

EPSN Science Facts: Insect and Pitcherplant Interactions

Insect Profiles by Dr. Debbie Folkerts, Auburn University

Essential Question:

Are all insects inside pitcherplants being eaten by the plants?

Do some insects survive and live within pitcherplants?

Do some insects eat or otherwise damage pitcherplants?

What insects do pitcherplants eat?

How do insects and plants interact?

Getting Ready:

Below are thirteen vignettes or profiles about suites of insects that live within and among pitcherplants. These vignettes will help teachers and students identify the insects and understand their relationships with pitcherplant species.

Procedure:

Either print the following pages and their photos to use in the classroom and bog habitat garden or have the students use these pages while investigating insects and pitcherplant bogs on the computer.

The vignettes and photos can be used with a variety of EPSN curricular activities including the following.

1. What's for Lunch? Excuse me, Waiter. There's Cotton in My Throat!
2. Bog Checks: Pitcherplant Autopsy

Who is Dr. Debbie Folkerts?

Assistant Professor in the Department of Biological Sciences, Auburn University
Ph.D., University of Georgia, 1992.

Ecology and Natural History of Carnivorous Plants, Spiders, Plant/Animal Interactions

Research Profile of Dr. Debbie Folkerts (<http://www.auburn.edu/~folkedr/>):



“Pitcherplants of the genus *Sarracenia* (Sarraceniaceae) are insectivorous species that inhabit bogs and other wetland habitats. As many as 11 species have been described in this genus, all of which can be found in the southeastern United States. Three of these species are currently on the federal list of threatened and endangered species. The U.S. Fish and Wildlife Service has funded several projects to survey the status of the threatened species and their habitats.

My research in this area has two separate focuses. One is to elucidate the life histories and interactions of the several species of insect which are adapted to live in or on pitcherplants, feed on them or their prey, and

avoid entrapment. In some cases the populations of these insects have reached high levels in dwindling pitcherplant populations, and have therefore aroused concern in the management of the plant populations.

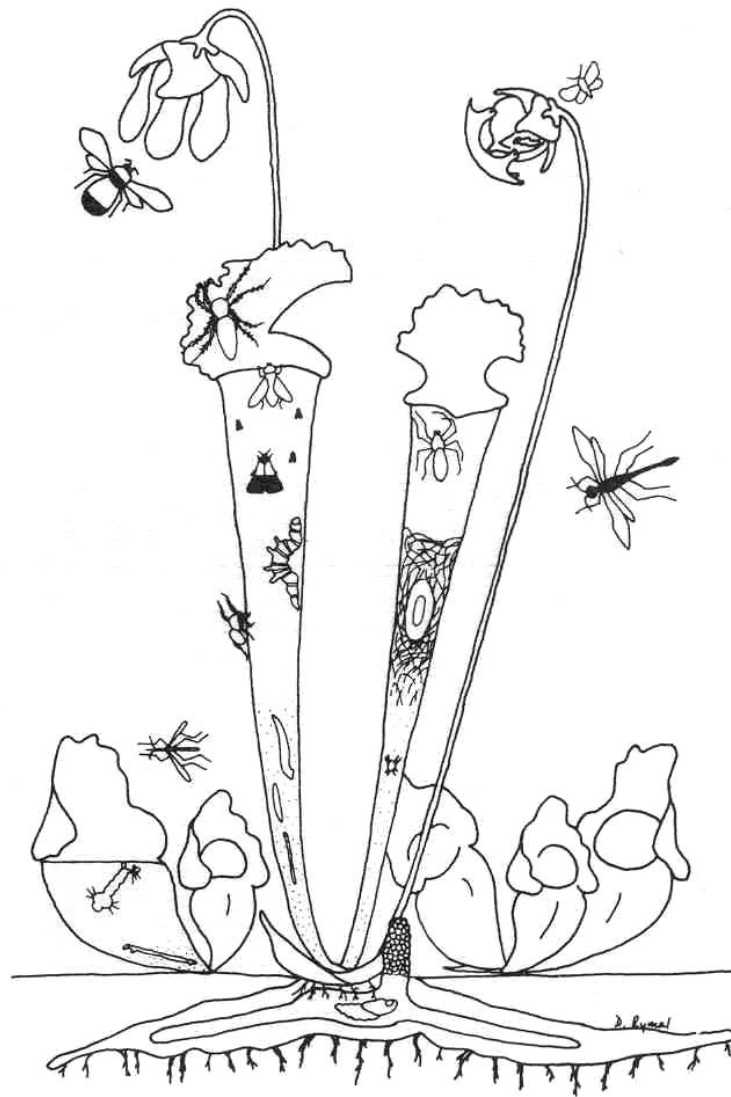
A second focus is on the interaction of insects as prey for the pitcherplants. *Sarracenia* species are morphologically diverse and possess several distinctly different trapping mechanisms. These trapping mechanisms allow pitcherplant species to specialize on specific spectrums of the insect prey available. Resource partitioning among the species has been indicated. Continuing research investigates the importance of competition for prey in several evolutionary processes evident in the group.

I am also involved in a long term project of surveying the spiders of Alabama. I have developed a preliminary checklist of the Alabama spider fauna. I am especially interested in the behavior and ecology of burrowing mygalomorphs in the southeastern U.S.”

Background Information:

Pitcherplant Insects

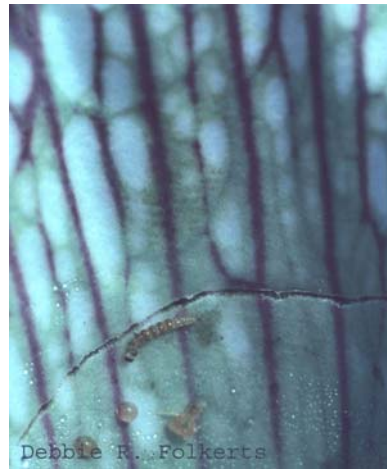
A great variety of interactions exist between pitcherplants and the insects that are associated with them. This drawing (diagram 1) depicts most of the insects and other arthropods that are commonly found in or on pitcherplants. Some of them are also found elsewhere, but many are dependent on pitcherplants for their survival. Some of them function as pollinators. Notice the queen bumble bee near the flower. There are herbivores that feed on flowers and fruits. Three species of moth live within the leaves of different pitcherplant species. They have caterpillars that live inside and feed on the leaves without becoming prey themselves. One moth species feeds as a caterpillar within the rhizome. A number of fly species develop as maggots that feed on the prey taken by pitcherplants. Leaves of the purple pitcherplant hold water and are home to the aquatic larvae of two species that live nowhere else. Numerous mites live within pitchers. A wasp frequently nests in pitchers and several spiders typically hunt for prey on the leaves. Among this group are those that are beneficial to the plants, such as prey and pollinators. Others like the spiders may have little effect on them. Some are clearly harmful while others interact in ways that are not easily understood. The numerous possibilities among them include: pollinators, prey, prey consumers, capture interruptors, herbivores and the parasites and predators of other pitcherplant associates.



**EPSN Science Facts Interactions Profile 1:
Pitcherplant moth - *Exyra semicrocea***

Pitcherplant moths are amazing animals. They seem to be the only insects that can walk up and down the slippery walls inside of pitcherplant leaves. This species may be found in any of the pitcherplant species. The black and ivory coloration of the adults seems vivid but may not be so easy to see when peering down into the shadows of a pitcher tube. All stages of the life cycle occur within pitchers. Male and female moths mate in an unusual position so that both can maintain a head upward-position (photo 1a). If they turn around, they will not be able to escape. Tiny white eggs are laid on the inner leaf surfaces just below the orifice. Young caterpillars (photo 1b), once they have hatched, feed in a girdling channel around the leaf causing the top of

the leaf to close over them (photo 1c). Older caterpillars may close the top of the pitcher by weaving a roof of silk (photo 1d). Caterpillars are beautifully colored with red and white bands and have lappets projecting from the mid-section the body (photo 1e). Usually, before pupating, caterpillars chew a tiny drainage hole to prevent flooding during this immobile stage of development (photo 1f). This species may be fairly abundant in some pitcherplant bogs and causes visible damage to pitchers (photo 1g), but they do not cause long term damage to the plants.





**EPSN Science Facts Interactions Profile 2:
Pitcherplant moth - *Exyra ridingsii***

This species of pitcherplant moth is found only in the yellow pitcherplant, (*Sarracenia flava*). The adults are easily distinguished by the black banded pattern on the wings (photo2a). The caterpillars (photo 2b) are not nearly as brightly colored as those of *E. semicrocea*. Most often the pupae are found hidden within the frass (caterpillar excrement) that remains in the bottom of pitchers that have been fed on by caterpillars.



**EPSN Science Facts Interactions Profile 3:
Pitcherplant moth - *Exyra fax***

This species of pitcherplant moth is found only in the purple pitcherplant (*Sarracenia purpurea*). Its geographic range extends all the way from the southeastern United States to the northern bogs of Canada. The adults (photo 3a) are variably colored but most often mottled in shades of red, yellow and grey. The caterpillars (photo 3b) are brightly colored but lack the projecting lappets found in *Exyra semicrocea*.



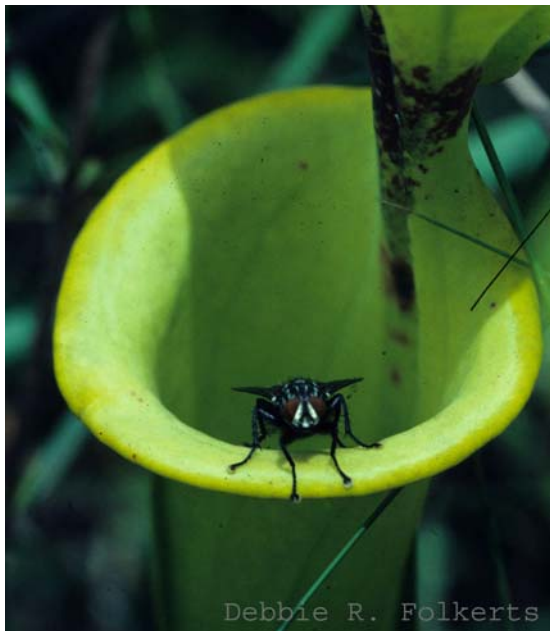
**EPSN Science Facts Interactions Profile 4:
Dark-winged Pitcherplant Gnat**

This tiny fly, *Bradysia macfarlanei*, belongs to the family of dark-winged fungus gnats (Sciaridae), but is found only within the leaves of pitcherplants. It is found most commonly in the white-topped pitcherplant (*Sarracenia leucophylla*). The adults are rarely seen because they are so small (photo 4a); but if you look inside the leaves within the mass of prey insects you can often see fly maggots feeding. The young of this species are easily distinguished by their vivid yellow color and by their brown head capsule (photo 4b). Other fly maggots that are found in pitcherplants are whitish and lack a head capsule.



EPSN Science Facts Interactions Profile 5: Pitcherplant flesh flies

These flies belong to the family of flesh flies (Sarcophagidae) but are found only in pitcherplants. If you visit a pitcherplant bog anytime from spring to fall you may see these flies darting from pitcher to pitcher. The adults do not normally enter pitchers and may become trapped if they do. Female flies perch on the edge of the pitcher orifice (photo 5a) to deposit their tiny maggots inside the leaves. There the maggots feed on prey insects that have accumulated in the bottom of pitchers (photo 5b). Most often pitchers contain only a single flesh fly maggot as they are cannibalistic. Once they have grown to their full size maggots leave pitchers and pupate in the soil surrounding the plants.



**EPSN Science Facts Interactions Profile 6:
Pitcherplant mites**

A surprising number of mite species have been discovered from inside of pitcherplant leaves. The species adapted to live in pitcherplants are members of two distantly related families. Scientists feel that there are more undescribed species among them. Some of these mites feed as scavengers on the prey mass whereas others prey on other mites. This is a species of predaceous mite that is known to live only in pitcherplant leaves (6a).



EPSN Science Facts Interactions Profile 7: Pitcherplant wasp

This grass-carrying wasp nests in small tubular crevices. It has been known to nest in hollow twigs but is probably found more frequently in tall-form pitcherplants than elsewhere. Adults fly with grass blade after grass blade (photo 7a) to construct elaborate nests in pitchers that they have emptied of prey. They often chew an opening into undeveloped, and therefore uninhabited, pitchers. Each nest contains one to several chambers between plugs of tightly packed grass (photo 7b). In each chamber the female wasp deposits several paralyzed grasshoppers and attaches an egg to one of them. The white, maggot-like larvae that hatch from the eggs feed on the grasshopper provisions.



**EPSN Science Facts Interactions Profile 8:
Pitcherplant mosquito**

A tiny aquatic habitat exists within the leaves of the Purple Pitcherplant, *Sarracenia purpurea*. This aquatic habitat is home to the pitcherplant mosquito, *Wyeomyia smithii*. Of all the pitcherplant insects, this one has been studied the most. Adults (photo 8a) fly near pitchers and oviposit on the inner surfaces of leaves, just about the water line. The larvae (photo 8b), or wrigglers, feed on protozoa and other microorganisms in the pitcher fluid. Their feeding activity has been shown to be beneficial to the plants by speeding up the rate of prey breakdown.



**EPSN Science Facts Interactions Profile 9:
Pitcherplant midge**

Larvae of the pitcherplant midge, *Metriocnemus knabi* live only in water held by the Purple Pitcherplant, *Sarracenia purpurea*. They inhabit the lower portions of pitchers and are difficult to see unless the contents of a pitcher are shaken or removed to another container. The tiny, white, thread-like larvae (photo 9a) feed on prey insect carcasses. Their feeding activity has been shown to speed up the rate of breakdown of prey and therefore may be beneficial to the plants. Feeding by this species also benefits the pitcherplant mosquito which too lives in the water held by Purple Pitcherplant leaves.



**EPSN Science Facts Interactions Profile 10:
Pitcherplant rhizome borer**

Probably the rarest of all pitcherplant insects is the pitcherplant rhizome borer, *Papaipema appassionata*. As an adult (photo 10a) it is a moth with mottled coloration; and as a larva (photo 10b) it is a caterpillar that bores within the tissue of pitcherplant rhizomes. Very often, the caterpillar causes frass (excrement) to exude from a hole in the rhizome near the base of the leaf rosette, forming an upright tube (photo 10c). This is usually the only way their presence can be detected externally. This species has been reported most often in the Purple Pitcherplant (*Sarracenia purpurea*) but has also been seen in the Yellow Pitcherplant (*Sarracenia flava*) where it may cause more damage to the plant. It is true that their apparent rarity may be in part because they are not often detected. Nonetheless, the species seems to be quite rare in the southeastern U.S. and perhaps was never very common.



EPSN Science Facts Interactions Profile 11: Pitcherplant fruit borer

Moths in the genus *Endothenia* can be found feeding in the fruits and flowers of most species of *Sarracenia*. One species seems to feed exclusively on the fruits of the Purple Pitcherplant and another is found in the flowers and fruits of any of the *Sarracenia* species. The moths are tiny and inconspicuous (photo 11a) but the presence of caterpillars in fruits can be detected by frass (caterpillar excrement) and damage to the fruit (photo 11b). These larvae (photo 11c) feed on flower parts as well as seeds within fruits. Their numbers can sometimes be alarming as they may occur in up to 90% of the fruits in a population. However, the caterpillars rarely damage all parts of a fruit and do not normally pose a threat to plant reproduction.



EPSN Science Facts Interactions Profile 12: Spiders of pitcherplants

Several species of spider are commonly seen in and on pitchers but all are capable of living elsewhere. One of the most frequently encountered species is the green lynx spider, *Peucetia viridans* (photo 12a). Individuals of this spider that hunt for prey on pitcherplants are more successful than those that hunt elsewhere; but they probably have little or no effect on the amount of prey taken by the plants. Jumping spiders like this one, *Phidippus audax* (photo 12b), are commonly found on or in pitchers. They can leap great distances (relative to their small size) from pitcher to pitcher to seize prey that are attracted to the plants. They often rest in silken retreats that they construct within pitchers. Their silk allows them to inhabit pitchers without becoming prey (usually). Their retreats do not damage pitchers but probably interfere with further trapping of insects.



**EPSN Science Facts Interactions Profile 13:
Prey**

Almost any insect in the vicinity of pitcherplants (photo 13a), and even small frogs and lizards (photo 13b), may be taken as prey. Prey animals are trapped by a passive pitfall mechanism. They enter pitchers because they are attracted to the appearance, odors and/or the moist cool shade within a pitcher but are then unable to escape because of the slippery walls and downward pointing hairs. Prey accumulate in the bottom of pitchers (photo 13c) where they are digested by plant and/or bacterial enzymes. Nutrients from the decomposing prey are absorbed by the plants and help them to survive in habitats where nutrients are scarce. Certain prey types are more common than others and pitcherplant species may each specialize to some degree on certain types. Moths are commonly found in the White-topped Pitcherplant, for instance, and ground crawling insects in the Parrot Pitcherplant.





Debbie R. Folkerts