White Fly Control in a Small Greenhouse

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Agriculturalists, academic institutions, and consumers throughout the country are becoming increasingly knowledgeable about and aware of the impact of pesticides, herbicides, and other biocides on humans and other life forms. The publication of more and more articles on organic gardening, the rise of the health food industry, and the changing patterns within major food industries to produce natural commodities that contain no preservatives reflect this awareness.

We believe that our academic institution should set a good example for the community we serve—we should "practice what we preach." As a demonstration of this philosophy, our biology department began a biological control program of the plant pests in our greenhouse in the fall of 1979.

The greenhouse is approximately 3.1 m by 10 m, and its exposed long side faces west. It is used to house live plant material for a variety of courses.

During the year, white flies (*Trialeurodes vaporariorum*) create our most recurrent plant pest problem (fig. 1). The plants they damage

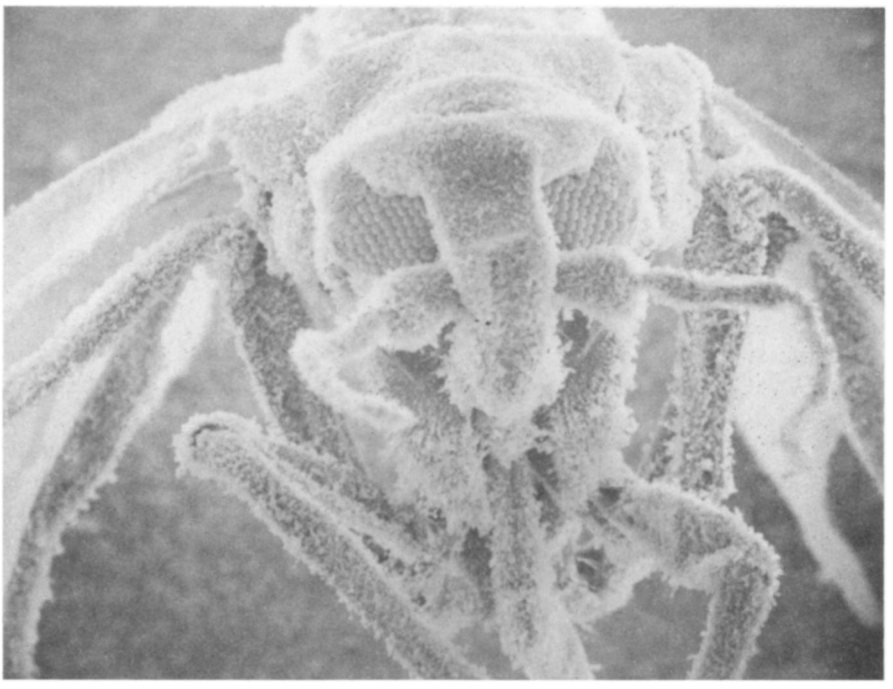


FIGURE 1. Adult white fly, *Trialeurodes vaporarium*. X200. SEM, International Scientific Instruments, Model MSM-3. Biology Department, Normandale Community College.

most severely are *Coleus* (coleus), *Nicotiana* (tobacco), *Petunia* (petunia), and *Lypersicon* (tomato).

The Control Procedure

To control the white fly population while the windows were open, we followed the recommendations and procedures outlined by Wolf (1979). The procedure is quite simple. One-quarter inch plywood is cut into rectangles that measure 23 cm by 30 cm (approximately 9 inches by 12 inches). The boards are then painted with Rust-Oleum chromium yellow number 659. Tests have confirmed that white flies are attracted most intensely to this color. After the boards are painted, thick mineral oil is spread over both surfaces of the yellow boards. The boards are then placed throughout the greenhouse between and among the plants that are most heavily infested. Every other day the boards should be cleaned with paper towels and fresh mineral oil applied. The procedure is followed throughout the time when greenhouse windows are open and for approximately three weeks after they are closed in the fall. This ensures that the white flies at various pre-adult stages when the windows were closed will be captured. We found this procedure effective in reducing the white fly population to a level where it was no longer a nuisance.

During the winter, we purchased a parasite to control the white fly population. The parasite is *Encarsia formosa* (fig. 2), which has been reared since 1926 for the control of white flies in greenhouses. Our supply came from the Whitefly Control Company, Milpitas, California; other sources for *Encarsia* (plus other biological control organisms) are listed in an article by DeCrosta (1980). *Encarsia*, a parasitic wasp, feeds only on white flies and will not harm humans, beneficial insects, or plants. It is about one-third the size of an adult white fly and has a black thorax and a yellow abdomen. The wasp is sensitive to insecticides and fungicides, so biocides must not be used in the greenhouse for a month or so prior to introducing *Encarsia*.

To understand how *Encarsia* controls white fly populations, it is necessary to describe briefly the life cycle of a white fly. Adult white flies are visible macroscopically and can usually be found on the underside of leaves and/or at the new growing tips of plants. The eggs are laid in the same general area where one would find adults. The eggs will hatch, and the larvae will move around for a few hours and then become stationary. The early scale stage is characterized by a gray or tan color with a white fringe. The proboscis is on the underside and inserted into the leaf tissue. The scales grow in four growth spurts; the late scale stages are the largest and most active in sucking plant juices. The pupa stage follows the late scale stage. During this stage, the stationary scale changes to the winged flying adult. The adult white fly emerges through a T-shaped slit in the pupal skin (fig. 3).

When adult *Encarsia formosa* wasps are released, they will oviposit in white flies that are in the early and late scale stages. Scales that are parasitized will turn black in the pupal stage and are easily distinguished from the normal white pupal case of an unparasitized white fly (figs. 4 and 5). The adult *Encarsia* emerges by cutting a small circular hole (as compared to the T-slit mentioned previously) in the top of the white fly pupal case. This is easy to see under 30X with a stereo dissecting microscope. It also can be seen in figures 3, 6, and 7.

The literature provided with *Encarsia* cultures gives detailed infor-

FIGURE 2. Adult parasitic wasp, *Encarsia formosa*. X100. SEM, International Scientific Instruments, Model MSM-3. Biology Department, Normandale Community College.

FIGURE 3. T-shaped hole left by *Trialeurodes vaporarium* as it emerged from its pupal case. X67. SEM. International Scientific Instruments, Model MSM-3. Biology Department, Normandale Community College.

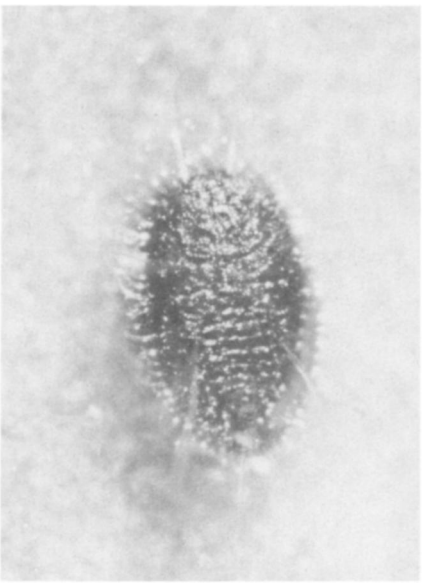


FIGURE 4. Pupa case of *Trialeurodes vaporarium* parasitized by *Encarsia formosa* as evidenced by the black coloration. X40. Nikon photoscope with Polaroid camera. Nicholas illuminator (above).

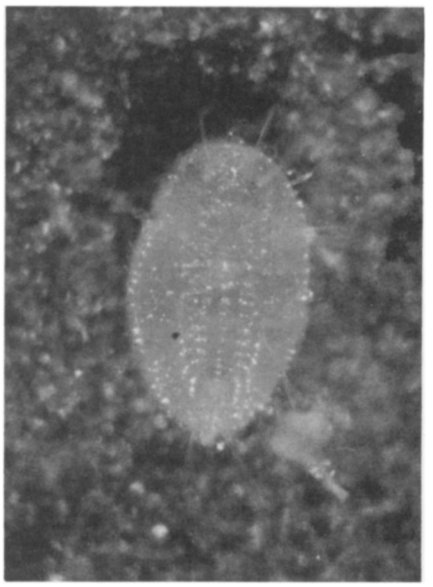


FIGURE 5. Pupa case of *Trialeurodes vaporarium* unparasitized as evidenced by the white coloration. X40. Nikon photoscope with Polaroid camera. Nicholas illuminator (above).

FIGURE 6. Pupal case of *Trialeurodes vaporarium*, prior to emergence. X95, SEM. International Scientific Instruments. Model MSM-3, Biology Department, Normandale Community College (below).

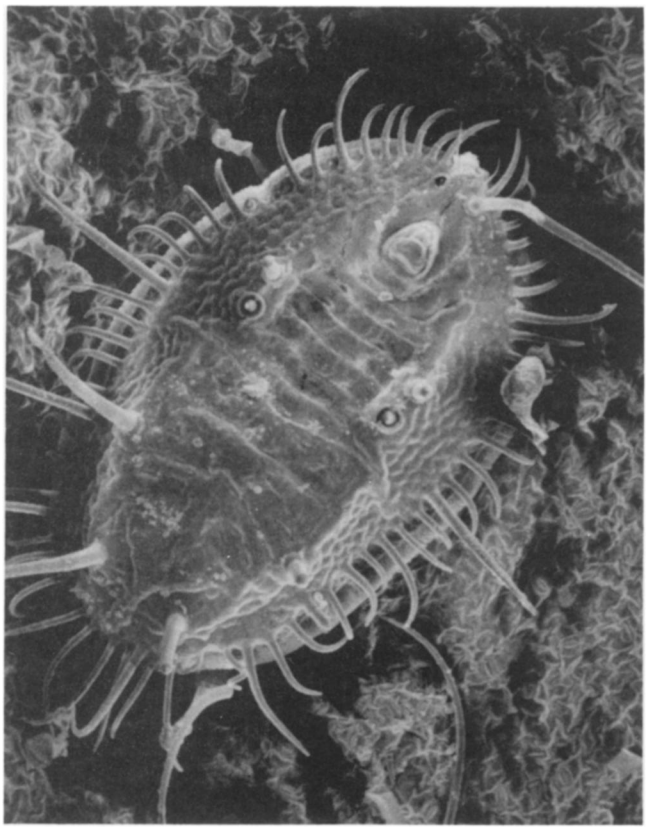
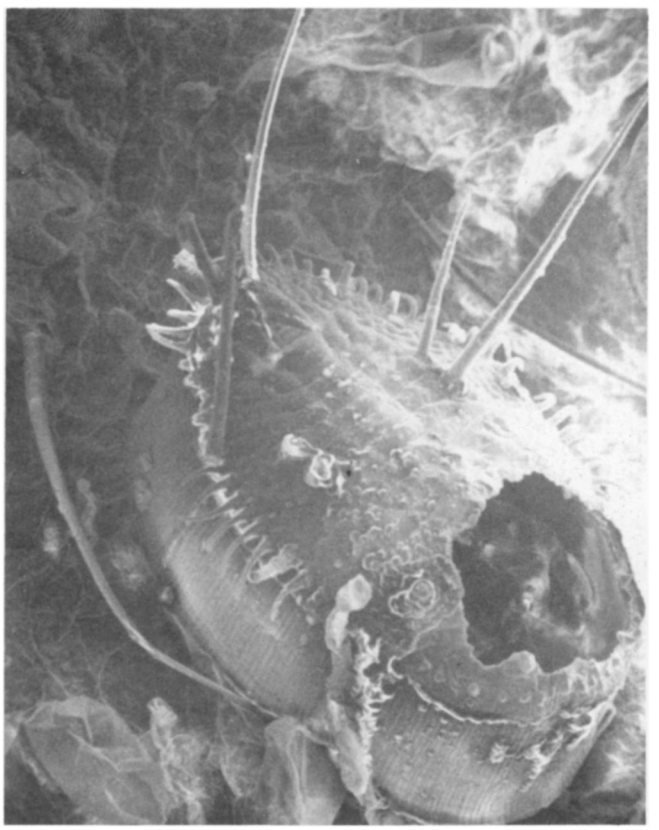


FIGURE 7. Circular hole left by *Encarsia formosa* as it emerged from the pupal case of *Trialeurodes vaporarium:* X95, SEM. International Scientific Instruments, Model MSM-3. Biology Department, Normandale Community College (below).



mation on the proper maintenance of the parasite. Greenhouse temperature is one of the most critical conditions for maintaining *Encarsia*. An average temperature of 75°F must be maintained, with temperatures no lower than 55°F at night. The yellow boards should not be used when *Encarsia* is present because the boards will attract the wasps more rapidly than white flies.

Generally, *Encarsia* must be released in two stages. Two releases are necessary to ensure progressive parasitizing of the white flies as they reach the late scale stage.

We have found using both control methods (the yellow boards and *Encarisa formosa*) highly effective in controlling the white fly population in a small greenhouse. Both methods are biologically safe, inexpensive, and uncomplicated. In addition to these benefits, we have used this project to illustrate biological control mechanisms for our environmental biology students and to demonstrate life cycles and parasitic relationships to general biology students.

We are presently experimenting with biological control methods for scales, mealy bugs, and spider mites and will report on the success of these methods in the future.

Acknowledgment—Our thanks to John Morris (Whitefly Control Company) for his ready and willing attitude in helping us initiate and maintain our project during its early stages.

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Another Worm Flattener

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Any number of devices for flattening annelid worms during fixation have been proposed, produced, and promoted. The system described here, however, is cheaper and simpler than most and yet quite effective. This system was devised specifically to prepare whole mount slides of leeches, but one of the unique features of the system is that it can be adapted readily to other forms as well by simple manipulations of its elements.

Live leeches are narcotized individually in the lid of a deep plastic petri dish by adding a few pieces of tobacco to the water. When they no longer respond to direct stimulation with a probe, the tobacco and some of the water are removed. The bottom of the petri dish is placed into the top, resting directly on the narcotized specimen, and weight is added to flatten the specimen. The remaining water is pipetted off and replaced quickly with the desired fixative.

A major advantage of this particular system is that the extent of flattening can be controlled rather precisely and conveniently by carefully controlling the weight placed in the petri dish bottom that rests on the specimen. A convenient method for accomplishing this is to set a beaker or other container large enough to cover the specimen in the petri dish bottom and then to add water to achieve the desired degree of flattening.

There is one precaution that should be noted. Because the fluid volume is relatively low in this system, several changes of fixative at 15-20 minute intervals assure more expedient and effective fixation. The fluid level can be conserved in the extended fixation period by enclosing the entire system in a plastic bag.

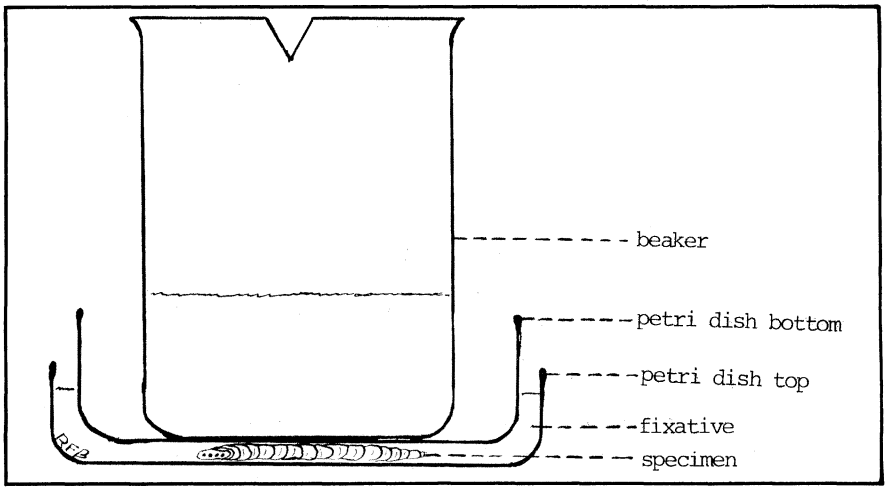

FIGURE 1. Worm-flattening device described in this article.