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Carnivorous Plants

by Harvey Black

More than 500 species of plants get what they need to grow and stay healthy, not from the nutrients in the soil brought in by their roots, but by trapping and digesting flies and other insects, as well as from spiders, snails, tiny worms called nematodes, and microscopic animals.

These species are known formally as carnivorous plants, and they eat insects and animals that victimize plants. "These plants have turned the tables on them," said Joseph Mazrimas of the Lawrence Livermore National Laboratory, a biochemist who coedits the newsletter of the International Carnivorous Plant Society.

Carnivorous plants make up a tiny fraction—one-fifth of one percent—of all plant species. They can be found on every continent except Antarctica or in the extreme deserts or the high Arctic. These plants can be just barely visible to the naked eye or they may be 150-foot-long vines that climb up trees in tropical rain forests.

Over the eons carnivorous plants have evolved a variety of ways of trapping the unwary critter that runs afoul of them. Take for instance the Venus flytrap. It has what's known as the *steel trap* method of getting its food. On its leaves are twin lobes that open like a steel trap. An insect creeping around one of these lobes might touch a sensitive hair. If that's done twice in 20 seconds, says Mazrimas, it's curtains for the insect. The trap slams shut in less than one-tenth of a second, and the plant begins to digest the insect.

But of course that's not the only way for these plants to trap a meal. With more than 500 different species, you might expect a variety of different traps. There are *pitfalls*, for example. After losing its footing on a leaf, the insect falls into what must look like a giant vat of fluid and meet its end. There are *lobster-pot traps* in some carnivorous plants that grow quite close to the water; these let prey swim in, but tiny hairs

prevent the animals from swimming out. And then there's the *flypaper* trap, which does what flypaper does. Once insects are lured to such plants by a sweet scent, bright colors, or glistening droplets, they get stuck on the plant's leaves or tentacles. Depending on the plant it may take from minutes to hours for the prey to be fully ensnared and for digestion to begin.

After the insect is captured, "The plants must break down the components of their prey to simple forms and make them over into ones they can use," said Mazrimas. This is what our bodies do with the food we eat.

To digest their prey, many of these plants secrete enzymes — proteins that can accelerate specific chemical reactions — to break down the proteins that compose the animals and turn them into ones the plants can use to grow and flourish. The enzymes are stored in parts of plant cells called lysosomes and are secreted when digestion is needed. But some plants, like the pitcher plant, have no digestive enzymes whatsoever, according to Professor Thomas Givnish of the University of Wisconsin-Madison. Instead, the pitcher plant relies on bacteria and fly larvae in the insect traps to digest the prey. These organisms take some of the nutrition for themselves and leave the leftovers for the plant.

The digestive enzymes are similar to the enzymes that animals use to digest the proteins they eat. For instance, in a carnivorous plant you're likely to find enzymes called proteases and peptidases. They break down proteins into amino acids that the plant can assemble into the proteins it needs to grow. There are also phosphotases to break down the phosphorus-containing compounds in animal bodies. Plants need phosphorus to make DNA (see Figure 1). Some plants also have an enzyme called chitenase to break down the substance called chitin that makes up the hard shell or exoskeleton of insects. Once broken down, the chitin is a rich supply of sugars.

Just how did all this come about? To answer that question it's necessary to understand something about the environment in which these plants evolved. Carnivorous plants grow in soils in which the nutrients required for plant growth are sparse. Many of these soils are sandy or gravelly and have little nitrogen, phosphorus, calcium, and other essential nutrients. In other cases the soils are composed of peat, which is made up of decayed plants. While peat can be rich in nutrients, they are so tightly tied or bound to the soil that they might as well not be there, as far as carnivorous plants are concerned.

Carnivorous plants also grow in soils that are acidic, with pH as low as 3.5 to 4.5. In such soils the acid leaches away the nutrients the plants need. Soils may also contain compounds based on metals, such as

aluminium, that are toxic to plants. High levels of acid can make these compounds soluble, and they can then be taken up by the roots.

So how are carnivorous plants able to thrive and exploit a niche that is inhospitable to most other plants? To make up for the dearth of nutrients in the soil, they get what is needed for growth from animals. They have adapted and developed the ability to capture and digest prey.

The way the plants actually developed the equipment to snare and digest their prey isn't completely understood. In some cases the traps and digestive system might have evolved from defensive measures to keep caterpillars and other plant-eaters at bay. In other cases this apparatus may have arisen from the cup-shaped or pellate leaves of plants like the pitcher plant, which grow in humid areas. Holding water, such leaves create pitfalls for insects.

In any case, among the areas today in which carnivorous plants can be found are regions where fire has taken its toll. Carnivorous plants are able to move into the initially nutrient-poor soil. If other conditions are right — such as little shade — they can flourish. But only for a while. Eventually grasses and shrubs will move in and simply out-compete the carnivorous plants, possibly because of their better developed root systems.

Carnivorous plants in fact can't stand nutrient-rich soil. It will kill them, according to Mazrimas. The roots of the Venus flytrap, he said, "have lost their ability to pick up nutrients." Instead, these plants have successfully developed an alternative method of getting their nourishment from animals. And those nutrients are directed to building their leaves and stems, not their roots.

Although some carnivorous plants such as bladderworts can flourish in the watery world of swamps, and others can do well in thin, nutrient-poor swamp soil, their lives are limited. In bogs and swamps, for instance, if there aren't periodic fires to clear out other plant species, carnivorous plants, which can tolerate the heat and flames, will lose out in the competitive game that nature plays.

Plants that eat animals may seem odd, but they are a dramatic example of organisms adapting to their environment and successfully exploiting it.

CAPTIONS

No escape. This insect is trapped by sticky droplets on the hairs of a sundew plant. Soon the leaf will close and surround the insect with even more sticky hairs.

Inside this closed Venus flytrap an insect is slowly being digested. The shadow of the insect can be seen through the leaf.

Figure 1. All organisms — plant or animal — need supplies of nitrogen and phosphorus, as well as other nutrients. Nitrogen (top row) is needed to make proteins for cell structures and enzymes. Phosphorus (bottom row) is a vital part of ATP and DNA. Most plants absorb these nutrients from the soil in the form of water-soluble ions (left column). Carnivorous plants get them by ingesting the biologically active molecules of their prey (right column).

BIOGRAPHY

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