INTRODUCTION: WHAT ARE CARNIVOROUS PLANTS?

"The Venus flytrap, a devouring organism, aptly named for the goddess of love."

—TENNESSEE WILLIAMS,
Suddenly Last Summer

I WAS A KID GROWING UP in the sixties when I had my first love affair with a Venus flytrap.

It was an advertisement in *Famous Monsters* magazine that first seduced me. The ad shouted something about the plant eating hamburger, and next to it was a fuzzy picture of Charles Darwin. As I already had pet turtles and a South American alligator trained to eat hamburger from a spoon, I convinced my mother that we could afford another mouth to feed and promptly had her write out a check.

The plants finally arrived in a Styrofoam pot wrapped in plastic. The pot was filled with dry peat moss and three or four "bulbs" with all of their leaves cut off. I followed the directions but nothing spectacular occurred. A few semideveloped leaves came up but soon all of the plants turned black.

It was my first experience with unrequited love. It never crossed my mind that the dim corner of my bedroom next to the heater in the month of December had anything to do with the plants' demise. Venus flytraps, I thought, must come from some dark, steamy, tropical jungle—didn't they?

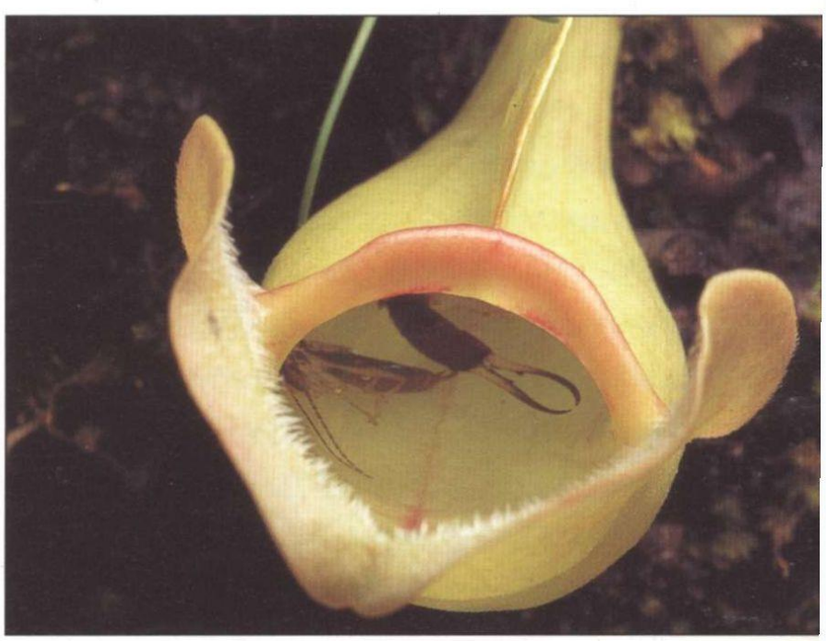
I was surprised when the following spring a friend and fellow student whispered to me, "I know where Venus flycatchers grow." I had just raised my hand in science class and volunteered to do a report on the Venus flytrap. As love springs eternal, I figured doing a school report

was one way my mom would write out another check and I could give Venus flytraps a second try. Since we lived on the seashore of southern New Jersey, I found my friend's statement rather hard to believe.

He took me to the boggy edge of a small lake right in the middle of town. The ground was covered in billowy, spongy green moss that my friend called sphagnum. The moss hugged the bases of southern white cedars that grew in the shallow, tea-colored water. It was a beautiful sight.

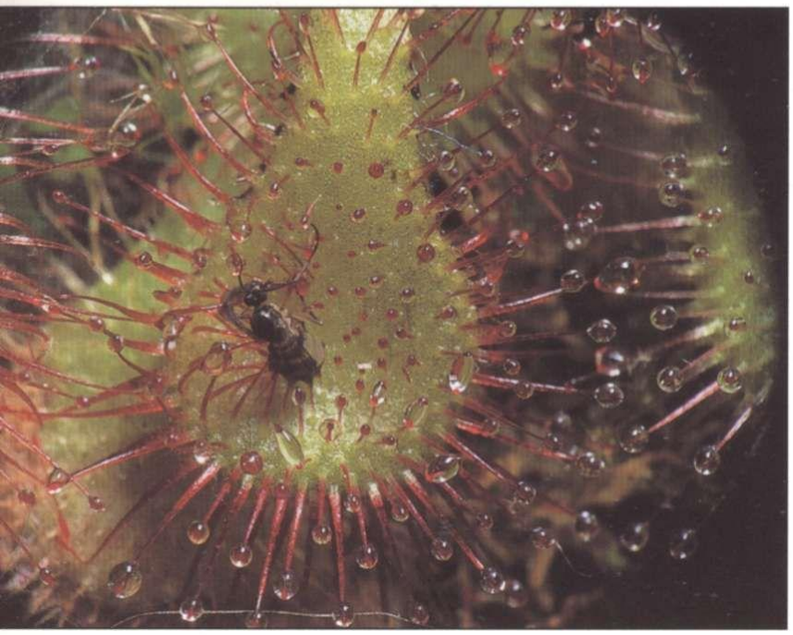
"There they are," my friend said, pointing. I looked in awe at the strangest plants I had ever seen. Half buried in the moss were rosetted clumps of deeply purple hollow leaves, with spiny collars and strange reddish flowers rising from the center. "These aren't Venus flytraps," I said, but I was hardly disappointed.

When my friend assured me they still ate bugs, I peered into one of the hollow, leathery leaves, and sure enough I saw insects struggling in the wells of water that each leaf held.



"...I saw struggling insects in the wells of water each leaf held."

"Look at this," my friend said. He plucked something from the moss and held it up in his fingers. It was an image that would forever be imprinted upon my brain. A ray of sunlight broke through the cedars, shining directly on what he held in his hand. It was a small, circular green leaf covered with hundreds of red tentacles like a pincushion, each ending in a tiny drop of dew. Every drop caught the light of the sun, and they sparkled and glittered like jewels. These small plants were dotted with numerous dead and struggling insects, their circular leaves sometimes clenched like tight fists, with wings and antennae sticking out and twitching. I looked around in awe, for it was an unforgettable image: tea-colored water, grayish trunks of cedars, and spongy mounds of reddish green islands with strange plants that looked like they came from outer space!



"It was an image that would forever be imprinted upon my brain."

My friend and I dug up some of the weird plants and took them to school the following week. Even our teachers were mystified. But soon I was led to the library and found several books that satisfied my curiosity. What we had found growing on the swampy edge of the lake were purple pitcher plants and sundews—carnivorous plants not unlike the famous Venus flytrap! I was also surprised to learn that the pine barrens of southern New Jersey were practically teeming with flesh-eating plants, and that the flytrap was native only to the Carolinas, a mere day's drive south of where I lived. I was almost dumbfounded to discover that North America has probably the widest variety of carnivorous plants in the world: pitcher plants, sundews, butterworts, cobra plants, bladderworts, and Venus flytraps all grow here! I wouldn't have to fly to Madagascar after all.

For me, it was the beginning of a mind-boggling adventure that would change my life.

Our general impression is that plants are fairly passive forms of life. Insects and animals eat them. We chop down trees to build houses, shred cabbage for coleslaw, and decorate our homes with their sex organs, which we call flowers. We eat their fruit, pull "weeds," and make medicine out of their sap. We bleed trees for maple syrup and burn them in fireplaces. We bake them, boil them, and sauté or stir-fry them. We even smoke them.

Plants can't scream and run away, but some of them do fight back to an extent. Mushrooms can kill you and poison ivy can make you itch. Many plants defend themselves with needles and toxins or bitter tastes and bad smells.

Typically we are not afraid of plants, but humans love to project their own fears onto other life-forms. That we can do this with plants,

seemingly the most passive and unfrightening of life-forms on earth, is obvious by just examining some of our more popular horror movies. *The Thing* featured an alien humanoid plant that fed on human blood. In *Day of the Triffids,* walking plants were stinging humans to death in their effort to take over the world. *Invasion of the Body Snatchers* had plant "pods" duplicating human beings and taking over their minds and bodies. In *Little Shop of Horrors*, a talking plant with a sense of humor swallows people whole. That these four famous horror movies were made—and remade—reflects the unconscious fear that we all have of pretty, pulpy, passive plants. Perhaps deep within our brains, tiny neurons still fire off flashbacks of ancient, inherited memories, horrible memories of the days when our ancestors had good reason to fear plants!

You might smirk and shake your head, but this primal fear may not be quite as far-fetched as you think. Just last year at the carnivorous plant nursery I own, where we have on public display over 500 varieties of flesh-eating plants, a well-to-do couple came in and were marveling at our collection of tropical pitcher plants, the *Nepenthes*. They told me with glee how they had recently returned from Malaysia, where they saw magnificent *Nepenthes* at a botanical garden. "We arrived early," the wife told me, "and we waited in line at the front gate. I peered through the fence, and saw these huge pitcher plants hanging in the trees. To my shock, an attendant was pulling tiny baby monkeys out of the traps! Most were alive, and scampered away. The dead ones he dropped in a pail." Her husband added that when they later caught up with the attendant and asked him about what he was doing, the embarrassed attendant explained that dead monkeys in the pitcher plants were upsetting to the tourists. While I have never been able to document this story, and suspect the prey were more akin to rodents, such tales have persisted for a very long time, a mythology that may have a basis in fact.

Thus, the following equation is not necessarily true: Plant eats monkey. Monkeys are primates. Humans are primates. Plant eats humans.

But surprisingly there was a brief time when some people truly believed in the Man-Eating Tree of Madagascar. It was in 1860 that Carle Liche wrote an article claiming he had witnessed a sacrifice of a young maiden to such a tree by natives of the island. Since he offered

grisly details and was published ipn scientific and popular magazines, the report was widely believed to be true. It was not.

During the same period Charles Darwin, among many others, studied and reported on the amazing carnivorous habits of many plants both familiar to them and being newly discovered around the world. Science was exploding in popularity during the nineteenth century, and explorations were uncovering many strange and exotic forms of life. Even plants long familiar to Europeans, like the sundews and butterworts common to local bogs and moors, were suddenly suspect.

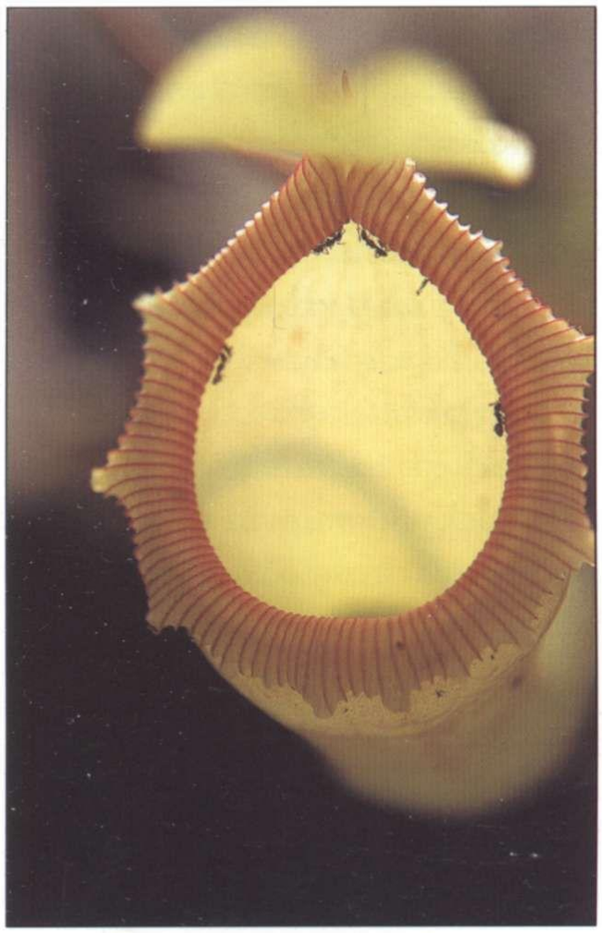
This suspicion over which plants are or are not carnivorous is a matter that is not quite settled even at the close of the twentieth century. "Carnivorous" means "flesh-eating." An older term, used by Darwin and sometimes referred to even today, was "insectivorous," or insect-eating. The latter term is not quite accurate and is rather limiting, for even though the vast majority of prey eaten by carnivorous plants are insects, this group of plants also consumes spiders, sow bugs, worms, tadpoles, frogs, lizards, and even rats, although admittedly the capture of larger animals such as mammals is a very rare event.

A typical "normal" plant works in the following way: the roots in the soil absorb water, including minerals. The leaves in the air absorb carbon dioxide. Through the complex process of photosynthesis, chlorophyll in the leaves uses the energy of sunlight to transform the carbon dioxide and minerals into carbohydrates and other organic compounds, which give the plant energy to grow.

But what if the soil a plant lives in is low in minerals, particularly nitrogen, phosphorous, or potassium, which are vital to the plant's health?

Most carnivorous plants grow in mineral-deficient soils. More often than not, these soils are very wet. The water moving through the ground carries away most of the much-needed minerals. Even nitrogen, returned to the soil by the slow decay of older, dying leaves, does not remain for long. A plant living in such an environment might be able to survive year after year, but wouldn't be able to manufacture the energy needed to produce flowers, seed, or offshoots.

Carnivorous plants have an answer to that survival dilemma. All around them are little, moving packets of minerals and nutrients, like



Small ants getting drunk on *Nepenthes ventricosa*

vitamin pills with legs and wings. We call them animals. All the plant has to do is catch them and somehow absorb through their leaves what they would normally take up through their roots. The development of leaves for such a purpose is what makes carnivorous plants so bizarre and beautiful.

Even "normal" plants can absorb minerals through their leaves. You can spray your rosebush with a watery solution of Miracle Grow and watch it take off. If you made a fertilizer solution for your rose bush by pulverizing dried crickets, mixing them in water, and spraying the solution on your plants, would you have a carnivorous rose? In fact, root fertilizers for plants such as palms do often have ground-up crickets, oyster, and crab shells in them. Do you then have an insectivorous or seafoodivrous or—God forbid—shellfishivorous palm tree? Maybe...maybe not.

The confusion over which plants are or are not carnivorous stems from how we define the term. It has been generally assumed that to be called carnivorous a plant needed to do several things: lure prey, somehow catch it, kill it, and then digest it, usually through the production of enzymes and acids used to dissolve the victim into palatable form. It's this "digesting" that's the controversial part.

***Pinguicula esseriana* snacking on fungus gnats**

Some plants are included under the heading of "carnivorous" even though they don't produce actual

digestive enzymes. *Darlingtonia* and *Heliamphora* are two examples of pitcher plants that apparently rely on bacterial action to dissolve their prey. This "digestion by proxy" can make the discussion of carnivores a rather complicated thing. If we simply defined a carnivorous plant as one that possibly benefited from the absorption of minerals obtained from captured and killed animals, instead of several hundred species, we might be talking about many thousands!

Petunias catch and kill insects. So do potato plants, tobacco, rhododendrons, and teasels. But they do so, it is believed, for defensive purposes. Plants like petunias are covered with sticky hairs, which make life difficult for insects like aphids who wish to eat them. Many insects become caught in these hairs and die. Potato plants also are covered with hairs. If an aphid breaks one of these hairs, a glue is secreted that cements the aphid to the spot. The common teasel has leaves that form "cups" where they join the stem. Rainwater collects in the cups, insects fall in, drown, and eventually dissolve. All of these plants, at one time or another, were viewed with suspicion by scientists studying carnivores. All of these plants probably absorb some nitrogen or other trace minerals through their leaves as the insects decompose. The rest of the minerals are possibly taken up through their root systems after rain. But they are not considered carnivorous because they lack the process of digestion.

Perhaps our definitions should be revamped. Many plants might fall under the category of "semicarnivorous." Take for example the long-standing problem of *Roridula*. The two species of this genus grow in South Africa. They look and behave so much like sundews they were originally included under the genus *Drosera*. Their leaves are covered with sticky glands that catch enormous amounts of insects. But earlier in this century *Roridula* was excluded from the carnivores because it did not produce digestive enzymes. And so it stood until the 1990s, when two surprising discoveries were made. The first was by Steve Williams. Through DNA research, he discovered that *Roridula* was more closely related to *Sarracenia,* the pitcher plants on the other side of the Atlantic, than they were to *Drosera*. He jokingly suggested that *Roridula* be included in the family Sarraceniacea and that its carnivorous nature be re-explored. It was, which led to the second surprise. It has been long known that *Roridula* plays host to a curious insect called the assassin bug. These bugs live on the plant, and for reasons still unknown can

traverse the sticky glands with no problem at all. When other insects become caught, the assassin bugs close in, stab their needle-like mouths into the struggling prey, and suck out the juices. Alan Ellis and Jeremy Midgely discovered the amazing reason for this cooperative venture. Assassin bugs, after sucking dry *Roridula's* prey, secret a nutritious substance onto the plant that the leaves then absorb—true carnivore by proxy! *Roridula* plays host to assassin bugs who act as a "surrogate gut." This discovery led Oxford carnivorous plant specialist Barry Juniper to comment on petunias, potatoes, and tobacco: "They're all killing machines. I wouldn't be surprised if they absorb decayed products from their prey."

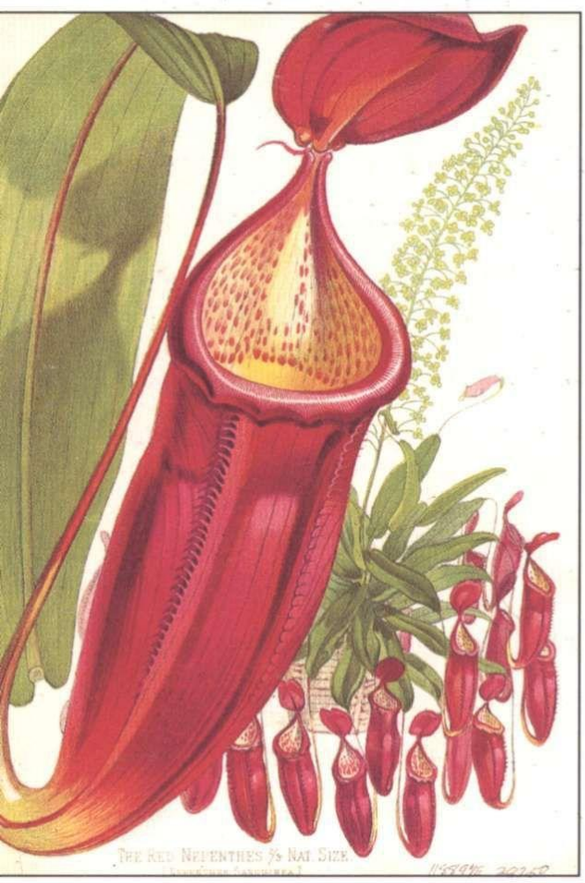
***Roridula gorgonius* covered with prey—but is it carnivorous?**

How have such plants evolved? Definite theories on the evolution of carnivorous plants are few; the almost complete lack of fossil evidence coupled with the current shifting of ideology among evolutionists may make theorizing an exercise in futility. Uniformitarianism, or gradualism, as popularized by Darwin, Wallace, and other nineteenth century scientists, holds that evolutionary change in both biology and geology is a very slow progression of events that occurs even as we speak. Darwin's theory of the origin of species by natural selection relied on rare and random mutation giving rise to new traits that, if beneficial to the species, allowed it to compete better among its peers and pass those traits down to its offspring. Darwin's dream that the fossil evidence for such transitional forms were simply missing from the evolutionary record has turned out to be mere wish fulfillment, for most scientists today agree that there are no transitional forms.

Thus, under gradualism, Darwinists imagined how a basic oval leaf slowly evolved, step by step, into the simple, rolled up, funnel shape of something like a *Heliamphora* leaf; then through random, accidental mutations over aeons of time, added genes to eventually produce the drug

coniine in *Sarracenia flava* or the light windows of *Darlingtonia* or the symbiotic relationship of *Roridula* and assassin bugs...well okay, maybe it's not so easy to imagine! Or, in the words of Francis Lloyd, who in his 1942 book, *The Carnivorous Plants,* mused on how the complex trap of *Utricularia* could have possibly evolved under gradualism: "Since we cannot answer these questions, it is perhaps as well to say no more."

Currently, beliefs in gradualism are eroding. Scientists are realizing that for long periods of time species of life on earth are stabilized, with little or no evolutionary progress. Then periodically and very suddenly, geological and biological changes take place. Older species suddenly vanish, while new ones appear quickly with no transitional forms. Others remain unchanged. While research in areas such as DNA may lead to conclusions concerning relationships between species, including carnivorous plants, how those species actually evolved is still the deepest of mysteries. The answers may come over the next century—maybe through the theories of punctuated equilibrium, but more likely through cosmic catastrophism; possibly through the studies of DNA or population genetics, or perhaps through some new theory no one has thought about yet.



Tropical pitcher plants, such as this *Nepenthes sanguinea,* were popular greenhouse specimens in Victorian England.

The invention of the greenhouse in the early 1800s and its growing popularity during the Victorian age among Europe's upper classes allowed for the first time exotic plants from around the world to be successfully grown under controlled conditions. Commercial nurseries were developed to cater to the demand for exotic plants. Some of these firms, such as the famous Vietch and Sons in England, financed expeditions to far-off lands around the world to collect unusual plant life. Their fanciful catalogues in the late 1800s boasted palms, orchids, hoyas, succulents, and carnivores. Among the most popular insect-eating plants offered were the *Nepenthes,* but such firms also sold *Sarrace-*

nia, Drosera, Dionaea, and *Cephalotus*. Breeding programs developed showy hybrids that competed—along with roses and orchids—for prestigious awards at the Chelsea Flower Show. Magazines like the *Gardener's Chronicle* popularized the plants and offered cultural techniques. Usually, exotic plants were very expensive and during the 1800s were affordable only to the very rich. But hardly a greenhouse existed on the estates of the wealthy that didn't have *Nepenthes* hanging from the rafters along with the palms and the orchids.

But World War I changed all of that. The shortage of fuels to heat the greenhouses caused the sudden death of vast botanical collections. Many prized cultivars and species disappeared forever. Only here and there, hidden away in public botanical gardens and universities, did some of the plants survive.

It wasn't until after World War II that the hobby of growing carnivorous plants began to make a modest comeback. During the war Francis Lloyd published his scientific work *The Carnivorous Plants* in America, the first such work since Darwin's 1860 *Insectivorous Plants*. In Japan, where the love of cultivating exotic plants (such as dwarf rhapis palms and bonsai) suffered heavily during the world war, the first carnivorous plant society was begun in 1948. It still thrives.

During the fifties and sixties, the cultivation of ornamental plants steadily increased with the booming economies worldwide. But except for a handful of interested individuals, carnivorous plants remained obscure to the general public. Venus flytraps, dug up out of their native North Carolina habitat and sold as an occasional novelty, were the only insect-eating plant available on the mass market. No popular literature on the plants appeared except for occasional articles in magazines such as *National Geographic*.

The modern carnivorous plant hobby began in earnest during the seventies. Two hobbyists, Joe Mazrimas in California and Don Schnell in North Carolina, began to communicate with other collectors around the world. This developed into the International Carnivorous Plant Society (ICPS) and its publication: *The Carnivorous Plant Newsletter*. For the first time, enthusiasts had an organized format to exchange cultural information as well as seed and plant material from around the world.

The seventies and eighties also saw the publication of several books on the subject, as well as a few nurseries and collectors that began to take the ecology of carnivorous plants seriously. Instead of removing

plants from their rapidly diminishing native habitat, they began to propagate them. Three nurserymen who helped distribute hundreds of rare, sought-after carnivores were Adrian Slack in England, Marcel Lecoufle in France, and Bob Hanrahan in the United States. Plants that many hobbyists never dreamed they would see in their lifetimes were suddenly becoming available.

The nineties have seen a steady increase in the popularity of carnivorous plants. Smaller local societies, usually associated with the ICPS, have sprung up in various parts of the United States, Europe, and Australia. Tissue culture propagation has made many once rare plants common and affordable. Numerous nature programs on cable television are making carnivorous plants more visible to the general public. The plants are beginning to appear more often at flower shows and public botanical gardens. General nurseries are retailing a wider variety than just the familiar Venus flytrap.

So how does one use this book?

I have written *The Savage Garden* as a practical guide to growing carnivorous plants (which, for the sake of brevity, I will refer to as "CPs" throughout the rest of the book). It is divided into three main parts: Part 1 covers the primary points of cultivation, including hard goods. Part 2 outlines the various places you can grow CPs, from greenhouses to bog gardens. Part 3 introduces all the popular genera of insect-eating plants, as well as their history, habitats, and habits, including their specific cultivation requirements. This is followed by a brief section on resources.

PART ONE

THE BASICS OF CULTIVATION

***Sarracenia flava* "red tube form" with *Drosera filiformis* ssp. *tracyi* and *Pinguicula* species in an open, wet, sunny habitat in the Florida panhandle.**

DR. LARRY MELLICHAMP of the University of North Carolina once told me, "Whenever I have seen carnivorous plants in the wild, whether it was in South Africa, the Florida panhandle, or Northern California, the habitats were often strikingly similar." Broadly speaking, this is a rather true statement, although of course some CP habitats are vastly different from others. I have been struck by the similarity of pygmy forest bogs in Mendocino County, California, to those I had explored as a youngster clear across the continent in the pine barrens of New Jersey. If someone were to show me photos of each, they

would be virtually indistinguishable. In fact, in a small boggy area of the pygmy forests near Fort Bragg on the Northern California coast, many carnivorous plants from around the world have been introduced, much to the annoyance of ecological purists. Once privately owned, this bog is now managed by the Nature Conservancy. Although the only native carnivorous species is *Drosera rotundifolia,* plants that have been introduced and have been growing well for many years include Venus flytraps from North Carolina, many *Drosera* species from South Africa, Australia, and Asia; *Sarracenia* from the southeast of North America; *Pinguicula* from Europe; and *Darlingtonia,* whose native habitat is found a few hundred miles to the north of Fort Bragg. Even *Heliamphora,* from Venezuela, survived—until the plants were stolen!

The above example illustrates that many CPs grow in habitats so similar to one another that cultivating the plants is simplified by an understanding of a few general facts. Carnivorous plants typically inhabit wet, low-nutrient soils through which water may be slowly moving. This moving water usually carries away what minerals there are in the soil, which explains why it tends to be low in nutrients. The soil is often sandy, with a ground cover of patchy mosses such as sphagnum, which turns into peat as it ages. The habitat is often sunny, and the few trees are commonly stunted due to the infertile soil. Pines or other evergreens, whose needle-droppings may further add to the soil's acidity, are most common in such habitats. Grasses are also common. In short, a wet, low-nutrient, sunny environment is preferred by most CPs. The only major difference between habitats, usually, is the climate.

SOILS

Specific soil recipes will be offered in the section on genus cultivation. Here I will discuss the individual ingredients used in most artificial soil mediums for carnivorous plants.

Peat Moss

Peat moss is probably the most important soil ingredient for most CPs. It must always be sphagnum peat moss; the word "sphagnum" must always appear on the moss' packaging. Peat moss is usually sold in packages ranging from small bags to large, dried, bricklike bales. It is commonly of Canadian, Irish, or German origin. It is a fibrous moss, with

Soils

TOP: Soil ingredients for carnivorous plants. *Left to right, top:* Pumice, lava rock, perlite. *Bottom:* Peat moss, sand, vermiculite.

LEFT: Dried long-fibered sphagnum moss is on the left. On the right is decorative green moss-lethal to carnivorous plants.

a consistency close to a fine sawdust, and from light to dark brown in color. It is available in most general nurseries, usually as an additive for garden soils. It is what many carnivorous plants grow in naturally. Sphagnum peat is very acidic, usually with a pH between 3 and 5. (On a scale of 1 to 14, a pH of 7 is neutral.) It can hold as much as ten times its own weight in water.

Peat moss should be broken up until it is similar to sawdust before it's used, with all lumps and clods gone. It should then be mixed with water until it resembles a soft, wet mud. Then it is ready for use. Avoid sedge peat or Michigan peat, which are entirely different substances. If the package doesn't say "sphagnum," don't use it!

Long-Fibered Sphagnum Moss

This is a problematic soil ingredient for two reasons. The first is that what is sold in most nurseries is often not sphagnum moss at all, but decorative green moss or "Oregon sheet moss." "Sphagnum moss" has unfortunately become the generic term used for any dried, fibrous moss used in horticulture. Decorative moss is often used as a basket liner or topdressing for potted plants, as is true sphagnum. Worse, I have seen packages of decorative green moss actually for sale as sphagnum moss. I have seen many CPs killed because decorative green moss was mistaken for true sphagnum.

Further complicating the situation is the confusion between long-fibered sphagnum and sphagnum peat. Sphagnum moss, usually greenish or reddish in color, grows along the surface of the moss bed in a typical bog. It grows in long, ropy strands, with the growing head of the strand at the bed's surface. These strands can be rather lengthy, extending deep below the surface of the growing tips. Only the first few inches at the surface are colorful and alive. Underground, the moss turns brown and a couple of feet below decomposes into sphagnum peat moss. The peat may extend quite a way underground and may be hundreds of years old. Testifying to the sterile conditions of the moss is the fact that centuries-old, virtually unspoiled human bodies have been found deep within peat bogs in Europe.

Long-fibered sphagnum usually refers to the dried, ropy strands collected from the moss bed's surface. Sphagnum peat is the decomposed moss harvested from deep underground. In soil recipes for most carnivorous plants, it is the more reliably labeled peat moss that is the preferred ingredient. For the few plants preferring long-fibered sphagnum moss, be sure you obtain your moss from a knowledgeable dealer. When in doubt, use the peat.

There is another item, available less frequently in specialty nurseries, known as New Zealand moss or New Zealand sphagnum. It is most often available through orchid dealers, as this moss is a recent favorite of orchid growers. New Zealand moss is a true, long-fibered, high grade sphagnum from the alpine bogs of that country. It is cleaned and sterilized before export, and is an excellent medium for plants that prefer long-fibered sphagnum. It is pale yellow in color, and is resistant to decomposition. Unfortunately, it is also very expensive. I have found that

domestic long-fibered sphagnum, often sold uncleaned with twigs and leaves interspersed, works just as well and is much more affordable.

Live Sphagnum Moss

Living sphagnum is a beautiful moss...lush, billowy, and colorful when well grown. Many carnivorous plant growers love the sight of bright green or red sphagnum covering the soil surface of a potted CP, even if it isn't used throughout the whole pot. Live sphagnum can be induced to grow as a topdressing to peaty, wet soils, although sometimes with difficulty.

The drawbacks to live sphagnum are many. First, it is difficult to obtain commercially. Second, it grows slowly. Third, when it does grow, it will easily cover up small plants like Venus flytraps, causing them to rot. Fourth, it is difficult to maintain. Hot sun will burn the growing tips and the lightest application of fertilizers or minerals can cause algae growth and death to the moss.

Among my own plants I have found that the only reliable place live sphagnum will grow for the long term is as a topdressing in pots of highland *Nepenthes* or similar genera that receive frequent overhead sprinkling with purified water. Live sphagnum will not survive for more than a year in hothouses, as the moss usually grows in cool alpine climates or climates with cold winters.

Live sphagnum will also usually grow well outdoors in climates that are humid and receive lots of rain. It will succeed in very wet bog gardens and, for instance, undrained tubs of tall Sarracenia. Since this is a live "soil" that grows, trimming will be needed to keep it from crowding smaller plants.

Dried, unsterilized long-fibered sphagnum can be encouraged to grow if you follow the above suggestions. Dormant spores in the moss will germinate if the moss is kept cool and very wet. Place some well-soaked, long-fibered sphagnum in an airtight plastic bag or in a seed tray covered with a clear plastic dome lid. Place it in a cool, bright area, and after many weeks the moss should start to grow.

Milled Sphagnum

This is dried, long-fibered sphagnum moss that is shredded to the consistency of fluffy, coarse sawdust. Usually sold as a medium on which to germinate seed, and resistant to the dreaded damp-off fungus that

attacks seedlings in damp environments, it would be excellent as a peat substitute were it not so expensive.

Peat Pellets

These are condensed beads of sphagnum peat moss, most often used to filter the water of acid-loving fish in aquariums. It can serve as a medium for some CPs rather successfully.

Sand

All sand used in soil recipes for carnivorous plants should be sand that has been well washed. Nurseries and garden centers usually have washed silica or other sands available for use with potted plants. Washed "play sand" meant for use in children's sandboxes is also good, and is often sold in plant nurseries. Avoid self-collected beach sands or river sands, which are often contaminated with mineral salts.

Perlite

Perlite is a mineral rock that is heated until it expands, creating a lightweight, granulated soil additive that will hold both water and air. Usually white in color, it is available at garden centers. Fine and medium grades are preferred for most CPs. As it is sterile, it adds no minerals to the soil.

Pumice

Another lightweight, airy, sterile rock used in horticulture. It's usually gray in color.

Lava Rock

This volcanic rock is sterile, reddish brown in color, and available at most garden and landscape centers.

Vermiculite

This is a mica, processed similarly to perlite and serving a similar purpose. It is usually a golden-brown color. Since most vermiculites contain some minerals (such as magnesium and potassium), it is used less often for most CPs but is excellent for a few varieties that grow in slightly richer soils, such as Mexican butterworts and *Nepenthes*.

Orchid Bark

Available at most garden centers, this is usually the bark of evergreen trees. Popular for orchids, it is helpful in soils for *Nepenthes,* among other CPs, and makes a decorative topdressing on peaty soils used for plants such as *Sarracenia*. A fine-grade bark is preferred by CPs.

Shredded Bark

Similar to orchid bark, this is shredded to the consistency of confetti.

Osmunda or Tree Fern Fiber

This natural material is usually blackish brown in color and has a consistency not unlike broken toothpicks. It is used to aerate soils.

Charcoal

Only charcoal meant for horticultural purposes should be used. Charcoal is rarely needed for most CPs, but it is helpful to aerate soils enjoyed by plants such as *Nepenthes*. It is also sometimes used in soils for terrariums. Charcoal is known to neutralize chlorine and is found in CP habitats that commonly burn in the wild.

Rock Wool

This interesting substance is sometimes used for plant propagation, especially in cases where stem cuttings are used. Rock is liquefied and spun into lightweight fibers, then usually molded into small bricks. Difficult to find in the general nursery, it can sometimes be obtained through specialty houses. Bricks of rock wool retain moisture, and stem cuttings of *Nepenthes* root well in it. The entire brick is later planted in soil.

WATER

This is probably the single most important issue concerning the cultivation of carnivorous plants. Generally speaking, CPs require water that is low in dissolved mineral salts, and they usually need lots of it. Dissolved minerals are usually indicated upon analysis as p.p.m., or parts per million. Water used for the cultivation of carnivorous plants is safest for the plants when it is below one hundred p.p.m. of dissolved solids, and the lower the better. It is the use of hard, mineral-laden

water that most often causes carnivorous plants to decline in cultivation. Since the majority of CPs are grown in basically undrained conditions, constant use of hard water continually adds minerals to the soil. Since CPs are adapted to grow in low-mineral soils, roots will begin to rot and the overall health of the plant will suffer when dissolved minerals are left behind as water evaporates or is absorbed by the plant. The more you water, the more minerals you add to the soil.

Some public water systems supply water that is naturally low in minerals, depending of course on where you live and where your water comes from. Your water company can supply you with an analyses of your tap water, or you can have it analyzed at a farm-supply business or pharmacy. Some folks mistakenly believe that boiling water or allowing it to sit out in an unsealed container for a day or two will allow the minerals to magically disappear. This is not true. The only thing that will vanish from the water with such treatments is the dissolved chlorine gas that is added to water to kill bacteria. The minerals, unfortunately, are left behind.

A reverse-osmosis water purifier

If you have hard tap water, the best water to use for carnivorous plants is collected rainwater or water that has been demineralized or purified. If you live in an area of frequent rainfall on a year-round basis, you can collect this water for use with CPs. Be sure, however, if you collect rainwater from the gutters on the roof of your house, that your roof has not recently been treated with fire retardant or other chemicals. In other situations, it is best to buy purified water or purify it yourself. For a small selection of plants, such as those in a terrarium under grow lights, water demand may not be high and you can purchase purified water from a grocery store or water machine.

Commercially bottled water has become a big business (in the United States, at least) as consumers have become wary of public water being contaminated and unsafe to drink. But this does not mean that

any bottled drinking water you buy in a store is safe for carnivorous plants! Often, bottled drinking water is purified and salt is added to improve the taste. (Purified or distilled water can taste rather flat.) So if you buy prebottled water, make sure the water is distilled or specifically states that it is low in sodium. Do not use mineral water, mountain water, or spring water, unless the label states it has been purified or is low in sodium.

If you purchase your water from a water machine, make sure you are buying low-sodium water. Some water machines offer a choice of salted drinking water or purified, low-sodium water. Always choose the latter. If you have bottled water delivered to your home or business, again, this is most often water that has been purified and has then had salt added to improve the taste. You can often request low-sodium water from the vendor who supplies your prebottled drinking water.

If your water use exceeds more than a couple of gallons a week, the only answer is to purify your own. Distilleries are impractical for home use, as much fuel is needed to boil water to evaporation and recondense it as distilled water. Much more practical is a reverse-osmosis unit to produce your own purified water. Reverse-osmosis (R.O.) systems used to be expensive and hard to find, but in recent years prices have gone down dramatically and under-the-sink units are available in most large home-supply and hardware stores, or at some specialty plant nurseries.

Most under-the-sink units run tap water through particulate canister filters, then through the R.O. membrane, which "squeezes" the water through a fine micron filter, separating the good, purified water from the bad, mineralized water. The former is collected in a tank under the sink, while the latter goes down the drain. The collected purified water, about 99 percent free of dissolved solids, is usually accessible through a separate faucet on the sink. A typical system of this sort will produce between three to five gallons a day of pure water. The wastewater can be as much as five to ten times the amount of pure water collected.

No-frills R.O. systems can be purchased through nurseries or magazines catering to people who need pure water for plants, such as orchid and CP growers. These units are hooked up to hose bibs in the garage or a protected place outdoors. With these simplified units, the user collects the purified water in his or her own bottles, water tanks, or clean plastic waste cans. The wastewater is either allowed to go down a sink

drain or run out via a tubing for use in the general garden. (Most garden plants are unaffected by the concentrated minerals, and rain will leach them away.)

R.O. units of either type should have their particulate prefilters changed every three to six months. The R.O. membrane itself will need to be replaced every two to four years, and is usually available through the supplier. If your water is chlorinated, you might prefer that at least one of the prefilters be charcoal-based to neutralize the dissolved chlorine gas in the water. Otherwise, let the purified water sit in an open container for a day or two and the chlorine will dissipate on its own.

The life of an R.O. membrane can be extended if your tap water first goes through a conventional water softener. However, the water softener adds salt, so using softened water directly will kill your plants rather quickly. Once water from a softener goes through the R.O. unit, all of the added salt will be removed.

Since water purified through reverse-osmosis is good not only for plants but for people too, I should add a cautionary note. Never let R.O. water meant for drinking sit out unrefrigerated for more than two days or so. Airborne bacteria, harmless to plants, may contaminate the water and make you ill. Always refrigerate R.O. water intended for human consumption.

THE WATER TRAY METHOD

Since most carnivorous plants need to grow in soils that are permanently wet, the easiest way to accommodate them is to grow the plants in pots that have drainage holes at the bottom, and set the pot in a saucer or tray that always has some water in it. The majority of CPs are happy when approximately one inch or so of water is maintained in the saucer at all times.

There is a wide variety of containers that can be used as a water tray, and unless you are around your plants all the time, or have a dependable person to water your plants when you are away, I recommend you search for rather large saucers to accommodate your plants.

In the greenhouse, most collectors use large, undrained seed flats that can hold several pots and are around two inches in depth. For single pots, regular saucers may be used but should be one or two sizes larger than normal so it will hold as much water as possible. There are

plastic saucers available that are extra deep, often as deep as the pot, and these are excellent for most CPs. Extra deep saucers are often used for houseplants whose pots sit in decorative baskets. They make great containers for pots of CPs because water can be flooded to the top of the pot and allowed to gradually evaporate before you add more. Not only will you have to add water less frequently, but this technique mimics the habitats of those carnivorous plants that live in soil waterlogged after heavy rains. As the water table drops, oxygen will permeate the still-wet soil.

So-called self-watering pots, sometimes used for plants such as African violets, are generally unsuitable for CPs. These pots work with wicks set into a water tray. They will keep the soil lightly dampish, which is fine for most houseplants but not wet enough for most CPs.

Avoid using clay saucers, unless they are glazed and therefore waterproof. Plastic water troughs can be decorative and large enough to hide the pots themselves. Busboy and dish tubs may not be attractive, but can serve the same purpose. The same goes for clean kitty litter trays.

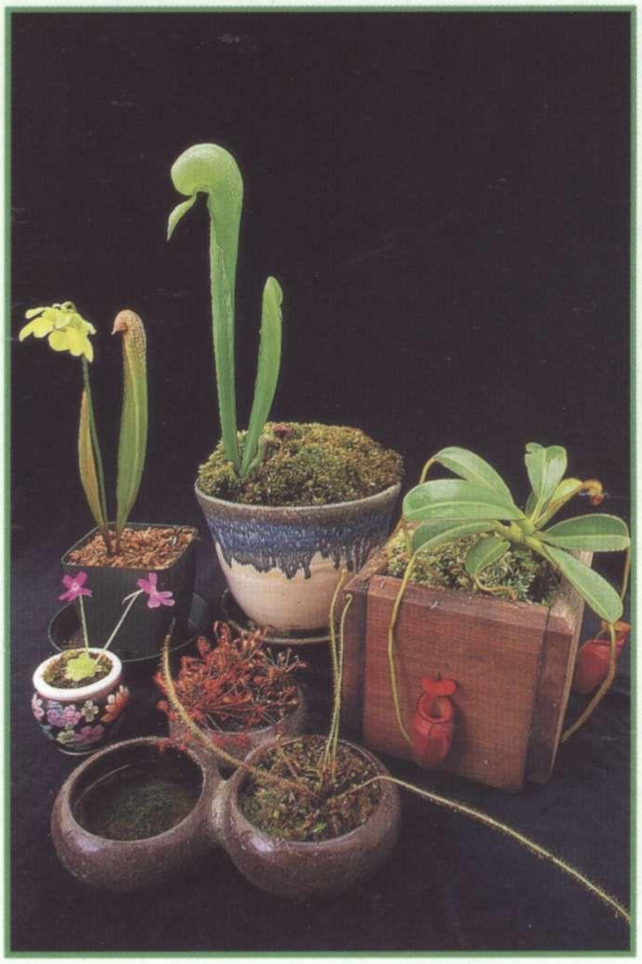
Pottery and Containers

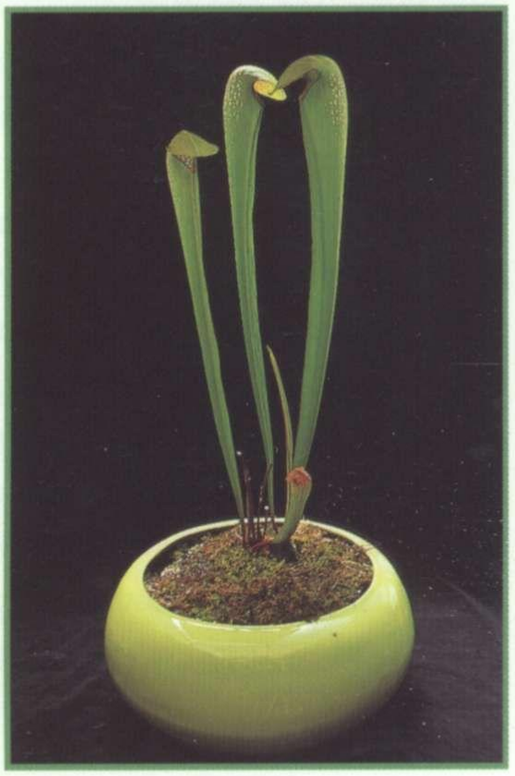
Generally speaking, plastic pots are usually best for carnivorous plants, but as we will later see in the section on genus cultivation, there are exceptions to this rule. Terra-cotta clay pots are usually avoided for several reasons. Evaporation will be high through the porous material, and clay can absorb harmful mineral salts that may accumulate in the soil. Also, since the soil is usually kept rather wet, unsightly and slippery algae and mosses may grow on the pot's surface. However, you will see in Part Three, on individual varieties of CPs, that there are a few plants that will actually prefer terra-cotta clay pots.

On the other hand, clay pottery that has been glazed makes very attractive and suitable containers in which to grow CPs. Glazed pots may be of the type with holes in the bottom, which can then be set into a saucer of water. But some CPs, such as *Sarracenia* and most *Drosera, Utricularia,* and *Pinguicula,* will also thrive in undrained pottery that has been glazed.

Although the tray system is the most common method used to grow carnivorous plants, it certainly is not necessary if you grow the plants

Pottery and Containers





LEFT: Containers for carnivores. *Clockwise from upper left: Sarracenia minor* in a plastic pot and saucer; *Darlingtonia* in a glazed ceramic pot and saucer; *Nepenthes villosa* in a wooden box; an undrained, glazed ceramic with *Drosera intermedia, D. filiformis* ssp. *filiformis* and *Utricularia gibba; Pinguicula moranensis* in an undrained ceramic teacup. ABOVE: *Sarracenia minor* "Okee Giant" in an undrained glazed ceramic bowl.

in undrained containers. These containers should be waterproof and made of materials such as plastic, glazed clay, or glass. Containers that are wooden may be lined with a durable sheet plastic, thus making them both undrained and waterproof. When CPs are grown in an undrained container, the soil should remain wet at all times. The water table should be allowed to fluctuate somewhat, from waterlogged to damp, so that air may be allowed to enter the soil.

Undrained containers are certainly not suitable for all carnivorous plants. *Nepenthes,* for instance, always requires wet but well-drained soil, and Venus flytraps and the West Australian pitcher plant generally despise undrained containers unless they are particularly deep. In

short, while almost all CPs grow in wet soils, the degree of that wetness may vary from genus to genus.

Natural Light

Only rarely will you find carnivorous plants growing in the wild in deep, dense shade. Although a few tropical pitcher plants may grow in the shade of a forest canopy, and several butterworts may be protected from sun by growing in shaded grottos of dripping, wet rock, the vast majority of CPs are found in open, sunny habitats. The occasional pine tree or tall grasses may offer partial shading in some instances, but for the most part sunlight is as important to many carnivorous plants as wet, acidic soil.

Let me be clear about what I mean when I use the terms "sunny," "partly sunny," and "bright shade" throughout this book. By "sunny," I mean that the plant will do well outdoors in full sun for most of the day. On a windowsill, sun should shine directly onto the plants for at least a few hours. A greenhouse should be in full sun most of the day, even when shadecloth is applied. "Partly sunny" conditions means that direct sun should bathe the plant for at least two to four hours, the rest of the time being spent in bright shade. "Bright shade" means intense light, but direct sun should not hit the plant for more than an hour or so each day.

How much sun your plants should receive may be influenced by where you live and how you grow them. In the northern hemisphere, east-facing windowsills receiving morning sun are generally less hot and burning than a west-facing window receiving afternoon sun. Some plants will look lush and beautiful at the former location, yet may burn at the tips and suffer low humidity at the latter. A trumpet plant outdoors in full sun in a humid state like Georgia may be lush and green, but a grower in California may find that the low humidity dries out the plants in the afternoon sun. The Californian will have healthier plants when they are exposed to sun only in the morning, or protected by a canopy of shade cloth in the afternoon.

Photoperiod (the length of time a plant is in the light) is an important part of natural lighting. This light does not necessarily mean direct sun. Along the equator, the daylight/darkness period is more or less evenly divided, with roughly twelve hours of daylight and twelve hours

of darkness. In a temperate zone, the daylight/darkness ratio changes season to season as the earth spins along its axis of rotation, so a *Nepenthes* from the tropics may receive an evenly divided day and night period through much of the year, while a Venus flytrap from North America may receive fifteen hours of light in summer and only nine hours of light in winter. This is very important when a grower is considering the dormancy or rest period of temperate carnivorous plants. Some people may think that cold weather is what makes a temperate species hibernate, but that is only half of the story. The length of the daylight period is the story's other half. Photoperiod also influences other things in the life cycle of plants, such as flowering times and the formation of reproductive brood bodies, as in the pygmy sundews.

DORMANCY

Dormancy in plants is rather similar to hibernation in animals. Many carnivorous plants go dormant during adverse seasonal conditions. Most temperate plants that grow in climates with cold winters and short daylight periods lose their leaves and stop actively growing during this time. As the weather warms up in spring and the photoperiod gets longer, the plant resumes its growth.

Dormancy can also take place for other reasons. As we will see with plants such as tuberous sundews from western Australia, almost the opposite occurs. Some plants actively grow during the cool, wet winters, and then go dormant as the days get longer, heat increases, and the winter-wet soils dry out.

Dormancy is crucial to many carnivorous plants. *Left to right: Sarracenia oreophila* showing characteristic phyllodia, *Drosera filiformis, Dionaea m., Sarracenia rubra* ssp. *alabamensis.*

Dormancy in carnivorous plants that require it must be respected and permitted to occur. Otherwise, the plant may die. A temperate Venus flytrap, for example, grown in tropical-like conditions such as a

warm terrarium with grow-lights operating permanently on a sixteen-hour photoperiod will eventually get sickly and die.

Winter dormancy in temperate carnivorous plants generally requires two things: a shortening of the photoperiod and a cooling of the temperature. For plants requiring a summer dormancy, usually a drying out of the soil is crucial. Other varieties, like most Mexican butterworts, change from a carnivorous habit during wet, hot summers, to a noncarnivorous stage of succulent-like growth during the cooler and drier winter months, when most of the subtropical zone experiences a drought.

For the most part, if left alone and if grown in the proper environment, carnivorous plants will go dormant on their own. Allow them to do so; you should never force a carnivorous plant into growth during a season when it should be resting.

People who live in tropical places often wonder if they can grow temperate plants there. The answer is yes, sometimes, if some extra effort is made to accommodate a plant's cool rest period. An American pitcher plant, for instance, grown outdoors in a warm, subtropical place like Hawaii, may need to be uprooted, put into a plastic bag, and refrigerated during the winter. If the Hawaiian gardener lives in the cooler highlands, the temperature drop and shorter daylight period in winter may be sufficient to carry his or her plant through its winter rest period. Cool basement windowsills may offer a similar environment.

Artificial Light

You live in a fifth-floor apartment in, let's say, Quebec, Canada, and all of your windows face north and are sunless. You have no patio to summer-grow your plants, and the fire escape is in permanent shade. Can you still grow carnivorous plants? Yes. In fact, even if you live in a dark basement or a densely shaded house in a redwood forest, carnivorous plants can thrive even in the darkest of corners. The solution is to grow them under artificial light, which can be done with or without a terrarium.

There is no doubt that the easiest and most affordable way to artificially light carnivorous plants indoors is to use fluorescent grow-lights. Equally good, but more expensive, are the Halide and sodium incandescent bulbs specifically meant for growing plants. These high intensity lights are more suitable for growing taller plants in a larger area.

Bulbs can be purchased of such high wattage that an entire room can be turned into a jungle, although you may have to sell the rest of your house to keep up with your electrical bills!

If you wish to use fluorescent lights, the most convenient size are the 40-watt, 48-inch-long tubes that will fit into 4-foot-long "shop-light" fixtures. These fixtures will sit comfortably on top of a 55-gallon "long" aquarium, or may be supported by other means if you don't wish to use a tank. Smaller size tubes are also available. You may use brands such as Vita-Light, Gro-Lux, or GE Plant and Aquarium Lights for a good spectrum for plant growth. Use a minimum of four bulbs for a 55-gallon tank. Two bulbs can be used over 20-gallon tanks. It is a good idea to surround most of the growing area with reflectors such as mirrors, Mylar, white cardboard, or other material that will reflect otherwise lost light back onto the plants. More will be said about this under the section on terrariums (page 41).

There is a common misconception about how far below the fluorescent lights the plants should be. The lights should generally be no further than ten to twelve inches above the pots, and even closer is better. Naturally, this means that tall plants such as mature *Sarracenia* are usually unsuitable for fluorescent grow-lights.

Halide and sodium lights, on the other hand, typically begin with a wattage of 175, and can be suspended about 24 inches above the pots. One 175-watt bulb will give you a growing area of about 6 square feet. Higher wattage bulbs will, of course, give you more growing space.

High intensity bulbs, because of their brilliance, are not the type of lights you would use, say, in a living room, unless you enjoy sitting next to a supernova! Usually growers will suspend these lights over tables in basements or large closets, as the light will be rather distracting elsewhere.

One form of grow-lights I cannot recommend for carnivorous plants are GE Grow and Show light bulbs, which are funnel-shaped, blue-tinted incandescent bulbs used for houseplants. The heat produced by these lights is too strong and the plants need to be too close to them for good growth. Plants such as sundews will dry out and be burned by them.

If the humidity in your home usually remains above 50 percent, many carnivores, such as Venus flytraps, Mexican butterworts, sundews, and most pitcher plants, will do fine out in the open and will not need

a tank or aquarium. However, most CPs appreciate the higher humidity provided by such enclosures, especially the tropicals. We will discuss this further under the section on terrariums, beginning on page 41.

Feeding Your Plants

"I gotta find food for Master. Food I gotta find for Master. For Master I gotta find food."

—Seymore Krelborn, *Little Shop of Horrors,* 1960

In horticulture, feeding one's plants usually means the application of fertilizers. With carnivorous plants, of course, we are speaking literally!

If you are growing your plants outdoors, feeding them certainly won't be necessary. CPs will lure, catch, and eat numerous insects outdoors on their own. Flies, ants, gnats, moths, beetles—the different plant species will attract and feed on prey similar to those they lure in their natural habitats. Flying insects usually are the most common victims. But even ants won't necessarily be saved by the water trays that surround the pots. Older trumpet leaves may lean over and touch the ground, providing a bridge for ants to cross. Some folks I know purposely put twigs or sticks across water barriers to entice crawling insects to visit their potted plants—a visit the insect may later regret.

Be warned, however, that bridges to pots set in water trays will also allow certain pests access to your plants, and a slug may eventually be caught in a flytrap only after having munched a few holes in a tender and newly emerging *Sarracenia* leaf.

Outdoors, some carnivores will catch such large quantities of insects that the result can be startling. A sundew's leaves may be black with gnats, every flytrap leaf may be shut tight upon flies, and American pitcher plant trumpets may topple from the weight of

An autopsy on *Sarracenia* proves they are gluttonous pigs.

hundreds, if not thousands, of prey. Sometimes the pitiful buzzing of trapped yellow jackets or flies may be unsettling to some people. The sensitive should never peer down the tube of a trumpet plant that is infested with ants and flies. The ants, quite insane by their predicament, will be merciless toward the helpless housefly who tumbles into their madhouse prison. At times, I have been so disturbed by their suffering I have freed ladybugs and even yellow jackets from an agonizing death.

And speaking of ants, I have a warning: Ants in a greenhouse will not only provide ample food for American or tropical pitcher plants, they will also sometimes begin to cultivate some of their own food, namely scale insects and aphids, from which the ants extract honeydew. This may be a revenge tactic of the ants: plant eats ants, ants farm scale on plant, scale sucks juices from plant, ants feed on scale honeydew. Nature works in funny ways.

Ants in the greenhouse are often of the nomadic sort. A queen may set up a nest in a potted *Nepenthes,* wondering where all her workers are disappearing to. (I have never found ant nests to do any particular damage to the roots of a potted CP.) When the pot is watered, the whole nest swarms in a panic, carrying eggs and pupae out of the deluge. They promptly move the nest to another pot, or return when the water drains.

If you have ant nests in your potted greenhouse plants, keep an eye on them. At the first sign of scale, you will have to use an insecticide, or you may want to discourage the ants by laying a few flea collars around the infested pots to keep the ants away. You'll find more about this under the section on pest control, beginning on page 25.

For plants grown in insect-free areas, you will have several possibilities of how to go about feeding them. One method is to simply hand-feed them. Usually, forceps or tweezers are helpful: if you catch a fly yourself, it is usually much easier to apply the doomed insect by means of forceps into the maws of a Venus flytrap, because you will have to stimulate the trigger hairs within the trap; you cannot simply drop the fly in. Often the fly escapes just as the trap closes, which is as cruel to the plant as stealing candy from a baby. Be sure to wash your hands after handling germ-ridden flies, and urge children to do likewise...or feed plants cleaner food such as sow or pill bugs.

Many CPs eat tiny insects. You can gather small ants from an ant trail on a sidewalk with a damp paper towel and drop them into a paper

cup. Your neighbors may think you strange, but if they know you grow carnivorous plants, they probably think you're strange anyway! You will have to separate the ants from the grains of sand and other debris. Then the ants can be sprinkled on plants such as sundews or butterworts.

The unhappy face of an earwig as it is digested alive

Alternatively, some windowsill plants may be placed outdoors temporarily to catch their own food. Be careful not to place them in an area hotter or sunnier than their normal environment, or the plant may burn or go into shock. Shade is best for a windowsill plant placed outdoors for "the hunt."

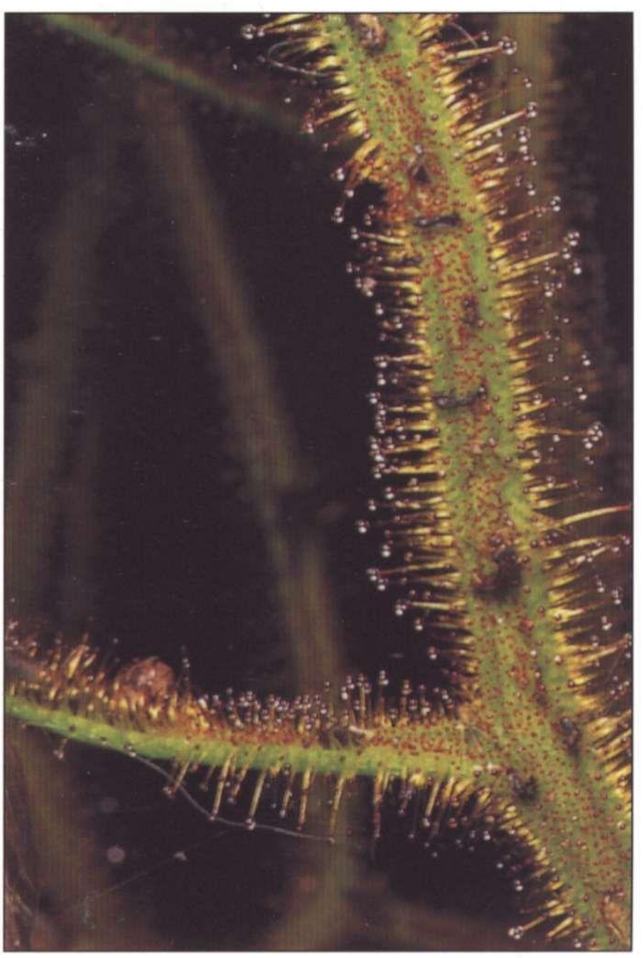
Aquatic bladderworts typically feed on minute swimming things such as daphnia (water fleas). You can collect these in almost any pond or lake with a paper cup, then add the contents to the water bowl where you grow your *Utricularia.*

Perhaps the easiest way to feed most carnivorous plants grown in an insect-free environment is to visit your local pet shop. Here you will usually find a great assortment of insect food, particularly if the shop caters to reptile and amphibian fanciers. Live crickets, from pinhead-sized newborns to adults, can be used to feed various plants from Venus flytraps to pitcher plants. Wingless fruit flies can be fed to sundews, butterworts, rainbow, and other sticky plants. Mealworms will drown quickly when dropped into various pitcher plants, but make sure they don't escape or they may infest your soil.

You can also freeze these insects for future use, whether you purchase them or catch them yourself. If feeding your plants live insects makes you feel ill or guilty, there is also an assortment of dried insect food available at good pet shops, which most carnivorous plants readily accept. Some are even vitamin fortified! Dried flies, musca larvae, and ant eggs will save you much fuss and bother. Even plants like sundews, which normally require some moving stimuli to activate the feed-

ing process, will soon curl around and drool over a dried insect applied to the leaf.

Carnivorous plants will also sometimes eat human food. (I am not suggesting you feed your plants humans, since this is highly illegal....) Some CPs will accept and even drool over tiny bits of raw hamburger, cheese, powdered milk, and even chocolate (female plants). But these food products may be harmful to your plant, especially if they are overfed. A sundew leaf may curl around a bit of Hershey's chocolate, soon secreting digestive juices and making a pig out of itself. But a few days later, mold or fungus may set in, so it is best to avoid such food as a regular part of the diet.



This staghorn sundew is a graveyard of insects.

Do carnivorous plants really need to eat insects for their health and well-being? The answer, in my opinion, is more of a yes than a no. Insect food is highly beneficial to most CPs in that it provides them with the extra nutrients they need to flower, set seed, and grow larger each year. When deprived of such nutrients and minerals, a gradual decline in the plant's health will occur over time. They may not flower or set seed. The following year the plant may grow weaker, and the year after that weaker still.

On the other hand, a *Sarracenia,* for instance, when going dormant in autumn, sends all of those minerals from the thousands of insects it has caught in its leaves down into its rhizome for winter. The rhizome swells, more offshoots develop, and more flowers are sent up in spring. The stored energy has to go somewhere!

This does not mean you have to feed your plants on a daily basis during the growing season. A once-a-month feeding schedule from spring through autumn will usually do the trick. A few houseflies for your flytrap or a dozen or so crickets for your pitcher plants will usually provide the plants with the minerals they need for good growth.

But you will probably notice that your healthiest plants are the ones that have eaten the most!

Fertilizing Carnivores

The basic rule of green thumb concerning the application of artificial fertilizers on carnivorous plants is: Strongly dilute the fertilizer and apply it as a foliar feed. That most noncarnivorous plants can absorb minerals through their leaves is well known in horticulture; spraying the foliage of plants with a fertilizer can be as effective as feeding through the roots. This is of course also true with carnivorous plants. Since most of their leaves are especially adapted to absorbing minerals through specialized digestive glands, artificial fertilizers can be as readily absorbed as insect prey. By applying fertilizers on the leaves and avoiding drenching the soils, you won't have to worry about changing the low-mineral content of the plant's preferred nutrient-poor medium.

I will offer specific fertilization recipes in Part Three of this book; here I will only suggest some guidelines. First, if your plants are receiving a steady diet of insects, it is probably not necessary to feed them. But you may want to supplement their diet in the hope of growing even more vigorous plants. Or, you may be using a terrarium and do not want to hassle with obtaining insect food. Or perhaps you wish to display a plant at an upcoming flower show, and would prefer to present a beautiful but "clean" specimen, without the carcasses of digested insects distracting from the beauty of the leaves. There are some varieties of carnivorous plants that certainly seem to benefit from a regular fertilization program. Others, however, seem to detest it.

There are many fertilizers on the market that have been developed for a wide variety of plants and purposes, and different products are available in different countries, but nowhere has a fertilizer ever been developed specifically for carnivorous plants. Therefore, we must select and experiment from the general forms of fertilizers available.

Fertilizers for Acid-Loving Plants

These are readily available in most general nurseries. They are used for plants that prefer an acidic soil, such as pines, firs, rhododendrons, and so on. Since many CPs grow in acidic soils, this form of fertilizer is useful. I have used it successfully on all *Sarracenia* species, *Darlingtonia,*

most but not all *Drosera,* temperate, acid-loving *Pinguicula,* most *Utricularia,* and *Dionaea.* Avoid it on tropical *Pinguicula* and most *Nepenthes.*

Orchid 30-10-10

This form of plant food is used to promote foliage growth, as opposed to bloom growth. I have used various brands on *Nepenthes, Heliamphora,* tropical *Pinguicula,* and most terrestrial *Utricularia,* and I believe it can be used successfully on most of the plants enjoying acidic conditions, as well.

Epiphytic Fertilizers

You may have to hunt for these in your nursery, as they are specifically developed for epiphytes such as *Tillandsias* and other Bromeliads. Many of these plants do not live in soils, and like carnivores absorb much of the nutritional requirements through their leaves, often in the form of leaf debris. These fertilizers were developed particularly to enhance mineral absorption through the leaves, and therefore can be quite beneficial to carnivorous plants. I have used brands such as Epiphytes Delight on virtually all carnivorous species, except those few that I will mention a bit later, which seem to dislike any fertilization regardless of the brand.

Generally speaking, fertilizers for carnivorous plants are usually best used when diluted to one fourth or one half of the manufacturer's directions. It can then be sprayed on the leaves of the plant until the foliage is wet. It is usually necessary to do this only once or twice monthly during the active growing season. (Do not fertilize dormant plants!) You can also apply fertilizer to the soil of some plants if they have good drainage and are watered frequently from overhead with purified water. Plants grown this way, such as *Nepenthes* in a greenhouse, will have excess minerals leached out of the soil every time the plants are watered. This avoids the much-feared mineral buildup. Otherwise, I would not apply fertilizers to the soil, especially in undrained containers such as bog gardens. Over time, the excess minerals will build up in the medium and possibly cause harm to the plants.

Some growers prefer to fertilize their plants more frequently using a more heavily diluted ratio. For instance, a 10 percent solution applied weekly to varieties such as *Sarracenia* can work well.

Be warned that by misting or spraying CPs with fertilizers, some will fall upon the soil surface and will subsequently encourage algae growth. The same is true of water trays, so it is wise to clean these periodically. Algae growth on soil can be scraped away with a spoon when the buildup becomes substantial, and fresh soil can be laid out to replace it. Mosses will often utilize the small amounts of fertilizers that fall upon it from mists or sprays. However, live sphagnum moss dislikes fertilizer buildup and usually only succeeds in pots that are frequently leached from overhead with pure water.

It is not wise or necessary to apply fertilizers directly into pitcher leaves. This can upset the delicate chemical balance of its digestive juices, and will often produce algae. Simply misting the foliage will benefit the plant enough.

Vitamin B-1 is a supplement for plants commonly available in nurseries, and found in the popular American brand Superthrive, which adds other vitamins and ingredients to its solution. These are not fertilizers as commonly supposed, and their use is often controversial among carnivorous plant enthusiasts. Some growers greatly applaud their use, while others find their benefits dubious. Personally, I have found products such as Superthrive quite good for carnivorous plants when one follows the manufacturer's instructions. Vitamin B-1 has long been used as a root-growth-promoting ingredient, primarily for general garden and houseplants. It is most often used when transplanting bare-rooted plants, and helps them overcome shock by encouraging root growth. Bare-rooted plants are usually soaked in a solution of ten drops per gallon of water for half an hour or so before they are put into soil. For general plant care, manufacturers of products such as Superthrive recommend a one-drop-per-gallon application with each regular watering. I have noticed that bare-root soaking of carnivorous plants in Superthrive or vitamin B-1 during the process of transplanting them can reduce losses due to shock. It is particularly helpful when moving tissue-cultured CPs from flask into soil. In my experience, losses due to shock were reduced considerably, if all other conditions were good. Keep in mind that a general application of such products in high doses will increase the growth of algae even more dramatically than is caused by the application of fertilizers. I would therefore not recommend high doses applied directly to soil.

CARNIVOROUS PLANTS AS PEST CONTROLLERS

I am often asked if insect-eating plants are suitable as pest controllers. Sometimes, yes, but more often...no.

Carnivorous plants are not the answer to problem insects in the home and garden. They will not zap mosquitoes around your patio, nor devour slugs and snails among vegetables. They are useless in combating aphids, mealybugs, or scale insects, and in fact are themselves often attacked by such pests.

But in a few limited circumstances, carnivorous plants may be somewhat helpful in controlling bothersome pests. In some situations where African violets, orchids, and other exotics are grown, a few sticky plants such as sundews or Mexican butterworts may be helpful in reducing fungus gnats, a bothersome insect when in its larval stage. Fungus gnats lay eggs on damp soil, which develop into tiny worms that may damage the roots of seedling plants. The gnats are very common among most plants, including cultivated carnivores, but usually are not harmful unless the plants are young and the infestation great. CPs will catch the tiny flying adults in large numbers, providing food for the plant. Terrestrial bladderworts also feed on the larva underground, sucking up the minute worms in their pinhead-sized suction traps. Mexican butterworts and some larger sundews have been known since the Victorian age to be grown in greenhouses as a gnat controller.

Yellow Trumpets love houseflies.

Whitefly can be greatly reduced in enclosed places like small greenhouses where a couple of large sundews in hanging pots are grown. An excellent species is *Drosera dichotoma* 'Giant', whose pale, yellowish green leaves attract whitefly.

One hobbyist told me she had great luck catching fleas in her house by using some windowsill- and terrarium-grown CPs. At night she

would place large butterworts and cape sundews in saucers on the carpet of the infested rooms. She would place a desk lamp or similar light close above the plants. The heat and light attracted the fleas, and the sticky plants would catch them. I tried this myself one bad flea season and was surprised at the positive result, although it is probably more beneficial to the plant than to any cat or dog!

Probably the most effective use for insect pest control are American pitcher plants. The trumpet varieties catch many houseflies and wasps, both of which find the *Sarracenia* irresistible. A trumpet plant on a deck, patio, or a sunny windowsill will catch a surprising number of such pests.

Restaurants with outdoor seating might benefit by having a pot of *Sarracenia* on each table instead of the usual cut flowers. The trumpet varieties can be a very ornamental conversation piece, and the plants will certainly lure and catch many flies. Good species to try would be *S. flava, S. rubra, S. alata,* and *S. leucophylla,* as well as hybrids of these.

Pests and Diseases

Even though carnivorous plants eat insects, there are insect pests that, will, unfortunately, eat carnivorous plants. There are also diseases that can attack CPs. To add further to one's anxiety, larger pests such as raccoons, squirrels, blue jays, and small children can wreak havoc on outdoor collections.

Do not despair. First of all, insect pests rarely kill CPs completely. Usually the infestation makes itself known to the collector fairly rapidly. Since the plants are so hypnotically beautiful, we barely can keep our eyes off our precious plants for more than a day! Secondly, despite our fears of chemicals, most are safe if one carefully follows the manufacturer's instructions. I strongly recommend isolating treated plants in large, airtight plastic bags or small tanks to make them even safer. I repeat: follow the manufacturer's instructions.

Let me also state something that is quite obvious to the most experienced and confident grower: sometimes plants die. Plants are not immortal. Most can be propagated and passed on generation after generation, but even redwood trees eventually die, even if it takes over two thousand years! A few carnivorous plants are annuals, meaning they only live a year at most. Many will offer decades of pleasure (I have one

Sarracenia purpurea that has been in my care for almost thirty years). Lastly, even if your cultivation techniques are meticulous, sometimes, for reasons inexplicably mysterious, a plant may kick the bucket for no apparent reason at all. But that is rare. The causes are usually obvious.

That said, let me mention a couple of points. The first is that whenever you obtain a new plant for your collection, inspect it thoroughly—even if you purchased it from a reputable nursery. Try as they might, no nursery is infallible. Secondly, if possible, propagate the plant immediately by taking some leaf or root cuttings. On rare occasions, plants may go into shock and decline in health when moved from one environment to another. Typically they come back with vigor after an adjustment period. For example, I have taken cape sundews and *Nepenthes* from my greenhouse nursery to a windowsill in my home. Occasionally the existing growing point on the plant stopped developing and went into suspended animation. After many weeks, after adjusting to the lower humidity and light levels, new shoots appeared at the base of the stems and grew beautifully. I then trimmed off the older tops.

Finally, I must admit that when compared to other plants, there is something a little odd about growing CPs. Because so many of them seem almost animal-like—they can appear to have faces and mouths, and most can be hand-fed—for many folks they become more like pets than mere plants! We project our own self-consciousness onto these plants and become emotionally attached to them. I have seen children weep over the demise of a beloved Venus flytrap whom they affectionately named Chuck or Cynthia. (Note that "whom" seems to fit better than "that" in the previous sentence!)

The Pests

Aphids

These are tiny, sap-sucking insects barely the size of a pinhead. They attack the newly developing leaves, and are the most common pests of CPs. Since females are born pregnant, they can spread faster than rabbits. Aphids can be green, brown, or even black. They are slow-moving and occasionally they fly. Ants like to farm them for their honeydew. Symptoms of an aphid attack are twisted, deformed leaves and sometimes whitish flecks of skin castings around the crown of the plant. They most frequently attack Venus flytraps, sundews, and American pitcher plants, among others.

Pests

CLOCKWISE FROM TOP: Aphid damage on a Venus flytrap. Mealybug on *Sarracenia*. Thripe damage on *Sarracenia*.

Fungus gnat

These tiny gnats provide a good food source for plants like butterworts and sundews, and their minute, wormlike larvae are eaten by terrestrial bladderworts. I rarely consider them a pest, as they live in almost any damp soil, but a bad infestation of the larvae in a pot may negatively affect the roots of plants. A spiderlike webbing may be seen on the soil surface, especially after misting.

Mealybug

Related to scale, this bothersome pest is the most difficult to eradicate when infestations are bad. Repeated applications of systemic insecticides are usually necessary to eliminate it completely. Mealybugs are slow-moving, soft-bodied, fuzzy little bugs that enjoy attacking pitcher plant rhi-

zomes and leaves. Symptoms of a mealybug infestation are fluffy dabs of cottony tufts among the growing points and older leaves of the plant. An excess of sooty mold (see page 31) is also a symptom.

Raccoons, opossums, squirrels, and blue jays

These can be an occasional hassle for outdoor plants. These critters enjoy playing with your water trays, carelessly tossing pots around, or digging in bog gardens in search of snails or winter storage caches. Jays love to collect shiny things like jewelry and sundews, and can also peck at *Sarracenia* to steal its bugs. I have no solutions to these problems, besides waiting for gene-splicing experiments to produce plants large enough to eat them!

Sarracenia root-borer and exyra moths

These two pests are found only in the southeastern United States, where they are a natural (and exclusive) pest of *Sarracenia*. The root-borer eats rhizomes of the pitcher plant, and is easy to spot due to the reddish orange piles of debris that appear above the rhizome. The moth attacks the pitcher leaves by sealing them up with a webbing at the mouth until the leaf crumples and withers. Both are easily controlled with insecticides.

Scale

Small, sucking insects that live under tiny, protective brown or tan oval shells barely larger than a pinhead. These clamlike shells won't move when you tease them, and are also farmed by ants. They can be scraped off the leaf, and those killed by insecticides leave their shells intact. They most often attack pitcher plants.

Slugs and snails

They occasionally chew a hole or two in newly developing pitcher plant leaves, but after ruining the leaf they seldom eat further, probably due to the taste. They can, however, ruin the appearance of butterworts and sundews, and love the bromeliad *Catopsis*.

Spider mite

The nightmare of plant lovers, this pest is only a problem in drier climates where humidity and rainfall are low. This minute pest appears as tiny red dots on the leaf, with a faint webbing not unlike that of spiders. I have only seen them on both *Sarracenia* and Venus flytraps in California during the dry summer months. Symptoms of a mite outbreak are vaguely similar to those of thripes (below), with a slight discoloration in leaf color and slow decline of the plant. Systemic insecticides are best.

Thripes

These pests attack pitcher plants, most commonly *Nepenthes, Sarracenia,* and *Darlingtonia.* These are very small, thin, black insects that move slowly while eating the surface cells of leaves. Symptoms are a silvery, "scraped" look on the leaf, with small peppery dots of their droppings. Easy to control with good pesticides, this irritating pest is damaging but not necessarily lethal.

The Controls

Many insecticides are harmless to carnivorous plants, but others can be rather damaging. Never use soap insecticides, such as Safers' Soap or Schultz Instant, as these products are alkaline and can severely harm your plants. Never use any insecticide from an aerosol spray can, as I have found the propellants to be rather harmful.

Listed below are some popular and easy-to-find insecticides that generally do CPs little or no harm. Occasionally, leaves of plants such as sundews may be damaged by prepared insecticides containing petroleum wetting agents, but the plants recover. Whenever possible, go for wettable powders, as these are mixed with water using no oils. Wettable powders are most often sold through agricultural supply companies.

Diazinon

Very good, particularly in wettable powder, but liquid brands with wetting agents (see above paragraph) such as Lily Miller appear fairly harmless.

Flea collars

Flea collars are a useful insecticide when placed in close proximity (such as in a small tank) to an infected plant. Don't let the collar come in contact with water saucers or soils.

Malathion

Another good insecticide, particularly in wettable powder form, but it may need reapplication, as it is not systemic. Good for all insect pests.

Orthene

This is the best insecticide to use, as it is systemic and absorbed by the plant, slowly poisoning the insects for many months. Excellent for mealybug, scale, thripes, aphids, and mites.

Sevin

Another good pesticide, best in wettable powder form.

Slug and snail poison

These powders and pellets are effective in keeping these pests under control. Avoid placing them on soils. Water trays and saucers provide good moats to prevent access of these pests. A slug captured by forceps makes a vengeful snack for Venus flytraps. Slightly crushed snails will provide ample vitamins for *Nepenthes*. Yum.

Some people wonder about natural controls, such as ladybugs (to eat aphids) or mealybug destroyers (beetles that eat, as you might guess, mealybugs). During an aphid outbreak one spring in my greenhouse nursery, we released ten thousand ladybugs to see what would happen. What happened was we found out that ladybugs make an excellent food for carnivorous plants, as all were eaten in about two days. Ladybugs were so drunk on the nectar of pitcher plants, we watched them stepping over aphids as they followed the nectar trails to their death. Members of a gardening group came by (timid growers of African violets, I believe) and, horrified at the wholesale massacre, promptly fled our facilities. The same result occurred when we tried the rather expensive mealybug destroyers.

Diseases

Diseases of carnivorous plants are thankfully few.

Black spot

This is similar to (or the same as; we're not sure) the disease fungus that attacks plants such as apple trees and roses. I have only seen it occur on Venus flytraps. As its name suggests, black spots appear on the leaves, gradually spreading until all the leaves rot away.

Rust spot

This fungi can cause reddish-orange spotting on *Nepenthes*. It rarely kills the plant, but can be unsightly.

Botrytis

This fungus is also known as damp-off disease. Fungus will most often attack newly sprouted seedlings and some rosetted sundews, among other plants. This most often occurs in terrariums that are overly humid, with

poor air circulation and low light levels. It can also occur in greenhouses, mostly in winter, when days are cool and overcast. Botrytis appears as a gray, fuzzy growth that usually attacks the crown of a plant. I have even seen it in the wild, killing sundews during dank winters. It loves the seeds of *Sarracenia* in late winter, just as they begin to germinate.

Fungicides to control the above diseases

Benomyl was a great control, but it was removed from the market in the early nineties. Check your nursery for Benomyl replacements. In the meantime, I have had excellent results with Captan. Captan is usually sold as a powder. Follow the manufacturer's directions to make a paste of this, which can then be dissolved in water and sprayed on the afflicted plant. Two other fungicides work well, particularly on black and rust spot diseases: Domain and 3336 Cleary. A distributor of these fungicides is V-J Growers Supply in Apopka, Florida. You can call them at (800) 327-5422.

Slime mold

This delightfully named pest is, I think, actually an algae and can grow in green, oozy puddles along soil surfaces. It is usually harmless to carnivorous plants, but is rather gross-looking and liable to lose you the blue ribbon at the county fair. Fertilizers and hard water encourage its growth. Scrape it off with a spoon and replace with fresh soil.

Sooty mold

This unsightly pest is actually harmless to CPs, and most often occurs on pitcher plants, where it feeds on nectar. True to its name, it looks like black soot. It can easily be wiped off with a wet towel. However, if sooty mold is produced in excess on *Sarracenia* or *Nepenthes,* it may be also feeding on the honeydew of scale insects and mealybugs, which is a warning sign that you may need to check for these pests.

Now a word about small children. If the pitter-patter of little feet is something you hear as you stare hypnotically at your carnivorous plants, make sure your CP growing area is child-safe. I will never forget the numbness in a friend's voice when he told me his toddler had pulled the plug on his greenhouse heater the night before a big freeze!