deficient in nutrient elements, which carnivorous plants can get from their captures."

In a recent letter, DAVE KUTT sent in some hints for growing CP as follows: (1) When budding leaf cuttings of Drosera or Pinguicula, the annoying and wasteful curling of the cuttings can be prevented by placing them on a mound of sphagnum, then stretching a single layer of cheesecloth over the whole thing. The budlings grow very well through the cloth. (2) For two years, he has found that small quantities of tropical fish food are useful for "feeding" Sarracenias, using the dead insect or ant egg types. (3) He feels that the end of season trimming of old Sarracenia pitchers should be reserved until they are entirely dead brown since live pitchers may yet contribute some nourishment. (4) He has confirmed an original Japanese idea of pot-nesting when trying to grow cool or montane plants in culture; that is, an outer clay pot filled with coarse perlite, and an inner pot of growing medium. The perlite is watered daily and evaporation through the clay and porous perlite is cooling. (5) He has been using foliar feeding with dilute fish emulsion and other fertilizers prior to the CPN discussions; in the case of pitcher species, applying the material on and in the pitchers.

SHORT NOTES

SARRACENIA--DESTRUCTIVE INSECT ASSOCIATES: A SUMMARY

by D. E. Schnell

Again by reader request, we are called to typewriter to discuss a curious group of insects who have managed to bypass the fate of their brethren in Sarracenia traps, and who would be known as pests by the strict horticulturist but which are quite fascinating in a broader perspective. Granted, this perspective has limitations. A good friend and botanist once introduced Exyra moths to his greenhouse collection for interest sake. Interest soon threatened decimation and the then unwelcomed guests were removed only after much time and effort. In nature, however and as always, there are the inevitable countercontrols and the ecologic relationships of these insects which provide endless hours of satisfying study.

Even though I have studied and dealt with all the insects to be described and more, this note is not really mine after all. Frank Morton Jones, a prominent entomologist of the first third of the century, first summarized and added much to our knowledge of these larvae. His observations are keen, pertinent, and presented in a refreshingly clear style in his writings. In addition, the papers have many fine line drawings illustrating the parasites and their activities and they should be consulted for complete information. Here we only have space for the briefest summation and some remedies for infestations of closed collections. A selected bibliography is presented at this note's conclusion.

EXYRA. In the conservatory and greenhouse, this moth is the most troublesome of all and will be mentioned first. The adult is a diminutive noctuid maximally about 1.5 cm. across and with yellow and black markings. The adults are of course harmless, the larvae being the culprits. There are three species involved: E. rolandiana which principally infests S. purpurea in northern reaches; E. ridingsii confines itself largely to S. flava; and E. semicrocea is cosmopolitan throughout the south. The moths conceal themselves inside the opened pitchers, always head up, and overcoming the usually fatal slide of the waxy inner surface of the upper pitcher. When disturbed, it will back down the pitcher and dodge about. If finally forced out, it will immediately seek the safety of another nearby pitcher. Small, corrugated orange eggs are laid, usually one to a pitcher. The larvae are brightly striped purple and white and the two southern species have peculiar lateral tubercles or lappets which help prevent their being wedged into the depths of the narrower southern pitchers.

Larval destructive activity is of two types, there being some variance according to species and climate. (1) An overwintered larva of late instar leaves the dead debris of last year's pitchers and climbs to the apex of an opened pitcher, chews its way in, girdles the inner layer of leaf tissue which prevents pitcher opening and undesirable intervention by other insects and rain. (2) A newly hatched or late instar larva of previous season enters or hatches in a newly opened pitcher where it spins a web across the mouth, and then proceeds to eat the inner layers of the leaf, always leaving the outer intact. This papery upper portion of the pitcher collapses and again provides a seclusive seal. So, infestation is immediately suggested at a glance by unopened pitchers with pinched dry tops, and opened pitchers with dry tops fallen over like empty cloth sacks. Investigation inside reveals the larvae and a great deal of bright orange, corky frass refuse in the bottom. As one might expect, it has been shown that these larvae produce anti-proteases.

Pupation has some interesting aspects. It occurs in the layer of frass. But before pupating, the larvae open two holes: one very low to drain any water that might get in, and one above the frass for later egress of the adult moth which does not have the mouth-parts to chew its way out. No adaptation is infallible. Certain birds have come to

recognize the meaning of the telltale holes and slash open the pitchers near the bottom to feed on the pupae. In the late fall, one can see the slash marks on the aging pitchers with their collapsed tops. And that is not all there is to infallibility. The natural burning of yesteryear in bogs and savannahs, and intentional controlled burning by the ecologically minded today, will effectively destroy the overwintering larvae and pupae of E. ridingsii. Strike, counterstrike, and now another strike: E. semicrocea frequently overwinters or pupates outside of the pitcher very low to the ground and effectively insulated from the rapid fire.

Well, what to do in one's collection when the dreaded signs appear. First, search all the opened pitchers for the progenating adults, remove them and destroy them. This is no easy task in such as S. minor with its closely approximated hood. (But no adults will be found in S. psittacina.) When you have found and destroyed the adults, and perhaps there are none if your plants recently came in with eggs or larvae only, then you must open or clear the webbing of all infested pitchers and seek out the larvae. There is always only one per pitcher. If it evades your probing forceps, pinch thepitcher where the larvae lies, destroying him in situ and providing some extra protein for the beleaguered Sarracenia as well. Try to leave as much pitcher as possible for photosynthetic reasons at least. The eggs and larvae will appear in succession as they were layed, so an entire summer may be spent clearing up a serious infestation. Inevitably, some pitchers will have to be sacrificed. In the fall, do clip all old pitchers, remove all surface debris, and destroy this material away from your plants. A few early instar larvae may overwinter among the buds and scales of the rhizome, but you can catch these early the next year and pretty well have things under control.

Prevention is worth...etc. etc. All newly acquired Sarracenias should be quarantined away from your collection because the eggs are nearly invisible to the naked eye. I would even suggest shearing all new plants of all mature and maturing pitchers even though this will set back growth another year. It will save a lot of trouble and damage.

PAPAIPEMA APPASIONATA. The Sarracenia root borer larva grows rapidly to be about 5 cm. long and can do much hidden damage deep within the rhizome. Its hallmark is the conical pile of bright orange droppings or frass at the apex of the rhizome which grows larger day by day. These conical piles of material are difficult to see in the field where there is much debris from the previous years around the plant base, but the larva activity is quite apparent in culture. The rhizomes are usually acquired already infested or with the egg, so the adult poses no problem. The larvae can be extracted in one of two ways. (1) Actually probe into the borer's cavity with a long narrow forceps and pull it out; or (2) inject a dilute solution of Malathion into the cavity. (The latter is an elegant suggestion by Joe Mazrimas, but I have found it considerably more satisfying to do forceps to body battle with the larva.) Usually, enough rhizome is left so that the plant is saved, though considerably smaller and requiring some care to prevent rot via the raw borer cavity.

SARCOPHAGA SARRACENIAE. This dipterid is really no problem but might cause some consternation to the uninitiated. The larva is a maggot that lives in and on the decaying material in the depths of an active pitcher. It does no harm but is interesting in its resistance to the usual digestive activities. There may be from one to five larvae on the average and they should cause no worry; they will not seriously deprive the plant of any nutrients. Local people tell of going through their fields, opening the "wild lillies" and removing the larvae to be used as fishing bait.

NEOSCIARA MACFARLANEI. A diptera similar to the previous, but it is rarer and can only be damaging to the extent that it does close an infested pitcher with a fine, frothy web. However, it does feed on the decaying debris and not the plant tissue, and usually the pitcher has caught enough prey to be physiologically useful for the season by the time the larva closes it. This insect can be eradicated by destroying the larvae as described for Exyra.

ISODONTIA PHILADELPHICUS. This wasp is of special interest to entomologists because it engages in the rare practice of grass cutting to prepare nests--in Sarracenias, of course. The pitcher is found to be filled by alternate layers of grass plugs with intervening chambers of an egg or newly hatched larva and a stunned food insect, usually a cricket. There may be three or four such chambers per pitcher. Of course, the pitcher is out of commission, but again the infested pitchers are comparatively rare. I have been privileged to observe and photograph this insect only a few times over many years in the field.

LARVAE THAT ATTACK SARRACENIA FLOWERS. These are detected in two ways: (1) the dead petals hang on the flower because they are bound there by webbing; (2) one can observe the destruction of the ovary after petalfall. There are two principal moth larvae involved, although many others may appear adventitiously. One is our old friend Exyra exhibiting some diversification. The other is Olethreutes daeckeana. Both areeasily searched out, or if the ovary is destroyed anyway, remove the flower.

CONCLUSION. This about covers the basics of the most prominent damaging insect associates

of Sarracenia. However, there are more--more parasites and commensals and opportunists which I have observed and read about. Perhaps your field studies will be equally rewarding. After all, the Sarracenias themselves are but one part of the well-cliched and now proverbial web of bog and savannah life, a web that grows more fascinating and complex the deeper we probe.

SELECTED REFERENCES. (The first six articles, available in any good biological library, are "musts" with their excellent narrative and descriptions coupled with fine drawings. The last is in a limited edition folio book which may be hard to find, is summary of the first six articles, but lacks the details and drawings.)

Jones, F.M. Pitcher-plant Insects. Entomol. News 15: 14-17, 1904

- - - - - Pitcher-plant Insects--II. Entomol. News 18:413-420, 1907.

- - - - - Pitcher-plant Insects--III. Entomol. News. 19:150-156, 1908.

- - - - - Another pitcher-plant insect. Entomol. News. 31:91-94, 1920.

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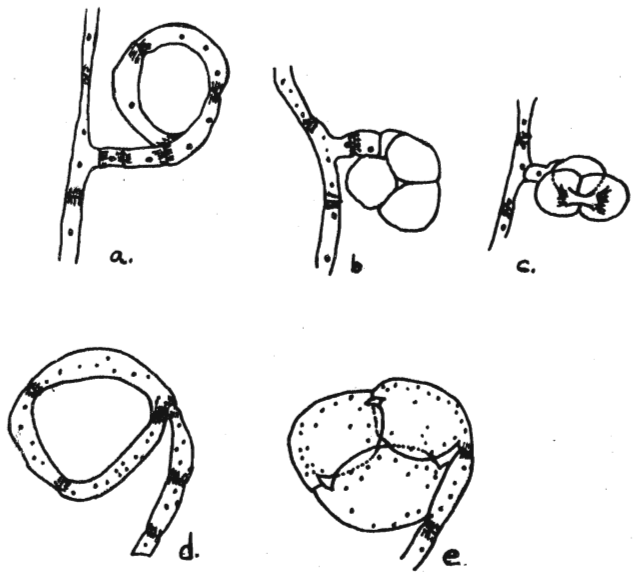
- - - - - In ILLUSTRATIONS OF NORTH AMERICAN PITCHER PLANTS (Mary Vaux Walcott), Smithsonian Inst., Washington, D.C. pp. 25-34, 1935.

CARNIVOROUS FUNGI

by Jacques Haldi

In the vegetal world which surrounds us, we are surprised by the variety of the carnivorous aquatic, terrestrial or epiphytic plants. We are much more surprised to know that some fungi, indeed microscopic, as for instance Arthrobotrys, Dactylella (which forms collars), and Dactylaria (which forms adhesives) are all carnivorous. They are specialized in the capture of nematodes which constitute the obligatory element of their food.



a, b, c = ARTHROBOTRYS OLIGOSPORA a et d : fig 1

d + e = DACTYLELLA DOEDYCOIDES b, c et e : fig 2.

There are two types of snares: one by adhesives and the other by collars. The fungi which capture with adhesive catch the worms by contact, similar to the Pinguiculas, the sticky glands fixed on peduncles which if lightly rubbed by the worms quickly secretes an acid liquid which goes quickly through the worms. The other fungi have a more crafty and efficient system with the collars that possess the digestive glands composed of three parts as in Fig. 1. The fungus forms a ring with a sensitive surface on the inside which on contact makes a reaction as in Fig. 2. The three parts of the ring increase in volume very quickly (around three times their initial volume) so that the worm finds itself squeezed in and finally in complete immobility in a few tenths of a second. I don't know if the collars return to the initial shape after digestion. By compression, these three parts go very strongly through the nematode emptying it of its contents. We can vary the number of collars in culture by adding or reducing the number of nematodes in solution. The culture is composed of a number of nutritive elements in a gelatinous substance. So in nature, it is the number of victims which determines the number of snares.