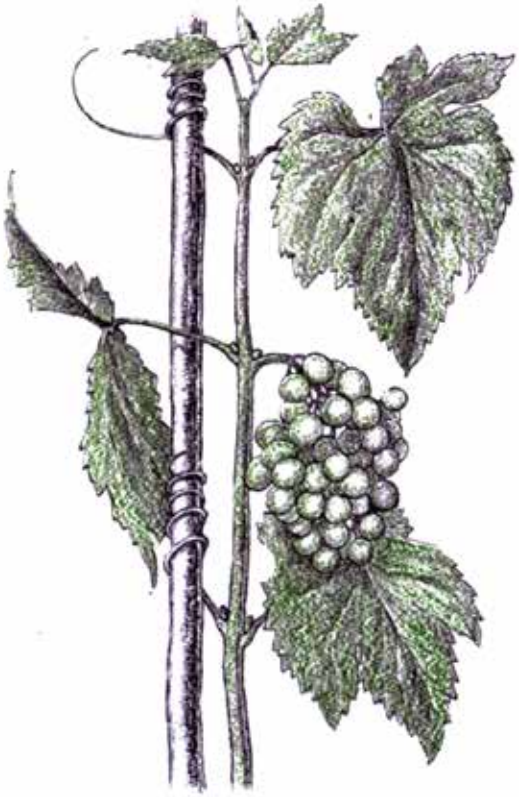
Witch grass and many other grasses have horizontal stems, growing underground.

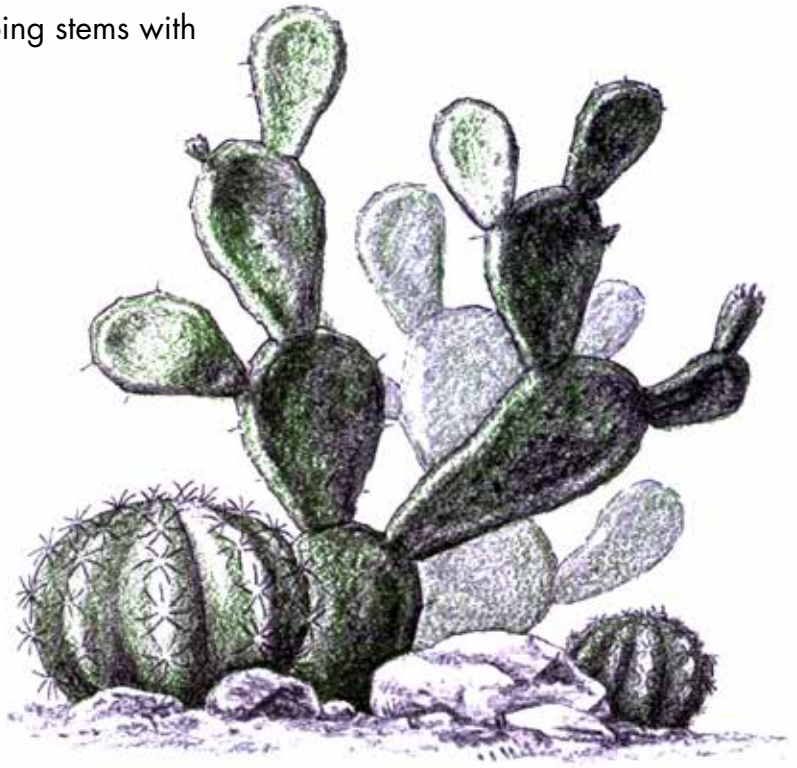
The trunks of maples and other trees are tall, woody stems.

Cucumbers have long stems that sprawl over the ground.



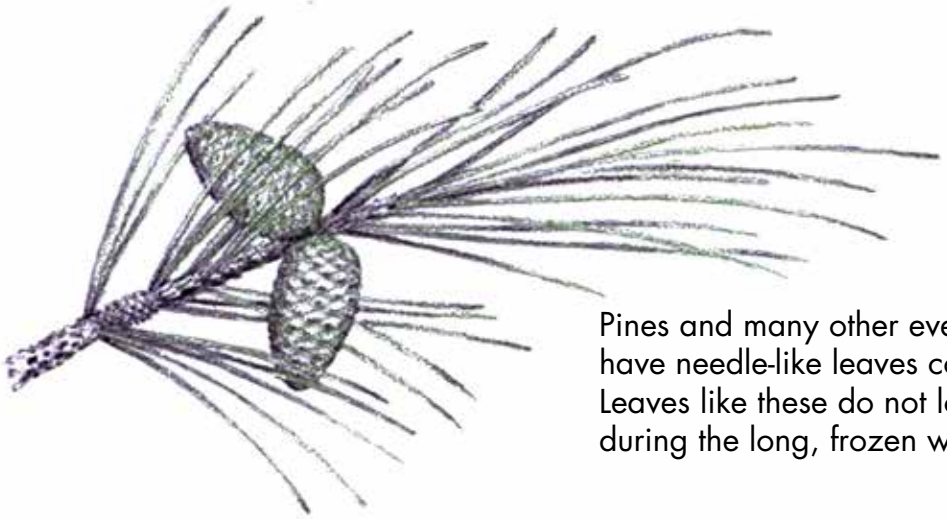
Grapevines have long, climbing stems with tendrils that cling to supports





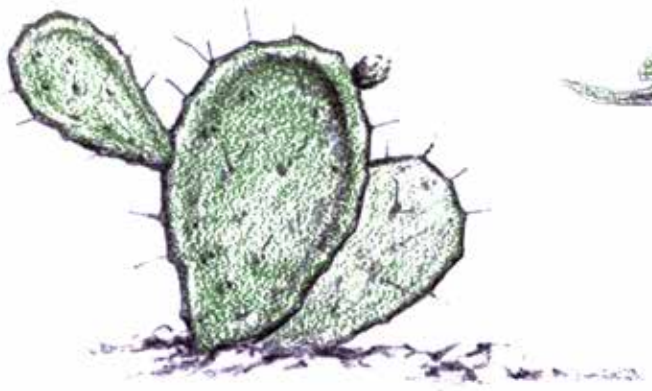
Prickly pear and barrel cactus are two of the many cactuses whose stems store water and make food. Spines replace their leaves.

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.



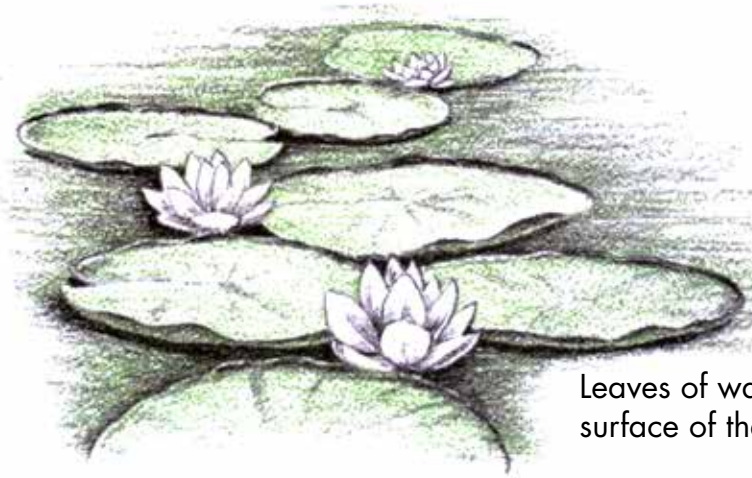
Cactus leaves have been replaced by spines that protect the plants from browsing animals.

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 hove 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.

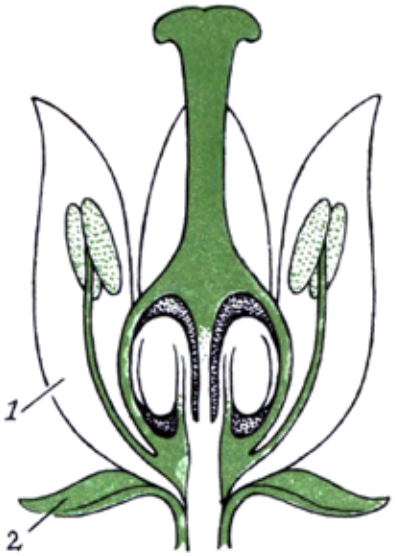
But to use energy, plants and animals must first set it free from the food where it is locked. Every living thing does this in the same way—by taking in oxygen. This is what happens: The oxygen joins together with food stored in the plants' or animals' cells and changes it, so that it gradually stops 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

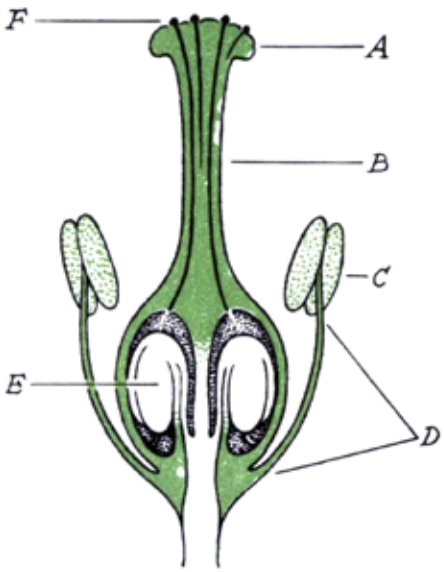
Roots, leaves and stems are the plants' food-making equipment. But besides making food, plants must grow new young ones, so that their very special kind, called their species, will not die out. The greatest number of land plants grow their young by means of seeds.



Flowers are plants' seed-making machines. A simple flower is built like this: Green, leaf-like 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 dust-like 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.