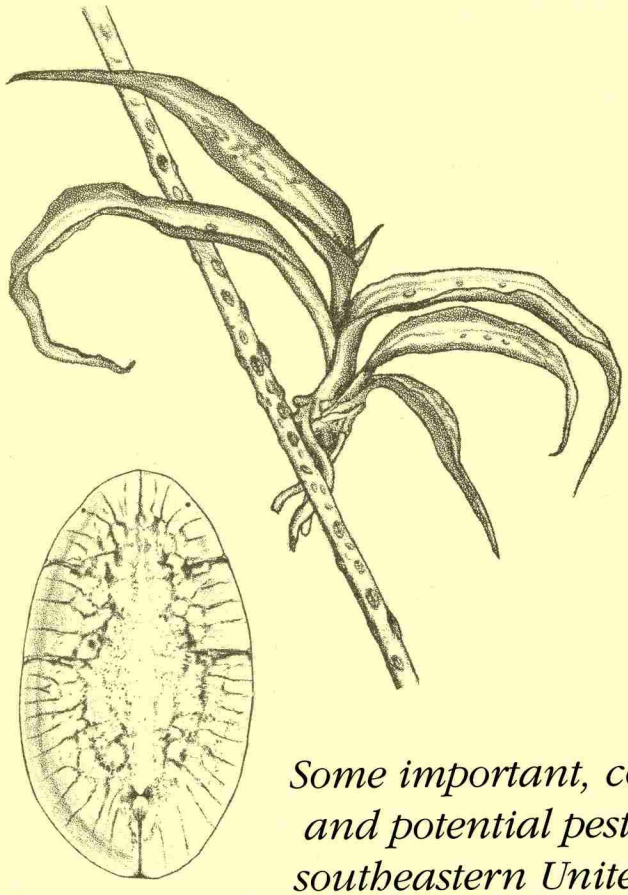
INSECT and related PESTS of FLOWERS and FOLIAGE PLANTS



Some important, common, and potential pests in the southeastern United States

Insect and Related Pests of Flowers and Foliage Plants

Some important, common, and potential pests in the southeastern United States

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PREFACE

This is the first real revision of a manual first published in 1978, bravely called, *Insect and Related Pests of Flowers and Foliage Plants.* In those innocent days, the western flower thrips and sweetpotato whitefly were not yet found as floricultural pests in the eastern United States. The leafminer, *Liriomyza trifolii*, was then a scourge of greenhouse flowering crops, and aphids were not particularly difficult to control with traditional pesticides. Nine additional entomologists have contributed to the expansion of the first edition, making this a truly regional publication.

A note about the illustrations in this manual. Special effort was made to assure all of the illustrations are all in the public domain. Consequently, no permission is required to use them. Whenever possible, the pests face up or to the left in each illustration. An exception to this rule is found in the Slugs and Snails section because the respiratory pore (an important diagnostic character) of slugs is on the right side of the body. The assistance of Ponglerd Kooaroon, whose many excellent illustrations appear throughout this manual, is especially noted (4B; 7B; 20; 23C; 25D; 39; 43; 44A; 53B; 59A; 66; 74B, C; 75A; 76G; 80A, C-D, F; 81; 91; 92B; 93; 98; 102A; 105B; 106A-H; 108A; 116; 121A, C-D; 123A; 125A, D). Likewise, the illustrations of Mrs. Susan Van Gieson add much to the worth of this manual (1; 17B; 27B; 53A; 59C-D; 73; 74A; 75C; 76D 77C-D; 79D; 80B, H, J-K; 106I; 108B; 111E; 117; 119B; 123C, D; 124C; 125C; 140A; 176D). Other especially noteworthy figure credits are given to Ramona Beshear (155) and Tong-Xian Liu (145-154; 156-160; 162, 164, 168,) who did wonderful drawings of thrips for the keys and insect notes. Other figure credits include Mei-Jung Lin and L. L. Deitz (103B); J. J. Davis (83B, E); H. A. Denmark (111B); J. B. Burch (from his USDA, ARS, PQD publication: 133-4; 136; 139; 142-3); F. H. Chittenden (64; 83A, C-D); Nellie M. Quaintance (68; 86 B-D); O. C. Mohr (56; 57; 58; 128; 130-1; 135; 137-8; 141; 144); James Wilcox (24D; 53C, 59E); and J. R. Baker (3A; 4A; 5A; 6B; 8; 9; 10; 11; 12; 14; 15; 16; 17A; 18; 19; 21; 22; 23A, B, D; 24A; 25B-C; 27A-D; 27A, D; 28B; 29; 30; 31A; 32; 33; 35; 36; 37; 40B;42; 44B; 45; 46; 48; 49; 52; 59B; 63; 65; 67; 69; 70-2; 76E; 77A-B; 78; 79B-C, E; 82A-C; 84-5; 86A; 87; 88C; 90; 92A; 94-7; 99; 100; 102B-D; 101B; 104; 105A; 107; 109; 110; 111A, C-D; 113A-D; 114; 115; 118; 119A; 120; 122; 123B; 124A, B; 125B; 129; 132; 140B; 163; 165A; 171; 172-5; 177A, B; 178). Illustrations from the California Experiment Station (88A-B; 160B-F) and the Connecticut Agricultural Experiment Station (41) also were used. Many fine but more or less anonymous illustrations from the United States Department of Agriculture were exceedingly useful (2; 3B; 6A; 7A; 13; 24B-C; 25A; 26; 28A; 31B; 34; 38; 40A; 47; 50; 51; 54; 55; 60; 61; 62; 75B; 76A-C, F, H; 77E; 79A; 80E,G,I; 82D; 89; 101A, C; 103A, C-H; 112; 113E; 121B; 126-7; 161; 163; 164; 165B; 166A, G; 167; 169-70; 177C, D).

Special thanks are extended to Drs. Maurice H. Farrier, North Carolina State University; Paul R. Heller, Pennsylvania State University; and Richard L. Miller, Ohio State University, for reviewing the manuscript of the first edition. Their time spent on the manuscript is well appreciated. Thanks also are extended to Ms. Katherine Curle who helped with translating much of the early draft into the American Language. The patience of Mrs. Vicki Grantham, Mrs. Carmen Sasser, Mrs. Teresa Snell, Ms. Sara Watson, and Mrs. Stella Nwosu as they prepared the typewritten copies of the manuscript is heartily appreciated. The enthusiastic proofing, guidance on page layout and other editorial duties by Dr. Deborah Dunsford is also greatly appreciated.

J. R. B.
February, 1994

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INSECT and related PESTS of FLOWERS and FOLIAGE PLANTS

INTRODUCTION

Horticulturists estimate that 1,500 varieties of herbaceous ornamental plants are grown commercially in North Carolina. Ornamentals are grown in commercial greenhouses, commercial fields, professionally maintained landscapes, interior plantscapes, and home grounds, as well as inside homes or in hobby greenhouses.

An amazing variety of insects feed on flowering and foliage plants. Many field, fruit, and vegetable crop pests such as the cabbage looper, corn earworm, diamondback moth, and obliquebanded leafroller also feed on ornamentals. Lush growth and sheltered growing conditions make ornamental herbs especially attractive to plant pests.

The routine use of insecticides usually eliminates predaceous insects and mites. However, pests remaining after treatment sometimes tolerate commonly used insecticides. To stay in business, most commercial flower and foliage plant growers must become fairly sophisticated in using various types of pest management practices, insecticide formulations, application equipment, and in rotating insecticides from one chemical group to another.

Commercial growers use a battery of general and restricted-use pesticides. Although amateur gardeners battle the same pests, the most effective chemicals for control are often very expensive or are restricted so that homeowners are not allowed to use them. This puts a moral burden on the commercial grower to try earnestly to eliminate all plant pests from bedding, potted, and cut plants before selling them.

Keys to adults and immatures of the pests referred to above are included in this publication following the next section on "Management of Insect and Related Pests." These keys, plus the color plates and the illustrations in the insect notes, will help you to identify the pests of herbaceous ornamental plants. Identification is important to assure proper control measures.

Management of Insect and Related Pests

This manual is designed to augment state Cooperative Extension Service publications on pest management, not to duplicate them. In no way are the suggestions for safe use and calibrations for proper application in the state Cooperative Extension Service recommendations to be belittled or ignored. This section on management should be viewed as an expansion of explanations begun in those publications.

Greenhouse

Chemical Control— Total reliance on pesticides for pest management is labor intensive and sometimes very hard on the plants. Although there are numerous practical and philosophical problems with the chemical control of insect and mite pests in the greenhouse, pesticides will remain important in greenhouse pest management at least for the next few years. Control of pests in the greenhouse is often difficult because of lush, sheltered growing conditions. In general, insects, mites, and slugs reproduce more rapidly in warmer temperatures. Also, periodic use of pesticides in greenhouses often reduces parasites and predators of greenhouse pests because the pests tend to be more resistant to pesticides than their predators and parasites.

Application of pesticides is almost essential if one is to stay in the greenhouse profession. Eliminating weeds inside and outside the greenhouse reduces alternate hosts for ornamental plant pests. Screen doors and vents make it harder for moths and beetles to fly in and lay eggs or feed. But, careful as the grower may be, sooner or later an insect or mite will come in on the clothes of workers, on cuttings, in pots, or in soil. Many growers apply pesticides periodically as "insurance" against accidental infestations. Despite these precautions, however, insects or other pests may become established. Some growers treat whenever they discover pests. Growers should survey the plants on a daily or every-other-day basis to guard against extensive damage by insects, mites, or slugs.

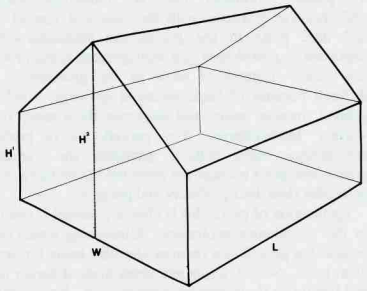
Pesticides are applied in greenhouses in almost every conceivable manner. Legal methods are usually the safest! Growers use aerosols, mists, smokes, fogs, dusts, sprays, drenches, and granules—everything but aerial application and backrubs. Aerosols, smokes, mists, and fogs must be applied when the greenhouse is closed (at night or in the winter). Since most pesticides are sensitive to ultraviolet rays, treatments made later in the evening will be more effective. After the waiting period specified on the label has passed, the structure must be well ventilated before workers can safely enter.

Fogs, smokes, and aerosols are generally applied on a cubic-foot basis. Compute cubic feet by multiplying the area of the floor times the average height of the roof: that is, the length times the width times the average height (Fig. 1). For houses with flat, sloping roofs, add the height at the eave to the height at the highest part, divide by 2, and multiply by the area of the floor. For houses with rounded roofs, measure the highest point in the middle and at 1/4, 1/2, and 3/4 of the distance to the low point. Add these 4 measurements, divide by 4, multiply by the area of the floor, and you have a pretty close estimate of the volume of the house. (Although this estimate is a little low, rounded roof houses are usually covered with polyethylene film and are consequently very tight. Thus, applications in these houses do not dissipate as rapidly as applications in fiberglass or glass houses.) Fogs, smokes,

and aerosols generally need to be diluted by the air in the greenhouse to avoid damage to the plants.

Place smoke fumigators so that the smoke does not vent directly onto the plant foliage. Growers customarily wear self-contained breathing systems or gas masks when applying fogs, smokes, or aerosols. Some growers who use smoke fumigators determine the number of fumigators needed, based on cubic feet, and light those furthest from the door first. This allows the grower to vacate the house before it becomes dangerously filled with fumes. Two people should always be present when applying toxic substances in the greenhouse. If one person gets accidentally poisoned, the other can drag the victim to safety and call for help. Dusts and sprays are applied with conventional dusting or spraying equipment. Necessary safety clothing must be worn.

Apply granular insecticides with a handheld shaker or some other device that does not grind up the granules. Wear boots, long pants, a longsleeved shirt, rubber gloves, and a respirator. The plants and potting mix should not be handled until the granular pesticide has been washed from the foliage and watered in thoroughly.

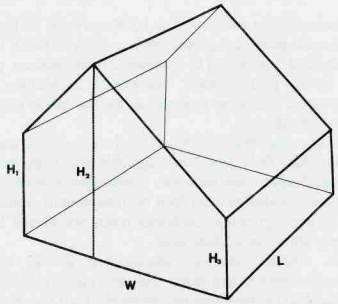


$\bar{H} \times W \times L = V$

$H_1 = 6$ $W = 34$

$H_2 = 12$ $L = 50$

$\frac{6+12}{2} \times 34 \times 50 = 15300$ cu. ft.



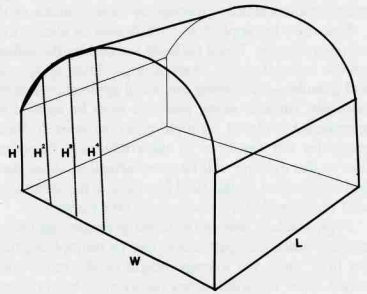
$\bar{H} \times W \times L = V$

$H_1 = 15$ $W = 18$

$H_2 = 7$ $L = 12$

$H_3 = 5$

$\frac{15+7+5}{3} \times 18 \times 12 = 1944$ cu.ft.

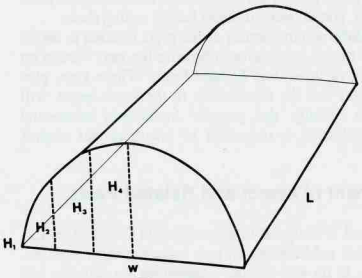


$\bar{H} \times W \times L = V$

$H_1 = 7$ $H_3 = 11$ $W = 20$

$H_3 = 10$ $H_4 = 12$ $L = 15$

$\frac{7+10+11+12}{4} \times 20 \times 15 = 3000$ cu.ft.



$\bar{H} \times W \times L = V$

$H_1 = 0$ $H_3 = 5$ $W = 15$

$H_2 = 4$ $H_4 = 7$ $L = 30$

$\frac{0+4+5+7}{4} \times 15 \times 30 = 1800$ cu.ft.

Fig. 1 The computation of volumes for various types of greenhouses.

Integrated Pest Management—IPM uses all suitable methods to reduce insect and mite populations to the lowest acceptable level. IPM is a complex program as each crop must be considered individually. However, there are a number of basic practices that apply to most greenhouse crops.

Clothing: An effort should be made to avoid carrying insects into the greenhouse by wearing clothes that are brown, red or black. Do not wear white, yellow, or green, as these colors are attractive to aphids, thrips, whiteflies, leafminers, and darkwinged fungus gnats. Light to dark blues also are attractive to aphids and thrips.

Quarantine: Before any plant material is brought into the greenhouse, it should be thoroughly inspected for insects, mites, and diseases. Furthermore, new plant material should be kept in a separate section for a week or more before such material is incorporated into the production area. Such highly resistant pests as the green peach aphid, western flower thrips, and silverleaf whitefly move readily on plant material. The swapping of insects, mites, and diseases on infested plant material is without doubt the major way resistant thrips, aphids, and whiteflies are transported throughout the greenhouse industry.

Screening: In an experiment with greenhouse screening in California, a crop of chrysanthemums was grown successfully without a single application of pesticides. Exclusion demonstrations at North Carolina State University with the western flower thrips and the silverleaf whitefly have shown that both pests can be significantly excluded by spunbonded and perforated polyethylene screening. With screening, the finer the mesh, the greater is the tendency to restrict air flow into the greenhouse. Polyspun materials cut air flow by a factor of two. The perforated polyethylene screening cut air volume by a factor of five.

Although the pore sizes of some screening materials are large enough that the thrips are capable of wedging through, the screening still excludes many thrips. Evidently, these materials are not recognized by thrips as a suitable substrate to feed on. When the thrips probes the screening it may instinctively resume flight searching for a suitable plant.

Pest Recognition: For proper management, it is important to be able to recognize the various kinds of pests in their various stages of development. Probably the most frequently misidentified pests are shore flies and darkwinged fungus gnats. Shore flies are of little economic consequence in the greenhouse but are very resistant to pesticides. Thus a grower can waste effort and pesticides trying to chemically control shore flies rather than trying to control algae the shore flies are breeding in. Another example of misidentification is the assumption that parasitized green peach aphids are some sort of new 'tan' aphid. Parasitized aphids adhere to the plant fairly tightly, so in spite of repeated applications, these tan' aphids seem to be impossible to kill.

Monitoring: Constant vigilance for insects, mites, and diseases is required for effective pest management. An employee or certain employees should be assigned the responsibility of scouting for insects and other pests on a regular basis (perhaps weekly during the winter and twice weekly during the summer). Written records of where various pests are found should be kept. Pests can be monitored by using yellow and blue sticky cards, by using yellow pan traps, and by examining the foliage, flowers, and occasionally the roots. Light traps outside can be used to monitor for European corn borer, corn earworm, and beet armyworm adults.

Record Keeping: A written log should be kept of pest type, locality, abundance, and all pesticides applied. Such records can be of long-term benefit as many pests tend to appear at about the same time each year. However, the short-term benefits of written records may be greater. Knowing what pests survive a pesticide application alerts the grower to the possibility of poor timing, poor application, or pesticide resistance in the pest population. A change in strategy, application technology, or type of pesticide can be made before the crops are significantly damaged.

Biological Control: Some growers use beneficial organisms for biological control where appropriate. Unfortunately, there are no really effective organisms available for managing the silverleaf whitefly or the western flower thrips. *Encarsia formosa* parasitic wasps infest silverleaf whiteflies to some degree and *Amblyseius* predatory mites, used for spider mite suppression, can feed on thrips. Bacterial and nematode organisms can be readily integrated into a traditional pest management scheme, whereas others require a fairly high level of managment. *Aphytis* wasps, *Aphidoletes* maggots, and green lacewings are available for aphid suppression. *Bacillus thuringiensis kurstaki* pesticides are available for caterpillars. *Bacillus thuringiensis israelensis* and *Steinernema carpocapsae* nematodes suppress darkwinged fungus gnats. *Cryptolaemus* and *Delphastus* lady beetles (when available) can be used for mealybugs and whiteflies. Parasitic wasps are available for soft scale management and predaceous mites are available for spider mite suppression. *Encarsia formosa* parasitic wasps can be used especially for greenhouse whitefly suppression. Except for *Bacillus thuringiensis* pesticides, the use of biological organisms is usually not compatible with the use of chemical sprays. It is possible to integrate sprays of soaps and oils with *Encarsia formosa* by timing pesticide applications to coincide with the "black scale stage" of the parasite's development. Also the "brown mummy" stage of aphids infected with *Aphytis* wasps are resistant to soaps and oils.

Organic Control—Organic growers tend to be wary of relying on pesticides for routine pest management. Most organic growers are highly receptive to the basic integrated pest management practices (screening, biological control, and monitoring). The range of chemicals organic growers can use is limited to those that are certified to be "organic" by various organizations such as the California Certified Organic Farmers. Some of these chemicals work well and others are marginally effective. Finding formulations that are certified as organic and that are actually labeled for greenhouse use is sometimes a problem. Some organic growers in North Carolina use screening to exclude pests and methods such as irrigation to dislodge and destroy mites and aphids or washing the produce by hand at harvest to remove pests.

Organic Chemicals: Soaps, oils, and nicotine sulfate can be used for aphid suppression. Soaps, oils, neem extracts, and pyrethrum sprays and aerosols are moderately toxic to

whiteflies. The *Bacillus thuringienses kurstaki* pesticides and pyrethrum sprays, and aerosols are effective for caterpillar control. Soaps and pyrethrum pesticides suppress mealybugs. Spider mites are susceptible to soaps and oils. Pyrethrum sprays and aerosols help suppress thrips.

Commercial Indoor Landscape

Commercial indoor landscape accounts are perhaps the most difficult areas in which to attempt pest control. Interior plantscapes extend from public conservatories to extensive plantings in homes, hotels, office buildings, restaurants, shopping malls, hospitals, schools, and other environmentally sensitive areas. The use of insecticides in many of these areas is often greatly restricted because of the sensitivity of the surroundings. In addition, few chemicals are cleared for ornamental plant use in public areas, and public prejudice against pesticide odors can prevent application of pesticides in many situations.

The first line of defense against ornamental plant pests is sanitation and quarantine. Taking steps to prevent pest problems is well worth the effort. Inspect plants thoroughly and only place insect-free plants into an indoor landscape. If possible, when insect infestations are first found, isolate infested plants to prevent spread of the infestation.

Interest in biological control in indoor landscapes has expanded in recent years because of restrictions placed on interior plantscape pesticide application, pesticide costs, poor control with pesticide products, phytotoxicity, and potential human health hazards. To be successful at managing pest problems with biological control agents requires a knowledge of the biology of the pest species, the biological control agent(s), and a great deal of time and commitment. Biological control systems do not look after themselves.

Thorough, timely applications of properly labeled pesticides are another important aspect of an integrated pest control program. Rotating infested plants back into a greenhouse where they can be treated thoroughly and revived in vigor before being returned to the indoor landscape is a sound practice but is often not practical. Treat commercial landscape areas at night, on weekends, or when a minimum number of people are present. The public should not be allowed in the vicinity of treated plants until the pesticide residue on the foliage has dried completely.

Commercial Field Grown Flowers

This is the sector of the ornamental plant industry that most closely parallels agricultural crop production in methods and equipment. Tractor-drawn spray rigs or mist blowers are often used for pest control. A broad range of chemicals is cleared for use on field-grown flowers. However, the number of insect and mite pests that can be tolerated is very low. Vigilance must be maintained to prevent extensive damage by ornamental plant insect, mite, and slug pests.

Home Grounds and Home Dwellings

Homeowners have difficulty in pest management of their grounds, in part due to the great diversity of ornamental plants. Homeowners are often not aware that many of these plants have insect and mite pests. Injury caused by insects and related pests is another source of potential confusion if the insect or mite is not available to help in the diagnosis. When they are willing to to educate themselves to recognize problems and to frequently inspect their ornamentals, homeowners can limit the number and scope of their pest problems.

Home gardeners have an adequate selection of pesticides labeled for home use, especially for home ornamentals. A variety of application equipment options are available to the amateur gardener. Probably the two most popular applicators are dusters and hose-end sprayers. Dusts require no mixing and are often applied directly from the purchased container, which has a perforated top. Plunger dusters and bulb dusters are still in use, but not as popular. These types have a reservoir that is filled with the dust. Dusts offer quick and convenient application, but are best applied when there is little wind to reduce drift. Hose-end sprayers use water pressure to siphon, dilute, and deliver the pesticide to its destination. Pesticide concentrate is placed in the reservoir of the hose-end sprayer and water added based on the volume of spray needed. Length of hose limits use of hose-end sprayers on large properties. The hose-end sprayer reservoir must be rinsed after each use.

Compressed air sprayers are available in several sizes and prices and are popular in the home garden. These sprayers use air pressure to deliver the diluted pesticide through the spray nozzle to the target. The nozzle is often adjustable, from a coarse to fine spray pattern. Spray coverage is more uniform with compressed air sprayers than with dusters and hose-end sprayers. Pesticides must be diluted according to label instructions, and sprayers must be cleaned after each use.

Ready-to-use pesticides and sprayers are the newest application technology. Pesticides are sold premixed, and the reservoir is connected to a plastic nozzle. The system is a closed one, with no mixing or cleaning necessary. Pressure is applied by a trigger. The system is adequate for small areas, but would not provide coverage to larger plantings.

Sprayers mounted on garden-type tractors similar to those available for farm use can be used on larger properties. Some models use the tractor battery to power the sprayer and others use a power-take-off system. As with other sprayers, proper mixing of pesticides and thorough cleaning of the equipment after use are required.

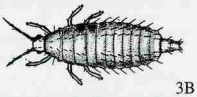
Key to Orders and Groups of Pests

1. Body and antennae unsegmented, contractile, slimy; entire lower surface modified as a sort of gliding foot; breathe through single, closable opening on right side of body (Fig. 2A, B) ..... **Slugs and Snails**, p. 70

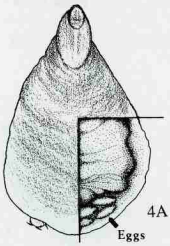

2A


2B

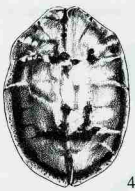

3A

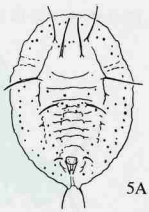

3B

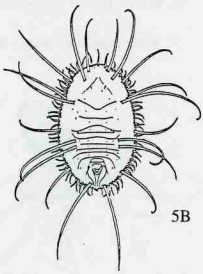
1.' Body and appendages segmented (3A, B), or if apparently not segmented, then specimens either permanently attached to plants (**scales**, Fig. 4A, B and **whiteflies**, Fig 5A, B) or less than 1 mm long (**mites**, Fig. 6A,B) 2

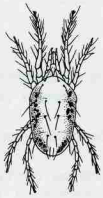


4A


4B


5A


5B


6A


6B

2. Some combination of the following: wings; three or four pairs of segmented legs; a pair of large compound eyes; a pair of well-developed antennae; body larger, darker and/or harder than that of the immature. (Adult and immatures of mites, aphids, mealybugs, and scales are very similar except for size and reproductive maturity and can be difficult to distinguish) ..... **Adults**

2.' No wings; some of the following present or absent: segmented thoracic legs; fleshy abdominal prolegs; eyes; antennae; body larviform (caterpillar, grub, or maggot) or at least smaller, paler, and softer than adult ..... **Immatures**

Key to Adults

1. Specimen permanently attached to leaves or stems, may be hidden under shell or wax secreted by specimen (Figs. 4A to 5B)..... **Scales** and immature **Whiteflies,** pp. 63 & 92

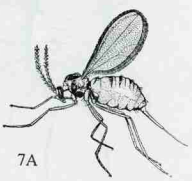
1.' Specimen mobile, not permanently attached to vegetation 2

2 Body unsegmented, usually less than 1 mm long; 4 pairs of segmented thoracic legs; wings, compound eyes, and antennae always absent (Fig. 6A, B)..... **Mites**, p. 57

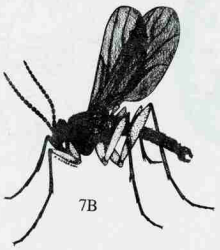
2.' Body segmented, usually longer than 1 mm; 3 pairs of segmented thoracic legs; wings, compound eyes, and antennae usually present..... 3

3. With 1 pair of transparent front wings, hind wings reduced to knob-like halteres (7A, B) ..... **Flies**, p. 44

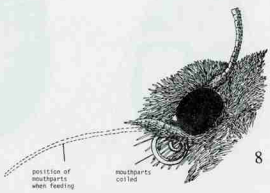
3.' With 2 pairs of wings or none, front wings may be shell-like, hiding the hind wings..... 4



7A



7B

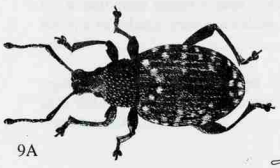


8

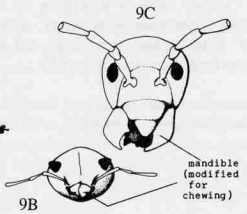
4. Body densely covered with scales and hairs; mouthparts in form of slender, unsegmented tube that is coiled and concealed under head (Fig. 8)..... **Moths** and **Butterflies**, p. 28

4.' Scales and hairs, if present, sparse and not concealing body surface; mouthparts different 5

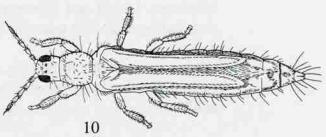
5. Front wings in form of a hard or leathery shell meeting at midline but not overlapping, covering the transparent folded hind wings; mouthparts of chewing type, mandibles on head or at tip of unsegmented snout (Fig. 9A to C)..... **Beetles**, p. 22



9A



9B



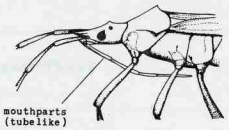
10

5'. Front wings, if present, either transparent, flexible, or overlapping when closed; mouthparts a segmented beak or cone for piercing and sucking 6

6. Tiny, slender insects more than twice as long as wide, usually 1 to 2 mm long; wings folded flat on back when closed, overlapping, much narrower than width of body, each bearing a long fringe of marginal hairs (Fig. 10) ..... **Thrips**, p. 78

6.' Not fitting this description 7

7. Mouthparts a segmented, hinged beak attached to underside of head anterior to eyes (Fig. 11); antenna of four or five distinct segments; front wings folded flat on back, usually (except lace bugs) leathery at base and membranous toward tips, tips overlapping ..... **Bugs**, p. 23



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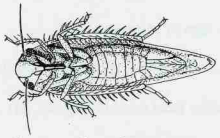

12

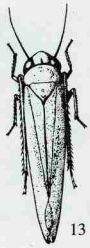
7.' Mouthparts a short beak attached to head under eyes or even between front legs; antennae and wings variable (Fig. 12)..... 8

8. Antennae distinct, segmented, arising from head in front of eyes; insects crawl or fly but don't jump 9

8.' Antennae slender, hairlike, arising from knobs beneath eyes; hind legs long, spiny, adapted for jumping; alert, active insects (Fig. 13) ..... **Leafhoppers**, p. 51

9. A pair of tubelike cornicles on abdomen (Fig. 14) ..... **Aphids**, p. 18

9.' Cornicles absent 10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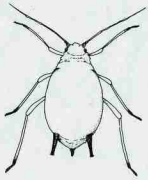
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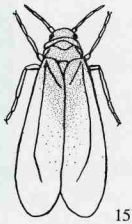
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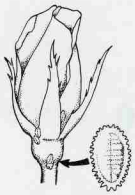
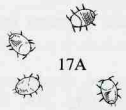

16

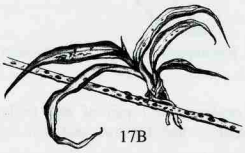
10. Fully winged, tiny, whitish, active insects with large eyes; found on undersides of leaves among their immobile immatures; fly in spiral pattern when disturbed (Fig. 15) ..... **Whiteflies**, p. 92

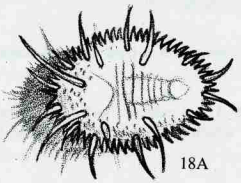
10.' Wingless, slow-moving, oval insects; body pinkish or grayish under a coat of powdery white wax, often with filaments and tufts of hairlike wax; usually concealed on various parts of plants (Fig. 16) .... **Mealybugs**, p. 52

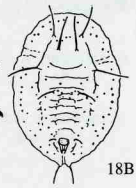
Key to Immatures

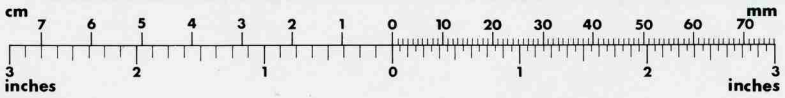
1. Becoming permanently attached to leaves or stems, may be hidden under shell or wax secreted by specimen (Figs. 17A, B, 18A, B) ..... **Scales** and **Whiteflies,** pp. 63 & 92


17A


17B


18A


18B



1.' Mobile, or capable of crawling when prodded 2

2. Lacks legs 3

2.' Possesses legs of some sort 5

3. Headless, with a pair of retractable mouth hooks, a maggot (Fig 19) ..... most **Fly maggots**, p 44

3.' Has a distinct head capsule (Fig. 20, 21) 4

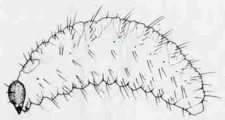
19

20

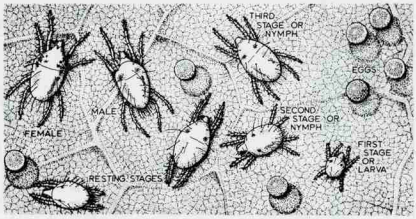
4. Slender maggot with shiny black head capsule, found in decaying plant tissues and in fungi (Fig. 20) ..... **Darkwinged fungus gnat**, p. 46

4.' Stout-bodied grub with orange or brown head capsule, in soil around roots or boring in healthy plant tissue (Fig 21) ..... **Weevils** and other **Beetles**, p. 22

5. Tiny, body unsegmented, less than 0.5 mm long; 3 or 4 pairs of segmented legs present; eyes and antennae always absent (Fig. 22) ..... **Mites**, p. 57



21



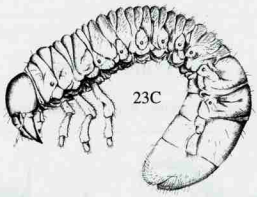
22

5.' Body segmented, usually longer than 0.5 mm; only 3 pairs of segmented legs; eyes and antennae usually present but may be small or obscure 6

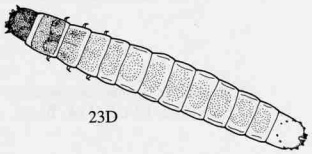
6. Immature a caterpillar or grub, with chewing mouthparts; looking very different from, and not found with, the adult. (Fig. 23A to D) 7

23A

23B



23C



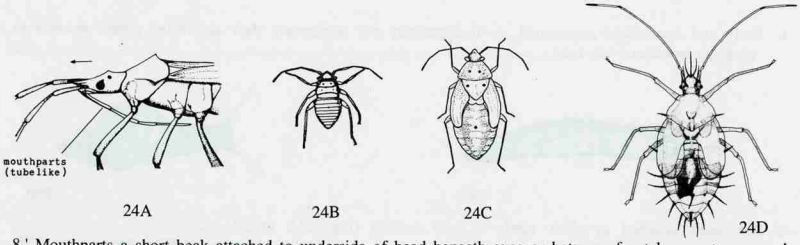
23D

6.' Immature a nymph, with a beak or cone-shaped mouthparts; similar to, and often found in groups with adults 8

7. Immatures with 3 or 4 pairs of fleshy abdominal prolegs and 1 pair of anal prolegs; some species can spin silk, which they use to tie foliage together, line burrows and spin cocoons (Fig. 23A, B). ..... **Caterpillars**, p. 28

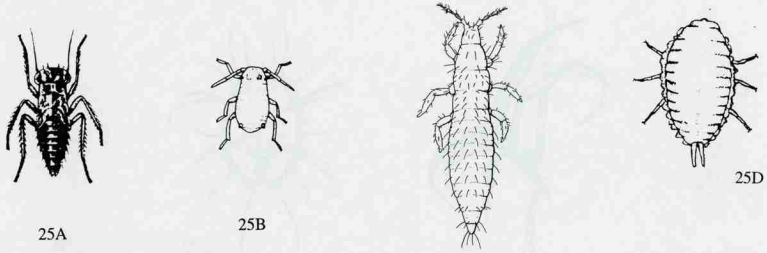
7.' Immatures lacking prolegs; can't spin silk (23 C to D) ..... **White grubs, Wireworms, other Beetles**

8. Mouthparts a segmented, hinged beak attached to underside of head anterior to eyes; antennae of 4 distinct segments; compound eyes well developed; stout-bodied, slender-legged, usually active and solitary nymphs (except lace bugs, which are spiny) (Fig. 24A to D) ..... **Bugs,** p. 23



24A 24B 24C 24D

8.' Mouthparts a short beak attached to underside of head beneath eyes or between front legs; antennae and eyes variable; body form variable (Fig 25) 9



25A 25B 25C 25D

9

9. Active, alert insects, solitary on foliage and stems; hind legs long, spiny, can jump; antennae hairlike, arising from head underneath eyes and above beak (Fig. 25A) ..... **Leafhoppers**, p. 51

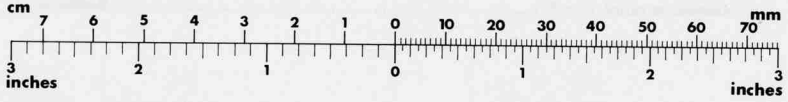
9.' Less active, often found in groups or concealed; hind legs not adapted for jumping; antennae arising from head in front of eyes 10

10. Possessing a pair of tubelike cornicles on abdomen; usually found in clusters or colonies on leaves, new shoots, nymphs and adults together (Fig 25B) ..... **Aphids**, p. 18

10.' Lacking cornicles 11

11. Slender insects, more than twice as long as wide; usually pale yellow or red, lacking a coating of powdery or filamentous wax; eyes visible; mouthparts concealed in a cone on part of head (Fig. 25C) ..... **Thrips**, p. 78

11.' Oval or rounded insects, less than twice as wide as long; body pinkish or grayish beneath a coating of powdery or filamentous wax; eyes lacking; mouthparts a short beak between front legs (Fig. 25D) ..... **Mealybugs**, p. 52

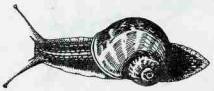


Key to Blossom and Leaf Feeders

1. Body and antennae unsegmented, contractile, slimy, legless; entire ventral surface modified as a sort of gliding foot; breathe through single, closable opening on right side of body (Fig. 26A, B) ..... **Slugs** and **Snails**, p. 69

1.' Body and appendages segmented, or if apparently not segmented, then specimens either attached to plants or less than 1 mm long 2

26A

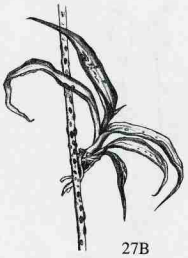


26B

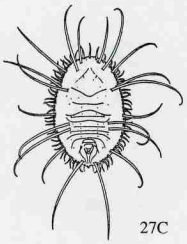
2. Specimens attached to plant, rarely if ever moving (Fig. 27A to D)..... ..... **Scales** and immature **Whiteflies**, pp. 63 & 89

2.' Specimens readily mobile..... 3

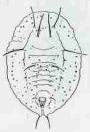
27A



27B



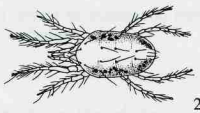
27C



27D

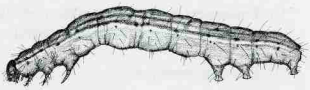
3. Tiny, 1 mm or less long; 3 or 4 pairs of segmented thoracic legs; antennae, compound eyes, and wings always absent; body unsegmented. (Fig. 28A, B) ..... **Mites**, p. 57

3.' Usually larger; 3 pairs of segmented thoracic legs; antennae, compound eyes, and wings (adults) usually present although they may be reduced or hidden; body segmented 3



28A

28B



29

4. Body elongate, soft; head capsule smooth and rounded, hard; eyes and antennae reduced; 3 pairs of thoracic legs plus 1 or more pairs of fleshy abdominal prolegs and 1 pair of fleshy anal prolegs (Fig. 29) ..... **Caterpillars**, p. 28

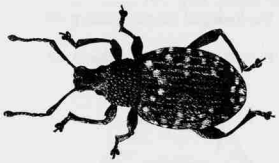
4.' Not a caterpillar, abdominal and anal prolegs absent 5

5. Mouthparts are chewing mandibles; body hard; front wings not overlapping, meeting at midline of body, modified into a shell that covers the transparent, folded hind wings; antennae may be elbowed, clubbed, or otherwise modified. (Fig. 30) ..... **Beetles**, p. 22

5.' Mouthparts beaklike or conelike, adapted for piercing and sucking; body leathery or soft; front wings not like a shell, may partly or completely overlap at rest; antennae (except leafhoppers) a simple, straight series of segments 6

6. Mouthparts an elongate three or four-segmented beak that arises in front of eyes on underside of head (Fig. 31A); large compound eyes always present; antennae of 4 or 5 distinct segments; front wings of 2 textures, leathery near base and membranous at tips, tips overlapping. (Fig. 31B) ..... **bugs,** p. 23

6.' Mouthparts a beak or cone, arising beneath eyes or (apparently) between first pair of legs (Fig. 32); eyes and antennae variable; front wing of uniform texture 7



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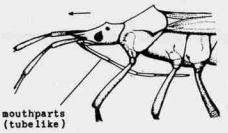
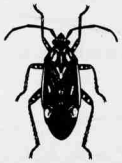
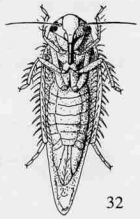


31A



31B



32

7. Slender insects, more than twice as long as wide 8

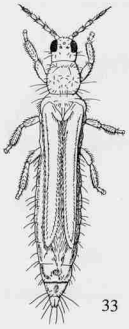
7.' Oval or rounded insects, less than twice as long as wide 9

8. Tiny yellow, brown or black insects, 1 to 2 mm long; antennae long, projecting from front of head; hind legs short, not modified for jumping; front wings (if present lying flat on back when closed, completely overlapping, each wing with a fringe of long hairs on its margins. (Fig. 33) ..... **Thrips**, p. 78

8.' Usually larger than 1 to 2 mm when mature; variously colored and patterned, often green; hind legs long, modified for jumping; antennae short, hairlike, arising under eyes; front wings not lying flat on back or overlapping when closed, lacking fringe (Fig. 34) ..... **Leafhoppers**, p. 51

9. With a pair of tubelike cornicles on abdomen; large compound eyes present; legs long and slender; body variously colored and patterned (Fig. 35) ..... **Aphids**, p. 18

9.' Cornicles and compound eyes absent; legs short, not slender; body pinkish or grayish; often covered with a white, waxy bloom (Fig. 36) ..... **Mealybugs**, p. 52



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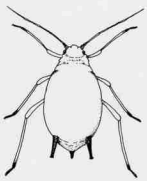

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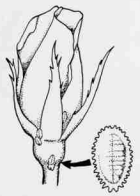

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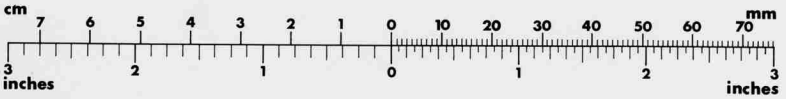


Key to Stem Borers

1. With 3 pairs of short, segmented thoracic legs, plus 1 or more pairs of fleshy abdominal prolegs and 1 pair of fleshy anal prolegs. (Fig. 37) ..... **Caterpillars**, p. 28

1.' Abdominal and anal prolegs absent 2

2. A distinct, hard, pigmented head capsule present, mouthparts are chewing mandibles 3

2.' No distinct head capsule, mouthparts are pair of retractile, downward curving hooks (Fig. 38) .... **Maggots,** p. 44

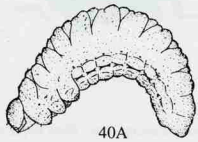
3. Head capsule shiny black; body slender, smooth, soft, white; thoracic legs absent. (Fig. 39) .... **Darkwinged fungus gnats**, p. 46

3.' Head capsule orange to brown; body variable; thoracic legs may be present (Fig. 40A and B) .... **Beetles**, p. 22

37

38

39



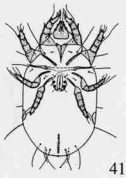
40A

40B

Key to Root Feeders

1. Tiny, slow moving, 1 mm or less long; 3 or 4 pairs of segmented thoracic legs; head and mouthparts cone shaped, eyes and antennae absent; body bulbous, unsegmented, with scattered long hairs; found in decaying or moldy vegetation (Fig. 41) ..... **Mites**, p. 57

1.' Larger; 3 pairs of segmented thoracic legs or all legs absent; body segmented; caterpillars, grubs, and maggots 2



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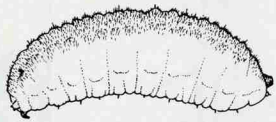


42

2. A distinct head present; mouthparts are chewing mandibles or a sucking beak 3

2.' No head capsule; mouthparts are a pair of retractile, downward curving hooks (Fig. 42) ..... **Maggots**, p 44

3. All legs absent 4

3.' Some legs present 5

4. Head capsule shiny black; body slender (Fig. 39) ..... **Darkwinged fungus gnats**, p. 46

4.' Head capsule orange to brown; body usually stout (Fig. 40A, 43) ..... **Weevils**, p. 22; **Leaf beetles**

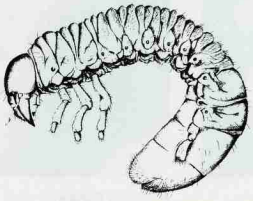
5. With three pairs of segmented thoracic legs, plus four pairs of fleshy abdominal prolegs and one pair of fleshy anal prolegs (Fig. 37) ..... **Caterpillars**, p. 28

5.' Prolegs absent..... 6

6. Head capsule distinct from body; mouthparts are chewing mandibles; body more than twice as long as wide; white, yellow, or orange to brown in color; no wax (Fig. 44A and B) ..... **White grubs** and **Wireworms**

6.' Head not distinct from body; mouthparts slender, short beak; body oval or rounded, usually less than twice as long as wide; pale pink or gray under a coating of powdery wax (Fig. 45) ..... **Mealybugs**, p. 52

43



44A

44B

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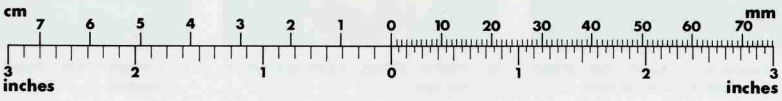


PLATE 1

A. Azalea leafminer damage to azaleas.

B. Banded Greenhouse Thrips. Adult (left) & nymphs.

C. Brown Soft Scales.

D. Cabbage Looper.

E. Citrus Mealybugs.

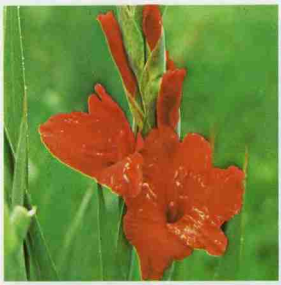
F. Corn Earworm.

G. Damage by cyclamen mites. African violet (left) & purple passion.

H. Flower Thrips. Adult (above) & damage.

I. Fungus Gnat. Adult (above) & maggots.

PLATE 2



J. Gladiolus thrips damage.

K. Greenhouse Whiteflies.

L. Green Peach Aphids.

M. Hemispherical Scales.

N. *Liriomyza trifolii* damage (left) & adult.

O. Longtailed Mealybugs.

P. Mexican Mealybug.

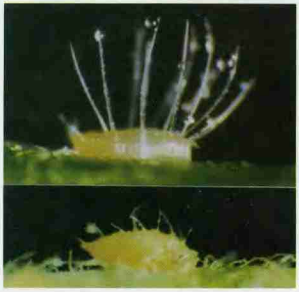
Q. Twospotted Spider Mites.

R. Variegated Cutworm.

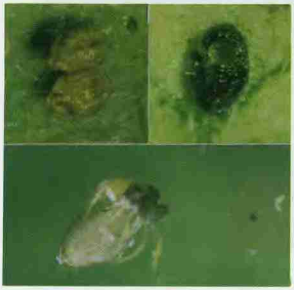
PLATE 3

S. Bandedwinged whitefly nymph (left) and silverleaf whitefly nymph.

T. Greenhouse whitefly nymph.



U. Greenhouse whitefly pupa (top) and silverleaf whitefly pupa.



V. *Encarsia formosa* emerging from a silverleaf whitefly pupa (b.) and parasitized silverleaf pupa (u.l.) and greenhouse whitefly pupa (u.r.).

W. Western flower thrips adult and second larva (inset).

X. Gloxinia flower and leaves with impatiens necrotic spot virus symptoms.

Y. Armored scale insects. Fern scale females (u.l.) and males (u.r.). Boisduval scale female (l.l.) and males.

Z. *Platynota* leafroller. Adult (u.l.). Pupa (u.r.) and caterpillar.

AA. Screening structure retrofitted to a commercial greenhouse.

PLATE 4

BB. An aphid on a yellow sticky card.

CC. Bandedwinged whitefly on yellow sticky card.

DD. Probably silverleaf whiteflies on a yellow sticky card.

EE. Silverleaf whiteflies on a yellow sticky card; time to change the card!

FF. Darkwinged fungus gnat on a yellow sticky card.

GG. Darkwinged fungus gnats. Time to scout for maggots on the roots of nearby plants.

HH. Various kinds of parasitic wasps found on yellow sticky cards.

II. Shore flies on yellow sticky cards.

JJ. Probably soybean thrips (left) and western flower thrips on sticky cards (not to same scale).

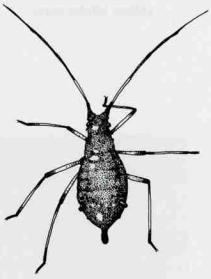
Key to Aphids Most Commonly Found in Greenhouses

1. Aphid dark mahogany brown; found exclusively on chrysanthemum (Fig. 46) ..... **Chrysanthemum aphid**, p. 19

1.' Aphid pale yellow, green, pink, or red; may be found on chrysanthemum but occurs on other plants as well 2

2. Cornicles long, slender, and pale in color but sometimes dark at the tip; body 2.0 mm long (Fig. 47) ..... **Green peach aphid**, p. 20

2.' Cornicles shorter and uniformly dark; body 1 to 1.8 mm long (Fig. 48) ..... **Melon aphid**, p. 21



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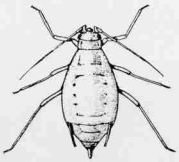

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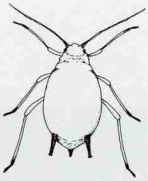

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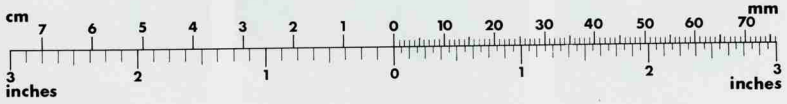


DESCRIPTION

Adult—The winged adults are about 2 to 2.5 mm long; soft bodied; and dark, shining mahogany brown. Due to their dark color they were once called "blackflies." Wingless adults are only 1.5 mm long. Small, black, sturdy cornicles are found on the end of the body.

Nymphs—Nymphs resemble smaller versions of the adult aphids (0.6 to 1 mm). Nymphs have dull, brick-red bodies with relatively long legs and antennae. The cornicles are short and dark. The outer two-thirds of the legs and antennae are gray (young nymphs) to dark gray. Older nymphs have proportionally longer cornicles. Those destined to be winged adults have wing buds in the later instars.

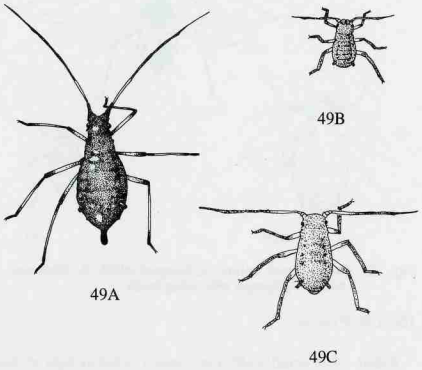


Fig. 49 Chrysanthemum aphid. A, Adult. B, Young nymph. C, Older nymph.

BIOLOGY

Distribution—The chrysanthemum aphid is of east Asian origin, but is now found where chrysanthemums are grown outdoors as well as in greenhouses.

Host Plants—Chrysanthemum is the only known host for this aphid in North America, but it has been reported on a few related plants in Asia.

Damage—The chrysanthemum aphid feeds by piercing the plant surface with its threadlike mouthparts to suck out plant juices. They gather about the terminal buds and feed on the new growth. This feeding causes distorted growth and the leaves may be covered by the feeding aphids' honeydew and cast skins. Sooty mold may grow on the honeydew giving the leaves and stems a black appearance. Chrysanthemum aphids are able to transmit chrysanthemum vein mottle virus and chrysanthemum virus B.

Life History—Only female chrysanthemum aphids are known. They reproduce by giving live birth to more females, without mating. Chrysanthemum aphids overwinter in greenhouses where they feed throughout the winter. During the warmer months they leave the greenhouses in search of new plants. They also may be moved about as plants are shipped or sold. When the winged female stage infests new plants, it usually starts feeding and producing live nymphs. Each female can produce four to eight young aphids per day.

Within about a week the new nymphs mature into wingless females which begin to bear young of their own. One aphid on a plant in a short time may build the population up to hundreds of individuals. As the plant becomes crowded, more and more of the offspring develop into winged females which in turn migrate to other plants to begin new infestations.

Syrphid fly maggots and ladybird beetles and their larvae feed upon chrysanthemum aphids. Ants feed upon the honeydew excreted by feeding aphids.

CONTROL

Infested plants in the greenhouse should be sprayed thoroughly when aphids are first noticed. On outdoor plantings natural enemies may control minor infestations. For specific chemical controls, see your county Extension agent or consult your state's pest management guide for the control of pests on ornamental plants.

**Macrosiphoniella sanborni* (Gillette), Aphididae, HOMOPTERA

APHIDS
Green Peach Aphid*

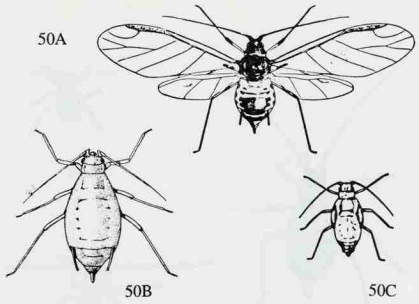


Fig. 50. Green peach aphid. A, Winged adult. B, Wingless adult. C, Nymph with wing buds.

DESCRIPTION

Adult—The small adult green peach aphid is light to dark green or pink, with red eyes. Three dark lines run down its back. Wings may or may not be present. The tobacco aphid is similar and can be either red or green.

Egg—Found only in the northern United States, the egg is black and shiny for the green peach aphid. The tobacco aphid has not been found to have an egg stage.

Nymph—The wingless nymph resembles the larger adult.

BIOLOGY

Distribution—The green peach aphid, also called the spinach aphid, was first described in Europe in 1776. It is a pest all over the world. In the 1940s, an aphid thought to be the green peach aphid was first found feeding on tobacco plants. In 1986, this aphid was recognized as a new species, the tobacco aphid. The tobacco aphid is found in the tobacco growing regions of the United States.

Host Plants—Green peach aphids have been collected from over 100 plants, including a wide variety of vegetable and ornamental crops. Spinach, potatoes, and peaches (the host on which eggs are laid) seem to be especially favored hosts. Tobacco aphids will be pests primarily on tobacco and closely related plants such as flowering tobacco and *Nicotiana.* It is probably not a major pest, but will feed on pepper and eggplant as well as cole crops such as turnips, kale, and collards.

Damage—Both aphids suck plant sap and contaminate the host with honeydew and cast skins. Some hospitals refuse to allow cut flowers in patients' rooms because of the mess by aphids. They are also the vectors of a number of plant viruses including tobacco, tomato, lettuce, dahlia, canna, and beet mosaics as well as tuber spindle, rugose mosaic, and leaf roll diseases of potato.

Life History—In the northern United States, green peach aphids overwinter as eggs, but in the Southeast, no eggs are laid. Instead, female aphids give birth to young females during the growing season. The reproductive capacity of green peach aphids has been described as "fantastic." High reproductive rate and resistance to pesticides make the green peach aphid a formidable pest in the greenhouse. Up to 30 generations per year may take place in this pest's southernmost range. Ladybugs, lacewings, syrphid flies, damsel bugs, wasps, and parasitic fungi tend to regulate green peach aphid populations outdoors. Rain, wind, and mud also help check aphid populations outside.

The tobacco aphid probably overwinters on weed hosts or on cole crops that remain alive through the winter. Tobacco aphids are not known to have an egg stage, and they reproduce by giving birth to live young female aphids without mating. Their young are able to produce young as well without mating. If the plant becomes too crowded or if it becomes late in the season and the aphids need to find a winter host, the aphids give birth to young that will grow up to have wings and can move to other plants. Differences on reproductive rates exist between the red and green forms of the tobacco aphids. The red form is able to reproduce much faster during extremely hot weather than the green form.

On chrysanthemums, green peach aphids feed on all parts of the plant (melon aphids feed only on the buds and leaves, and chrysanthemum aphids feed only on the stems and leaves). Green peach aphids will not become established in the presence of the other two aphids unless pesticides are applied. In that case, green peach aphids outlive both melon aphids and chrysanthemum aphids.

CONTROL

Because green peach aphids overwinter on weed hosts, infestations can occur in the greenhouse any time of year. Green peach aphids readily infest bedding plants and can be introduced into greenhouses whenever bedding plants are brought in from another grower. Although damage per aphid is often not serious, these aphids reproduce so rapidly that serious harm can be done in a short time. Moreover, these aphids' resistance to pesticides calls for thorough applications whenever a new infestation is found. Tobacco aphids can be controlled in the same manner as green peach aphids. For specific chemical controls, see your county Extension agent or consult your state's pest management guide for the control of pests of ornamental plants.

**Myzus persicae* (Sulzer); also the closely related tobacco aphid, *Myzus nicotianae* Blackman, Aphididae, HOMOPTERA

DESCRIPTION

Adult—This is a small aphid, smaller than most other aphids. The winged adults are about 1.25 mm long, soft bodied, and yellow to dark green with a black head and thorax. The wings are held rooflike over the abdomen at rest. Wingless adults tend to be 1.0 to 1.5 mm long, uniform in color, and yellow to dark green. The antennae and cornicles are shorter than those of winged adults. Cornicles are small, tail-pipe-like structures on the end of the body. Pale individuals tend to be smaller and to have fewer antennal segments than dark individuals.

Nymphs—Nymphs resemble adult aphids except for size (about 0.5 to 1.0 mm long). Those destined to be winged adults have wing buds in the later instars.

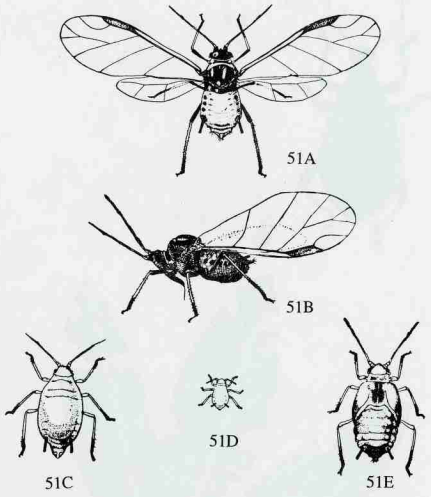


Fig. 51 Melon aphid. A-B, Winged adults. C, Wingless adult. D-E, Nymphs.

BIOLOGY

Distribution—The melon aphid is apparently distributed throughout the tropic, subtropic, and temperate zones of the world. It is more of a problem in the southern portions of the United States.

Host Plants—Melons and other cucurbits, okra, hops, strawberries, beans, spinach, tomatoes, clover, asparagus, citrus, catalpa, violet, hydrangea, begonia, ground ivy, and weeds are some melon aphid hosts. They have been discovered feeding on plants in 25 plant families. The melon aphid is an important pest of cotton and is also called the cotton aphid.

Damage—The melon aphid feeds by piercing the plant surface with its threadlike mouthparts to suck out plant juices. This feeding causes distorted growth, decreased yield, reduced quality of yield, and prematurely ripened fruit. The fruit may be covered by the feeding aphids' honeydew and by cast skins.

The melon aphid transmits several important plant viruses including cucumber mosaic, onion yellow dwarf, citrus quick decline, lily symptomless diseases, and lily rosette.

Life History—The melon aphid is an important pest of both agricultural and ornamental plants. Being practically omnipresent, it feeds upon many host plants. The melon aphid spends the winter on weed hosts and on cold-tolerant plants probably both as nymphs and adult females in the south. During warm periods of winter they start feeding until cold weather inactivates them again. In the spring the adult females move to new hosts and start feeding and rapidly reproducing. In northern climates the aphid overwinters in the egg stage. Indoors and in greenhouses the aphids feed and reproduce throughout the winter. Melon aphids commonly start out on one plant and spread out from that point. On woody ornamentals such as gardenias, feeding is confined to new growth in the spring.

For the melon aphid there are two kinds of hosts, primary and secondary. In late fall, aphids feed upon primary plants mate and lay overwintering eggs. Melon aphids feeding on secondary plants always give birth to live young. In spring, winged forms usually infest new plants, both primary and secondary, and the females produce live nymphs. Within about a week the new nymphs mature into wingless females that begin to bear young of their own. As the plant becomes crowded, more and more of the offspring develop into winged females which in turn migrate to other plants to begin new infestations.

CONTROL

Syrphid fly maggots and ladybird beetles and their larvae feed upon melon aphids. Braconid wasps parasitize the aphids, and ants feed on the honeydew excreted by feeding aphids.

Because the winged forms are 2 to 3.7 times more resistant to organophosphate pesticides than are wingless forms, infested plants in the greenhouse should be sprayed thoroughly when aphids are first noticed. Wingless forms usually predominate in low aphid populations. On outdoor ornamentals natural enemies may control minor infestations. For specific chemical controls, see your county Extension agent or consult your state's pest management guide for the control of ornamental plants.

* also called the cotton aphid, *Aphis gossypii* Glover, Aphididae, HOMOPTERA

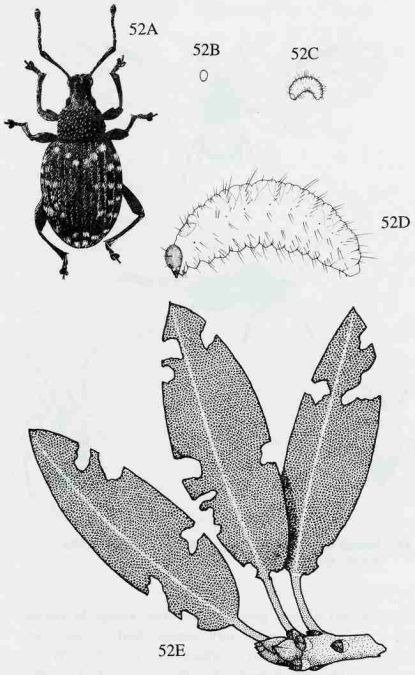


Fig. 52 **Black vine weevil. A, Adult. B, Egg. C and D, larvae. E, Damage to foliage by adults.**

DESCRIPTION

Adult—The adult black vine weevil is a beetle about 10 to 11 mm in length with an elongated snout. The antennae are long and slender with an obvious elbow. The wing covers are relatively rounded, with parallel ridges running lengthwise, and have patches of yellowish hair. The wing covers are fused so that the insect cannot fly.

Egg—Eggs are almost spherical and about 0.7 mm in diameter. They are pearly white when first laid and darken to a light brown in about 24 hours.

Larva—Newly hatched larvae have straight, pinkish-white bodies with brown heads. As the larva matures, the body becomes curved by the thickening of the area behind the head so that the head appears small. Mature larvae are about 7 mm long and have no legs.

Pupa—When the pupa is first formed, it is milky white with large spines on the head, legs, and abdomen. As it matures it darkens until it is almost black.

BIOLOGY

Distribution—The black vine weevil is a native of Europe. It was first noted in the United States from Massachusetts in 1835. The first report of the weevil as a pest was in 1871 from Missouri. Since its introduction, the black vine weevil has spread west to Wisconsin and Missouri, south to North Carolina, and north into Canada. It also is found in the western United States from New Mexico north to British Columbia, Nevada, Utah, Idaho, Montana, and South Dakota.

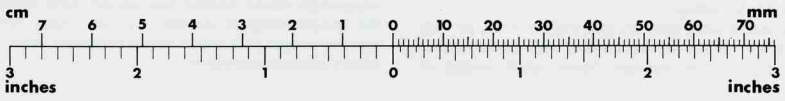
Host plants—The black vine weevil feeds on numerous outdoor and greenhouse plants. Some of the recorded greenhouse host plants are: asparagus fern, aster, astilbe, begonia, Boston fern, cyclamen, geranium, gloxinia, hydrangea, impatiens, primrose, and saxifrage.

Damage—The young larvae feed on small roots. As they mature, they entirely devour larger roots or cut them off. Large larvae also may bore into crowns or corms. Infested plants suddenly wilt and die because of lack of roots. Adults feed at night and notch foliage and flowers.

Life history—In the greenhouse the black vine weevil may have 2 generations each year. Eggs are laid in the soil and hatch in 15 to 21 days. Larvae feed for 3 to 4 months before pupating. The pupal cell is formed 1 to 2 inches below the soil surface. The pupal period lasts about 18 days. Adults feed for 30 days before laying eggs. Peak adult emergence is in January and February and again in August and September. All adults are females. Males are not known for this species. Because they cannot fly, they rely on man for distribution.

CONTROL

One thing to remember is not to rescue potting media from infested plants or compost the media near a greenhouse unless the mix is sterilized or pasteurized. Foliar applications of certain pesticides are effective against the adults. Soil drenches can be used to control larvae. When using soil treatments, watch for phytotoxic responses of the plants. Research has shown that soil treatments are not as effective in media with a high organic matter content. For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.

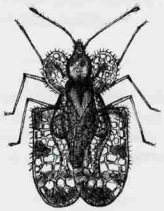


Otiorhynchis sulcatus (Fabricius), Curculionidae, COLEOPTERA

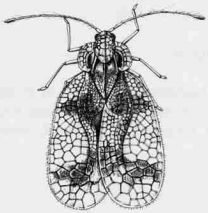
Key to the Most Common Bugs Found on Flowers and Foliage Plants

1. Thorax with lateral extensions divided into numerous small cells (Fig. 53A, B) 2

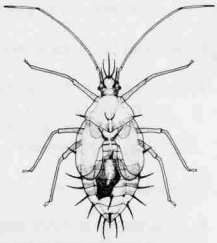
1.' Thorax without lateral extension and not divided into numerous small cells 3



53A



53B



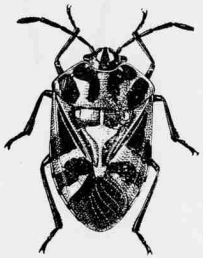
53C

2. Lateral extensions of thorax with tiny spines (Fig. 53A) (Immatures with each segment of abdomen with a multiple-tipped spine on each side); feeds on chrysanthemum, aster, scabiosa, and goldenrod ..... **Chrysanthemum lace bug**

2.' Lateral extensions of thorax without spines (Fig. 53B) (Immatures with each segment of abdomen with a slender, simple spine on each side, Fig. 53C); feeds beneath azalea and rhododendron leaves; Upper surface of leaves stippled with a gray coat, the undersurface often spotted with excrement ("fly specks") ..... **Azalea lace bug**, p. 25

3. Robust bug with black, red or orange, and yellow markings; shield-shaped or oval in top view (Fig. 54); feeds on cleome and flowering cabbage and kale ..... **Harlequin bug**

3.' Not as above: if bug has conspicuous red markings, then it is slender; not shield-shaped 4



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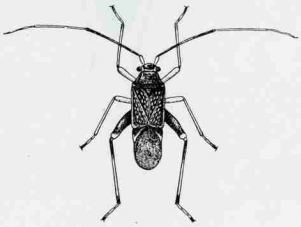
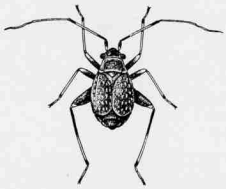


55A



55B

4. Small (1.6 to 2 mm), black bugs (Fig. 55A, B) that jump readily (nymphs 0.7 to 2 mm long and yellow to dark green with a black spot on each side) ..... **Garden Fleahopper**, p. 26

4.' Bug larger than 2 mm or does not have jumping habit and does not always cause pale spots 5

5. Bug relatively slender (about three times longer than wide); rosy red or pink with a black stripe or indistinct band down the back (Fig. 56); found on iris, daylily ..... ***Lopidea confluenta***

5.' Bug oval or variously shaped; not rosy red or pink with a single black strip down the back; found on many plants 6

6. Oval bug up to 7 mm long; greenish yellow with four black stripes down wings (Fig. 57); (immatures bright red with black dots on thorax; last instar with yellow outer strip on wing pads); damage round, depressed spots that may be almost white to almost black ..... **Fourlined plant bug**

6.' Not with four black stripes down wings, etc. 7

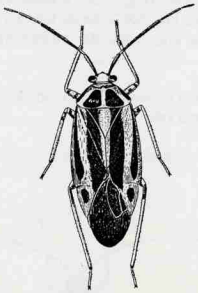
7. Oval bug up to 6.4 mm long; white markings form a sort of triangle on thorax; color various hues of brown (Fig. 58) (nymphs are yellow-green to green with small black spots; older nymphs similar to adult); young tender growth (terminal) yellowed or distorted, stunted, or twisted; shiny circular excrement spots on leaf surface ..... **Tarnished plant bug**, p. 27

7.' Not quite as above 8

8. Oval bug up to 5 mm long; green with indistinct brown marking; widely distributed in the United States but more abundant in the South, especially southern Florida ..... ***Taylorilygus pallidulus***

8.' Oval bug up to 4 mm long; dark, smoky brown with wine-red marking on outer wing margin; infested chrysanthemum buds later produce misshapened flowers; reportedly common in Florida ..... ***Polymerus testaceipes***

56



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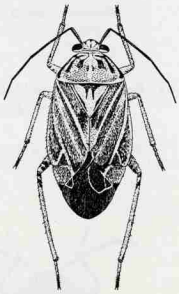

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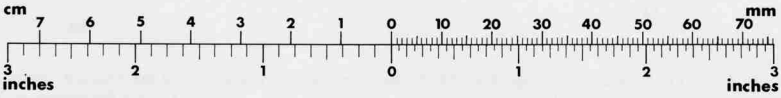


DESCRIPTION

Adult—The adult is 3 mm long and 1.5 mm wide, dark in color with a hoodlike covering on the head and netted, lacy, off-white wings with brown or black markings. The wings are folded flat over the abdomen. The legs and antennae are light brown.

Eggs—The small (0.8 by 0.4 mm), smooth, white egg is oval with the neck to one side. It is usually deposited in the tissue of the leaf along the midrib or a large vein. In some cultivars, the eggs are deposited along the leaf margins. The eggs are inserted with the neck slightly above the leaf surface, and they are covered with a "flyspeck" of blackish frass.

Nymph—Found almost exclusively on the underside of the leaf, the nymph is colorless at birth but soon turns black and spiny. Nymphs pass through five nymphal instars before molting into the adult stage. They grow from 0.4 to 1.8 mm. Wingpads develop after the fourth instar.

BIOLOGY

Distribution—In the United States, the azalea lace bug occurs from New York to Massachusetts southward to Florida and west to Texas.

Host Plants—The evergreen azalea cultivars are the preferred hosts of azalea lace bugs, although deciduous cultivars may be attacked as well as mountain laurel and rhododendrons.

Damage—Injury is caused by the adults and nymphs as they feed through piercing, sucking mouthparts. They extract the liquid contents of the leaf tissue through the undersurface. The upper surface of infested leaves become stippled or blanched, and in severe infestations, leaves gradually turn gray to white and eventually may dry up and fall. The undersurface becomes rust colored and covered with dark spots ("varnish spots") of tarlike excrement. Cast skins of nymphs are often observed on the undersurfaces. Damage usually begins on the lower leaves and moves upward.

Life History—Since its introduction from Japan in the 1920s, the azalea lace bug has become the most serious pest of azaleas. Females lay groups of eggs along the midribs of leaves, along the larger veins (and along the margins of some cultivars) on the undersurface. Females deposit eggs over a 2- to 3-month period. The eggs hatch in about 2 weeks and the nymphs develop through five stages. Newly hatched nymphs are colorless but gradually turn black. Depending on temperatures, nymphs take 10 to 21 days to develop into adults. With such a long egg-laying period, it is common to see all life stages at any time during the growing season. Outdoors there are four generations produced each year. The egg is the usual overwintering stage, although in mild winters adults survive to lay eggs the following spring. In the south eggs begin hatching in late February producing dense populations in March, April, and May. A second generation occurs in July, August, or September, depending on location. This generation lays the overwintering eggs in October. In the greenhouse, azalea lace bugs can appear in large numbers in early spring and occur throughout the spring, summer, and into the fall.

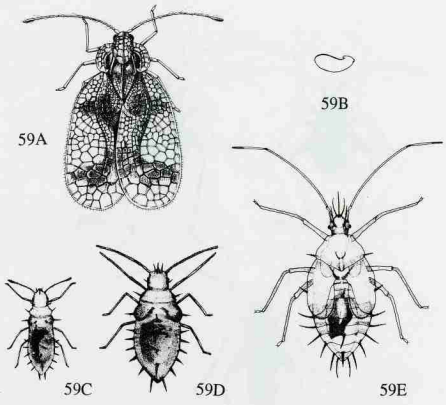


Fig. 59 Azalea lace bug. A. Adult. B, Egg. C to E, Nymphs.

CONTROL

Insecticides may be required for effective control. A predaceous plant bug, *Stethoconus japonicus* Schumacher, from Maryland and New York has been reported to feed voraciously on azalea lace bugs in landscapes. Perhaps sometime in the near future *Stethoconus japonicus* may contribute to effective management of azalea lace bugs throughout the southern United States.

Control can be accomplished if the life cycles are broken early. Sprays should be timed for the first appearance of adults or nymphs in the spring just after the blooms have faded. Two applications or more may be needed because of the extended oviposition time. Systemic insecticides are most effective, and one application may suffice. Nonsystemic insecticides require thorough coverage of the undersurfaces of the foliage, and several applications may be required for complete control. Once damage has occurred, control of the lace bugs will not correct their injury. For specific chemical controls, see the current Cooperative Extension publications on ornamental plant pests or contact your local county Extension agent.

**Stephanitis pyrioides* (Scott), Tingidae, HEMIPTERA

Garden Fleahopper*

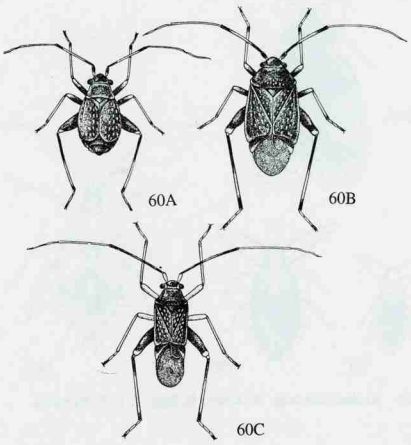


Fig. 60 Garden fleahopper. A and B, Females. C, Male.

DESCRIPTION

Adult—There are three forms of garden fleahopper adults: slender, long-winged females; oval-bodied, short-winged females; and slender, long-winged males. All forms are black and have long legs and antennae. They tend to jump actively but are also capable of flying. The body may be 1.6 to 2.0 mm long.

Egg—Each white, somewhat curved egg is rounded at one end, truncate at the other, about 7 mm long and 1 to 2 mm wide. Usually inserted into the plant, the egg is seldom if ever seen.

Nymph—Nymphs are pale yellow to dark green and range from 0.7 to 2 mm in length with five instars. Later instars have a distinct black spot on each side of the first thoracic segment. All stages have a jumping habit.

BIOLOGY

Distribution—Though infestations are sporadic in occurrence, garden fleahoppers can be found throughout the eastern United States as well as in some western areas.

Host Plants—A wide range of garden, ornamental, and forage plants as well as many weeds and grasses are subject to infestation by this fleahopper.

Damage—Garden fleahoppers cause pale spots to develop on leaves by sucking sap from the foliage. Heavily infested foliage dies and drops from the plant. Such defoliation interferes with growth and development of the crop.

Life History—Garden fleahoppers overwinter as eggs laid from August through September. Nymphs emerge in early spring and feed on undersides of leaves. Nymphs feed and develop from 11 to 35 days before maturing into adults. The duration depends on temperature.

Adults live 1 to 3 months. Each female lays approximately 105 eggs. Eggs are inserted into punctures made by the mouthparts in stems or leaves. About 12 to 20 days later eggs hatch and the life cycle is repeated. Five generations are completed each year.

CONTROL

For specific chemical controls, see the current Cooperative Extension publications on ornamental plant pests or contact your local county Extension agent.

**Halticus bractatus* (Say), Miridae, HEMIPTERA

Tarnished Plant Bug*

DESCRIPTION

Adult—The tarnished plant bug is oval and pale yellow with a few black markings or reddish brown to black with a few pale yellow markings. There is sometimes a characteristic white triangle between its shoulders. The antennae and legs are relatively long. Males are 5 to 6 mm long and females are up to 6.5 mm long.

Egg—The egg is small, truncate and slightly curved. It is about 1 mm long and 0.25 mm wide.

Nymph—Newly hatched nymphs are yellowish green and about 1 mm long. Older nymphs are yellow green to green and wingless. As they mature the nymphs develop yellow, green or black spots. Older nymphs have four black spots on the thorax and one on the abdomen. The head is light green. There are five nymphal instars. The full-grown nymph has wingpads and is about 4 to 4.5 mm long.

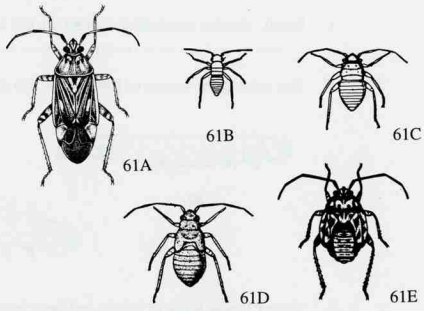


Fig. 61 Tarnished plant bug. A, Adult. B to E, Nymphs.

BIOLOGY

Distribution—This plant bug is found throughout the United States. It prefers warm, humid to dry climates in the South, Southeast, and Southwest.

Host Plants—The host range of this pest seems endless. It attacks some 50 species of economic plants, including fruits, vegetables, ornamentals, field, and forage crops. Greenhouse hosts include asters, chrysanthemums, dahlias, impatiens, and marigolds. Weed hosts include butterweed, fleabane, goldenrod, vetch, dock, and dogfennel.

Damage—The tarnished plant bug is among the most damaging of the true bugs. The bugs use their needlelike mouthparts to extract plant juices. These bugs are known to transmit plant diseases. Their feeding causes terminal growth to be yellowed or distorted thereby reducing plant growth and causing them to appear unthrifty. Leaves from damaged buds are sometimes ragged and discolored. Flowers from damaged buds sometimes fail to develop on one side or the whole bud aborts.

Life History—In the South (warmer states) all stages of the tarnished plant bug may be found year round. In cooler climates the adults overwinter in litter or other trash in protected areas, such as woods or ditch banks along fields. Once established in greenhouses, a population may breed continuously unless the cycle is broken by good sanitation or chemical controls. Reinfestation usually occurs through unscreened vents or doors during ventilation. The adults and young feed on the young tender growth of plants but usually prefer the foliage.

Oviposition is in the young tender stem, leaves or flowers of plants in the composite family. Egg hatch occurs in about 1 to 3 weeks. Eggs deposited in the veins or the leaves cause tiny swellings. The nymphs pass through five instars over a 2- to 3-week period and the whole life cycle takes 3 to 4 weeks. The nymphs usually remain in the area of hatching, but as adults the bugs are very active and fly freely. The tarnished plant bug is prolific and produces several generations a year. Peaks of abundance for adult tarnished plant bugs are usually in early July, early August, and early September.

CONTROL

Removal of preferred host plants from around greenhouses and cleaning up favorable overwintering sites should help reduce numbers of tarnished plant bugs for the following year. For specific chemical controls, see the current Cooperative Extension publications on ornamental plant pests or contact your local county Extension agent.

**Lygus lineolaris* (Palisot de Beauvois), Miridae, HEMIPTERA

Key to Most Common Caterpillars Found on Flowers and Foliage Plants

1. Small, slender caterpillar mining in the leaves or folding the tips of the leaves of azaleas (Fig. 62) ..... **Azalea leafminer**, p. 30

1'. Not mining the leaves or folding the tips of leaves of azalea 2

62

64

63

2. Young larvae mine in leaves and later burrow into the stem, petioles, flowers, or seed pods of geranium and snapdragon (Fig. 63) ..... **Plume moth caterpillars** p. 43

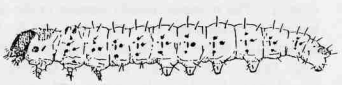
2'. Not mining in leaves and burrowing into the stem, petioles, flowers, or seed pods of geranium 3

3. Variously spotted and marked caterpillars feeding on the foliage of ferns (Fig. 64) ..... **Florida fern caterpillar**, p. 38

3'. Not feeding on ferns 4

4. Whitish caterpillar feeding on and within the rhizomes of iris (Fig. 65) ..... **Iris borer**, p. 40

4'. Not feeding on or within the rhizomes of iris 5



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67

66

5. Relatively slender caterpillar (Fig. 66) feeding only on plants in the mustard family (Cruciferae), at least 4 pairs of prolegs, prolegs relatively long, one row of crochets around the end of each proleg, usually feeds under leaves, riddling the foliage; when disturbed often hangs down by a silk thread ..... **Diamondback moth**, p. 36

5'. Not exactly as above 6

6. Boring into the stalks of garden mums and shasta daisies and other stems of flowering crops (Fig. 67) ..... **European corn borer**, p. 37

6'. Not boring into the stalks of garden mums, shasta daisies, and other stems 7

7. Tying or rolling the leaves of the host plant with silk strands 8

7.' Not tying or rolling the leaves of the host plant with silk strands 11

8. Tying or rolling the leaves of canna 9

8.' Not tying or rolling the leaves of canna 10

9. Caterpillar slender, up to 23 mm long with yellowish head (Fig. 68)... **Lesser canna leafroller**, p. 41

9'. Caterpillar relatively robust, green, somewhat transparent, brown head on a distinct neck ..... **Larger canna leafroller**

68

69A

69B

10. Shield on first thoracic segment only slightly darker than rest of skin but with a distinct dark spot on either side; there are two prespiracular setae on the first thoracic segment; caterpillar green and sometimes with a darker green stripe along the back and a paler green stripe along either side (Fig. 69A); prolegs with crochets in arranged in circles with three rows on the inside but one row on the outside (Fig. 69B); no anal fork ..... **Greenhouse leaftier**, p. 39

10'. Not as above; three prespiracular setae on first throacic segment, anal fork or comb present on last abdominal segment (Fig. 70); crochets on last pair of prolegs not in a complete circle ....***Choristoneura*** and ***Platynota*** **leafrollers**, pp. 33 & 42

11. Caterpillar with only two pairs of prolegs (plus three pairs of legs on the thorax, Fig. 71), loops as it travels on plant; feeds on leaves and flowers ..... **Cabbage looper**, p. 32

11.' Caterpillar with five pairs of prolegs on abdomen (plus three pairs of legs on thorax), does not loop as it travels along; feeds on various parts 12

70

71

12. First and second instars are pale green with dark heads; older caterpillars are green to almost black with stripes along each side; always have a black spot on the side above the second pair of legs (counting from the head, Fig.72) ..... **Beet armyworm**, p. 31

12'. Caterpillar variously colored but never with a black spot on the side above the second pair of legs (counting from the head) 13

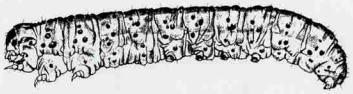
13. Primarily a pest of buds and flowers, caterpillar remains on plant during the day (Fig. 73) ..... **Corn earworm**, p.34

13.' Primarily a pest of foliage; caterpillars (especially older caterpillars) tend to hide in the soil or potting mix during the day (Fig. 74 A to C) ..... **Cutworms**, p. 35

72

73

74A



74B

74C

CATERPILLARS
Azalea Leafminer*

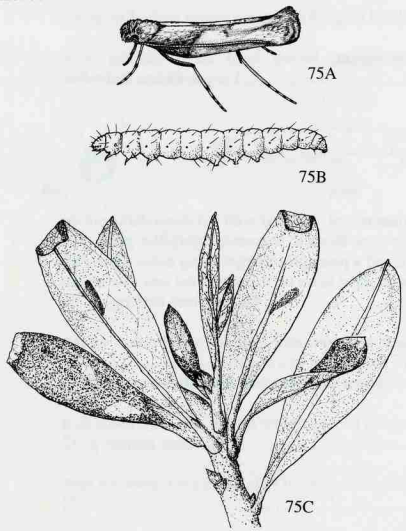


Fig. 75 Azalea leafminer. A, Adult. B, Larva. C, Damaged leaves.

DESCRIPTION

Adult—The adult azalea leafminer is a small yellow moth with purplish markings on the wings. The wingspread is about 10 to 13 mm.

Larva—In the larval stage, the azalea leafminer is a yellowish caterpillar about 7 to 13 mm long. It has three pairs of prolegs found on abdominal segments 3, 4, and 5. The proleg hooks (crochets) on each proleg are arranged in a U-shaped pattern (penellipse) with another series of crochets within the U-shape.

BIOLOGY

Distribution—The azalea leafminer is found in most states where azaleas are grown.

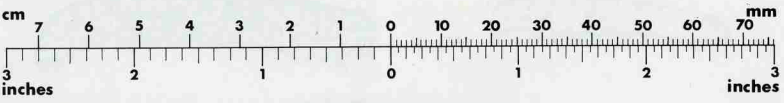
Host Plants—Azaleas are the only known hosts for this insect.

Damage—Injury is usually not apparent until brown blisters appear in the leaves or until the tips and margins of leaves are rolled and damaged by feeding larvae inside. Seriously injured leaves usually turn yellow and drop, thereby causing an unsightly plant. Azalea leafminers usually cause little damage in the field but may do considerable damage to cuttings or potted plants being forced into bloom in the greenhouse.

Life History—Eggs (usually one to five per leaf) are deposited singly on the underside of the leaf along the midrib. The young larvae hatch in about 4 days, mine into the leaf, and feed between the two leaf surfaces. At this stage the leaf appears to have blisters on it; if it is held up to the light, the larva may be seen inside. When about one third grown, the larva emerges, moves to the tip of a new leaf, and rolls it up for protection while feeding and growing. When nearly grown, the larva rolls up the margin of a leaf and spins a cocoon inside. The moth emerges from the cocoon, mates, and deposits eggs for another generation. Development takes about 6 weeks. Under greenhouse conditions the larva may be found anytime during the year. Outdoors, the insect overwinters as a larva or pupa. Adults appear and females begin to lay eggs about the time azaleas bloom in the spring.

CONTROL

Because the larva protects itself by mining into and rolling the leaf, this insect is not easy to control. Chemical control is possible if applied at the first sign either of the moths or of foliar injury by the larvae. One or two applications, 1 to 2 weeks apart should give adequate suppression. For chemical control recommendations, consult the current Cooperative Extension Service publications on ornamental plant pest management.



*_Caloptilia azaleella_ (Brants), Gracillariidae, LEPIDOPTERA

DESCRIPTION

Adult—The beet armyworm adult is a grayish brown moth with a pale circular spot near the middle of the forewing. The wingspan is 25 to 30 mm. The hind wings are whitish with dark edges.

Larva—First and second instars are pale green with dark heads. Older caterpillars are green to almost black with stripes along each side. Beet armyworms always have a black spot on the side above the second pair of legs (counting from the head).

Pupa—At first the beet armyworm pupa is light brown, but it soon darkens.

BIOLOGY

Distribution—The beet armyworm originated in southern Asia and has since spread throughout most temperate and tropic countries.

Host Plants—The beet armyworm has an extremely wide host range including numerous ornamental crops such as roses and geraniums. Chrysanthemums, carnations, and *Gypsophila* are especially preferred.

Damage—Beet armyworms web foliage together and feed within this shelter. They also bore into flower buds. Older larvae feed extensively on flowers, buds, and foliage.

Life History—The beet armyworm has several generations per year. Flight activity is greatest in July and August. Eggs are laid in masses of 15 to 150 mostly on the undersides of leaves and mostly within 10 cm of the soil surface. Females may cover the eggs with a mat of scales that protects them from parasites and insecticides. Females prefer younger plants to older plants. Two to 9 days later the eggs hatch. First and second instar beet armyworms feed in groups, especially in the growing tips where they web several leaves together. Older larvae do not restrict feeding to young leaves. The third and fourth instars last 1 to 3 days. The fifth instar feed for 2 to 6 days. Beet armyworms are cannibalistic, particularly when feeding on plants with low nitrogen levels. Moths that develop from cannibalistic caterpillars lay more eggs than moths that developed from caterpillars that fed only on plant material. Mature beet armyworms tunnel into the soil 2.5 cm and form a cell in which they pupate. The pupal stage lasts 4 to 11 days. The moths are nocturnal and mating and egg laying occur at night. Females deposit up to 600 eggs during their 7- or 8-day life. Moths may live up to 30 days.

CONTROL

Cotesia marginiventris (Cresson) is a common parasite of the beet armyworm. *Meteorus laphygmae* Viereck, *Pristomerus spinator* (Fabricius), *Campoletis flavicincta* (Ashmead), and *Chelonus insularis* Cresson also parasitize the immature stages of the beet armyworm. A polyhedrosis virus sometimes causes epizootics in beet armyworm populations that causes virtually 100 percent mortality in some fields.

The beet armyworm is difficult to control with chemicals because the young larvae web leaves together and feed under the webbing that protects them from insecticides. Older larvae are more tolerant of pesticides. In addition, some beet armyworm populations have acquired resistance to methomyl and perhaps other pesticides. Pheromone traps can help monitor for moth flight activity. All *Bacillus thuringiensis* strains are not necessarily acutely toxic to beet armyworms, but some strains do cause significant mortality and stunt the development of surviving caterpillars. The use of bacterial pesticides may help delay the acquisition of resistance to pesticides by the beet armyworm. For specific chemical control recommendations, consult the current Cooperative Extension Service publications on ornamental plant pest management.

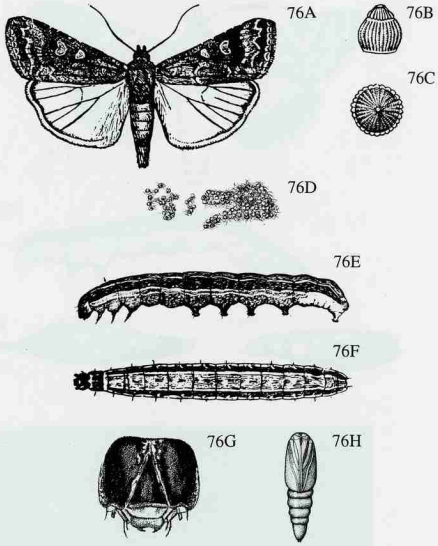
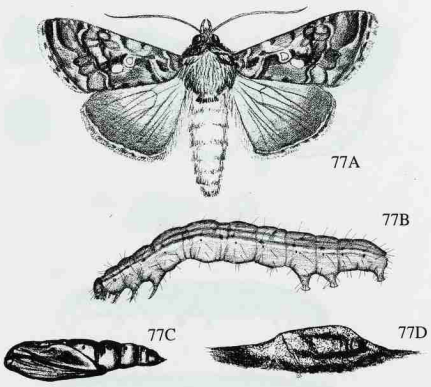
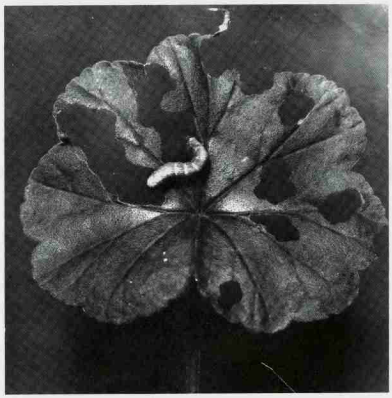


Fig. 76 Beet armyworm. A, Adult. B-C, Eggs (enlarged). D, Egg mass. E-F, Larvae. G, Larval head. H, Pupa.

Spodoptera exigua (Hübner), Noctuidae, LEPIDOPTERA

CATERPILLARS
Cabbage Looper*





77E

Fig. 77 Cabbage looper. A, Adult. B, Larva. C, Pupa. D, Cocoon. E, Damage.

DESCRIPTION

Adult—The adult cabbage looper is a grayish-brown moth with a wingspan up to 33 mm. The forewings have a distinct irregular, white mark.

Egg—When first deposited, the eggs are white but darken as they get older. The eggs are hemispherical with fine transverse lines and longitudinal ribs.

Larva—Newly hatched larvae are whitish with a black head and shield immediately posterior to the head. As the larvae grow, they become light green with two dorsal white stripes and two wider lateral white stripes. The markings become less distinct in the last instar. The body tapers toward the head, and the full grown larva is 35 to 40 mm long.

Pupa—Easily seen through the webby cocoon, the pupa is light green when first formed and darkens to almost black later.

BIOLOGY

Distribution—The cabbage looper is found throughout the United States.

Host Plants—The cabbage looper larva is a general feeder with a wide range of possible food plants. Some hosts are cabbage, carnation, snapdragon, nasturtium, mignonette, celery, tomato, beet, pea, and lettuce.

Damage—On some plants the larva has a distinctive feeding habit. The holes it makes are arc-shaped. The area of the hole is determined by the size of the larva that made it. The characteristic pattern is caused by the larva partly cutting the leaf as far as it can reach by holding fast with its hind legs.

Life History—Because the larva of the cabbage looper lacks 2 pairs of prolegs, it is necessary for the caterpillar to arch its back in a looping fashion to move, hence the common name looper.

Eggs are deposited singly on either side of the leaf by the cabbage looper. Each female is capable of producing 200 or more eggs. Hatching occurs 3 to 10 days after the eggs are laid. There are four or five larval instars that develop in 10 to 50 days. If food is abundant and environmental conditions are favorable, only four instars develop. The larvae are strong crawlers and will travel some distance to reach a new host. If disturbed, the caterpillars characteristically curl into a ball and drop from the plant. Pupae are formed within a thin, white cocoon that may be attached to different objects or under a clod of soil. The pupal stage lasts from 6 days to as long as several months (overwintering stage). The adults are strong fliers and are active about dusk and on cloudy and cool fall days. The moths avoid strong sunlight.

CONTROL

A number of parasitic wasps and flies attack cabbage looper caterpillars, and birds and bats feed on the adult moths. For specific chemical control recommendations, consult current Cooperative Extension Service publications.

**Trichoplasia ni* (Hübner), Noctuidae, LEPIDOPTERA

CATERPILLARS
Choristoneura Leafrollers*

DESCRIPTION

Adult—The adult obliquebanded leafroller is a 1.7 to 3.3 cm, dark deep yellow to reddish-brown moth with pale orange-yellow (males) to deep yellow (females) hind wings. Female moths are larger than males. The spotted fireworm moth is a smallish (1.9 to 2.5 cm) light reddish to orange-brown moth with two dark patches on the outer magins of the top wings.

Eggs—No description found.

Larvae—The spotted fireworm has two small brown spots on the front margin of the thoracic shield and the anal shield has some brownish pigments. The obliquebanded leafroller does not have spots on the throracic shield or brownish pigment on the anal shield (the length of both species ranges up to 19 mm).

Pupae—No description found.

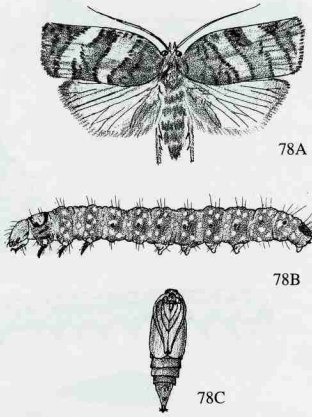


Fig. 78 Spotted fireworm. A, Adult. B, Larva. C, Pupa.

BIOLOGY

Distribution—The obliquebanded leafroller is found throughout most of the United States except the arid Southwest. The spotted fireworm occurs from Ontario and Maine to Florida and west to Missouri and Mississippi.

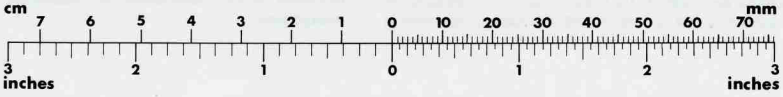
Host Plants—The obliquebanded leafroller feeds on many kinds of plants including poinsettia. It overwinters on the stems of rosaceous trees and other hardwoods. Spotted fireworms have been collected from blueberries, citrus, cranberry, almond, gardenia, goldenrod, roses, sheep laurel, and azalea leaves.

Damage—The obliquebanded leafroller ties leaves together and feeds in that shelter. The caterpillars often tie the new leaves of poinsettia together so firmly that as the leaves develop, they are constricted and distorted by the silk.

Life History—There are two broods of obliquebanded leafrollers in North Carolina although there may be three generations per year in Tennessee. Moths have been collected from late April through October. The obliquebanded leafroller enters diapause in autumn when shorter days and lower temperatures make conditions unsuitable for growth and development. The obliquebanded leafroller overwinters as second to fourth stage larvae in tiny, tight cocoons called hibernacula. The overwintering caterpillars emerge and begin feeding on the new growth in spring. The caterpillars pupate and within a few weeks a new generation of moths emerges to mate and lay eggs. Males emerge before females. Therefore it is best to wait a few days after adults are first noticed before applying some sort of control measures. Females lay their eggs in small masses of about 200 on the leaves of various trees, shrubs and flowers. Newly hatched caterpillars disperse vigorously and even can be blown about from plant to plant. The caterpillars develop through seven instars. It has been shown that obliquebanded leafroller caterpillars develop more rapidly on tender new leaves than on mature leaves.

CONTROL

The obliquebanded leafroller has several parasites including *Meterous trachynotus* Viereck and *Macrocentrus iridescens* (Fr.). The microsporidian *Nosema fumiferanae* (Thomson) causes high mortality in young larvae. However, if older larvae become infected, some pupate successfully and (infected) adults may emerge. Frass from infected caterpillars may infect other larvae. For specific chemical control recommendations, consult the current Cooperative Extension Service publications on ornamental plant pest management.



*Obliquebanded leafroller, *Choristoneura rosaceana* (Harris); spotted fireworm, *Choristoneura parallela* (Robinson), Tortricidae, LEPIDOPTERA

CATERPILLARS
Corn Earworm*

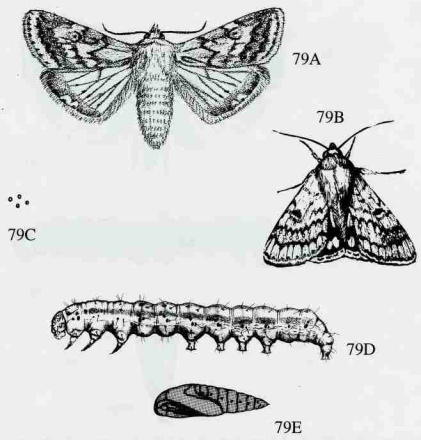


Fig. 79 Corn earworm. A-B, Adults. C, Eggs. D, Larva. E, Pupa.

DESCRIPTION

Adult—Adult corn earworm moths vary in color and markings, but the forewings are usually light yellow or yellowish brown, with dark irregular lines and a dark area near the tip. The hind wings, usually partially covered by the forewings, are white with irregular dark markings near the border. Wingspan is about 40 mm. The eyes of the moths are green.

Egg—When first laid, the hemispherical and ridged eggs are pale white. A pale reddish band develops around the egg, and then it darkens prior to hatching.

Larva—Larvae vary from pale green to dark brown, with alternating light and dark longitudinal stripes, generally brown or orange, running the length of the body. The head is dark yellow or reddish orange. Newly hatched larvae are about 1.6 mm long and yellowish white with dark head capsules. Full-grown larvae are about 43 mm long.

Pupa—Pupae are glossy brown and taper at one end. The pupa is about 32 mm long and 6 mm wide.

BIOLOGY

Distribution— The corn earworm feeds on many plants throughout the world. In the United States, the corn earworm is a destructive pest of corn, cotton, and tomato, especially in the South. The corn earworm also is referred to as the cotton bollworm or the tomato fruitworm. Two similar and related species, the tobacco budworm, *Heliothis virescens* (F.), and *Heliothis phloxiphaga* Grt. & Rob., may be confused with the corn earworm. Damage to the plant by each species is similar.

Host Plants—The corn earworm feeds on a wide variety of plant species. Ageratum, carnations, chrysanthemums, and roses are severely injured by the corn earworm in unscreened greenhouses. Additional hosts include amaranth, canna, cleome, dahlia, geranium, gladiolus, hibiscus, lathyrus, lupine, mint, morning glory, nasturtium, phlox, poppy, and sunflower. The tobacco budworm and *H. phloxiphaga* also feed on aster, columbine, delphinium, and snapdragon.

Damage—Corn earworm larvae feed on all exposed plant parts, particularly the buds and flowers, and may defoliate the plant. Infestations on flowering plants are more likely in the fall after many of the field crops and weeds are unattractive, unsuitable, or unavailable for moths. Moths, attracted to these flowering hosts, may feed on nectar and oviposit on the plant. Moths do not damage the plant.

Life History—Adult moths begin to emerge from overwintering sites in early May and are most active at night. Male and female corn earworms live about 10 to 14 days. During that period, each corn earworm female may lay 450 to 2,000 eggs singly on host plants. Eggs are laid on open foliage, but are usually densest on younger leaves. Eggs hatch in 2 to 5 days. The larval stage lasts about 2 to 3 weeks and has five or six instars. Smaller larvae tend to occur in new, still-rolled foliage, whereas larger larvae tend to feed on open leaves. All stages tend to feed on flowers, tender new leaves and fruit. Late-stage larvae tunnel 5 to 15 cm into the soil and pupate. The pupal stage lasts about 2 to 3 weeks. Adults then emerge from the soil. Duration from egg to adult emergence is 6 to 8 weeks under field conditions. Corn earworm overwinters as a diapausing pupa in the soil and undergoes several generations each year. In the North, the pupa can survive only during mild winters. Adults are strong fliers and, in the spring, are spread northward from warmer overwintering areas. Infestations in greenhouses occur when the corn earworm moths fly through open doors, windows, and vents and then deposit eggs on the plants. Corn earworm larvae are cannibalistic.

CONTROL

Damage by corn earworms in a greenhouse can be reduced by adequate screening of window and open areas, as well as proper sealing of door edges. Use of natural enemies (e.g., *Trichogramma* wasps and predatory insects) may help to reduce infestation by corn earworm. Chemical insecticides provide adequate control of corn earworm. For chemical control recommendations, consult the current Cooperative Extension Service publications on ornamental plant pest management.

**Helicoverpa* (= *Heliothis*) *zea* (Boddie), Noctuidae, LEPIDOPTERA

DESCRIPTION

Adult—When resting, adult cutworm moths hold their wings back in a triangular position. The moths are stocky and have wingspans of about 40 mm. The forewings are dark and mottled or streaked; the hind wings are lightly colored and not marked.

Eggs—The eggs are usually white (becoming darker prior to hatching), round, and 0.5 to 0.75 mm in diameter.

Larva—If disturbed, the larvae usually curl into a C-shaped ball. Cutworms are dull-colored, fat, smooth caterpillars that become about 45 mm when fully grown.

Pupa—Pupae are brown and 15 to 22 mm long.

BIOLOGY

Distribution—Cutworms are found throughout the United States.

Host Plants—Besides field and vegetable crops, some of the plants attacked by cutworms are aster, carnation, chrysanthemum, dahlia, gladiolus, marigold, nasturtium, pansy, rose, violet and zinnia.

Damage—Many cutworms prefer wilted plant material and cut the plants a night ahead. Stems are chewed off near the soil. Some cutworms climb the host and feed on unopened buds.

Life History—Cutworms are caterpillars that feed on the stems and leaves of young plants and often cut them off near the soil line, hence their common name. Although there are many important species of cutworms, the black, granulate and variegated cutworms are particularly destructive to flowers. Each cutworm differs slightly from the others in details of habits and appearance, but their life histories are generally similar. Adults and larvae are nocturnal and hide during the day but become active on cloudy days. The overwintering forms of cutworms occur in the soil either as pupae or mature larvae. In the spring, the hibernating larvae pupate. Adults begin to appear in the middle of March. Females deposit eggs singly or in clusters, and each female can lay as many as 500 eggs. Under optimum conditions, the eggs hatch in 3 to 5 days, and the larvae develop in 3 to 4 weeks passing through 6 instars. Pupae mature in 2 weeks during the summer and as many as 9 weeks in the fall. Some of the cutworms can produce as many as four generations each year in the southeastern United States.

Cutworms can enter a greenhouse as moths which fly in and deposit eggs. Often eggs, larvae, and pupae gain entry in contaminated soil or on infested plants brought into the greenhouse. Cutworms can be found throughout the year in the greenhouse if a population is established there.

CONTROL

For specific chemical control recommendations, consult the current Cooperative Extension Service publications on ornamental plant pest management.

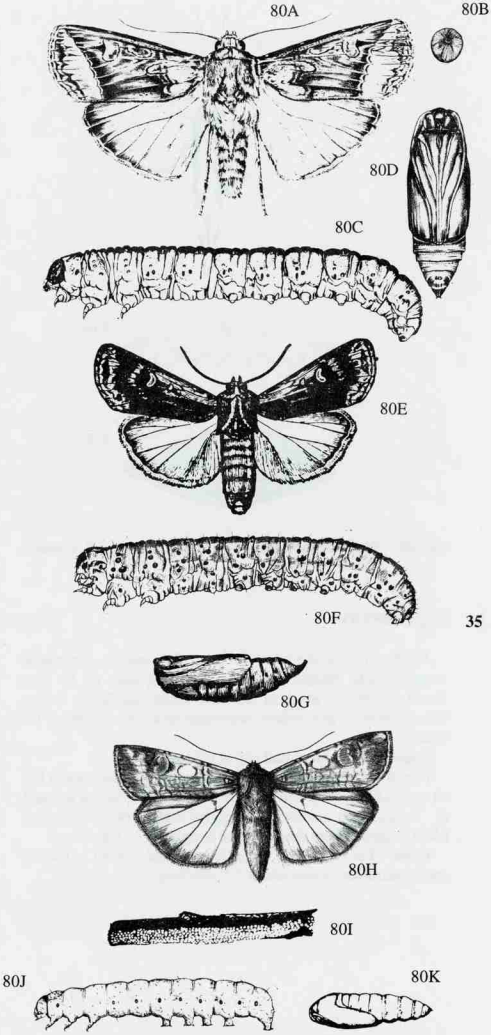


Fig. 80 Cutworms. A-D, Black cutworm. A, Adult. B, Egg. C, Larva. D, Pupa. E-G, Granulate cutworm. E, Adult. F, Larva. G, Pupa. H-K, Variegated cutworm. H, Adult. I, Egg mass. J, Larva. K, Pupa.

*Black Cutworm, *Agrotis ipsilon* (Hufnagel); Granulate cutworm, *Feltia subterranea* (Fabricius); Variegated cutworm, *Peridroma saucia* (Hübner), Noctuidae, LEPIDOPTERA

CATERPILLARS
Diamondback Moth*

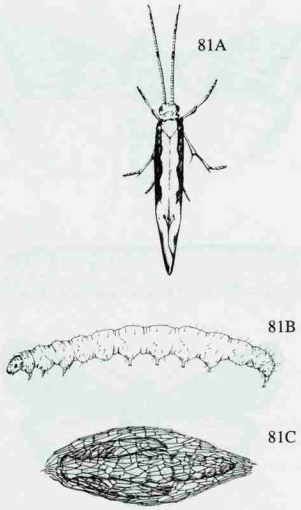


Fig. 81 Diamondback moth. A, Adult. B, Larva. C, Cocoon with pupa inside.

DESCRIPTION

Adult—This grayish-brown moth has narrow forewings, conspicuously fringed hind wings with a span of 18 mm. When at rest, the wings of the male come together to form a line of white or pale yellow diamonds down the middle of the back.

Egg—The minute round egg is pale yellow.

Larva—Tapering slightly at both ends, this pale-green larva with a black head and scattered black hairs reaches a length of 7 mm when mature. It wriggles rapidly when disturbed, often dropping from the plant and hanging by a silk thread.

Pupa—The yellowish pupa is enclosed within a loosely spun, gauzelike cocoon about 7.5 mm long.

BIOLOGY

Distribution—Originally from Europe, the diamondback moth can be found throughout all areas of the world where cole crops are grown. It can be a problem in greenhouses also.

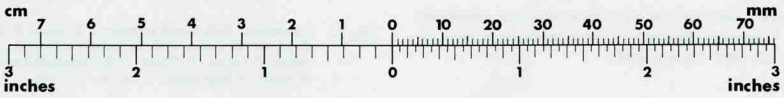
Host Plants—Diamondback moth caterpillars are pests of practically all crucifers, including sweet alyssum, candytuft, stocks, honesty, flowering cabbage, flowering kale, as well as the vegetables broccoli, cauliflower, collards, brussel sprouts, kale, kohlrabi, turnip, radish, mustard, and watercress. Weeds in the family Cruciferae are also infested.

Damage—Diamondback moth larvae feed on all plant parts but prefer the undersides of older leaves, crevices between loose leaves and young buds. They eat small holes in leaves and buds, or feed superficially leaving only slight perforations. When populations remain low, these small caterpillars cause little damage; however, in large numbers, they are particularly injurious to young plants. Heavy feeding on buds may cause the plant to fail to develop properly.

Life History—Diamondback moths overwinter as adults among field debris of crucifer crops. In spring, eggs are laid, singly or in groups of two or three on foliage. Larvae, which hatch from eggs a few days later, feed for about 10 days during warm weather and a month during cool seasons. Larvae first feed as leafminers but soon emerge and infest the undersides of leaves. Once mature, larvae spin loose cocoons which remain attached to lower leaf surfaces. After a 2-week pupal period, a new generation of moths emerges. In temperate regions, the diamondback moth has two to six or more generations each year.

CONTROL

Because the moths overwinter outdoors, destroying or plowing under crucifer crop debris is a recommended cultural practice. Planting resistant varieties also reduces damage. The following crucifer varieties are less attractive to diamondback moth larvae: Michihli Chinese and Mammoth Red Rock (cabbage); Southern Giant Curled (mustard); Seven Top and Purple Top White Globe (turnip); Vates (kale); and Cherry Belle, White Icicle, Globemaster, and Champion (radish). For specific chemical control recommendations, consult the current Cooperative Extension Service publications on ornamental plant pest management.



**Plutella xylostella* (Linnaeus), Plutellidae, LEPIDOPTERA

DESCRIPTION

Adult—The female moth has a robust body and a wingspread of about 25 mm. It is colored pale yellow to light brown. The outer third of the wings is usually crossed by dark zigzag lines. The male moth is smaller, more slender, and darker than the female. The outer third of its wings is usually crossed by two zigzag streaks of pale yellow, and often there are pale-yellow areas of the forewings.

Egg—Each white egg is about half the size of a sewing pin head. The eggs change to pale yellow and darken just before hatching as the brown head of the borer inside becomes visible. Within the egg mass, the eggs overlap each other like fish scales. The masses of 20 to 30 eggs are covered with a shining waxy substance.

Larva—The newly hatched larva, about 1.5 mm long, has a black head, five pairs of prolegs, and a pale-yellow body bearing several rows of small black or brown spots. It develops through five or six instars to become a fully grown larva about 25 mm long.

Pupa—The brown pupa is 13 to 15 mm long with a smooth capsulelike body.

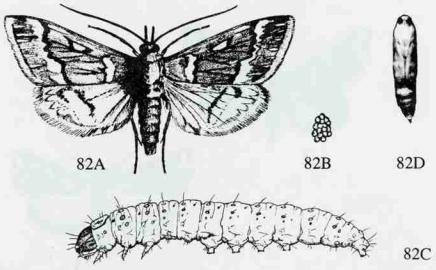


Fig. 82 European corn borer. A, Adult. B, Eggs. C, Larva. D, Pupa.

BIOLOGY

Distribution—Introduced into the United States from Europe in 1909, the European corn borer has spread throughout the contiguous states and into Canada. In North Carolina, the largest populations of this pest occur in the Coastal Plain where 75 percent of the stalks in some fields have been attacked.

Host Plants—The European corn borer infests over 200 plants, but corn is a preferred host. Chrysanthemums and Shasta daisies are often infested in the summer and early fall. Other vegetable crops likely to be injured include bean, beet, celery, potato, pepper, and tomato.

Damage—On most crops, borers begin feeding on the leaf surface. Later the larvae bore down midribs of leaves into the stalk. Frass and silk near entrance holes are evidence of their presence. Borers weaken stalks or stems and interfere with the movement of plant nutrients. Infested stems often lodge.

Life History—Mature larvae overwinter inside tunnels in stubble, stalks, ears, or other protective plant material. They pupate in spring. During April and May, adult moths emerge. Females do not mate the first day, but most mate within the next 48 to 72 hours. Flight activity begins at dusk when moths apparently disperse to drink dew. Most mating takes place about midnight in tall, dense grass such as foxtail as much as 100 m from the nearest host plants. Usually in early morning, each female lays 500 to 600 eggs in small masses of 20 to 30 on the undersides of leaves. Eggs hatch in 3 to 12 days, depending upon temperature. Young larvae usually begin feeding on leaf surfaces and, as they mature, begin boring in the midribs of the leaves. European corn borer larvae are cannibalistic and at most only a few survive to emerge as adults. Two to 3 days after eggs hatch, stalk or ear boring commences and continues until pupation. In Florence, South Carolina, the European corn borer completes four generations per year. Therefore in much of the Southeast, eggs of the second generation are laid in mid- to late June, those of the third generation in late July, and those of the fourth generation in September. The third and fouth generations are much more of a threat to garden mums and other ornamentals as corn is not suitable for oviposition late in the season. The shorter days and high temperatures of late summer induce the larvae to develop into a diapausing state from which they emerge the following spring due to longer days and higher temperatures (following low winter temperatures).

CONTROL

Many natural parasites of the European corn borer have been introduced from Europe. Other biological control agents such as ladybird beetles, predaceous mites, and downy woodpeckers also have been responsible for some European corn borer reduction. The bacterial insecticide, *Bacillus thuringiensis*, also shows some promise for borer control.

Chemical control of the European corn borer is difficult because the caterpillars are exposed only during the 2- to 3-day period after eggs hatch and before larvae bore into stems. Therefore, close attention should be paid to the presence of moths and eggs. The emergence of the first moths can be determined by using either light traps or pheromone traps. Treatments should begin 7 to 10 days after a moth flight or about 5 days after the first egg masses are found. Pyrethroid insecticides have relatively long residual lives and are toxic to caterpillars and other pests of garden mums. Growers should consider pyrethroids because of the extended flight period of the third and fourth generations of European corn borer moths in late summer. For specific chemical control recommendations, consult the current Cooperative Extension Service publications on ornamental plant pest management.

**Ostrinia nubilalis* (Hübner), Pyralidae, LEPIDOPTERA

CATERPILLARS
Florida Fern Caterpillar*

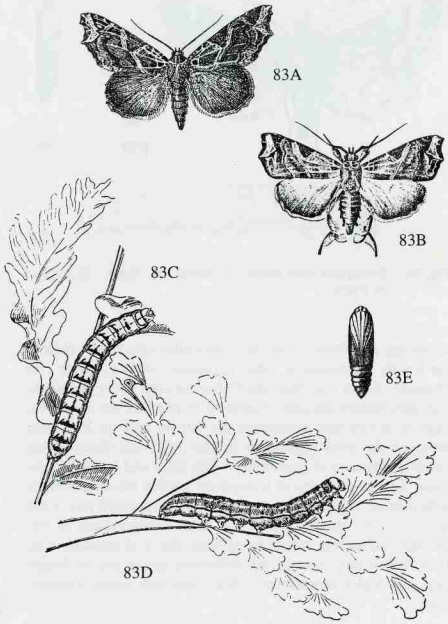


Fig. 83 Florida fern caterpillar. A, Adult female. B, Adult male. C-D, Larvae. E, Pupa.

DESCRIPTION

Adult—The Florida fern caterpillar moth is an attractive brownish insect with variegated wings. The forewings have a dark-reddish-brown triangle on the outer margin and a pale chevron at the tip. The ends of the forewings are somewhat ragged. The wingspan is 28 mm. The legs are conspicuously tufted, especially in the males. Female moths tend to be darker than males.

Egg—The eggs are slightly flattened spheres covered with tiny longitudinal and transverse ribs. They are pale green with a yellow tint and are 0.5 mm wide.

Larva—The Florida fern caterpillar has five color forms: a light-green form; a green form with an upper white line and a lower black line down each side; a form with the upper and lower white and black lines down each side plus black spots on the back and upper sides; a velvety dark-striped or black form; and a velvety dark-striped or black form with a white line down each side. Sometimes green worms occur with thin, pale, yellow stripes on the back and bold, white stripes on each side. The caterpillars grow 32 to 38 mm long when mature.

Pupa—The pupa of the Florida fern caterpillar is reddish-brown and cylindrical, tapering toward the hind end and is 13 to 20 mm long. There are two minute, outcurved spines at the hind end. The pupa occurs inside a cocoon that is usually covered with particles of soil and dead or cut leaflets.

BIOLOGY

Distribution—The Florida fern caterpillar occurs naturally in Florida and tropical America. It occurs as an occasional pest in greenhouses wherever ferns are shipped.

Host Plants—The Florida fern caterpillar has been reported to feed primarily on ferns (at least 14 species) including maidenhair fern (*Adiantum* sp.), Boston fern and other varieties of sword fern (*Nephrolepis exultata*), holly fern (*Cyrtomium*), table ferns and silver fern (*Pteris* spp.), rabbit's foot fern (*Polypodium* spp.), and *Blechnum* spp. *Asparagus sprengeri* has also been reported as a host.

Damage—Florida fern caterpillars are active feeders; several caterpillars may damage a plant severely. The caterpillars tend to feed on the most tender foliage, but larger caterpillars will feed on tougher leaves and tender stems. The caterpillars often chew off more plant material than they consume.

Life History—The eggs are laid singly under fern leaflets near the tips. Females averaged 465.4 eggs each in one study. The eggs hatch in 5 to 7 days, and the tiny new caterpillars feed on the tender new leaflets mostly at night. As the caterpillars mature they usually hide on the stems at the base of the plants or in the soil during the day. Most of the larvae develop through five stages although some female larvae may develop through six stages. In about 36 days the caterpillars mature and spin a cocoon on the soil surface to pupate. Twelve to 16 days later (almost 4 weeks in cool weather), a new generation of moths emerges to mate and lay eggs. Development is probably slower in winter months at northern latitudes as the caterpillars seem to do little damage during this period. In tropical areas, Florida fern caterpillars are most damaging in dry seasons. The moths are nocturnal, hiding under benches or other dark locations during the day. The moths live about 10 days.

CONTROL

Apparently hand removal of the Florida fern caterpillars from infested plants is usually not sufficient to control the population. Early control recommendations included using pyrethrum powder and laundry soap combination sprays. For specific chemical control recommendations, consult the current Cooperative Extension Service publications on ornamental plant pest management.

**Callopistria floridensis* (Guenée), Noctuidae, LEPIDOPTERA

DESCRIPTION

Adult—The greenhouse leaftier moth has prominent, black compound eyes. The body and wings are clay brown. The wings are bordered by small black dots and have irregular black lines running across them. The hind wings are broader than the forewings. The legs are whitish and the antennae are 3/4 the length of the forewings. The wingspan is 18 to 19 mm.

Egg—The egg, white when first laid, later becomes shiny. It is flattened with fine reticulations (ridges) and is 0.8 mm long and 0.6 mm broad.

Larva—Tapering toward both ends, the mature larva is slender, pale green with a narrow, darker green band along the back and with a broader, whitish band along each side. The underside of the caterpillar is yellowish or greenish yellow; the head is pale whitish or greenish yellow and faintly mottled with brownish yellow. The full grown larva is 17 to 19 mm long.

Pupa—The pupa is smoky brown with pale-yellow bands across the abdomen. It is generally smooth and 8.5 to 9.0 mm long and 2.5 mm across.

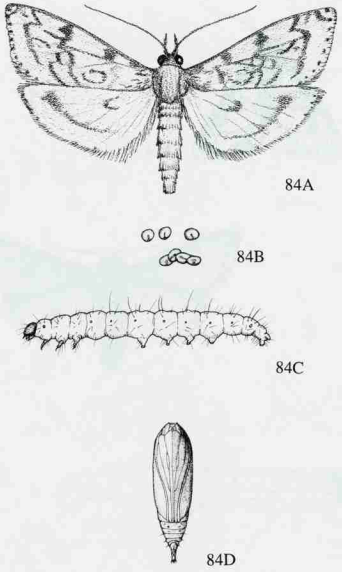


Fig. 84 Greenhouse leaftier. A, Adult. B, Eggs. C, Larva. D, Pupa.

BIOLOGY

Distribution—The greenhouse leaftier is found throughout the United States, Canada, and Central and South America.

Host Plants—The most severely damaged greenhouse plants are chrysanthemum, carnation, cineraria, geranium, marguerite, pot-marigold, rose, snapdragon, and violet. Other hosts of the greenhouse leaftier are azalea, begonia, coleus, ground ivy, and petunia. Celery, beets, and lettuce are outdoor hosts for this insect.

Damage—The larvae usually damage the underside of the leaves by skeletonizing them. The plants have a silvery appearance when heavily infested. Later, the damaged areas become pitted. A slight, silken web is spun in a leaf, or between two adjacent leaves and the leaf is folded or woven together to form a sheltered area in which the larvae feed.

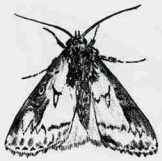
Life History—Indoors, the greenhouse leaftier can destroy a crop of chrysanthemums or cinerarias in 2 weeks, if not properly controlled. Outdoors, the insect is called the celery leaftier and is a serious pest of celery. It is called "leaftier" because the larvae tie together the leaves of their host plants with silk. This insect is native to America. Greenhouse leaftier moths become active at dusk. Eggs are deposited on the undersurface of leaves singly or in groups of up to 10 with some of the eggs overlapping one another. Each female is capable of laying about 130 eggs. The eggs are deposited in about 13 days. The moths live nearly 35 days; females live a bit longer than males. In approximately 9 days, small larvae hatch from the eggs. There are five larval instars requiring 3 to 4 weeks to become full grown. Pupation occurs in folded leaves or in some sheltered area. Adults emerge from the pupae after about 2 weeks. The entire life cycle requires about 6 weeks, so there can be as many as nine generations each year in the greenhouse. Outside there may be four generations during the year.

CONTROL

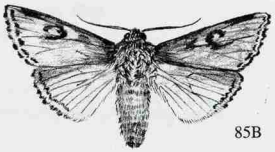
For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or contact your Cooperative Extension Agent.

Udea rubigalis (Guenée), Pyralidae, LEPIDOPTERA

CATERPILLARS
Iris Borer*



85A



85B

85C

Fig. 85 Iris borer. A, Female moth. B, Male moth. C, Larva.

DESCRIPTION

Adult—Iris borer moths are mottled brown with yellow-brown hind wings. Most of the time, the iris borer is represented only by its injury that is discovered when people dig the rhizomes to transplant them in late summer. The borer is a caterpillar in the same family as the corn earworm and cabbage looper.

Eggs—The eggs are almost spherical and are creamy with a greenish tinge to pale purple. The eggs are about 0.5 mm in diameter.

Larva—The mature caterpillars are fat and pale-yellowish-pink to pink worms with brown heads. They grow to almost 3.5 cm long.

Pupa—The pupae are about 3 cm long and 6 mm wide. Pupae are reddish brown to dark brown.

BIOLOGY

Distribution—The iris borer is found throughout the eastern United States and parts of Canada.

Host Plants—Iris borer apparently feeds on Japanese, German, and blueflag irises.

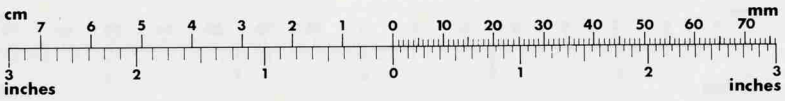
Damage—The tiny caterpillars first feed on the new foliage and sometimes cause the margins of the leaves to bleed sap and be ragged. Narrow, watersoaked slits appear where the external feeding and mining have injured the leaves. As the caterpillars grow, they excrete slimy frass in which grow soft-rot bacteria and fungi. The bacteria cause an unpleasant odor and further damage the rhizome. Often a single iris borer may completely devour the insides of a rhizome before migrating to others. Several rhizomes may be injured by a single iris borer.

Life History—The moths emerge in late summer to mate and lay eggs on the oldest, roughest, dead, and bleached-out iris leaves or on plants nearby. A single female may lay more than 1,000 eggs usually in crevices or in folds of the leaves. The eggs are placed singly or in rows of three to five or even more. The eggs hatch the following spring. The tiny caterpillars first feed on the new foliage and sometimes cause the margins of the leaves to be ragged. The caterpillars then mine in the leaves for a while before working downward toward the rhizomes. The caterpillars are about half grown by the time they reach the rhizome. There they feed on the edge or on the underside of the rhizome and sometimes bore right in. They pupate in late summer, and a new generation of moths emerges in the fall to lay eggs for the following year's generation of iris borers.

CONTROL

To control the iris borer, it is important to remove all old iris leaves and other plant rubbish from the beds in early spring before new growth emerges. If the borers are discovered later in the spring, it may be possible to crush them with the thumb and finger inside the leaf. If the injured leaf is held so that the sun shines on the far side, the silhouette of the small caterpillar should be easily visible through the leaf. In summer during the digging of iris to thin the beds, the infested rhizomes may be probed with a soft wire to destroy the borers and the heavily infested rhizomes should be cut off and destroyed. The divided rhizomes should be laid in the sun for a few days to allow the cut surfaces to heal before replanting.

For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or contact your Cooperative Extension Agent.



* *Macronoctua onusta* Grote, Noctuidae, LEPIDOPTERA

DESCRIPTION

Adult—The lesser canna leafroller moth has a wingspan of 25 mm. Adults often rest upside down on a shady portion of the plant with the forewings straight out from the body and the hind wings fanned out so their rear margins form a low arch. The wings are light brown with dark lines that form two irregular, concentric low arches.

Egg—The egg is oval, 0.9 mm long, and flat. It is whitish yellow and occurs with six to 15 others in a mass.

Larva—Lesser canna leafroller caterpillars grow from 1.4 mm to 23 mm long. The head of the young caterpillar is relatively wide, and the body tapers gradually to the tail. Older larvae are more or less cylindrical and taper toward the head and tail. These caterpillars are cream to greenish, and the heads of all stages are yellowish.

Pupa—The pupa is 11.5 mm long. The head, thorax, and wings are chocolate brown, and the abdomen is somewhat lighter.

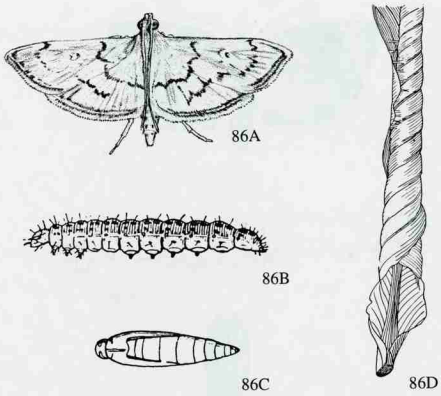


Fig. 86 Lesser canna leafroller. A, Adult. B, Larva. C. Pupa. D, Rolled canna leaf.

BIOLOGY

Distribution—The lesser canna leafroller is found throughout the southeastern United States. Since *Canna* is native to Central America and tropical South America, it seems likely the lesser canna leafroller also occurs in these regions.

Host Plants—Lesser canna leafrollers apparently feed only on plants in the genus *Canna*.

Damage—Lesser canna leafroller caterpillars fasten the edges of leaves before the leaves unroll or the caterpillars can roll up one side of an open leaf. Within this shelter, the caterpillars feed on the upper surface of the leaves, rarely chewing through the lower epidermis except when the caterpillar bores through the rolled leaves. Infested leaves become ragged and shot through with holes. Heavily infested leaves may never open and may die. Infested plants become unsightly and fail to bloom.

Life History—The lesser canna leafroller overwinters as medium to large larvae within rolled, dead leaves of the frost-killed tops in central North Carolina. The caterpillars are apparently not cannabalistic as five or six larvae may reside in one rolled leaf. These larvae pupate and adults appear in February and March in Florida and probably March and April in North Carolina. Females lay eggs in small patches of six to 15 which are firmly glued to the plant but without much order (some overlapping and some directly on top of others). Tiny new caterpillars mine into the leaves until they outgrow the tunnels. They then chew a circular hole to the upper surface and begin to roll the leaves. The caterpillars may feed gregariously. Some of the larvae may crawl down inside the petiole and feed there. When fully grown, the caterpillars pull the surface of the leaf firmly together and spin a filmy cocoon. After pupating, adults emerge 10 to 12 days later. In North Carolina, the second generation emerges in June. During the summer, lesser canna leafrollers may be found in any stage.

CONTROL

Because lesser canna leafrollers overwinter as larvae in rolled canna leaves, collecting and destroying the above ground portions of cannas during the winter will remove most of the population. During the growing season, contact insecticides should be directed downward so as to force the residue into the open tops of the rolled leaves. For specific chemical control recommendations, see current Cooperative Extension publications on ornamental plant pest management.

**Geshna cannalis* (Quaintance), Pyralidae, LEPIDOPTERA

CATERPILLARS
Platynota leafrollers*

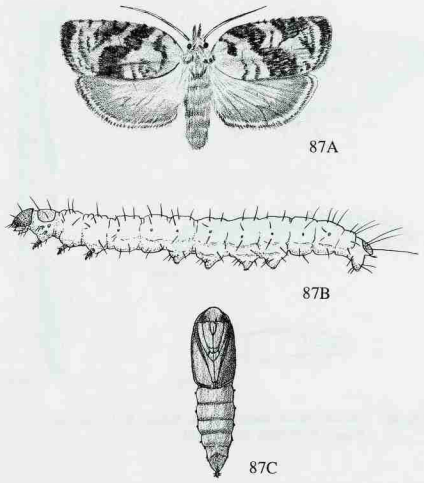


Fig. 87 ***Platynota*** **leafrollers. A, Variegated leafroller moth. B,** ***Platynota*** **sp. caterpillar from poinsettia and chrysanthemum. C, Pupa of Platynota sp. caterpillar.**

DESCRIPTION

Adult—Female variegated leafroller moths are reddish-brown and fairly evenly marked. Males are blackish-brown with contrasting reddish-ochre tips of the wings. The tufted apple bud moth is an ash-gray moth (12 to 25 mm) with blackish and dull-brown markings. There are oblique black lines on the forewings as well as scales that are raised into conspicuous tufts. The hind wings are smoky brown. The palpi are as long as the head and thorax combined.

Larva-*Platynota* caterpillars are slender, pale, and grow to about 25 mm. Older caterpillars have a dark line along each side of the upper back. The head, thoracic shield, and anal shield are brownish. *Platynota* caterpillars have a small, but distinct anal comb (see Fig. 70).

BIOLOGY

Distribution—The variegated leafroller occurs from Maine to Florida and west to Kansas and Texas.

Host Plants—The variegated leafroller has been described as a general feeder. Host plants include apple, clover, maple, rose, sassafras, strawberry, and poinsettia. The tufted apple bud moth has been collected from apple, black walnut, boxelder, pine, and willow. Poinsettia, goldenrod, *Solanum*, and clover are also infested.

Damage—Leaves that are not directly fed upon by the variegated leafroller are ragged and distorted because of the silk tying them together even after the caterpillar has matured.

Life History—There are two main broods of variegated leafroller each year. A large flight occurs in April and May and a smaller flight occurs in August and September. Moths have been collected from April to October. Larvae tie the leaves of poinsettia together with silk and feed within. Tufted apple bud moths overwinter as diapausing caterpillars in the leaf litter. In spring in response to longer days and warmer temperatures, the overwintering caterpillars molt into pupae and 6 to 28 days later a new generation of tufted apple bud moths emerges to mate and lay eggs. Tufted apple bud moth moths have been collected from June to August in New York and April to October in North Carolina. Peak flights occur in April through May and August through October. The developmental rate from egg to adult moth varies greatly with temperature. Complete development takes 25 days at 32.2°C and 140 days at 10.6°C, but the greatest survival of the caterpillars occurred at 26.7°C (35 days from egg to moth). The tufted apple bud moth larvae tie leaves together with silk and reside in the enclosure formed. The worms cut leaves and drag them into the nest. When the leaf has withered sufficiently, the caterpillar then feeds on it.

CONTROL

Larvae of a predaceous mite (*Callidosoma metzi* Sharma, Drooz and Treat) parasitize the larvae and moths of the tufted apple bud moth from late May through July. Up to 13 larval mites have been found on one moth. *Callidosoma metzi* deutonymphs and adults feed on caterpillar eggs. This species has potential for biological control. Fenoxycarb applied for tufted apple bud moth control had good residual activity and little effect on beneficial organisms except the lady beetle, *Stethorus punctum* (LeConte). Timing of pesticide applications is critical as these caterpillars become much more difficult to control once the larvae have begun constructing their nests of tied and rolled leaves.

Adults of *Platynota* leaftiers are large enough to be excluded by ordinary window screening. Commercial flower growers should consider screening as a first pest management practice. For chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management.

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*Variegated leafroller, *Platynota flavedana* Clemens; omnivorous leafroller, *Platynota stultana* Walsingham; tufted apple bud moth, *Platynota idaeusalis* (Walker), Tortricidae, LEPIDOPTERA

DESCRIPTION

Adult—The wings of plume moths are lobed and fringed with long setae. The forewings are bilobed, the lobes starting 2/3 from the wing base. The hindwings have three lobes. These moths hold their wings out horizontally forming a sort of T shape or obliquely. The moths move the wings up and down erratically. Plume moths have slender bodies and legs. They are white or brownish with a wingspan from 15 to 25 mm. The members of this genus are very closely related, and it is often difficult to determine which species is involved by adult specimens.

Egg—Some plume moths produce eggs that have distinct reticulations. In general, the eggs are oval or elliptical, glossy, white or pale yellow and about 0.4 mm long.

Larva—Larvae of plume moths can be recognized by their slender, stalk-like prolegs and their setae with swollen tips. Full-grown larvae are about 10 mm long and tapered at both ends.

Pupa—Usually the pupae are not in cocoons. They vary from very light to brown, are angulate, and are about 10 mm long.

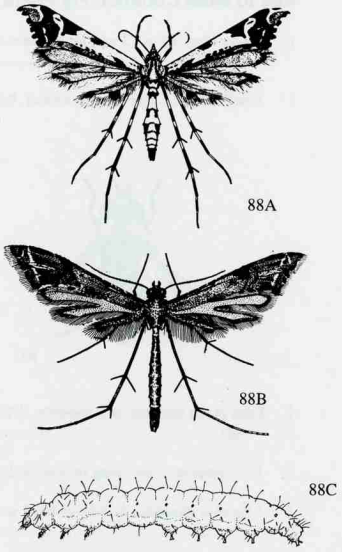


Fig. 88. Plume moths. A, Geranium plume moth. B, Snapdragon plume moth. C, Plume moth caterpillar.

BIOLOGY

Distribution—Geranium plume moths and snapdragon plume moths appear to be most active in California although they have been found in southeastern greenhouses that have received cuttings from California.

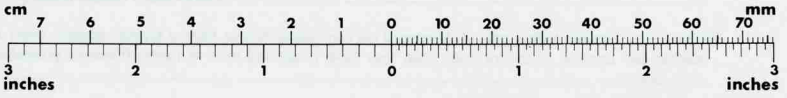
Host Plants—Snapdragon and geranium are the two groups of ornamental plants most frequently attacked by plume moths in the Southeast.

Damage—Plume moth larvae mine the leaves and feed externally on leaves, buds, and flower parts.

Life History—There are more than 40 species of plume moths of the genus *Platyptilia* occurring in the United States. Two of the economically important members of this genus are the geranium plume moth and the snapdragon plume moth. Eggs are deposited singly any place on the plants, but are usually laid on newly forming flowers or on the underside of leaves of terminal young growth. Hatching occurs in 2 to 3 weeks. Young larvae mine in leaves and later burrow into the stem, petioles, flowers, or seed pods. It takes 3 to 5 weeks for the larvae to develop through four instars. The caterpillars emerge to form pupae that hang upside down on the plant. The adults are weak fliers and usually remain on or near the host plant. The moths are most active during the early evening. If hibernation is necessary, it is the adult stage that overwinters; however, the plume moths are not well adapted for hibernation or aestivation.

CONTROL

Geranium cuttings should be inspected upon arrival for plume moth caterpillars. A pyrethroid dip with a labeled pesticide should give adequate control of plume moth caterpillars without damaging the cuttings or affecting rooting percentage. For specific rates and chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management.

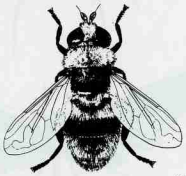


*Geranium plume moth, *Platyptilia pica* Walsingham; Snapdragon plume moth, *Stenoptilodes antirrhina* (Lange), Pterophoridae, LEPIDOPTERA

Key to Most Common Fly Pests Found on Flowers and Foliage Plants

1. Larger flies, 10 to 12 mm long; dense covering of long hairs that gives a furry look, resembling that of bees (Fig. 89) ..... **Narcissus bulb fly**, p. 49

1.' Smaller flies, 6 mm long or shorter; hairs scattered or very short, flies not beelike 2



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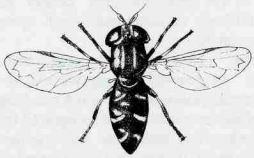


90

2. Flies about the size of a housefly, 5 to 6 mm long; body shiny under a dense covering of short hairs (Fig. 90) ..... **Lesser bulb fly**, p. 47

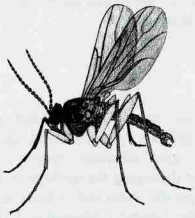
2.' Flies smaller, 3 mm long or less; body either dull colored or with scattered long hairs 3

3. Antennae elongate, as long as head and thorax; flies dull black with uniformly dark-colored wings (Fig. 91) ..... **Darkwinged fungus gnats**, p. 46

3.' Antennae no longer than head; pattern usually present on body or wings 4

4. Flies shiny black and yellow; wings clear (Fig. 92A) ..... ***Liriomyza*** spp., p. 48

4.' Flies dull; some species have patterned body or wings (Fig. 92B) ..... **Shore flies,** p. 50



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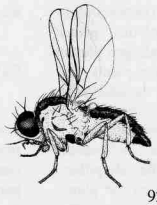
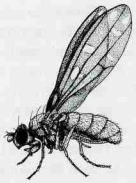


92A



92B

Key to Most Maggots Found on Flowers and Foliage Plants

1. Larva with shiny black head capsule; body slender, white, smooth; found in decaying roots or stems or soil around them, rarely even on terminals; mostly in greenhouses (Fig. 93) ..... **Darkwinged fungus gnats**, p. 46

1.' Without head capsule, with a pair of downward curving mouth hooks; body a typical maggot, wider in middle and tapering to one or both ends, may have roughened skin or fleshy filaments protruding from body 2

2. Tiny yellow maggots, smooth; mining in leaves of plants (Fig. 94) ..... ***Liriomyza*** spp., p. 48

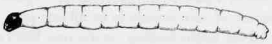
2.' Not yellow and not leafminers 3

3. Larvae found in roots, rhizomes or bulbs 4

3.' Larvae found among algae or on wet surfaces, in hydroponic operations, filters, wet benches, etc. (Fig. 95) ..... **Shore flies**, p. 50

4. Mature larva large, more than 10 mm long; with only 1 pair of very short fleshy filaments under the spiracular tube at end of body; spiracular tube about as long as wide (Fig 96) ..... **Narcissus bulb fly**, p. 49

4.' Mature larva small, less than 10 mm long; with 3 pairs of fleshy filaments around the spiracular tube; spiracular tube about twice as long as wide (Fig. 97) ..... **Lesser bulb fly**, p. 47



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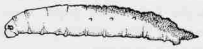

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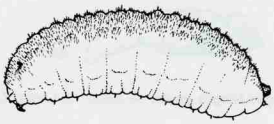

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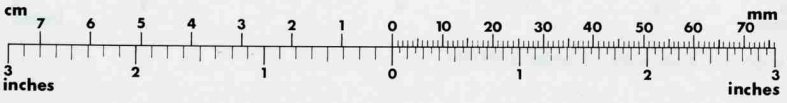
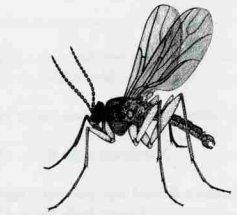


FLIES
Darkwinged Fungus Gnats*



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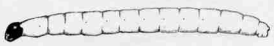


98B

98C

Fig. 98 Darkwinged fungus gnats. A, Adult. B, Larva. C, Pupa.

DESCRIPTION

Adult—The flies are slender with comparatively long legs and antennae. They are greyish-black and about 2.5 mm long.

Egg—The yellowish white tiny eggs are 0.2 mm long and 0.1 mm wide.

Larva—Darkwinged fungus gnat maggots have shiny black head capsules and white bodies. The last body segment is lobed and helps push the insect along. Mature larvae are about 5.5 mm long.

Pupa— Initially white, pupae become dark shortly before the adult emerges.

BIOLOGY

Distribution—Darkwinged fungus gnats are found throughout the United States.

Host Plants—Darkwinged fungus gnat maggots feed on the roots of alfalfa, carnations, clover, corn, cucumbers, Easter lilies, geraniums, lettuce, nasturtium, peppers, rape, poinsettias, potatoes, soybeans, wheat, and organic matter.

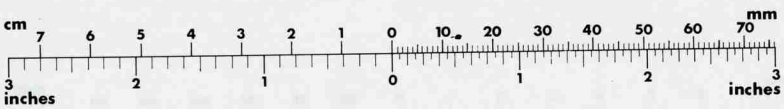
Damage—Damage first becomes apparent when plants lose their healthy appearance and wilt. Darkwinged fungus gnat adults are usually noticed before injury caused by the maggots is apparent.

Life History—Darkwinged fungus gnat maggots have only recently been recognized as important pests in greenhouses and mushroom cellars. They are also pests of house plants. Several of these flies are of economic concern. Generally, darkwinged fungus gnats are most abundant in greenhouses in the winter and spring. Adults and larvae inhabit moist, shady areas. Adults live about 1 week, during which time each female deposits 100 to 150 eggs. They are laid in strings of 3 to 40 in the top of the soil, usually near stems of plants. They hatch within 4 days in the greenhouse. There is a tendency for the progeny of each female to be all one sex.

The larvae begin feeding on the root hairs and roots usually in the upper cm of medium, working their way up the plant and into the stem; however, they also feed on any organic matter in the soil. Being somewhat gregarious, the larvae often form clusters in the soil. They mature in about 14 days, after which they construct a pupal case, made of silk and debris, in the soil. The pupal stage lasts about 3.5 days. Adults are weak fliers, but they run rapidly on the soil surface or may remain motionless.

CONTROL

Clean cultural practices and lack of excessive watering usually will prevent fungus gnat infestations. Since fungus gnats prefer potting mixes containing peat moss and abundant moisture, consider using bark mixes and avoid overwatering ornamental plants. Decoy pots of sprouting grain are attractive to females, that lay eggs in these pots. Afterwards, the pots should be submerged in boiling water or the contents destroyed in some manner every 2 weeks to destroy the eggs and maggots. Fungus gnats have few efficient natural enemies. The predaceous nematode, *Steinernema bibionis*, has reduced fungus gnats in mushroom houses 85 percent when applied at a rate of 600 per m^2. Another nematode, *Steinernema carpocapsae*, is now on the market for funus gnat control in greenhouses. Some species of fungus gnats in mushroom houses have developed up to 47-fold resistance to a pyrethroid insecticides. For chemical control recommendations, see current state Cooperative Extension publications on ornamental plant pests.



**Lycoriella* spp. and *Bradysia* spp., Sciaridae, DIPTERA

DESCRIPTION

Adult—Lesser bulb flies are 5 to 9 mm dark blue insects that have a metallic bronze sheen (they appear black at a distance). There are three pairs of grayish white crescents on the abdomen and yellowish hairs at the tip. The thorax has 2 lengthwise pale stripes. The hind legs have wide segments that look as though the legs are adapted for jumping.

Egg—Lesser bulb fly eggs are very small (0.72 by 0.24 mm), slender, and somewhat pointed on one end. They are usually laid in small clusters.

Larva—Maggots of the lesser bulb fly are tiny (0.75 mm) to small (7 to 10 mm) and white to grayish yellow depending on the quality of the host bulb. The larvae are wrinkled and covered with minute spines. They are slightly flattened (2.5 mm wide and 1.8 mm high) and are more slender than those of the narcissus bulb fly. The breathing tube is brick red or brown. There is a fleshy tubercle on either side of the breathing tube (no other maggot pests of bulbs have these tubercles).

Pupa—The pupa develops within the last larval skin, which becomes a tough protective covering about 6 to 8 mm long, 3 mm wide, and 2.8 mm high (the puparium). The puparium is light gray to reddish brown, but when the maggot pupates in the soil, the puparium is completely covered with fine particles of soil.

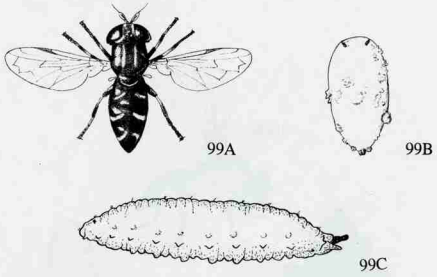


Fig. 99 Lesser bulb flies. A, Adult. B, Larva. C, Puparium.

BIOLOGY

Distribution—Lesser bulb flies were introduced into the United States from Europe. These flies occur wherever narcissus are grown.

Host Plants—Lesser bulb flies are sometimes damaging to onion, narcissus, and hyacinth. Other hosts include shallots, garlic, iris, lilies, parsnips, potato tubers, amaryllis, cabbage roots, *Calla elliottiana*, *Eurycies*, *Galtonia*, *Gladiolus*, Scilla, *Sprekelia formosissima*, and vallota.

Damage—Up to 25 percent of some varieties of narcissus and 10 percent of hyacinths have been infested by lesser bulb flies in some landscapes. The maggots scrape away the bulb tissue and tunnel in. The infested bulbs begin to decay and the interior of the bulb fills with a semiliquid mass. The bulb may be killed completely, or damaged to the point that only stunted leaves appear the following year.

Life History—The winter is spent as maggots in the bulbs. In spring, the maggots migrate toward the soil surface and pupate. The first generation of flies emerges in April and May. These flies live about 3 weeks. The second generation emerges in midsummer, and a small third generation emerges in late summer. Female lesser bulb flies crawl down into cracks in the soil and lay eggs near, on or under the dead skin covering the bulbs. Some eggs are laid on the leaves at the neck of the bulbs and some are laid on the soil surface. Females lay their eggs singly or in small masses of 2 to 40. More than 100 eggs have been found around one bulb. The eggs hatch in 5 to 10 days. Newly hatched maggots emerge from the pointed end of the egg. Ten to 30 maggots may develop in a bulb (947 is the maximum number recorded from a single bulb). The tiny maggots usually attack the base of the bulb although sometimes only the upper portion of the bulb is infested. Infested bulbs begin to decay and the interior of the bulb fills with a semiliquid mass. Although the maggots can successfully attack a healthy bulb, the maggots cannot complete their development in the absence of certain decay organisms. Bulbs infested with stem nematodes (*Tylenchus dipsaci* Kuehn) or infected with a root rot fungus are especially vulnerable to attack. After about 30 days, the maggots mature and some of them crawl to the surface where they pupate inside the last larval skin. One to 4 weeks later, adult flies emerge from the puparia. If a source of nectar is available and temperatures are not extreme, some of the lesser bulb flies may live up to 36 days.

CONTROL

If the narcissus are planted as winter annuals and the bulbs discarded after blooming in the spring, there will be no problem with lesser bulb fly maggot damage as the flies oviposit only during the warm growing season. If the bulbs are left in the landscape semiperminantly and only lifted every three or four years, then injury caused by the lesser bulb fly may become excessive if the flies are active in the neighborhood. Because of the extended flight period of the lesser bulb fly, it may be necessary to resort to the application of pesticides in neighborhoods in which the flies are active. Over-planting beds of narcissus with summer annuals may greatly reduce lesser bulb fly damage. Tilling the soil destroys the holes left by the dying narcissus leaves that the flies often use to reach the bulbs. Many of the tiny maggots may perish before they can reach the bulbs.

When digging, all bulbs should be removed. Soft, decaying bulbs should be destroyed. Bulbs in marginal condition can be treated in hot water (43 to 44° C) for 3 hours to control lesser bulb flies as well as stem nematodes.

**Eumerus tuberculatus* Rondani (the most abundant), *Eumerus strigatus* Fallén, and *Eumerus narcissi* Smith; Syrphidae; DIPTERA

Flies
*Liriomyza trifolii**

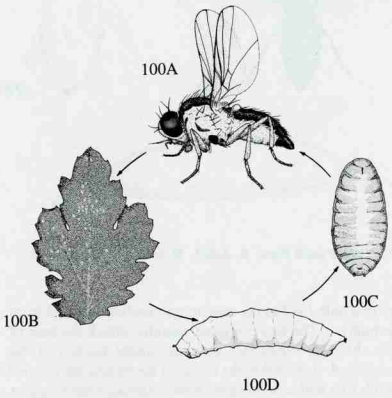


Fig. 100 ***Liriomyza trifolii.*** **A, Adult. B, Egg punctures. C, Larva. D, Puparium.**

DESCRIPTION

Adult—The small fly, about 2.5 mm long, is dark gray with yellow markings.

Egg—The tiny, whitish egg is deposited in the leaf.

Larva—The legless, whitish to yellow larva grows to about 2 mm long, with a darker head and a mouthhook structure that is retractable into the body.

Pupa—The pupa, formed within the old skin of the last larva (puparium), is yellowish brown.

BIOLOGY

Distribution—Presently, *Liriomyza trifolii* occurs primarily in Florida and California, and is found rarely in greenhouses along the eastern United States to Maryland. It is also found in Central America.

Host Plants—*Liriomyza trifolii* has been found on many plants. Some of the hosts are aster, dahlia, marigold, chrysanthemum, sunflower, zinnia, baby's breath, mistflower, petunia, daisy, eggplant, celery, carrot, potato, beans, garden peas, cantaloupe, lettuce, cucumber, and garden onion.

Damage—Large populations of these flies destroy leaves and seriously retard growth of young plants. The presence of the larval mines reduces the commercial value of ornamental plants and cut flowers.

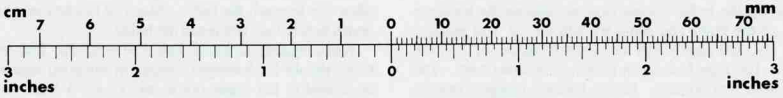
Life History—*Liriomyza trifolii* is one of a few leafmining flies that are truly polyphagous. It feeds on many economically important plants and can be a destructive leaf miner of chrysanthemums, gerbera daisies, *Gypsophila*, tomatoes, celery, and other vegetables.

Liriomyza trifolii breeds throughout the year in southern Florida, but it has only 3 to 4 complete generations in its more northerly range. The first generation appears in April, and the egg stage last only 2 days. In the leaves, the larvae form linear mines, if space is available, confining frass to the sides in regular, alternate strips. If leaves are very small, the larvae form blotch mines. There are three larval stages, each requiring 7 to 8 days to develop. Pupation occurs within the leaf and lasts 7 to 11 days, depending upon the time of the year. Adults live 3 or 4 weeks. Partial generations occur in the winter when the reproductive activities of the insects decrease. The flies can be found in greenhouses year-round.

CONTROL

Liriomyza trifolii can develop and emerge successfully from infested leaves that are detached and drop to the bench top or greenhouse flower, particularly if the relative humidity remains high. It is important to remove infested plant debris from the greenhouse to impede the populations of *Liriomyza trifolii.* At one time *Liriomyza trifolii* was a very difficult insect to control because it is highly resistant to many organophospate, carbamate, and pyrethroid insecticides. With the introduction of cyromazine and abamectin for leafminer management, the incidence of *Liriomyza trifolii* decreased dramatically.

For specific chemical control recommendations, see your Cooperative Extension Service publications on ornamental plant pest management.



**Liriomyza trifolii* (Burgess), no common name, Agromyzidae, DIPTERA

DESCRIPTION

Adult—Narcissus bulb flies are 9 to 12 mm flies that resemble bumble bees although some individual flies are more reddish brown, orange, or tan than the species of bumble bees that occur in the southeastern United States. Unlike bumble bees, narcissus bulb flies have a very rapid flight and also tend to hover in flight. Narcissus bulb flies also show a marked preference for narcissus plants whereas bumble bees usually forage on flowers.

Egg—Narcissus bulb fly eggs are white and slender and about 1.5 mm long. They usually occur on the host plant leaves close to the soil.

Larva—Newly hatched maggots are about 1 mm long. Third stage maggots are about 19 mm long and are a dirty tan. The maggot is plump and slightly arched. The skin is tough and wrinkled. The mouth hooks and breathing tube are almost black.

Pupa—The pupa occurs in the last larval skin. The skin becomes a tough, brown, 13 by 7 mm case (puparium) inside of which the relatively delicate pupa develops.

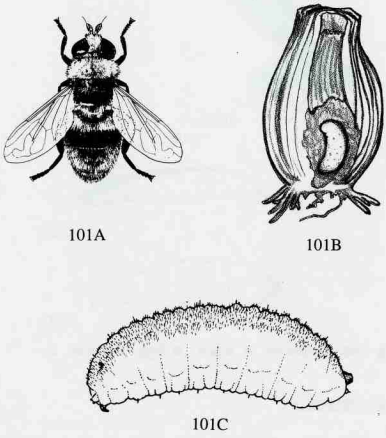


Fig. 101 Narcissus bulb fly. A, Adult. B, Larva. C, Damaged narcisus bulb.

BIOLOGY

Distribution—The narcissus bulb fly occurs wherever narcissus are grown throughout the United States. This pest was introduced from Europe in about 1869.

Host Plants—The narcissus bulb fly has been reported to infest amaryllis, daffodil, *Galtonia*, *Flanthus*, hyacinth, *Iris*, lilies, *Leucojum*, *Narcissus*, *Scilla*, tulips, and *Vallota*.

Damage—The center of the bulb is hollowed out and the flower bud is destroyed. Many infested bulbs rot away although some survive to send up a few scrawny grasslike blades the following year.

Life History—Narcissus bulb flies now occur throughout the world wherever narcissus are grown. In the United States, narcissus had been virtually pest free here until the fly was introduced. Narcissus bulb flies emerge from the soil usually in May. After mating, females lay one to three eggs between the sheath and stem of each bulb or between the layers of skin enclosing the neck of the bulb. Females lay from 40 to 100 eggs each. Ten days to 2 weeks later the eggs hatch and the tiny maggots bore down through the outer bulb scales to the basal plate where they tunnel extensively for some time. Later they bore directly inside the bulb. The maggots develop rapidly in the next two months and become virtually fully grown, although they do not pupate until the following spring. Usually only one maggot develops per bulb although more are occasionally found. Five to 7 weeks are spent in the pupal stage before a new generation of adults emerges. There is one generation per year although some individuals require 2 years to mature.

CONTROL

Control of the narcissus bulb fly is not easy. The insect has few natural enemies. Cultural controls include mowing the leaves as soon as they dry in late spring and then cultivating the soil lightly to prevent the females from finding the holes left by the leaves. Lifting the bulbs as soon as the tops die back and then sorting out and destroying infested bulbs should also help to decrease the population for the following year. Catching the flies in an insect net and destroying them should also help to decrease the population (each female destroyed means 100 potential maggots are destroyed).

A hot water bath has also been found to be effective in killing maggots in infested bulbs. Maggots can be killed if bulbs are submerged in water kept at about 43 to 44° C for 40 minutes. Care must be taken to avoid overheating the bulbs even for a short time as the bulbs may be adversely affected by high temperatures. For chemical control, drench a mixture of insecticides and water in early May. For specific chemical control recommendations, see your Cooperative Extension publications on ornamental plant pest management.

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* *Merodon equestris* (Fabricius), Syrphidae, DIPTERA

FLIES
Shore Flies*

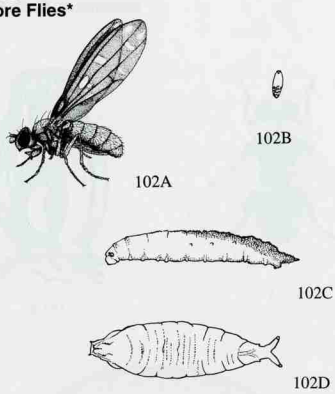

Fig. 102 Shore fly. A, Adult . B, Egg. C, Larva. D,

DESCRIPTION

Adult—Shore flies in the genus *Scatella* are small (2 mm), black flies with reddish eyes and gray wings with clear spots. Shore flies resemble eye gnats, fruit flies, or vinegar flies in general shape. Shore flies are sometimes confused with darkwinged fungus gnats which are about the same size and color. (Darkwinged fungus gnats are shaped more like miniature mosquitoes and have relatively long legs and antennae.)

Egg—Shore fly eggs are about 0.42 long and 0.2 mm wide. They are fairly rounded at both ends although there are small lobes on one end. The surface of the egg is covered with minute, faint polygons. The eggs remain white throughout the development of the embryo.

Larva—The tiny first stage maggots have two spiracles only at the rear. The next two larval stages have two spiracles on the rear and a spiracle on either side near the head. The mature maggot is about 2.6 mm long and 0.9 mm wide and 0.5 mm high. The hind spiracles are black and are located at the end of small but conspicuous tubes. The anterior spiracles each resemble the fingers of a slightly inflated rubber glove but these spiracles are microscopic and inconspicuous.

Puparium—The puparia of *Scatella* shore flies are brown to dark brown, curved, and tapered on both ends. The puparia are about 2.6 mm long and 0.9 mm wide. At the hind end, the spiracles resemble stiff antennae. On the front, the anterior spiracles stick out sideways like microscopic horns. The puparia are curved toward the top side of the developing fly.

BIOLOGY

Distribution—Shore flies in the genus *Scatella* are found throughout the United States, Canada and northern Mexico. *Scatella stagnalis* also occurs widely in Europe and Asia. Most species naturally occur on muddy or marshy lake shores and intertidal zones of beaches.

Food Plants—Adult and immature shore flies feed on microscopic algae, dinoflagellates, bacteria, cyanobacteria, and other unicellular forms.

Damage—Neither adult nor immature shore flies feed upon ornamental plants. The damage caused by shore flies consists primarily in the excrement ("fly specks") left on the foliage of bedding plants and other ornamentals. Because shore flies are often confused with darkwinged fungus gnats, control efforts are often wasted (darkwinged fungus gnats may be harmful to plants but are relatively easy to control; shore flies are harmless but are very difficult to control with insecticides). Sometimes shore flies become so abundant in greenhouses that the sheer numbers of flies becomes a deterrent to customers browsing or even employees working.

Life History—*Scatella* shore flies are commonly found in greenhouses where they breed in algae growing on the potting mix, pots, benches and floors. Females scatter eggs right on the surface of the potting mix. The eggs hatch in 2 to 3 days. The larvae are found within the crust of algae and very top layer of potting mix. The maggots feed on bacteria and yeasts as well as diatoms and flagellates growing on the surface of the potting mix. The larvae mature in 3 to 6 days and pupate inside the skin of the last larval stage (this kind of pupa is called a puparium). The last larval skin affords the relatively tender and completely helpless pupa protection from environmental hazards (including insecticides). Some of the puparia are found on top of the potting mix or are very close to the surface. A new generation of adult flies emerges 4 to 5 days later. The adults crawl about on the surface of the potting mix, on the plants or they fly about the pots and plants. The flies move and fly rapidly but generally stay close to their breeding sites. The adults feed primarily on diatoms and flagellates on the surface of the potting mix or mats.

CONTROL

Perhaps because of the high biological activity of the surface of the potting mix, the protection afforded the pupa by the last larval skin, and the water repellent property of the adults, insecticides do not seem to readily suppress shore flies in greenhouses. Cultural methods of shore fly management include avoiding excessive use of water during irrigation, using the minimal optimum levels of fertilizers for adequate plant growth (and lower levels of excess fertilizers that encourage algal blooms), and a drier greenhouse environment. Algae on mats, benches, the walls or other structural members, and the soil beneath benches should be eliminated by using an approved algicide. Because shore fly maggots can also develop on rotting vegetable matter, general greenhouse sanitation should also help suppress shore fly numbers. For specific chemical recommendations see your Cooperative Extension Service publications on ornamental plant pest management.

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* *Scatella stagnalis* (Fallén) and perhaps other spp., Ephydridae, DIPTERA

DESCRIPTION

Adults—Adult potato leafhoppers are usually yellowish or pale green. They exhibit much color variation, often leading to misidentification. The head of the adult often has pale or dark green spots, and six or more pale (white) spots can be found on the back immediately behind the head. Wings are held rooflike over the abdomen. Adults are about 3.5 mm long and wedge-shaped, tapering to the rear.

Egg—The eggs are white to pale white, slender, elongate, and about 0.9 mm long.

Nymph—Nymphs are similar in shape to the adults but are smaller and lack wings. There are five nymphal instars.

BIOLOGY

Distribution—Although found throughout much of the United States east of the Rocky Mountains, the potato leafhopper only overwinters along the Gulf Coast. The insect undergoes mass movements northward in the spring and early summer and becomes established in many areas of the country. The potato leafhopper is generally distributed northward by wind. Although the potato leafhopper does not overwinter in northern areas, it may complete several generations in these areas.

Host Plants—The potato leafhopper feeds on a variety of plant species and has been reported to feed on nearly 200 kinds of plants. Flowers attacked by the potato leafhopper include dahlia, rose, and sunflower. Ornamental trees that are hosts for this leafhopper are Chinese chestnut, elm, English walnut, flowering Japanese cherry, hickory, locust, oak, and redbud. Flowering fruit trees, e.g., crabapple, also have been reported as hosts of potato leafhopper. A few of the economic plants that are infested with this insect are alfalfa, apple, eggplant, peanut, potato, soybean, and sweet potato.

Damage—Feeding and egg laying cause damage, e.g., curling, stunting, and dwarfing, to the infested plant. The leaves turn yellow, or sometimes pink or purple, and become wilted or stunted. Later, the leaf becomes brown and dies. Larger nymphs cause most of the damage. The injection of saliva into the phloem during feeding by potato leafhoppers may cause disease-like symptoms. Infested plants may exhibit a condition known as "hopperburn" in which there is a distortion of the leaf veins, a subsequent yellowing of tissue around the margin and tip of the leaf, and eventually a rolling and curling inward of the leaf. Floral development may be reduced or obstructed completely.

Life History—When dispersing northward, populations of potato leafhopper increase on young oak and hickory foliage and then attack other plant species. Potato leafhoppers usually are first found in North Carolina about mid-May. Eggs are deposited in the midrib or larger veins of the leaves, or in the petioles or stems, and hatch in about 10 days. The five nymphal instars require about 2 weeks to develop into adults.

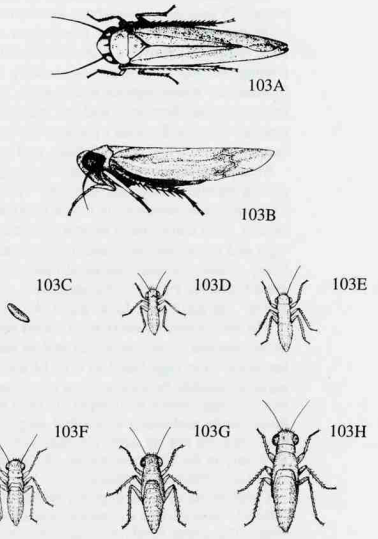


Fig. 103 Potato leafhopper. A & B, Adults. C, Egg. D-H, Nymphs.

Adults live about one month, but have been recorded as living as long as 120 days. Females mate within 2 days after their final molt and begin laying eggs about 6 days afterwards. An entire life cycle can be completed in about 4 weeks, and as many as six generations may occur each year. Jumping or flying when disturbed, these insects are active and can run as quickly sideways or backwards as they can forwards.

CONTROL

Infestation by potato leafhopper in a greenhouse can be reduced by adequate screening of window and open areas, as well as proper sealing of door edges. Chemical insecticides provide adequate control of potato leafhopper. Contact your local county Extension personnel for a listing of chemical insecticides available for control of potato leafhopper.

**Empoasca fabae* (Harris), Cicadellidae, HOMOPTERA

Introduction to Mealybugs

One of the more common groups of scale insects attacking ornamental plants are called mealybugs. There are about 275 species of mealybugs known to occur in the continental United States. Mealybugs are prevalent pests in greenhouses and interior plantscapes such as shopping malls, conservatories, hotels, and office buildings. Mealybugs cost growers and retailers millions of dollars per year in control costs and crop damage or loss. Damage is caused by mealybugs feeding on host tissues and injecting toxins or plant pathogens into host plants. In addition, mealybugs secrete a waste product, honeydew, which is a syrupy, sugary liquid that falls on the leaves, coating them with a shiny, sticky film. Honeydew serves as a medium for the growth of sooty mold fungus that reduces the plant's photosynthetic abilities and ruins the plant's appearance. Feeding by mealybugs can cause premature leaf drop, dieback, and may even kill plants if left unchecked.

Mealybugs are one of the more active groups of scale insects as most of them retain well-developed legs and remain mobile throughout their life. However, they generally move little once a suitable feeding site is found. They are small insects (1 to 4 mm long) and the body is usually covered with a white cottony or mealy wax secretion. This makes them appear like small spots of cotton on the plant, particularly when the female is laying eggs and producing an ovisac to cover and protect the eggs. Mealybugs generally have an oval body outline. Many of them produce marginal filaments of wax that may be wedge-shaped or spinelike, but others lack marginal filaments entirely. As immatures, male and female mealybugs look alike, but as adults they are quite different. The adult male looks more like a small two-winged fly.

The life history of mealybugs varies depending on the species. Basically female mealybugs go through four developmental stages or instars and as adults may lay up to 600 eggs, usually in a cottony-like ovisac beneath her body. The eggs hatch in 6 to 14 days and the first instars or "crawlers", as they are commonly called disperse to suitable feeding sites on new plant parts or hosts. They can survive only about a day without feeding, and once they insert their stylets to feed they generally remain anchored permanently. The crawler stage is the most fragile and easily controlled stage in a mealybug's life history. Some mealybugs, like the longtailed mealybug, do not lay eggs, but bear their young as active crawlers. Male mealybugs go through five instars and feed only in the first two instars. Adult males have no functional mouthparts, live only a day or two, and exist solely to fertilize the females.

Outdoors most mealybugs go through one or two synchronized generations and overwinter as second instars. Indoors, there may be a continuous overlapping of generations and all stages can be found on the host at a given time. The citrus mealybug may have as many as eight generations indoors. The overlapping of generations makes control difficult. One of the first methods of control is to purchase plants that are not infested with mealybugs. Commercial flower growers sometimes discard plants infested with mealybugs rather than try to rescue them with insecticidal treatments.

Common mealybugs occurring indoors include: the citrus mealybug, the longtailed mealybug, the Mexican mealybug, and Pritchard's ground mealybug. Citrus mealybug is by far the most common and widespread mealybug pest. It attacks nearly every flowering species grown in the greenhouse.

Key to the Most Common Mealybugs found on Flowers and Foliage Plants

1. Adult females with long, white filaments at the rear (Fig. 104A); females apparently giving birth to live young ..... **Longtailed mealybug**, p. 54

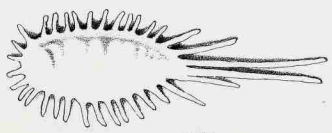
1.' Adult females without long, white filament at the rear; females lay eggs in a dense, white fluffy ovisac 2

2. Female feeding on above ground portion of plant 3

2.' Female never feeding on above ground portions of plant; white mealybug feeding on roots (Fig. 104B) ..... **Pritchard's mealybug** and other **Root mealybugs**, p. 56

3. Body orangish or purplish and covered with white bloom; a darker line down the middle of the back (Fig. 105A); mealybug very damaging to the health of many plants..... **Citrus mealybug**, p. 53

3.' Body purplish and covered with white bloom; three rows of white tufts down the back (Fig. 105B); may occur in high numbers with little effect on the health of the plant..... **Mexican mealybug**, p. 55



104A

104B

105A

105B

DESCRIPTION

Adult—The female citrus mealybug is wingless and appears to have been rolled in flour (hence the name). It grows to 3 mm long and 1.5 mm wide. A fringe of small waxy filaments protrude from the periphery. The male is small, but with its wings and tail filaments, it appears to be 4.5 mm long.

Egg—The oblong, yellow eggs are enmeshed in a dense, fluffy, white ovisac.

Crawler—The tiny crawler is oval and yellow, with red eyes. The antennae are rather distinct.

Nymph—Female nymphs resemble the larger adult females. Male nymphs are narrower and often occur in a loose cocoon.

BIOLOGY

Distribution—Citrus mealybugs occur in southern Europe and in the southern United States, where they overwinter outdoors. Further north, they survive in greenhouses and homes.

Host Plants—Citrus mealybugs have been collected from at least 27 host plant families. Many ornamental plants grown in greenhouses are susceptible to attack including begonia, coleus, amaryllis, cyclamen, and dahlia. Citrus mealybug has been collected on canna, narcissus, and tulip outdoors.

Damage—Citrus mealybugs damage hosts by sucking out plant sap, by excreting honeydew in which sooty mold can grow, and by causing distorted growth and premature leaf drop with their toxic saliva. They further disfigure plants by secreting cottony wax. Infested plants usually die unless the pest is controlled.

Life History—The citrus mealybug has been recognized as a pest of citrus and ornamental plants in Europe since 1813 (where it is called the greenhouse mealybug) and in the United States since 1879. Because female citrus mealybugs have no wings, they must be transported to the proximity of the next host plant. They can, however, travel short distances by crawling and the immatures can be blown about. Males are small, winged insects. After mating, each female lays up to hundreds of eggs in a dense, fluffy secretion called the egg sac or ovisac. Within a few days, new mealybugs (crawlers) hatch and begin to squirm out of the ovisac. Light infestations are easily overlooked because the mealybugs tend to wedge into crevices on the host plant. As their numbers increase, mealybugs of all sizes can be seen crawling around or feeding on all exposed plant surfaces.

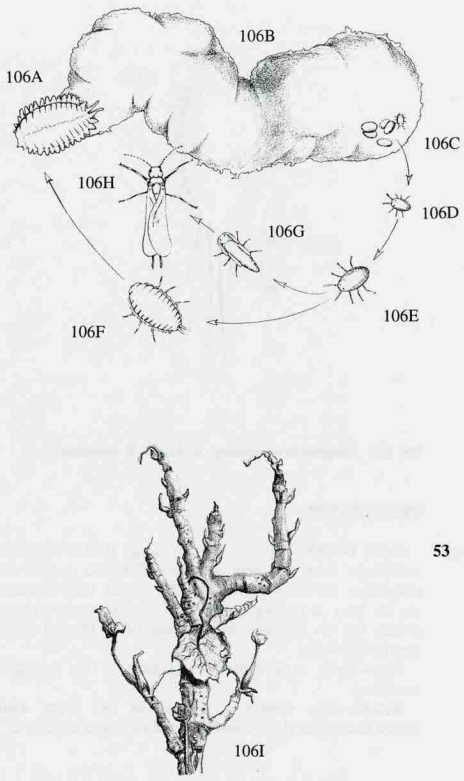


Fig. 106 Citrus mealybug. A, Adult female. B, Egg mass. C-G, Nymphs. H, Adult male. I, Damaged *Polyscias* plant.

CONTROL

Control of citrus mealybugs is amazingly difficult. Some commercial flower growers merely discard infested plants rather than trying to rescue them from citrus mealybugs. Horticultural oils may damage amaryllis. For specific chemical controls, consult the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension Agent.

**Planococcus citri* (Risso), Pseudococcidae, HOMOPTERA

MEALYBUGS
Longtailed Mealybug*

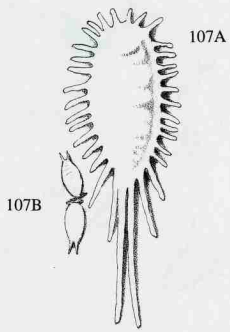


Fig. 107 Longtailed mealybug. A, Adult. B, Nymphs.

DESCRIPTION

Adult Female—Up to 3 mm long, female longtailed mealybugs have 17 pairs of waxy filaments around the periphery. On mature specimens, the caudal (tail) filaments are as long as or longer than the yellowish to grayish body (unless the tail filaments have broken off). Overall length may be 6 to 7 mm.

Egg—There is no external egg stage of the longtailed mealybug.

Nymph—The nymph is similar to the larger adult female except that the filaments around the edges are shorter.

BIOLOGY

Distribution—Longtailed mealybugs appear to be cosmopolitan in tropical and subtropical environments. In temperate zones, they survive in greenhouses or homes throughout the world.

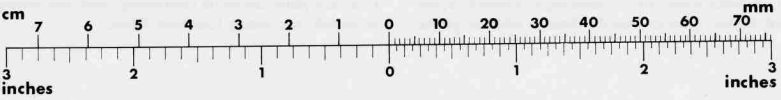
Host Plants—Longtailed mealybugs have been found on at least 26 plant families. *Dracaena* appears to be the favored host, but most flowering and ornamental foliage plants are susceptible.

Damage—Longtailed mealybugs feed by sucking out plant sap from leaves and stems. Honeydew and sooty mold further disfigure infested plants, which may eventually be killed. These pests also secrete a fluffy white wax which also detracts from the appearance of infested plants.

Life History—Although longtailed mealybugs were first described in 1867, not much has been published on their biology. Females give birth to live young on a shallow pile of white waxy secretions. Because the females are wingless, they must be brought into proximity of a host plant before it can be infested. A small wasp, *Anagyrus nigricornis*, parasitizes longtailed mealybugs, and a small, predaceous, brown lacewing insect feeds on them. Ants sometimes protect longtailed mealybugs from parasites and predators and feed upon the honeydew excreted by these mealybugs.

CONTROL

Brown and green lacewings exert some biological control of these mealybugs. Longtailed mealybugs are sometimes difficult to control, even though there is no egg stage protected by a dense ovisac. If many plants are infested, they should be dipped or sprayed thoroughly with a pesticide mixture or the entire greenhouse treated with an aerosol. It is best to retreat two or more times at weekly intervals. Retreatment will control mealybugs that were missed by earlier control efforts. For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.



**Pseudococcus longispinus* (Targioni-Tozzetti), Pseudococcidae, HOMOPTERA

DESCRIPTION

Adult—The female Mexican mealybug adult is 3 to 4 mm long, oval, grayish and covered with a thin waxy secretion. There are three parallel rows of small waxy tufts down the back. This insect is a short-tailed mealybug (the caudal filaments do not exceed 1/4 the body length). The lateral filaments are also short. Males are small gnatlike insects with only two wings. Adult Mexican mealybug males have four waxy, posterior filaments.

Eggs—The egg sac is white, dense, narrow, and longer than the female secreting it.

Nymphs—The nymphs are small and yellowish with white waxy secretions.

BIOLOGY

Distribution—From Mexico the mealybug has spread throughout the United States, Hawaii, Cuba, and Puerto Rico. It survives in greenhouses and on houseplants in temperate climates and outdoors in subtropical areas of the United States.

Host Plants—The Mexican mealybug is found commonly on numerous ornamental plants, a few of which are aralia, chrysanthemum, English ivy, geranium, *Gynura*, hollyhock, *Ixia*, lantana, and poinsettia. This insect is also a minor pest of lima beans in the warmer parts of the United States.

Damage—Wilting and stunting are common symptoms of Mexican mealybug attack. This insect can be as damaging as the citrus mealybug. The mealybugs and ovisacs also disfigure heavily infested plants.

Life History—In the greenhouse, the Mexican mealybug may have seven complete generations in one year. The average time required from oviposition to the adult stage is 47 days. Each female deposits about 400 eggs. The eggs are enclosed in an elongate cottony mass called the ovisac that originates at the back of the female. The ovisac is about 6 mm long. The eggs hatch in 6 to 14 days. The life cycles of the male and female Mexican mealybugs differ. A female passes through three nymphal stages only. Male Mexican mealybugs pass through two nymphal stages and two resting stages (prepupal and pupal stages). Normally, these mealybugs are found above ground on the leaves, stems or flowers, but occasionally will be found feeding on the roots.

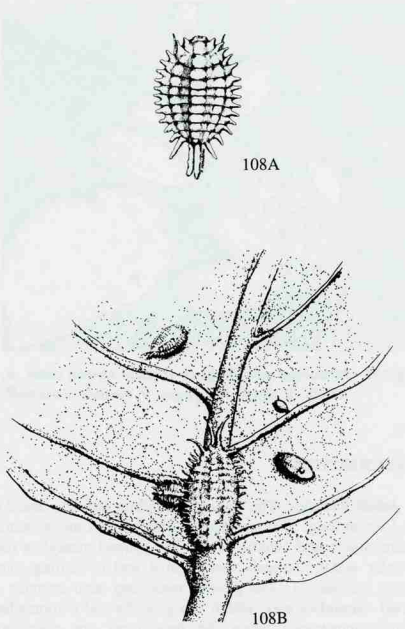


Fig. 108 Mexican mealybug. A, Adult female. B, Infested plant.

CONTROL

For chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.

**Phenacoccus gossypii* Townsend and Cockerell, Pseudococcidae, HOMOPTERA

MEALYBUGS
Root Mealybugs*

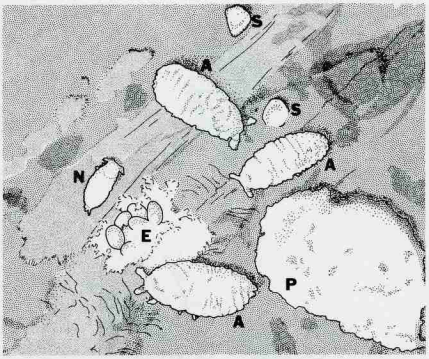


Fig. 109 ***Rhizoecus*** **mealybugs on roots of African violet. A, Adults. E, Eggs. N, Nymph. P, Particle of Perlite®.**

DESCRIPTION

Adult Female—The ground mealybug is white and 2.4 to 3.9 mm long. It resembles a springtail, but moves much more slowly and cannot jump. The ground mealybug has slender waxy filaments that form a sort of netting over some individuals. The ground mealybug also secretes a small amount of wax, which can give the soil a somewhat bluish appearance when the mealybugs are abundant. Pritchard's mealybug is snow white and 1.6 to 2.1 mm long and oval. It has small- to non-existent eyes.

BIOLOGY

Distribution—The ground mealybug was described in France and occurs in scattered locations across the United States. Pritchard's mealybug is found across the United States.

Host Plants—The ground mealybug feeds on the roots of anemone, chrysanthemum, gladiolus, iris, and numerous other flowers, shrubs, and ornamental grasses. Pritchard's mealybug has become a serious pest of African violet, although it also infests *Achillea*, *Arctostaphylos*, *Geum*, and *Polygala*.

Damage—At times the ground mealybug becomes abundant enough to damage its host. Pritchard's mealybug causes devitalization, foliage deterioration, and even death of its host plant.

Life History—Little has been published on the life history of root mealybugs. When infested African violets are irrigated, Pritchard's mealybugs crawl out of the drainage holes and spread throughout the greenhouse. Eggs are laid in a loose ovisac in clusters of at least six eggs. All stages can be found on the roots and potting mix of African violets where they resemble slow moving, snowy white collembola.

CONTROL

Pesticides applied as dips, drenches, or granulars are more effective for root mealybug control than are foliar sprays. For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.

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*Ground mealybug, *Rhizoecus falcifer* Künckel d'Herculais; Pritchard's mealybug, *Rhizoecus pritchardi* McKenzie; and *Rhizoecus americanus* (Hambleton), Pseudococcidae, HOMOPTERA

Introduction to Mites

Although mites differ from insects in several ways, their damage to ornamental plants resembles that of thrips and lace bugs. Most mites have eight legs as adults (adult insects usually have six). Mites do not have wings (some adult insects have wings) but can be aerially dispersed by breezes and winds more or less like aerial plankton, particularly in hot, dry weather. It is thought the mouthparts (*chelae*) of mites evolved from legs with a prehensile joint, (the *digitus mobilus*) which allows the mite to chew with a vertical, scissorslike action. In spider mites, broad mites, and cyclamen mites, the *chelae* have evolved into sharp mouthparts that mites use to pierce the surface of the plants they feed on in order to suck out the contents of the plant cells. Mites evidently inject saliva as they feed for one of the first symptoms of broad mite and cyclamen mite feeding is failure of the host plant to blossom. Infested plants then exhibit a variety of plant growth regulator symptoms including twisted and distorted growth, and shortened internodes and petioles.

Key to the Most Common Mites Found on Flowers and Foliage Plants

1. Mites visible to the naked eye; infested plant may be discolored but usually not distorted by feeding 2

1.' Mites not visible without at least a 10 X hand lens; infested plants usually cease blooming and have shortened internodes, distorted leaves and stems, and blasted buds 3

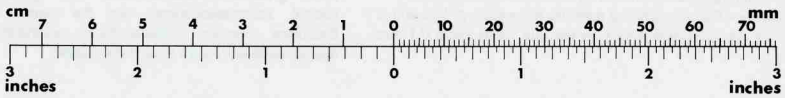
2. Mites feeding on foliage and causing tiny chlorotic spots, mites sometimes accompanied by fine silk webbing..... **Twospotted spider mite**, p. 62

2.' Mites feeding primarily in the bulbs of Easter lilies..... **Bulb mites**, p. 59

3. Egg oval, about 0.08 mm long, covered with minute white bumps (Fig. 110); female translucent brown and about 0.2 mm long, shaped like a fat football ..... **Broad mite**, p. 58

3.' Egg oval, about 0.1 mm long, without minute bumps; female translucent brown, about 0.3 mm long, shaped like a skinny football ..... **Cyclamen mite**, p. 61

110



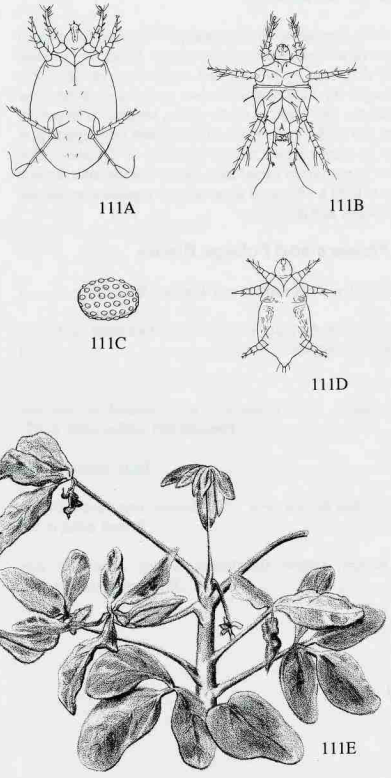


Fig. 111 Broad mite. A, Adult female. B, Male. C, Egg. D, Nymph. E, Damaged schefflera plant.

DESCRIPTION

Adult—Broad mites are almost microscopic (less than 0.2 mm long). They are translucent and colorless to pale brown. There are four pairs of legs; the last pair in the female ends in a long hair; the last pair on the male ends in a strong claw.

Egg—The egg is elliptical, translucent, colorless, about 0.08 mm long , and is covered by 29 to 37 whitish bumps.

Larva—The young broad mite has three pairs of legs and is whitish due to minute ridges on the skin. It is about 0.1 mm long.

BIOLOGY

Distribution—The broad mite is found in India, Ceylon (where it is called the yellow tea mite), Bangladesh (where it is called the yellow jute mite), Rumania (where it is called the broad spider) and other European countries, Africa, Brazil (where it is called the tropical mite and the broad rust mite), and the United States.

Host Plants—Broad mites feed on a large number of field crops, including potato, tomato, chili, cotton, mango, papaya, and tea. Broad mites also infest African violet, ageratum, azalea, begonia, dahlia, gerbera, gloxinia, ivy, jasmine, impatiens, lantana, marigold, peperomia, snapdragon, verbena, and zinnia.

Damage—Infested plants become unthrifty. Leaves curl downward and turn coppery or purplish. Internodes shorten and lateral buds break more than normal. This new growth may also be stunted or killed which forces out additional shoots. Flowers are distorted and fail to open normally. Unless controlled, broad mites usually destroy the commercial value of infested ornamental corps. Broad mites damage flowers and foliage of begonia and cyclamen, and bronze the lower leaf surfaces. Broad mites are so small that they are virtually invisible on the host plant even with a good hand lens. Also the mites tend to crowd into crevices and buds and feed on the growing tips. Their toxic saliva causes twisted, hardened and distorted growth in the terminal of the plant. The effects of their feeding may persist long after the mites have been eradicated.

Life History—Female broad mites lay 30 to 76 eggs on the leaf surface over an 8- to 13-day oviposition period. Unmated females lay male eggs; mated females usually lay four female eggs for every male egg. The larvae hatch in 2 or 3 days and emerge from the egg shell to feed. Larvae are slow moving and do not disperse far. In 2 or 3 days, the larvae develop into a quiescent larval stage. Quiescent female larvae become attractive to the males which pick them up and carry them to the new foliage. Males and females are very active, but the males apparently account for much of the dispersal of a broad mite population in their frenzy to carry the quiescent female larvae to new leaves. When females emerge from the quiescent stage, males immediately mate with them. Males live 5 to 9 days; females live 8 to 13 days.

CONTROL

Broad mites are very sensitive to heat. Lowering infested plants into water held at 43 to 49 ° C for 15 minutes will destroy broad mites without damaging the plants. Broad mites are also susceptible to various miticides. However, they are more difficult to control in winter than in summer due to lower greenhouse temperatures. For specific chemical control recommendations, see the current Cooperative Extension Service publications on ornamental plant pest management or consult your county agent.

**Polyphagotarsonemus latus* (Banks), Tarsonemidae, PROSTIGMATA

DESCRIPTION

Adult—Mature bulb mites vary from 0.5 to 0.9 mm long and have four pairs of legs. Their bodies are shiny, white, somewhat transparent, and smooth with reddish brown appendages.

Egg—The egg is white and translucent, 0.12 mm long, and ellipsoidal.

Larva—Shortly after hatching, the larva is 0.15 to 0.2 mm long and when well developed is 0.25 mm long. White and oval, larvae have only three pairs of legs and lack genital suckers.

Protonymph—The protonymph has four pairs of legs; it is oval and approximately 0.4 mm long. This stage can be distinguished from the tritonymph by having two genital suckers, whereas the tritonymph has three or four suckers.

Deutonymph or Hypopus—This quiescent stage is oval, convex on top, flattened below, brown, and 0.2 to 0.3 mm long. The mouthparts are absent. On the back lower side is a conspicuous sucker plate.

Tritonymph—The tritonymph is about 0.5 mm in length and has not yet developed a distinct genital aperture.

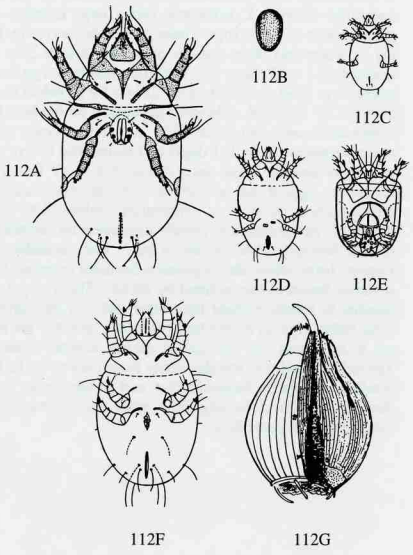


Fig 112. Bulb mites. A, Female. B, Egg. C, Larva. D, Protonymph. E, Hypopus. F, Tritonymph. G, Damaged bulb.

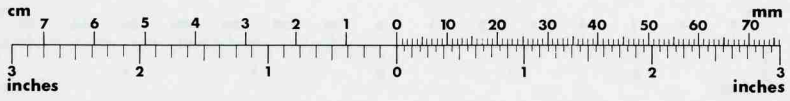
BIOLOGY

Distribution—From their original discovery in Europe, bulb mites have now been found throughout the United States, Canada, Japan, and the Bermuda Islands. These mites are easily transported in shipments of infested bulbs.

Host Plants—Bulb mites have been recorded feeding on forced iris, lily, narcissus, *Gloriosa*, *Hippeastrum*, *Eucharis*, orchid, hyacinth and tulip bulbs, dahlia tubers, and freesia and gladiolus corms. These mites also infest vegetable bulbs.

Damage—Bulbs infested with bulb mites may rot and fail to produce new growth, or new growth may be off color, stunted, and distorted. Although the bulb mite is not considered a primary pest of bulbs, it is often responsible for serious losses; the slightest injury to a bulb will allow bulb mites to enter and become established. Once the mites are inside the bulb, they rapidly turn the bulbs into rotten pulp. Infestations of the bulb mite generally indicate that the bulbs have already been injured. This damage could have been caused by other pests, such as the bulb scale mite or bulb flies, mechanical injury, or improper storage. The root primordia of freesia and gladiolus may be bruised at planting. Apparently bulb mites can attack healthy new roots and corms, especially in greenhouses. The mites may penetrate into lily stems which become brittle. Infested lilies are often dwarfed, distorted, and the stem roots are suppressed. Bulb mites attack the young root tips of *Hippeastrum* and *Eucharis*. When bulb mites attack *Gloriosa,* the new tubers get numerous small cavities and tunnels and become distorted. Bulb mites may enter prematurely opened tulip buds (due to high storage temperatures or ethylene generated by diseased bulbs in storage) and cause bud necrosis.

Life History—Bulb mites are rarely noticed as isolated individuals, but rather as large colonies. All stages of the mite can be found throughout the year. Development may occur in five or six stages (a hypopal stage is sometimes produced). In those forms with six stages, the life cycle proceeds from egg to larva to protonymph to hypopus to tritonymph to adult.



*Bulb mite, *Rhizoglyphus echinopus* (Fumouze and Robin). Other important species include *Rhizoglyphus robini* Claparède, *Rhizoglyphus hyacinthi* Banks, and *Rhizoglyphus engeli* v. Eijndhoven, Acaridae, ACARI

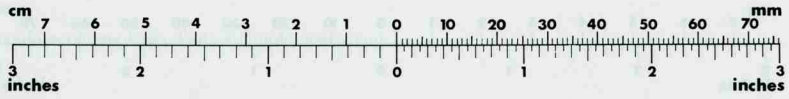
MITES

Bulb Mites (Continued)

Females lay up to 700 eggs each depending on the host. *R. robini* tends to form relatively small colonies on narcissus and tulips whereas *R. echinopus* forms large colonies on a greater range of bulb crops. These mites can survive by feeding on paper and other sources of organic matter. The eggs mature in 5.1 to 27 days. The total life cycle from egg to adult could be as short as 12.2 days (at 25° C) for *R. robini* or 13.9 days (at 25° C) for *R. echinopus* depending on the host bulb, temperature, and relative humidity. Adults live longer at lower temperatures (up to 121 days) and males tend to live twice as long as females. These mites can survive at 35° C, but they cannot lay eggs at that temperature. On the other hand these mites cannot develop at temperatures below 11.8° C. The length of development is greatly dependent on temperature, relative humidity (100 percent is best), and available food. Hypopi form when the population becomes crowded, or the substrate becomes too polluted by decay. The hypopal stage attaches to insects visiting the bulbs and may be carried to other bulbs. Hypopi do not feed (no head), and they are resistant to starvation and desiccation during adverse conditions. The ratio of males to females varies from 1 to1 to 1.9 to 1, depending on relative humidity, diet, and perhaps other factors. Besides their direct feeding, bulb mites are a threat because they carry pathogenic fungi.

CONTROL

It is very important to avoid rough handling of bulbs to prevent injury that might afford an entry point for fungi and bulb mites. Bulb mites cannot withstand drought and dry bulbs in storage are usually not attacked (unless mites are already deep inside tissue). Bulb mites are very tolerant of a number of synthetic pesticides apparently due to active oxidases, esterases, and transferases that detoxify such chemicals. Flooding gladiolus corms for 5 days gave 96.1 percent mortality; 14 days gave 100 percent mortality. A predaceous mite, *Cosmolaelaps claviger*, feeds readily on *R. echinopus* and other soil organisms. *R. robini* has an alarm pheromone, citral, which although not toxic to the mites, was definitely repellent. These mites left bulbs treated with citral at 100 ppm, and a mixture of citral and a miticide gave significantly better control of *R. robini* than the miticide by itself. Evidently the alarm pheromone made the mites more active and increased their contact with the pesticide. Soaking bulbs in a miticide before planting has been shown to prevent bulb mite injury. Steam sterilization and methyl bromide at low concentrations eliminated the mites from soil. For specific chemicals and control methods see your county Extension Agent or consult your state's management guide for ornamental plant pests.



DESCRIPTION

Adult—These mites are tiny animals, less than 0.3 mm long. Colorless or brown tinted and waxy looking, they have four pairs of legs. The fourth pair of the female is slender with a long, hair extending from the tip. The fourth pair of legs of the males ends in a strong claw.

Egg—The elliptical egg is 0.1 mm long and smooth.

Larva—The young mites are about 0.2 mm long and are whitish and have three pairs of legs. The legs have microscopic claws and suction cups.

Quiescent Stage—This stage appears as an immobile, engorged larva.

BIOLOGY

Distribution—The cyclamen mite is found throughout the United States and Europe

Host Plants—African violets are most often damaged by cyclamen mites. They also have been found on ivy, snapdragon, chrysanthemum, larkspur, geranium, fuschia, begonia, petunia, daisy, and azalea.

Damage—Cyclamen mites cause tuberous begonia and cyclamen flowers to be discolored or to shrivel or wilt. Infested flowers may not open properly or may not open at all. The mites also cause puckering, crinkling, and curling of leaves; infested leaves become brittle. Infested cyclamen buds fail to open or the flowers are distorted.

Life History—Cyclamen mites were first reported in the United States about 1900. It has since become famous as a harmful plant pest. Cyclamen mites seem to avoid the light; they occur in hidden areas on plants (buds and between the calyx and corolla and the stamens and ovaries of flowers). This mite also prefers high humidity. The eggs have delicate shells that can often be found collapsed among masses of unhatched eggs and mites. Deposited in moist, dark places and in small groups, the eggs require about 11 days to hatch. The mites molt only once. New larvae have wrinkled skin that stretches as they grow. They are highly active for about one week, after which they enter a quiescent stage for a few days and then molt to the adult stage. Each day the female lays two or three eggs. Eggs are relatively large in comparison to the adults. Cyclamen mites often exist wherever old cyclamen corms are preserved in the greenhouse. If a suitable host is not present year-round, female mites may semihibernate in the soil until a host becomes available. Females are usually more abundant than males in the winter months, and they live longer than males.

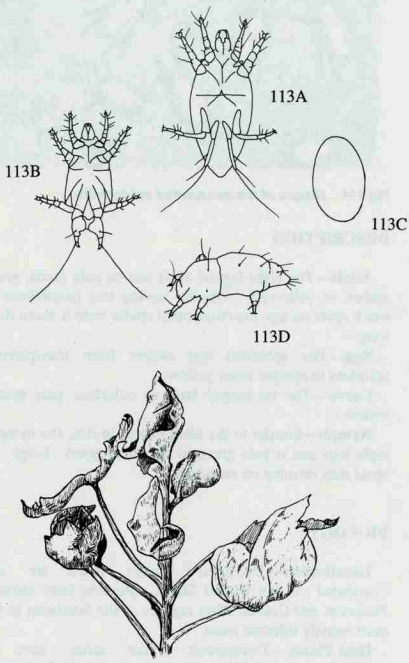


Fig. 113 Cyclamen mite. A, Female. B, Male. C, Eggs. D, Larva. E, Delphinium damaged by cyclamen mites.

CONTROL

Immersing infested plants (pot and all) into water heated to 43° C for 15 minutes kills cyclamen mites without harming most plants. If chemical control is desired, spray or dip the plant thoroughly with a miticide. For specific chemical control recommendations, see the current Cooperative Extension Service publications on ornamental plant pest management or consult your county Extension agent.

**Stenotarsonemus pallidus* (Banks), Tarsonemidae, ACARINA

MITES
Twospotted Spider Mite*

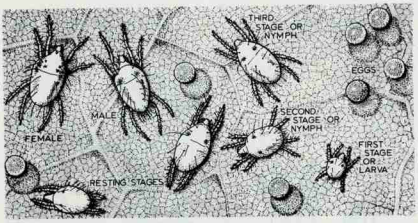


Fig 114 Stages of the twospotted spider mite.

DESCRIPTION

Adult—The eight-legged adult can be pale green, greenish amber, or yellowish. Usually having two (sometimes four) black spots on top, the twospotted spider mite is about 0.4 mm long.

Egg—The spherical egg ranges from transparent and colorless to opaque straw yellow.

Larva—The six-legged larva is colorless, pale green, or yellow.

Nymph—Similar to the adult except in size, the nymph has eight legs and is pale green to brownish green. Large black spots may develop on each side.

BIOLOGY

Distribution—Twospotted spider mites are widely distributed in the United States. Reports have shown the Piedmont and Coastal Plain regions of the Southeast to be the most heavily infested areas.

Host Plants—Twospotted spider mites have been reported on over 300 host plants, that include over 100 cultivated species. Violets, chickweed, pokeweed, wild mustard, henbit, vetch, and blackberry are common foci from which infestations develop on nearby crops.

Damage—Twospotted spider mites pierce the epidermis of the host plant leaf with their sharp, slender mouthparts. When they extract the sap, the mesophyll tissue of the leaf collapses in the area of the puncture. Soon a chlorotic spot forms at each feeding site. After a heavy attack, an entire plant may become yellowed, bronzed, or killed completely. The mites may completely web over entire plants.

Life History—Twospotted spider mites are important pests on more crops than any other arthropod in the Southeast. Though insects and mites are in a group called the Arthropoda (meaning jointed foot) because jointed legs are common to both, spider mites are not actually insects. They are more closely related to spiders, and they derive their name from the thin web which some species spin.

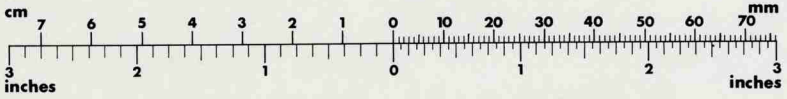
In North Carolina, twospotted spider mites overwinter as adults in the soil or on weed hosts such as violets, henbit, and hollyhocks. In mild winter weather, twospotted spider mites continue to feed and lay eggs, although development in the winter is much slower than in the summer. From the eggs hatch six-legged larvae. They develop into eight-legged nymphs which pass through two nymphal stages. After each larval and nymphal stage, there is a resting stage. The adults mate soon after emerging from the last resting stage, and in warm weather the females soon lay eggs. Each female may lay over 100 eggs in her life and up to 19 eggs per day. Development is rapid in hot, dry weather. Each generation may take as many as 20 or as few as 5 days to mature.

They often damage one species of plant quite heavily and then disperse to other hosts. When a plant is heavily damaged, the mites migrate to the outer periphery of the plant. From here, even the gentlest of breezes can carry them a significant distance to attack new hosts.

CONTROL

The use of foliar insecticides in hot, dry weather can induce spider mite outbreaks by killing the beneficial arthropods that would normally feed on the mites. In addition, a fungal pathogen attacks spider mites following short periods of cool, damp weather. Certain fungicides can eliminate this fungus and should be avoided for several weeks if plants are infested and such conditions occur. If spider mite infestations are detected early enough, a daily misting or spraying with a garden hose can be an effective control.

The resting stages and eggs of the twospotted spider mite are more tolerant to pesticides than the motile forms. Consequently, a second application of pesticide may be necessary at 4- or 5-day intervals in hot weather (7 to 10 days in cool weather) to kill those mites that may have survived the first application. For specific chemical control recommendations, see your Cooperative Extension publications on ornamental plant pest management or consult your Extension agent.



*_Tetranychus urticae Koch_, Tetranychidae, PROSTIGMATA

Introduction to Scale Insects

Scale insects are a diverse group of insects in the order Homoptera. There are about 6,000 species of scale insects in 21 families worldwide. About 1,000 species occur in North America. The three most common families of scale insects are the armored scale, the soft scale, and the mealybugs (p. 52). Most of the pest species belong to one of these three families.

Armored Scale Insects—Armored scales are the smallest of scale insects, ranging in size from 1 to 3 mm. The body of the scale insect is protected by a cover (the armor) made from wax secreted by the insect and cast skins (exuviae) of previous growth stages. One must remove the hardened wax cover to expose the body of the insect. The exposed body usually is yellow or orange, but may have a pink or red color to it. This cover also protects the eggs laid by the female. Armored scale insect covers vary from circular to elongate or oystershell-shaped (Fig. 115). Male and female covers may differ in size and shape for the same species. The cover of the female is generally largest. Boisduval scale and fern scale are common armored scale insects attacking flowers and foliage plants.

Most armored scale insects reproduce sexually. The eggs hatch beneath the protective scale cover and the first instars, commonly called "crawlers", migrate to the new growth to settle and feed. Armored scale females lose their legs at the first molt and are sessile for the rest of their lives. Females develop through three instars and males develop through five. Armored scales may overwinter as eggs, nymphs, or adult females. Adult males are usually present about two weeks in each generation. Some armored scales have four generations per year.

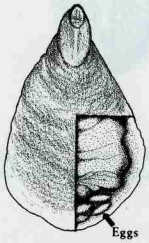
Soft Scale Insects—Soft scales (Fig. 116) differ from armored scales in that they do not secrete a waxy covering that is separate from the body. If wax is present, it adheres tightly to the body of the female and cannot be easily separated from it. Most soft scales produce a thin, glassy wax that does not obscure the color or form of the female soft scale. Soft scales are fairly large (2 to 6 mm long) and can be distinguished by their larger size, round or oval body outline, and convex or hemispherical profile. Soft scale females vary from flat to almost spherical. Often different host plants will alter the body form of a single species so much that taxonomists have described the different forms as separate species. If one turns the adult soft scale over, legs, antennae and thread-like mouthparts are readily visible with the aid of a microscope. Three common soft scales found in greenhouses and interior plantscapes are the brown soft scale, hemispherical scale, and tessellated scale.

Soft scales may reproduce sexually or parthenogenetically and every female may be capable of producing progeny without fertilization. Tremendous populations can develop during a single growing season. Most outdoor species have one generation per year. Females either lay eggs or give live birth, depending on the species. There are three instars in the females and five instars in the males. In warmer climates and in greenhouses, species with multiple generations may have all stages present simultaneously throughout the year.

Key to some Common Scale Insects Found on flowers and Foliage Plants

1. Body of insect protected with a wax or varnish-like covering that is not attached to the body of the insect; the insect can be seen by lifting off this covering (Fig. 115) **(Armored scale insects)** 2

1.' Body of insect oval in top view, bare or covered with a clear glassy-type wax that adheres to the insect's body (Fig. 116) ; infested plants often sticky with honeydew excreted by the insect **(Soft scale insects)** 3



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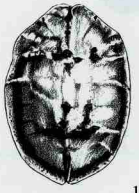

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SCALE INSECTS

Key to Scale Insects

2. Scale covering of female brownish and oystershell shaped (Fig. 117A); male cover snow-white with three ridges down the back (Fig. 117B) ..... **Fern scale,** p. 67

2.' Scale covering circular or oval, thin, flat, white to light yellow, semitransparent, and exuviae central or subcentral (Fig. 118A); male cover oblong oval, white, also with three ridges down the back (Fig. 118B)..... **Boisduval scale**, p. 65

3. Mature individuals noticeably convex or hemispherical in side view (Fig. 119A), shiny brown in color; sometimes hundreds of eggs found under the body (Fig. 119B) ..... **Hemispherical scale** p. 68

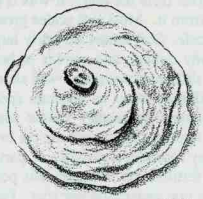
3.' Mature individuals flat or only slightly convex in side view (Fig. 120); yellowish-green to black in color; no eggs found under body although a few crawlers may be present under the female 4

4. Body yellowish-green to yellowish-brown in color; often mottled with brown spots (Fig. 121A) ..... **Brown soft scale**, p. 66

4.' Body oval, opaque, reddish-brown, and 4 to 5 mm in length; the dorsal surface appears checkered or cellular in pattern when examined with a magnifying glass (Fig. 121B) ..... **Tessellated scale,** p. 69

117A

117B



118A

118B

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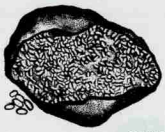
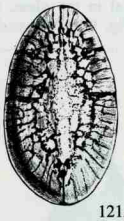
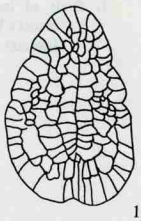
119A



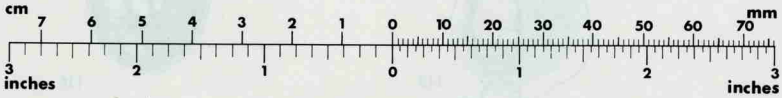
119B



121A



121B



DESCRIPTION

Adult Female—Cover of the adult female boisduval scale is circular or oval, thin, flat, white to light yellow, semitransparent, and 1.2 to 2.25 mm in diameter. Exuviae central to subcentral in position.

Other Stages—The male cover is somewhat rectangular in shape, elongate, about 1 mm in length, and snow white with three ridges down the back.

Eggs—Boisduval scale eggs are oval and pale yellow to pale orange.

Nymphs—Newly settled nymphs are pale orange.

BIOLOGY

Distribution—Boisduval scale attacks orchids and palms in the warmer areas of California and Florida where these hosts are grown extensively. It can be found indoors in all parts of the world and is a common greenhouse pest.

Host Plants—*Cattleya* and *Cymbidium* orchids are the most common hosts, but this scale insect thrives on the leaves and bark of other orchids, palms, banana, and cacti.

Damage—New growth is frequently attacked prior to opening, and leaves may be killed if the infestation is dense. Lighter infestations produce irregular chlorotic spots that mark feeding sites and spoil the appearance of the leaves.

Life History—Under greenhouse conditions, boisduval scale can complete its life cycle in about 50 days. Females may produce up to 200 eggs in a lifetime. Eggs hatch in 5 to 7 days and most of the crawlers settle to feed within 24 hours after hatching. The first stage lasts about 10 days, the second about 8 to 10 days for females and 15 for males. After mating, females retain their eggs for a short period, then oviposit. Because females produce eggs over a long period, generations overlap, and usually all stages can be found at any one time. Crawlers can settle anywhere on the leaf, but seem to prefer the midrib and major veins.

CONTROL

Try to purchase plants from a supplier who does not have a scale infestation. When scales are encountered, horticultural oils give adequate control without excessive phytotoxicity. Two thorough treatments 2 weeks apart should give good control. Boisduval scale crawlers often establish themselves near the base of the plant and in leaf sheaths making control difficult. Also, both upper and lower leaf surfaces are attacked, so thorough coverage of any treatment is essential. For specific control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.

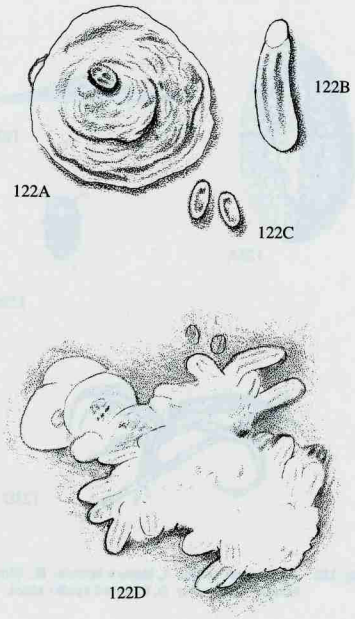


Fig. 122 Boisduval scale. A, Female. B, Male. C, Eggs. D, Infestation on orchid leaf.

**Diaspis boisduvali* Signoret, Diaspididae, HOMOPTERA

SCALE INSECTS
Brown Soft Scale*

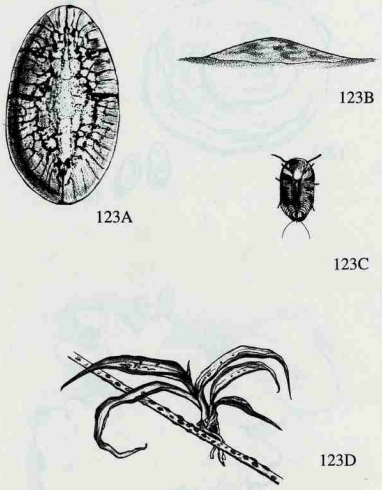


Fig. 123 Brown soft scale. A, Mature female. B, Side view of female. C, Crawler. D, Infested spider plant.

DESCRIPTION

Adult—Living adult female brown soft scales are pale yellowish green to yellowish brown, often mottled with brown spots. Older females are brown. the body is usually oval in outline, 2.5 to 4mm in length and slightly convex in profile. The shape tends to vary according to position on the host plant. Males look like tiny two-winged wasps or flies and are rare.

Other Stages—Crawlers and young nymphs are yellow and almost flat in profile. Parasitized nymphs are dark brown to black and convex. Crawlers have well-developed legs and antennae and are quite active until settling. Older nymphs are sessile.

BIOLOGY

Distribution—Brown soft scale is cosmopolitan in tropical and subtropical regions and in greenhouses in northern regions. In North America it occurs out of doors in the deep South, and north along the eastern seaboard to Virginia and as far north as southern Vancouver island on the west coast.

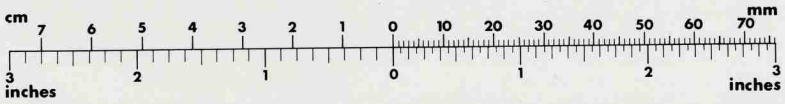
Host Plants—Brown soft scale has been reported feeding on hundreds of different plants. It can survive on most greenhouse plants, but seems to prefer perennials over annuals. Ferns are a favored host.

Damage—Brown soft scale is probably the most frequently encountered scale on plants indoors. Infestations of brown soft scale can become so heavy as to encrust the stems and petioles of their host plant. They also settle on leaves, usually along midribs and occasionally on the fruit. Large colonies remove large quantities of plant fluids and can cause wilting, but they seldom kill their host. Immatures and adults produce much honey dew that serves as a medium for the growth of sooty molds. These fungi inhibit photosynthesis and make infested plants unsightly. Obnoxious insects such as ants and wasps are also attracted to feed on the honeydew.

Life History—Females are ovoviviparous and retain the eggs in the body until hatching. Brown soft scales are born as active crawlers but remain under the body of the female for a short time before emerging and selecting a feeding site to settle and complete their development. Females molt twice before reaching maturity. Males undergo four molts before emerging as winged adults, but are rarely seen. All stages are found throughout the year in warmer regions and in greenhouses. Brown soft scales can complete three to seven generations per year depending on temperature. It takes about 60 days to complete a generation.

CONTROL

Brown soft scales are surprisingly difficult to control even though there is no external egg stage and only a few very young nymphs are protected by the body of the mother. Although reported as a pest species of many host plants in many countries, outdoors it may be suppressed by natural enemies in many areas. *Scutellista cyanea* Motschulsky is a common parasite and *Metaphycus luteolus* Timberlake controls brown soft scale in California. For specific chemical control recommendations, see current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.



**Coccus hesperidium* Linnaeus, Coccidae, HOMOPTERA

DESCRIPTION

Adult—Female fern scale armor is oystershell or pear shaped, flat, light brown with the crawler cast skin a paler brown. Sometimes the second stage armor is also paler than the adult armor. They are 1.5 to 2.5 mm long. The male armor is white felted, three-ridged, and the crowler cast skin is beige to yellowish brown. Adult males are tiny, two winged, gnatlike insects that are easily overlooked.

Egg—Eggs of armored scales are usually oval and about 0.2 mm long. They are laid in groups under the female armor.

Crawler—Fern scale crawlers are about 0.2 mm long, flat, and yellow with red eyes. The legs and antennae are well developed.

Nymph—Female second-stage nymphs secrete an oval, pale brown armor about 0.8 mm long. Male second stage nymphs secrete a white armor which has three long ridges. Mature male second stage nymphs are about 1 mm long.

BIOLOGY

Distribution—Fern scales are found on ferns in greenhouses and homes, and they are found outdoors on liriope in the Coastal Plain and Piedmont of the Southeast.

Host Plants—Fern scales mainly infest true ferns (not asparagus ferns) and liriope. This pest has been recorded from numerous foliage plants, citrus, and other woody ornamental trees and shrubs in Florida.

Damage—Infested ferns are disfigured by the presence of male second stage armor which is conspicuous against the dark green foliage. Ferns in commercial production sometimes tolerate a tremendous scale population with little noticeable reduction in vigor or color. Feeding by female scales causes yellow spots on some fern varieties and on liriope. Males do not feed beyond the second stage of development.

Life History—Little is known about the biology of fern scales specifically. Female scales lay their eggs under the armor. The female dies after the last egg is laid. Tiny crawlers hatch from the eggs and eventually emerge from under the mother's armor. The crawlers move about until they begin to feed by inserting their long, threadlike mouthparts into the leaf and sucking out nutrients. The insect molts into a second stage which begins to secrete a waxy material from under the rear of the first stage (crawler) cast skin. Eventually these insects molt into the adult stage. Female scales begin to secrete the adult armor at the rear of the second stage armor. Males emerge from their second stage armor as tiny, gnatlike insects that crawl or fly to female scales to mate. The armor remains fastened to the plant long after the scale insect leaves (male) or dies inside (female). When populations become dense, females tend to lay male eggs so that heavily infested plants become conspicuously spotted by second stage male armor.

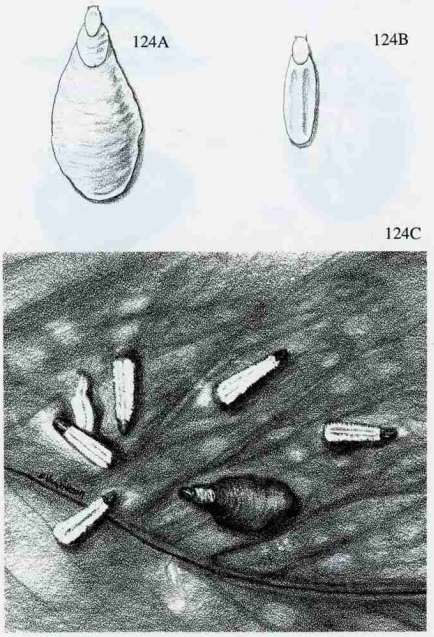


Fig. 124 Fern scale. A, Female. B, Male. C, Infestation on Boston fern leaflet.

Fern scales are frequently parasitized by tiny wasps which may help to keep popualtions low on outdoor plants.

CONTROL

Try to purchase plants from a supplier who does not have a fern scale infestation. When fern scales are encountered, horticultural oils give adequate control without excessive phytotoxicity to ferns. Two thorough treatments 2 weeks apart should give good control. Ferns are notoriously sensitive to pesticides. Whenever treating ferns and other sensitive plants, treat at a time that the pesticide will be dry on the foliage before the plants are exposed to full sunlight. For specific chemical control recommendations, see current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.

**Pinnaspis aspidistrae* (Signoret), Diaspididae, HOMOPTERA

SCALE INSECTS
Hemispherical Scale*

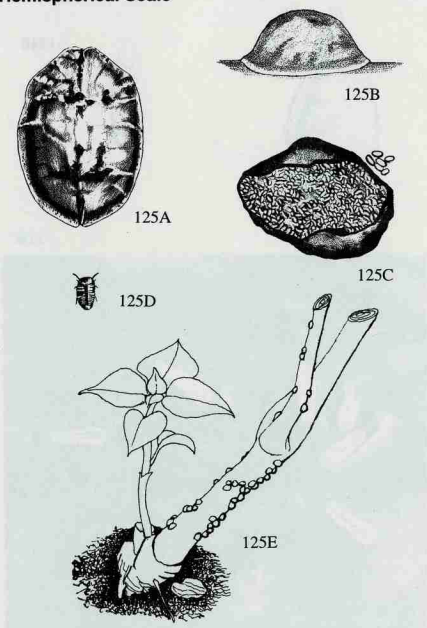


Fig. 125 Hemispherical scale. A, Top view. B,Side view. C, Dead adult with eggs. D, Crawler. E, Infested plant.

DESCRIPTION

Adult—Depending on the host plant, the adult scale may vary in size. The scale varies from 4.5 mm on Cycas to as small as 2.0 mm on Asparagus fern. Relatively hemispherical, brown, smooth, and shiny, the scale may resemble a miniature army helmet. Young females may have a pattern of ridges in the form of the letter "H" on the dorsal surface.

Egg—The oblong, pinkish beige eggs are about 0.7 mm long and are protected by the mother's body in a mass of hundreds.

Crawler—The flat, pinkish beige crawler is about 1.0 mm long with two red eye spots. The antennae and legs are short and spindly. There are two setae protruding from the rear.

Nymph—Nymphs are semitransparent, light yellow or pink, and flat (young) to humped (older). They are so closely attached to the host plant that the legs and antennae are concealed. Two pale lines start at the margin on each side and fade in intensity toward the middle. Nymphs and young adults may exhibit the characteristic "H" pattern of the black scale group.

BIOLOGY

Distribution—From its probable origin in South America, the hemispherical scale insect is now found in greenhouses and interiorscapes throughout the United States.

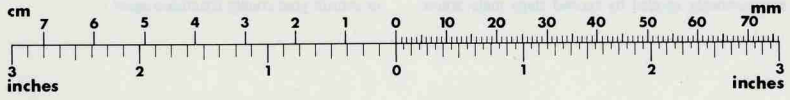
Host Plants—The hemispherical scale insect has a wide range of hosts including bamboo, camellia, chrysanthemum, crape myrtle, croton, ferns, figs, gardenia, honeysuckle, lily, orchids, and zamia.

Damage—The secretion of honeydew and subsequent formation of sooty mold detracts from the beauty and commercial value of the plant. Feeding causes the plant to become stunted and lose its leaves.

Life History—The hemispherical scale insect is a tropical insect that has become a common greenhouse pest. In warmer temperate areas, the scale can live outside. Unlike many other scales, the hemispherical scale secretes little wax. However, the scales do produce much honeydew which allows sooty mold to grow. Males are unknown and reproduction is by parthenogenesis. Each female may deposit up to 1000 eggs. After laying the eggs, the female dies and her body shrinks to form a cup or helmet over the eggs. Development for the egg stage and the three nymphal instars requires at least 40 days and may take as long as 105 days. There may be several generations each year in the greenhouse, with all stages being present at any one time. The nymphs do not move much once they have begun to feed. The hemispherical scale insect has a low rate of parasitism indoors, and it often becomes a serious pest.

CONTROL

Hemispherical scale insects are relatively difficult to control because the eggs and young nymphs are protected by the body of the mother. For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent. The most important parasite of hemispherical scale in the United States is *Metaphycus helvolus* Compere.



**Saissetia coffeae* (Walker), Coccidae, HOMOPTERA

DESCRIPTION

Adult Female—Living adult females are flattened, reddish brown to dark brown, and 4-5 mm in length. The body is usually somewhat oval in outline, with the anterior end angulate and the posterior broadly rounded, but the shape may change due to position on the plant. When viewed under a hand lens or magnifying glass, the dorsal surface of the body has a checkered or cellular pattern, divided by a smooth longitudinal median ridge.

Crawlers—Tessallated scale crawlers are reddish brown, flat, elongate oval, and widest in the middle area of the body.

Nymphs—Settled nymphs are light golden in color, flat, oval, and adhering so closely to the leaf surfaces as to be nearly transparent. Males are unknown.

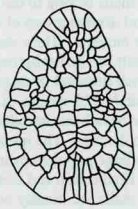


Fig. 126 Tessellated scale insect.

BIOLOGY

Distribution—Tessellated scale is a tropical species whose original home was probably South America. It has been disseminated by man to all parts of the world on its cultivated hosts. Tessellated scale occurs out-of-doors in Florida, California and most tropical areas, and in greenhouses throughout the world.

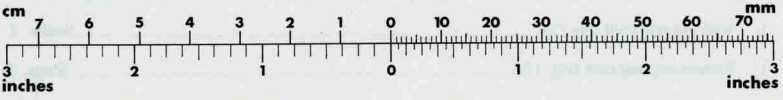
Host Plants—Tessellated scale occurs most commonly on palms and several species of Ficus, but it has been found on a wide variety of host plants.

Damage—Tesselated scale is primarily a leaf-infesting soft scale and a greenhouse pest. Heavy infestations weaken the plant but seldom kill it. Infestations are often of economic importance in commercial nurseries whenever pest management programs are neglected.

Life History—One or two generations per year, and in greenhouses generations will overlap. Tessellated scale is parthenogenetic and ovoviviparous, giving birth to living young. Males are unknown.

CONTROL

The parasitic wasp, *Metaphycus stanleyi* Compere is a natural enemy of tessellated scale. As with other scale insects, tessellated scale is best controlled in the immature stage. For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county agent.



**Eucalymnatus tessellatus* (Signoret), Coccidae, HOMOPTERA

Introduction to Slugs and Snails

Slugs and snails belong to the Phylum Mollusca and are more closely related to octopi than insects. Mollusks are a large and diverse group of animals of worldwide distribution. The slugs and snails are much like some insects in their biology. Their damage to ornamental plants resembles that done by caterpillars or wireworms. Slugs and snails are in a subgroup called the Gastropoda, the members of which have a head, a ventral muscular foot, and a shell (internal in slugs and external on snails).

Approximately 725 species of land snails and about 40 species of slugs are now known from North America. Most of these have been introduced accidentally. With few exceptions, native species are solitary in habit and do little or no damage. The introduced slugs and snails are usually gregarious and may cause serious damage as they build up large populations in a local area. In many places, slugs and snails have caused as much damage as insect pests. Eradication and control of slugs and snails is difficult and costly.

Slugs and snails are usually nocturnal so their damage is noticed before the pests are. Slugs and snails leave silvery slime trails on the ground and over plants. Slugs are able to crawl over the sharp edge of a razor blade without harm. Whenever the plant damage done by snails and slugs is easily observable, it has been determined the live weight of the slugs infesting the area may be around 70 pounds per acre! Slugs and snails may consume several times their own body weight each night; damage can be serious within a short time.

Movement of plant material facilitates the dispersal of these pest snails and slugs. Growers need to examine the plant material as it arrives at the facility. If live snails or slugs in the plant material are noticed, the local Department of Agriculture inspector should be called immediately. Failure to take quick action before the slugs or snails become established at the facility can be costly. For example, in a greenhouse complex in Maryland where the brown garden snail was detected as plant material was being unloaded, the grower took no action. One year later the snail was found in a routine inspection by the Department of Agriculture. The grower was then required to have all outgoing shipments inspected for the snail and to begin eradication treatments. It took over three years for the snail to be eradicated from the premises.

As the slugs mature, they become functional males and then true hermaphrodites (self fertilization has been observed in some species). Older slugs are females. Slugs are apparently not repelled by light, but are repelled by rising temperatures. As temperatures rise, slugs crawl down to their hiding places on the soil surface to rest and absorb water through their skin. As temperatures start to fall, slugs actively begin foraging. Thus slugs may be active during the day after a cooling shower as long as the temperatures decline or remain steady. Slugs are very sensitive to ambient temperature and can detect temperature changes as gradual as 2° F per hour! Slugs prefer to remain at 17 to 18° C although they lay eggs and develop normally (but slower) at lower temperatures. Development ceases below 5°C. Slugs can withstand slight freezing temperatures although their tendency to take shelter in cold weather protects them from freezing. Slugs try to escape from temperatures higher than 21°C. Slugs are also sensitive to air currents. Gentle breezes elicit a positive response in which the slug turns toward the source and extends its antennae. As the breezes become more brisk, the slugs turn away from the source evidently to escape dehydration. Slugs can withstand brief periods of immersion under water, although they drown after several hours.

Birds (up to 6 per cent of the diet of starlings), ducks, moles, toads, shrews and carnivorous ground beetles, rove beetles, and firefly beetles feed on slugs. Sciomyzid flies and nematodes also parasitize slugs. In addition, slugs are preyed upon by omnivorous slugs such as the spotted garden slug. Dry weather may kill up to 90 percent of slug eggs and young per year.

Metaldehyde baits have been shown to attract slugs up to 1 m away. The toxic effects of metaldehyde seem to be primarily due to dehydration as metaldehyde elicits excessive mucus production (mucus is 98 percent water and 2 per cent mucoproteins.) Thus in dry weather, metaldehyde is more effective. In wet weather, slugs sometimes can absorb enough moisture to compensate for the water lost in mucus production and therefore recover from the effects of metaldehyde. However, if slugs consume too much metaldehyde, they do not recover. Slugs seem to become more susceptible to carbamate pesticides as they mature. Copper sulfate is toxic to slugs and slugs will not crawl across a barrier of copper metal or wooden surfaces treated with copper sulfate.

Key to Common and Potential Slug and Snail Pests of Flowers and Foliage Plants

1. With external shell (Fig.127) ..... **Snails**, 2

1.' Without external shell (Fig. 128) ..... **Slugs**, 5

127

128

2. Shell an elongate spire that is often broken off (Fig. 129); These snails mainly feed on other snails; they are not considered a pest ..... ***Rumina*** sp.

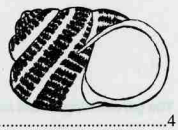
2.' Shell not an elongate spire 3

3. Shell a flattened disc spiraling toward the center (Fig. 130); these snails mainly feed on other snails, they are not considered a pest, ... ***Oxychilus*** sp.


129


130


131


132

3.' Shell not as above 4

4. Shell oval, with a large teardrop-shaped aperture which is approximately two-thirds the total shell length (these snails feed on algae and soft vegetable matter, they are not considered a pest, Fig. 131) ..... ***Succinia*** sp.

4.' Shell globular, with the aperture approximately 1/2 the shell diameter (Fig. 132) ..... **Brown garden snail**, p. 73

5. Breathing pore located in anterior half of mantle; back never keeled; posterior end rounded when viewed from above (Fig. 133); these slugs can do considerable damage, ... ***Arion*** sp., p. 72

5.' Breathing pore located in posterior half of mantle; back keeled at least at posterior end which is pointed in dorsal view..... 6

6. Back strongly keeled from the mantle to tip of tail; mantle grainy with center part bound by a groove (Fig. 134); usually burrows in the soil and feeds on roots, ... **Greenhouse slug** , p 75

6.' Back keeled only near posterior end; mantle wrinkled in concentric circles, without a groove 7

7. Mantle and body with black spots; large slug (up to 150 mm) (Fig. 135) ..... **Spotted garden slug**, p. 77

7.' Mantle and back without well defined spots 8

8. Mantle and back with well defined, dark stripes; breathing pore not surronded by a pale ring (Fig. 136); exudes watery slime when irritated ..... ***Lehmannia*** **slug**, p. 76

8.' Mantle and back without well defined stripes; breathing pore surrounded by a pale ring 9

9. Medium sized slug (up to 50 mm) (Fig. 137) ; gray to reddish brown; exudes milky adhesive slime when irritated ..... **Gray garden slug**, p. 74

9.' Relatively small slug (up to 25 mm) (Fig. 138) light gray to blackish brown; exudes clear, watery mucus when irritated ..... **Brown slug**, p. 74


133


136


134


137A


135


137B

SLUGS AND SNAILS
Arionid Slugs*

Fig 139 The garden slug, *Arion hortensis.*

DESCRIPTION

Adult—Garden slugs grow up to 25 to 30 mm. The mantle is on the anterior part of the slug and the breathing pore is in the anterior half of the mantle. Garden slugs have a band along either side which is not distinct on the lower border. There is no dorsal row of tubercles, and the creeping sole is yellow to dark yellow or orange. The respiratory pore is in front of the midpoint of the mantle shield. There is no keel, and the sole of foot is not divided. The skin is rough and wrinkled, gray to dark brownish gray and often with small yellow-brown dots (color lighter toward the foot). Hedgehog slugs are about 20 mm long, and are greenish to yellowish gray with one prominent dark lateral band on each side and on the mantle. The head is dark gray or black with dark gray tentacles, and the skin is covered with conical tubercles with transparent tips when contracted giving the slug a spiky appearance. The sole is yellow at the rear.

Mucus—When irritated, the slime on the body of the garden slug is yellow to dark yellow and the slime on the sole is colorless. The mucus of the hedgehog slug is golden yellow.

Young—Young garden slugs are slate gray on top. There is a dark band on each side (the band on the right enclosing the respiratory pore). The sole is yellow to orange.

BIOLOGY

Distribution—The arionid slugs are introduced from Europe. They can survive only in areas of moderate to high humidity. In the United States, arionid slugs occur naturally only in the North. Hedgehog slugs are found in the British Isles, Spain, Central Europe, and North America.

Host Plants—The garden slug is a pest of narcissus. The hedgehog slug feeds on narcissus, grasses, lilies, (leaves, brood bulbs, flowers), and iris in greenhouses. Jimson weeds are highly favored, amaryllus (leaves, bulbs), coleus, tulip (germinating bulbs, leaves, flowers), and vegetables.

Life History—The garden slug (also called the black field slug) creeps very slowly (covers 90 cm per night) and becomes inactive at 5° C. The life span is 7.5 to 12 months and females lay 158 to 205 eggs. Garden slugs increase in size during the summer and reach sexual maturity in the autumn and winter. This slug only reproduces in the early months of the following spring. Crowding increases mortality. These slugs forage primarily from 0530 to 0600 hours although activity starts at 1900 hours. The garden slug feeds more frequently than the gray garden slug, but eats the same amount. Maximum seasonal feeding and mobility occurs in October and November. Frost and dryness drives these slugs deeper into the soil. Garden slugs reproduce faster on alkaline to neutral soils than on acid soils. The garden slug can consume 56 percent of its body weight in 1 day. Hedgehog slugs oviposit in July and August. Eggs of hedgehog slugs hatch in September and October. These new slugs mature the following spring. The life span is about 12 months.

CONTROL

Hedgehog slugs become infected with the ciliate, *Tetrahymena rostrata* (Kahl) by contact with cysts in the soil during winter. A sciomyzid fly, *Tetanocera elata* Meigen, parasitizes this slug in North America and Europe. Hedgehog slugs are also infected with the cestode, *Davainea proglottina* (Davaine).

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*The garden slug (also black field slug), *Arion hortensis* Férussac; Hedgehog slug, *Arion intermedius* Normand, Arionidae, STYLOMMATOPHORA

DESCRIPTION

Adult—An adult shell has 4 to 5 whorls and is 28 to 32 mm in diameter. The shell is large, globose, rather thin, and has fine wrinkles on the surface. It is yellowish or horn-colored with chestnut brown spiral bands that are interrupted by yellow flecks or streaks. The aperture is crescent-shaped or oval-crescent-shaped, approximately one half the shell diameter, and has the tip turned back.

Young—Young brown garden snails are similar in appearance to adults, but are smaller.

Eggs—Brown garden snail eggs are white, spherical, and about 5 mm in diameter.

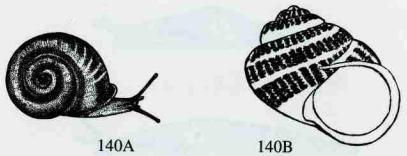


Fig 140 Brown garden snail (A) and shell opening (B).

BIOLOGY

Distribution—The brown garden snail is native to Europe and the Mediterranean Region. It was introduced by French immigrants into California, Kentucky, Louisiana, New Mexico, Oregon, South Carolina, Texas, Utah, and Washington.

Host Plants—The brown garden snail is a general feeder and will probably attack anything in a greenhouse.

Damage—The brown garden snail eats large ragged holes in leaves and may totally consume seedlings. Low growing plants generally suffer the most damage, but this snail climbs trees to feed and has been reported as a pest in citrus orchards.

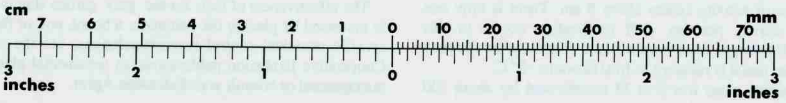
Life History—Eggs are laid in a nest 2.5 to 4 cm deep in the soil. Each snail lays an average of 85 eggs. Eggs hatch in 2 to 4 weeks depending on soil moisture and temperature. The egg mass is concealed by a mixture of soil and secreted mucus, and is then covered with excrement. The number of times a snail oviposits is dependent on temperature, humidity, and soil conditions. Low temperatures (less than 12° C) and low humidity inhibit the activity of the snail. Dry soil is unsuitable for nest preparation.

During warm, damp weather, ovipositions may be as frequent as once a month. Peak activity period is February to October. Each adult snail during this period will oviposit about once every six weeks. During these five ovipositions, each snail lays an average of 430 eggs.

When dry conditions prevail, the snail may seal itself to an object or close off the aperture of the shell with a parchment-like material. With the return of moist or humid conditions, the snail will again become active.

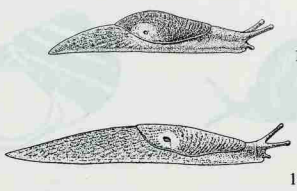
CONTROL

One control option is to hand pick the snails from plants. Place the snails in a jar, fill it with water, put the lid on securely, and let them drown. The addition of dish detergent to the water will kill them faster. Another big help is to clean up the area by removing the hiding places in which the snails spend the day. Sometimes bands of wood ashes or lime are recommended to discourage snails from entering an area. Lime may work as long as it is kept dry, but lime may adversely affect the soil pH. Wood ashes appear to be somewhat effective. Snails will avoid crossing copper screening or banding because the mollusc apparently receives a minute electric shock when it contacts copper.



**Helix aspersa* Miller, Helicidae, STYLOMMATOPHORA

SLUGS AND SNAILS
Deroceras Slugs*



141A

141B

Fig 141 ***Deroceras*** **slugs. A, Brown slug. B, Gray garden slug.**

DESCRIPTION

Adult—The brown slug (also marsh slug or smooth slug) grows up to 25 mm long. It is very soft and translucent and is covered with watery slime. The brown slug is light gray or brown to blackish brown with only slight marks if any. The mantle is central and half of the body length. The sole is pale brown or light gray. The gray garden slug grows to about 50 mm long. It is pale cream or yellow white, gray to reddish brown; with a network of mottled, dark brown grooves, spots, and streaks (these rarely absent). The mantle is rounded at both ends with dark dots and flecks; the mantle and body are not banded; the rim of the respiratory pore is slightly paler than the mantle and the center point of the concentrically ridged mantel lies to the right of the midline. There is a short, truncated keel at the rear. The sole is pale or light brown;

Mucus—The mucus of the brown slug is thin, clear, and colorless. When the gray garden slug is irritated, the mucus is milky (the white pigment is lime) and sticky.

BIOLOGY

Distribution—The brown slug is found in Europe, England, the United States, and in the former USSR. Introduced from Europe, the gray garden slug has spread throughout most of the United States except perhaps for the Coastal Plains of the Southeast.

Host Plants—The brown slug feeds on coleus, lilies, iris, narcissus, chrysanthemums, *Fittonia verschaffeltii,* jimson weed, strawberries, and vegetables (especially lettuce), and (in greenhouses) amaryllis leaves and bulbs, cyclamen, ferns, and orchids. The gray garden slug feeds on narcissus and other ornamentals.

Damage—These slugs may eat 60 mg (about 2 sq cm) or up to 40 percent of its total body weight per day.

Life History—The brown slug is well known for its great mobility. It is most active from 6:30 am to 2 hours after sunrise and most activity ceases about 9 am. There is only one peak of activity per day. Self fertilization occurs in this species. It emerges from hibernation 3 weeks before the gray garden slug and it is resistant to frost down to - 8° C.

Gray garden slugs live 9 to 13 months and lay about 300 eggs. Gray garden slugs cover up to 90 cm per night and are active from 17.5 to 20.5° C although they may forage at 1 to 2° C. The gray garden slug forages even in mild winters and may not be completely immobile even at 0° C. This slug can survive -8° C for several days. They regulate body temperature by evaporation of water from the skin (up to 12° C difference in body temperature and environment). When it is too warm, field slugs immediately seek shelter to conserve moisture. In damp soil, slugs move singly; in dry soil they bunch together. This slug can loose up to 50 percent body weight and recover within two hours of exposure to water. September is the period of maximum feeding and mobility. Field slugs tend to reside in coarse soils, and tend to oviposit in fine soils. They prefer to retreat into holes that touch all sides, and they penetrate much deeper into coarse soils (12 to 14 cm). Field slugs may oviposit on the surface of damp soils but oviposit deeper into dryer soils. They prefer soil moisture content of 60 to 85 percent water. These slugs may drown in excessively wet soils. Field slugs reproduce faster on alkaline to neutral soils. They have one or two generations per year depending on weather. There are usually two generations per year in England and one in central Europe. Sometimes there are three overlapping generations (one from a late population of the preceding year). This slug covers significant distances in search of a new source of food only when the old supply has been exhausted.

CONTROL

Brown slugs are infected by the ciliates, *Tetrahyema limacis* (Warren), and *T. Rostrata* (Kahl). The latter is so highly pathogenic that it is a possible biological control organism. The trematode, *Rhabditis lambdiensis* (Maupas), also infects the brown slug. This slug also is sensitive to *Angiostrongylus cantonensis* Chen (a cause of eosinophilic meningoencephalitis of people so do not eat slugs raw). Brown slugs are hosts of *Pneumostrongylus tenuis* Dougherty, a lungworm parasite of Virginia deer. About 25 percent of brown slug populations are infected from spring to June. By July only 1.5 per cent are infected apparently due to mortality in the population. The slug is the main overwintering host of this trematode. The trombidiid mite, *Riccardoella limacum* (Shrank), lives in the mantle cavity of brown slugs and retreats to the respiratory pore when disturbed. Harvestmen, (Opiliones) prey on this species. The sciomyzid flies, *Tetanocera plebeia* Loew and *Tetanocera valida* Loew prey on brown slugs. Slices of raw potato can be used to monitor brown slug populations. Better control of the brown slug is obtained by scattering baits near the edges of gardens or near shelters, and greenhouse benches. Metaldehyde is fairly effective, but metaldehyde at high concentrations is repellent to brown slugs. Carbamates are much more effective if slugs can get to water after treatment.

The effectiveness of baits for the gray garden slug is greatly increased by placing the bait under a board, pot, or flat. For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your Extension Agent.

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*The brown slug (also marsh slug or smooth slug), *Deroceras laeve* (Müller); gray garden slug, *Deroceras reticulatum* (O. F. Müller) (also netted slug or gray field slug), Limacidae, STYLOMMATOPHORA

DESCRIPTION

Adult—An adult greenhouse slug is 50 to 70 mm in length. The body color is gray or black without distinct markings or patterns. The mantle is slightly granulose but not concentrically wrinkled, the central portion bounded by a horseshoe-shaped groove. The breathing pore is on the right posterior half of the mantle. The body is strongly keeled from mantle to posterior end. The mucus is colorless.

Eggs—Greenhouse slug eggs are opaque to whitish, oval, and about 2.5 mm in diameter.

Fig 142 Greenhouse slug.

BIOLOGY

Distribution—The greenhouse slug was introduced into the United States from Europe. It is found throughout the temperate regions of the world.

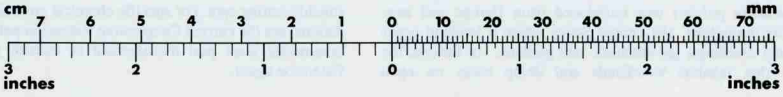
Damage—The greenhouse slug differs from most pest slugs in that it is a burrowing species. It can cause serious injury to roots and stems. A few seen on plants and stems means that many more are below the soil surface.

Life History—Eggs are laid in a tunnel 3 to 5 cm from the soil surface, either singly or in clusters of up to 16. The adult slug plugs the end of the tunnel with mucus material which dries to resemble the soil surface. Eggs hatch in 11 to 24 days depending on the temperature. Parthenogenesis has been observed in the greenhouse slug. There is little information available on the life history of the greenhouse slug. One study noted that slugs preferred drier sites during the day and moved to more humid areas at night.

CONTROL

Control of the greenhouse slug consists primarily of placing baits in likely areas the slugs would encounter. The effectiveness of such baits is greatly increased by placing the bait under a board, pot, or flat.

For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.



**Milax gagates* (Draparnaud), Limacidae, STYLOMMATOPHORA

SLUGS AND SNAILS
Lehmannia Slugs*

Fig 143 ***Lehmannia*** **slug.**

DESCRIPTION

Adult—*Lehmannia poirieri* is a light brown to yellowish gray slug with dark lines along the top of the body. There is a pair of faint grooves just above the foot. The mantle does not have a groove or fold although it is faintly concentrically wrinkled. When irritated, the mucus secreted is colorless. This slug grows to about 60 mm long and can stretch to about 75 mm.

The tree slug, *Lehmannia marginata* (Müller), is a gray to reddish slug with a lighter median stripe down the back. It usually has a large, translucent water reservoir (body) at the tail. The respiratory pore is behind the middle of the mantle, and the body is keeled only at tail. The mantle is 1/3 of the body length just behind the head. Each side has two dark bands lengthwise (lower band sometimes forming a network, and often faint). The mantle has three dark, lengthwise bands (median faint) and the pale areas between the bands forming a lyre shape. The sole is gray, often with a darker median area. The mucus is colorless and watery.

Egg—The eggs of the tree slug are oval to somewhat pointed on one end. The eggs tend to be opaque when first laid and become more transparent as the embryo develops. The surface of the eggs is covered by tiny wavy wrinkles. The size of the eggs may vary from one slug to the next although the eggs in one clutch (up to 63 eggs per clutch) are fairly uniform (2 to 2.5 mm).

Young—No description found.

BIOLOGY

Distribution—There is some confusion in the literature about the identity of *Lehmannia poirieri.* In the American literature this slug was at one time called *Limax marginatus.* There is now an old world slug called *Lehmannia marginatus* (Müller), the tree slug, which is apparently similar to if not the same species as *Lehmannia poirieri.* However, the tree is an arboreal slug in Europe whereas *Lehmannia poirieri* seems to be terrestrial in the United States. It is thought that *Lehmannia poirieri* was introduced from Europe and now occurs throughout the United States where it tends to occur around dwellings, greenhouses, and gardens. In Europe, the tree slug inhabits woodlands and damp rocks on open hillsides. The tree slug is found in England, Europe, Australia, Japan, Mexico, and Venezuela.

Host Plants—*Lehmannia poirieri* feeds readily on living plant material and has been associated with damage to pepper plants, carnation, ivy, vinca, and *Cymbidium.* Tree slugs feed on hosta, vegetables, wheat, jimson weed, and usually prefer vegetable diet to casein or blood meal. In the greenhouse it feeds on amaryllus, asters, mums, orchids, and *Tradescantia.*

Damage—Aside from the direct damage *Lehmannia poirieri* does to bedding plants and vegetables, this slug (or a very closely related species) has been found to be an intermediate host of a parasitic nematode of rats. Slugs have been implicated as intermediate hosts of the fowl tapeworm, *Davainea proglottina* (for this reason it is suggested slugs not be eaten raw). The tree slug can transmit tobacco mosaic virus.

Life History—*Lehmannia* slugs require a higher moisture substrate than other limacid slugs. *Lehmannia poirieri* also tends to burrow into soft soil. During the day this slug tends to rest under boards, logs, flats, and other debris. *Lehmannia* slugs space themselves so they do not touch in the daytime resting sites in summer, but cluster tightly during the winter. *Lehmannia* slugs have an elaborate courtship behavior which lasts from a half to 2 hours. Eggs are laid sometime later (perhaps many weeks later). Young slugs hatch from the eggs about 2 weeks later at 68° F. Tree slugs live 24 to 26 months, and lay 105 to 132 eggs. This slug searches the edges of strange environments and can learn the position of food.

CONTROL

Tree slugs are infected with the sporozoan, *Pfeifferinela impudica* Leger & Hollande, and with the ciliates, *Colpoda steini* Maupas, *Tetrahymena limacis* (Warren), and *Tetrahymena rostrata* (Kahl) that infect this slug during the winter probably from cysts in the soil. The trematode, *Strongylus* spp. has been found in eggs of tree slugs. The trombidiid mite, *Riccardoella limacum* (Schrank), can considerably reduce a slug population especially in captivity. The mites crawl rapidly on the surface of the slug and disappear into the respiratory pore when mites are disturbed.

Tree slugs are intermediate in resistance to molluscicides. Tree slugs habituate to the attractiveness of metaldehyde so that broadcasting of baits tends to give better control than clumps. When sprayed, these slugs crawl onto each other to avoid the residue. Metaldehyde only gives 35 percent mortality if the weather is cool and rainy. Moisture does not seem to improve the efficacy of carbamates for tree slug management. One method of controlling *Lehmannia poirieri* is removal of its hiding places. Picking up flats, boards, pots, and debris will force the slugs to crawl elsewhere for a suitable resting spot. For specific chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.

**Lehmannia poirieri* (Mabille)(= *Limax marginatus* of Pilsbry); tree slug, *Lehmannia marginatus* (O. M. Müller) (= *Limax arborum* Bouchard-Chantereaux), Limacidae, STYLOMMATOPHORA

DESCRIPTION

Adult—An adult spotted garden slug is 80 to 150 mm in length. The body color is usually yellowish gray, but may be brown. There are two or three darker rows of spots or strips on each side. The mantle is only on the anterior end of the animal, it is concentrically wrinkled, without a groove, the breathing pore is located in the posterior half of the mantle. The body is keeled only near the posterior end. Both the body and the mantle have large black spots. The mantle and body are often banded, and the foot fringe has small black grooves. The mucus is colorless and sticky.

Eggs—The light yellow eggs are laid in clusters of about 25 in the soil.

Young—Young slugs are about 14 mm long at hatching. They are usually dull white when they hatch. A few hours after hatching the body begins to darken and in about two days it is brownish in color. The body darkening lasts about a month, at which time the black spots begin to appear (the slug is about 25 mm. long now). Immature slugs remain together in a colony near where the eggs are deposited for four to five weeks.

Fig 144 Spotted garden slug.

BIOLOGY

Distribution—The spotted garden slug was introduced into the United States from Europe. In this country it is recorded from Massachusetts south to Georgia and west to Oregon and California.

Host Plants—Spotted garden slugs feed on lilies, iris, and narcissus in greenhouses and bedding plants outdoors.

Damage—This slug leaves a trail of slime wherever it goes. It eats large ragged holes in the leaves of mature plants and may completely devour small seedlings. They usually are most serious on plants growing close to the soil surface.

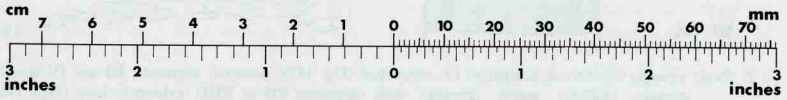
Life History—The spotted garden slug lays clusters of about 25 light yellow eggs covered by mucus (674 to 834 total). Eggs are usually deposited under objects on the ground such as stones and boards. Eggs hatch in about 30 days at 24° C (sooner at higher temperatures). Immature slugs remain together in a colony near where the eggs are deposited for four to five weeks.

Activity is greatest during the night and on damp, cloudy days. Spotted garden slugs prefer temperatures of 21 to 27° C. They can survive 30 to 34° C for a short while, but they immediately seek shelter to conserve moisture. These slugs regulate body temperature by evaporation of water from the skin (maintaining up to 12°C difference). They often feed and hide among the leaves of large-leafed plants. Outdoors they are among the first pests to begin feeding in the spring and among the last to stop feeding in the fall. Indoors they will feed as long as environmental conditions are favorable. In damp soil they tend to be solitary, but in dry soil spotted garden slugs bunch together. They may live 30 to 36 months.

CONTROL

Spotted garden slugs can loose up to 50 per cent body weight and recover after 2 hours of exposure to water. Thus if poisoned with metaldehyde, spotted garden slugs may recover if they have access to water.

For chemical control recommendations, see the current Cooperative Extension publications on ornamental plant pest management or consult your county Extension agent.



**Limax maximus* Linnaeus, Limacidae, STYLOMMATOPHORA

Introduction to Thrips

Thrips are relatively small, 0.5 to 5 mm long (most are 1 to 2 mm). Wings may be present or absent; and the wings when present are unique among insects because they are narrow, with few or no veins, fringed with long hairs that hence give the order's name, Thysanoptera. Mouthparts are piercing-sucking with only a left mandible. Antennae are short (four to nine segments). The tarsi have one or two segments with one or two claws and are bladderlike at the end. They can reproduce sexually or asexually, and females are the most common sex found.

Thrips are divided into two suborders, **Terebrantia** and **Tubulifera**, that differ in the shape of the last abdominal segment and the development of the ovipositor. The Terebrantia have the last abdominal segment more or less conical or rounded, and the female almost always has a well-developed, sawlike ovipositor. The Tubulifera have the last abdominal segment tubular, and the females lack an ovipositor. The families of thrips are separated largely by the characters of the antennae, particularly the number of antennal segments and the nature of the sensoria on the third and fourth segments. A total of 11 species belonging to two families of two suborders (Phlaeothripidae-Tubulifera, Thripidae-Terebrantia) are included here.

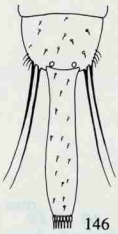
The metamorphosis of thrips is somewhat intermediate between simple and complete. The first two instars are called larvae. In the suborder Terebrantia, these are followed by the third and fourth instars which are inactive, do not feed, and have external wing pads. The third instar is called a prepupa and the fourth the pupa, and are often spent on the ground in soil or litter. In the suborder Tubulifera, the third and fourth instars are prepupae and the fifth pupa. The two sexes of thrips are similar in appearance, but the females are usually larger in size and lighter in color. The thrips with an ovipositor usually lay their eggs in plant tissue; those without an ovipositor lay their eggs in crevices or under bark. Thrips run, crawl, and jump and can move rapidly. Flight is the major method of active dispersal; however, they can be aerially dispersed by drifting in wind currents for many miles.

A great number of thrips are plant feeders. Both larvae and adults feed on flowers, leaves, twigs, or buds, using their piercing-sucking mouthparts, causing structural abnormalities of foliage in the form of leaf malformation (distorted, dwarfed, and matted), leaf fold, leaf roll, leaf blisters, and sometimes defoliation; causing discoloration of petals, deformation, or scarring of flowers. A few species feed on fungus spores, a few species are predaceous on other small arthropods (mites, thrips, and aphids) and a few species may bite man. A very important aspect of thrips is the transmission of virus diseases. Tomato spotted wilt virus, is transmitted by the western flower thrips, tobacco thrips, and onion thrips.

Key to Eleven Species of Thrips Found in Greenhouses

1. Last abdominal segment (**X**) tubelike (Fig. 145); female without sawlike ovipositor; body blackish brown, antennae yellow except for light brown terminal segment; on *Ficus* (Phlaeothripidae) ..... **Cuban laurel thrips**, p. 83

1.' Last abdominal segment (**X**) rarely tubelike (Fig. 146); female always with sawlike ovipositor (Thripidae)..... 2



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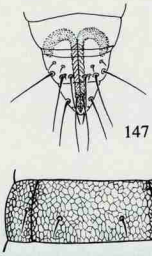

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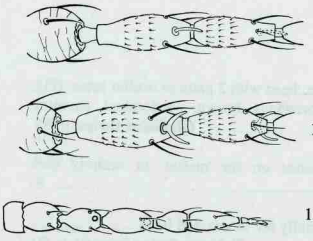
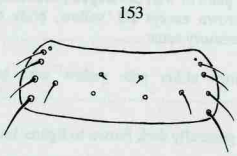
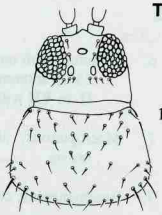
150

2. Body strongly sclerotized, sculptured or reticulated (Fig. 147); antennal segments **III** and **IV** usually strongly vasiform and/or antennal style (segments **VII** to **VIII**) extremely long (Figs. 148, 149), at least two-thirds as long as **VI** 3

2.' Body usually with transverse sculpture; antennal style shorter 4







3. Forewings with fringe cilia straight; median dorsal abdominal setae closely set; sense cones on antennal segments **III** and **IV** simple (Fig. 148); legs entirely pale yellow ... **Greenhouse thrips**, p. 87

3.' Forewings with fringe cilia predominately wavy (Fig. 155); median dorsal setae placed fairly far apart; sense cones on antennal segments **III** and **IV** forked (Figs. 149, 152); legs yellow except mid and hind femora, which are brown ..... **Banded greenhouse thrips**, p. 81

3." Forewings with fringe cilia wavy (Fig. 155); median dorsal setae closely set; sense cones on antennal segments **III** and **IV** simple (Figs. 150, 151); head and pronotum with wrinkles inside reticulations; legs brown with base of femora, apical one third to half of tibiae and all tarsi yellow ..... ***Echinothrips americanus***, p. 84

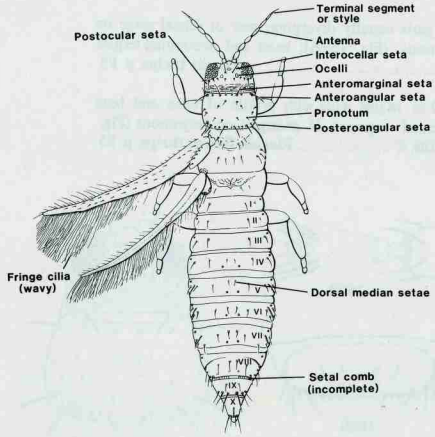
4. Antennae each seven segmented (Fig. 154A) 5

4.' Antennae each eight segmented 6

5. Abdomen uniformly pale yellow, body without any brown makings; posterior margins of abdominal tergites **II** to **VII** without conical teeth; abdominal tergite **II** with four lateral setae (Fig. 153) ..... **Melon thrips**, p. 88

5.' Abdomen uniformly brown; posterior margins of abdominal tergites **II** to **VII** with conical teeth; abdominal tegite **II** with 0 to 3 lateral setae; head narrow, prothorax as in Fig. 154B ..... **Composite thrips**, p. 82

6. Pronotum with well developed anteromarginal, anteroangular setae, and 2 pairs of posteroangular setae; head with 3 pairs of ocellar setae (Fig. 155); coloration of antennae, body and forewings various; abdominal sternites lack accessory setae (*Frankliniella* spp.) 7



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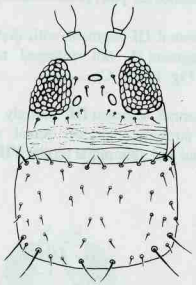
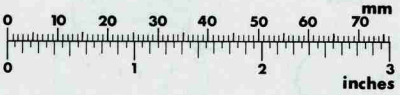




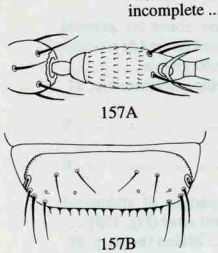
6.' Pronotum with only 2 pairs of well developed posteroangular setae; head with 2 pairs of ocellar setae (Fig. 156); antennae brown except **III** yellow, body brown, forewings brown, abdominal sternites **II** to **VII** with accessory setae ..... **Gladiolus thrips**, p. 86

7. Macropterous; abdomen either pale yellow with brown patches on the meson, or entirely dark brown 8

7.' Brachypterous; color generally dark brown to lighter brown especially the thorax and head ..... **Tobacco thrips** (in part), p. 90

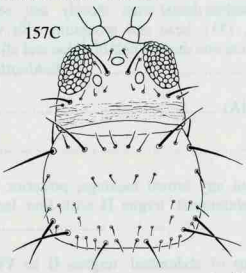
8. Pedicel of antennal segment **III** straight without thickened middle ring (Figs. 157A, 158A); comb on posterior margin of abdominal tergite **VIII** complete or incomplete (Figs. 157B , 158B) 9

8.' Pedicel of antennal segment **III** with a distinctly thickened middle ring which in profile appears as angulations (Figs. 159A, 160A); setal comb on posterior margin of abdominal tergite **VIII** incomplete 10

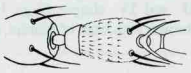


157A

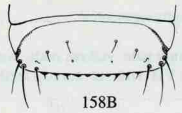
157B



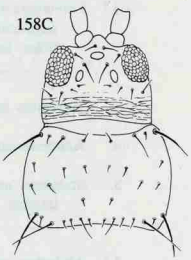
157C



158A



158B



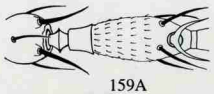
158C

9. Comb on posterior margin of abdominal tergite **VIII** complete (Fig. 157B); anteromarginal and anteroangular setae on pronotum of similar length; postocular setae longer, as stout as the interocellar setae (Fig. 157C); color various ..... **Western flower thrips**, p. 91

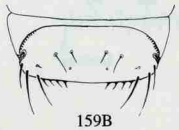
9.' Setal comb on posterior margin of abdominal tergite **VIII** incomplete (Fig. 158B); anteroangular setae usually longer then anteromarginal setae on pronotum; postocular setae shorter and more slender than the interocellar pair; predominately brown (Fig. 158C) ..... **Tobacco thrips**, p. 90

10. Pedicel of antennal **III** segment with distal and basal parts equally diverging; pair of dorsal setae on antennal segment **II** not enlarged nor on projections (Fig. 159A); head and abdominal tergite **VIII** as in Fig. 159 B, C) ..... **Flower thrips**, p. 85

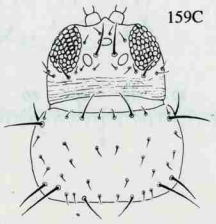
10.' Pedicel of antennal segment **III** strongly angulated, 12 to 14 µm wide with profile of apex and base diverging strongly; pair of dorsal setae on antennal segment **II** enlarged, on projections (Fig. 154A); head and abdominal tergite **VIII** as in Fig. 160B, C ..... **Florida flower thrips**, p. 85



159A



159B



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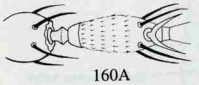

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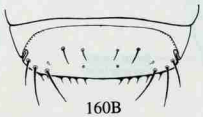

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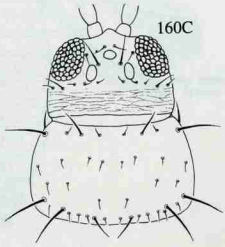


160C

DESCRIPTION

Adult—Female banded greenhouse thrips, approximately 1.5 mm long, are primarily yellow at first but gradually darken to brown or black. The eyes are red; the narrow, fringed wings are gray brown with 3 white crossbands. Males are rare.

Egg—When first deposited, the translucent elongate eggs are white 0.25 mm in length. Before hatching, each egg swells and becomes dull white.

Larva—The yellow or white larvae vary from 0.48 to 1.5 mm in length. They are wingless and have red eyes.

Pupa and Prepupa—These stages are white and found on the leaves. There are usually more individuals on the lower surface.

BIOLOGY

Distribution—Although sporadically distributed throughout North America, banded greenhouse thrips are widely distributed throughout the world. They are particularly common in the British Isles, Europe, and East Africa.

Host Plants—In the greenhouse, banded greenhouse thrips attack many crops including cucumbers, begonias, cacti, date palm, bananas, callas, cestrum, amaryllis, aralia, chrysanthemum, dracaena, rubber tree, gardenia, croton, hydrangea, moon flower, schefflera, screw pine, tomato, and Mexican tea. In one experiment in Georgia, 44 species of plants were used as host plants out of 50 presented. The banded greenhouse thrips showed definite preference for some species among those accepted as host plants.

Damage— Banded greenhouse thrips pierce plant tissues with their mouthparts and suck the juices. As a result, irregular white spots form on the leaf giving it an overall silver appearance. Eventually, these areas dry out and turn light brown. Some defoliation results.

Life History— The banded greenhouse thrips, sometimes referred to as the sugar beet thrips, has gained notoriety as a major floricultural pest. In North Carolina, this thrips was first reported as a greenhouse pest in 1943 on white callas. In the greenhouse, thrips may breed continuously and have several generations per year. Eggs are deposited on the underside of leaves or along the stem. Approximately 2 weeks later, larvae emerge and begin feeding. Colonies of young larvae congregate on the underside of leaves and

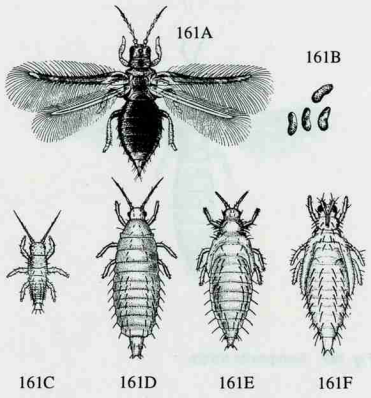


Fig. 161 Banded greenhouse thrips. A, Adult. B, Eggs. C-D, Larvae. E, Prepupa. F, Pupa.

individuals are often covered with a watery globule of excrement. As the larvae feed, they develop through four instars, molting between each stage. The more mature larvae are typically found along leaf midribs or among dried-up foliage. After a larval stage of approximately 18 days, banded greenhouse thrips pupate. Adult thrips that emerge shortly thereafter are less voracious feeders than the larvae. Adults live 40 or more days and females may reproduce with or without mating. Males of this species are rarely found.

CONTROL

Banded greenhouse thrips are vulnerable to contact insecticides. Stored bulbs can be dusted with such an insecticide to prevent a thrips infestation on plants the following season. For specific insecticides and rates, consult the current Cooperative Extension Service publications on ornamental plant pests for your state.

**Hercinothrips femoralis* (O. M. Reuter), Thripidae, THYSANOPTERA

THRIPS
Composite thrips*

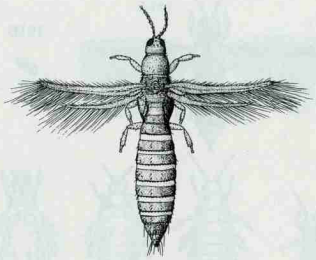


Fig. 162 Composite thrips.

DESCRIPTION

Adult—Females of this species are yellowish brown to dark brown, and the head is small with black eyes and red ocelli. Intermediate antennal segment, apex of fore femora, and all tarsi lighter, becoming yellow brown to yellow. The forewings are brownish gray. Prothorax longer than wide and moderately covered with setae. Males are smaller and paler than females. Males have a dark brown head and pale yellow body.

Eggs—The eggs are yellowish and small, almost spherical (with a slightly narrow anterior end). Eggs average 0.12 mm long and 0.08 mm in diameter.

Larva—The first instar is translucent to whitish yellow and is 0.36 to 0.68 mm long. The second instar is yellow with the head smaller in relation to thorax and abdomen. Body length is 0.68 to 1.0 mm.

Pupa and Prepupa—The prepupa is sluggish and moves only when disturbed. It is pinkish yellow and 0.71 to 1.0 mm long. It rests in the outer bracts of the flower or between the lower ends of florets. The pupa is inactive, robust, and pinkish yellow. Male pupae are 0.63 to 0.81 mm and female pupae are 0.89 to 1.4 mm long.

BIOLOGY

Distribution—The composite thrips is a new world thrips found throughout most of North America. It is an occasional inhabitant of greenhouses throughout the southeastern United States.

Host Plants—Adults and larvae usually are found in the flowers and are rarely found on the foliage. Composite thrips occurs in great abundance on flowers of chrysanthemum, cosmos, zinnia, and marigold.

Damage—Heavy infestations cause damage to the corolla, stamens, and developing seed of plants in the Compositae. Petals lose pigmentation, senesce early, and drop prematurely.

Life History—The life cycle requires 11 to 13 days at 27° C. Eggs hatch in 72 to 80 hours. The first and second instars last about 3 days each, the prepupal stage requires 24 hours or less, and the pupal stage varies from 24 to 48 hours. Eggs are laid inside the tissue of the disc floret. Females are 15 times more numerous than males. Reproduction is both sexual and parthenogenetic. New females begin to lay eggs 72 to 96 hours after emergence from the pupal stage.

CONTROL

For specific insecticides recommendations, consult current Cooperative Extension Service publications on ornamental plant pests for your state.

**Microcephalothrips abdominalis* (D. L. Crawford), Thripidae, THYSANOPTERA

DESCRIPTION

Adult—Cuban laurel thrips are large thrips (2.6 to 3.6 mm) that are dark yellowish brown to black.

Egg—The eggs is cylindrical with rounded ends, smooth, and translucent white.

Larvae—The first stage larva is a tiny, translucent white insect. In top view the first stage larva is almost oval. Second stage larvae are also translucent white but are similar to the adult in size and shape. Both instars have red eyes. The abdominal segments taper from the thorax. In top view the second stage larvae are shaped like an elongate diamond. The posterior tube becomes dark in older larvae and is held pointing up.

Prepupa and Pupa—Prepupae are similar to second stage larvae except that the wing buds are externally visible. Pupae have longer wing buds and the antennae are folded back over the head.

BIOLOGY

Distribution—The Cuban laurel thrips is a pantropical species that occurs wherever *Ficus retusa* is planted. It has been recorded outdoors in California, Texas, Hawaii, and Florida.

Host Plants—Cuban laurel thrips feed on Indian laurel, weeping fig, India rubber plant, other figs, and various shrubs and herbs. In the floricultural industry, weeping fig is the host most often infested.

Damage—This pest feeds on the tender, pale green leaves causing sunken, reddish to purplish spots along the midrib. Immature thrips cause the leaves to curl inward or fold into a pocket in which the thrips continue to develop and in which they lay eggs. Heavily infested leaves eventually become tough and brown or yellow. They eventually drop from the plant prematurely. Infested trees will not be killed, but the ornamental value of the plant is reduced markedly. Like the flower thrips, the Cuban laurel thrips also bites people.

Life History—Eggs are laid in great numbers inside the surface of the curled leaf. All stages of development can be found at any time within the pocket galls. Development from egg to egg-laying females takes about 30 days. Adult Cuban laurel thrips are active fliers and migrate rapidly during hot weather.

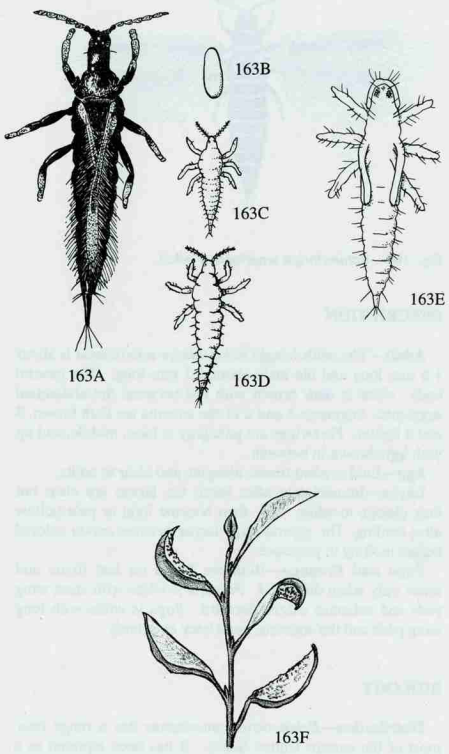


Fig. 163 Cuban laurel thrips. A, Adult. B, Egg. C-D, Larvae. E, Pupa. F, Damage to ornamental fig.

CONTROL

Because the Cuban laurel thrips only attacks the tender, new foliage on small plants, it should be possible to prune out the new growth and eliminate the thrips population. Consequently there is no suitable foliage for feeding and oviposition and the infestation should die out before new growth emerges.

Two anthocorid bugs, *Macrotracheliella laevis* Champion and *Cardiastethus rugicollis* Champion have been reported to be predators of the Cuban laurel thrips in Puerto Rico. Another anthocorid bug, *Montandoniola moraguesi* (Puton), was introduced from the Philippines in Hawaii to control this thrips. The insidious flower bug is a common predator of the Cuban laurel thrips in Florida. For specific insecticides and rates, consult the current Cooperative Extension Service publications on ornamental plant pests for your state.

**Gynaikothrips ficorum* (Marchal), Phlaeothripidae, THYSANOPTERA

THRIPS
*Echinothrips americanus**

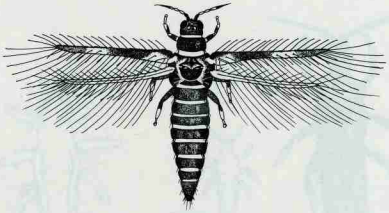


Fig. 164 ***Echinothrips americanus*** **adult.**

DESCRIPTION

Adult—The adult female *Echinothrips americanus* is about 1.6 mm long and the male about 1.3 mm long. The general body color is dark brown with red between the abdominal segments. Segments 1 and 2 of the antenna are dark brown, 3 and 4 lighter. Forewings are pale gray at base, middle, and tip with light brown in between.

Egg—Laid in plant tissue, elongate and clear to white.

Larva—Immediately after hatch the larvae are clear but they change to white and then become light or pale yellow after feeding. The second-stage larvae become cream colored before molting to prepupae.

Pupa and Prepupa—Both are found on leaf tissue and move only when disturbed. Prepupa is white with short wing pads and antennae extend forward. Pupa is white with long wing pads and the antennae bend back over body.

BIOLOGY

Distribution—*Echinothrips americanus* has a range over most of the eastern United States. It has been reported as a pest of nursery and landscape plants in the southern part of its range and as a greenhouse pest on several plants.

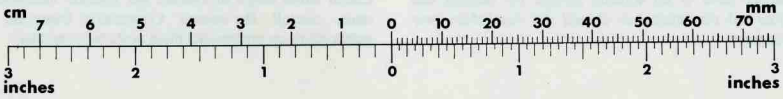
Host Plant—This thrips will feed on both the upper and lower leaf surfaces but is usually more common on the lower surface. They have been found and reproduce on most ornamental plants tested and many of the common weed species of Georgia. In an experiment in Georgia, out of 51 species of cultivated plants and 75 native plants studied, feeding and reproduction was observed on 40 cultivated and 59 native species. Of all the greenhouse host plants; poinsettias, Irish shamrock, and impatiens are the most common hosts in Georgia. They also have been common on chrysanthemum foliage and flowers. They also have been a pest on woody ornamentals.

Damage—This thrips feeds on leaf tissue and the damage is very similar to typical mite damage with light spots on the leaf. Their numerous but shallow punctures result in injured tissue with a shrunken appearance, and the light color is a result of the cell constituents, including chlorophyll, being removed. Infested leaves will have numerous black specs on them that are fecal drippings of the thrips. They also will feed on parts of the flower.

Life History— Female *E. americanus* deposits eggs separately in slits in the leaf tissue. Eggs were deposited at random on the leaf surface. Developmental time depended on temperature, at 15° C the egg stage averaged 15.5 days and the immatures took 18.4 days for a total of 33.9 days. Under warmer conditions development was faster, at 30° C the egg stage took 5.8 days and the immatures only 5.6 days for a total of 11.4 days from egg to adult. Developmental time varied with different host species. All stages were present throughout the year in the greenhouse. Adults and immatures were not very active and would remain in the same area of a leaf for days if not disturbed.

CONTROL

Different populations of this thrips have expressed different susceptibility to insecticides. Greenhouse populations in Georgia have been susceptible to most insecticides. There have been reports of populations on woody nursery plants that were difficult to control. For specific insecticides and rates, consult current Cooperative Extension Service publications on ornamental plant pests for your state.



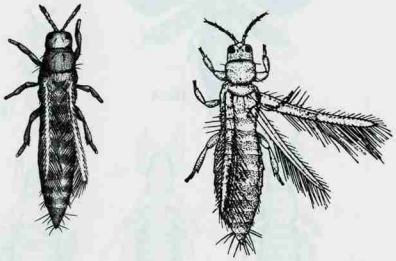
**Echinothrips americanus* Morgan, Thripidae, THYSANOPTERA

DESCRIPTION

Adult—The flower thrips and the Florida flower thrips are exceedingly similar. They can be separated only by microscopic examination using the key at the beginning of this THRIPS section. Both are approximately 1 mm to 1.25 mm long and yellow, with brown blotching, especially about the middle of the thorax and abdomen. Males are smaller than females and are lighter in color.

Egg—The flower thrips delicate egg is cylindrical, and slightly kidney-shaped, with a smooth pale or yellow surface.

Larva—The immature thrips is lemon yellow, resembling the adult except for its lack of wings.



165A 165B

Fig. 165 Flower thrips.

BIOLOGY

Distribution—The Florida flower thrips has been found in Florida, Georgia, and Alabama and is likely distributed in other states of the southern United States. Evidently because of their small size, flower thrips are carried over large areas by frontal wind systems, the maximum rate of migration taking place in early week of June. Trapping records by sticky cards showed that these thrips are found in relatively equal numbers up to 135 feet (45 m). They have even been trapped at altitudes of 10,000 feet (3,100 m). The flower thrips has also been reported in western states. These thrips enter greenhouses through vents or doors, on plants brought into the house, or on people or supplies coming into the house.

Host Plants—Florida flower thrips have been reported from over one hundred species of plants. Roses and citrus are favorite hosts, particularly the white varieties. Most plants of the Rosaceae are infested. Flowers of a more or less open structure, where the stamens and pistils are easily accessible, are favorites. Flowers such as nightshade with stamens in a tube about the pistil are also favorites. Flower thrips have been collected from 29 plant orders including various berries, cotton, chrysanthemums, daisies, day lilies, field crops, forage crops, grass flowers, legumes, peonies, privet, roses, trees, truck crops, vines, and weeds. They seem to prefer grasses and yellow or light-colored blossoms. Roses are most susceptible in June.

Damage—Florida flower thrips always feeds on the most tender part of the plant, such as buds, flowers, or leaves. The effect of their numerous but shallow punctures is to give the injured tissue a shrunken appearance, and the damage is described as piercing and sucking fluids from the cells. The thrips feeds on the thick fleshy petals, pistils, and stamens of the flower, and then the affected parts turn brownish-yellow, blacken, shrivel up, and drop prematurely. Infested rose blossoms turn brown, and buds open only partially. The petals, distorted with brown edges, seem to stick together. Only the epidermis and relatively few mesophyll cells are affected. They also may feed on ovary or young fruit on some host plants. The numerous and shallow punctures on the surface cause characteristic markings that lower marketability dramatically.

Life History—No published work has been done on the biology of the Florida Flower Thrips. The flower thrips was described in 1855 from Wisconsin. During warm periods, swarms of these tiny insects often fly in the afternoon. Flower thrips bite people, causing a noticeable stinging sensation. Their large numbers account for considerable and rapid damage to flowers, especially those with light-colored petals. Yet thrips contribute to pollination of some crops, an unexpected benefit! Flower thrips are generally found at the bases of the petals. They reproduce throughout the year in the warmer parts of the Southeast, with the majority of their 12 to 15 generations occurring in the warmer months. Newly emerged females begin to lay eggs within 1 to 4 days in summer and within 10 to 35 days in winter, reproduction being much faster in warmer weather. In summer, the adult stage is reached in about 11 days. Flower thrips pass through egg, two larval, prepupal, pupal, and adult stages. The eggs are inserted into flower or leaf tissue, and the prepupal and pupal stages are spent in the soil. In summer, flower thrips may live 26 days, though overwintering thrips may live all winter. Flower thrips can overwinter as far north as North Dakota in grass clumps and other sheltered refuges.

CONTROL

Insecticides are currently used by most flower growers for control of flower thrips. As these thrips are not present until the blossoms open, pesticide applications may cause flower burn. For specific insecticides and rates, consult the current Cooperative Extension Service publications on ornamental plant pests for your state.

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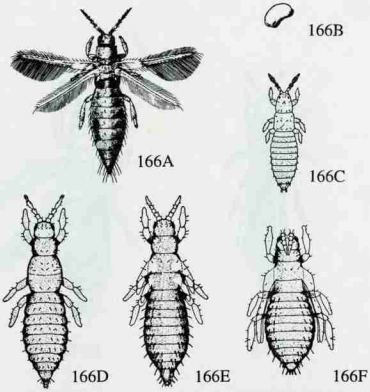
*Flower thrips, *Frankliniella tritici* (Fitch) and Florida flower thrips (common name not approved by ESA) *Frankliniella bispinosa* Morgan, Thripidae, THYSANOPTERA.

THRIPS
Gladiolus Thrips*



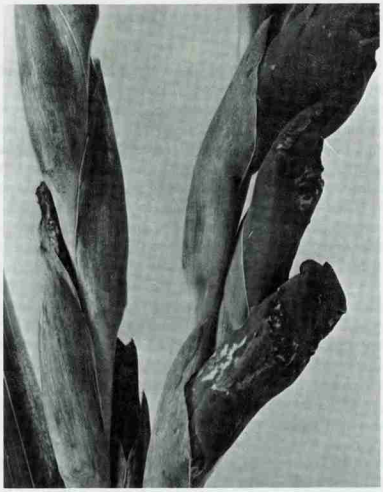

166G

Fig. 166 Gladiolus thrips. A, Adult. B, Egg. C-D, larvae. E, Prepupa. F, Pupa. G, Damage to gladiolus buds.

DESCRIPTION

Adult—Gladiolus thrips emerge milky-white, but soon turn dark brown, except for the apical portions of the legs which are lighter. The wings, brown apically and lighter basally, appear to be darker with a grey band when folded over the back. This thrips is about 1.5 to 1.65 mm long. Males are slightly smaller and lighter in color than the females.

Egg—The eggs are opaque, white, kidney-shaped, and about 0.34 mm long and 0.2 mm in diameter.

Larva—The larvae of the gladiolus thrips are light or pale yellow with red eyes and are about 1.0 mm long when fully developed.

Pupa and Prepupa—The pupae move only when disturbed and develop through 2 instars. The first instar (prepupa) has short wing pads and the antennae project forward. The second instar (pupa) has long wing pads and the antennae are folded back onto the head. Both stages are dark orange with red eyes and about 1.2 mm in length.

BIOLOGY

Distribution—Gladiolus thrips is now found wherever gladioli are grown. However, it cannot overwinter out-of-doors in northern Europe and northern North America.

Host Plants—The gladiolus thrips most seriously damages gladioli, but is also a pest of iris, carnation, lily, narcissus, freesia, amaryllis, tigerflower, poker plant, tomato, begonia, primula, snapdragon, chrysanthemum, and geranium.

Damage—Plants severely infested with gladiolus thrips have a spotted, bleached appearance (see Color Plate). Both leaves and petals are fed upon and appear withered. If flower buds are seriously damaged, the flowers fail to open. The entire plant may become stunted.

Life History—Gladiolus thrips are believed to be an introduced pest from Africa, where gladioli are native. The thrips are brought into previously uninfested fields or greenhouses on infested corms. These rather sluggish thrips can overwinter at any stage on stored corms or on plants growing in greenhouses. Although the gladiolus thrips can maintain a population outside during the summer, they cannot overwinter outside in areas where the temperature consistently falls below 10° C.

These thrips have six stages in their life cycle: the egg, two larval instars, two pupal instars and the adult stage. Females deposit 100 to 200 eggs. Many times females greatly out-number the males in a population and parthenogenesis occurs. Parthenogenetic females produce eggs that develop into males. Temperature greatly determines the duration of each stage. During the warm growing season the development of the gladiolus thrips can occur in about 2 weeks. With such rapid development, the thrips can have nine or more generations outside during the growing season. The eggs are deposited in the leaves of gladioli or in the corms in storage. Larvae and pupae can be found in the buds or leaf sheaths, although the larvae often drop to the ground to transform into the quiescent pupae. Adult gladiolus thrips live 35 to 40 days.

CONTROL

For specific insecticides and rates, consult the current Cooperative Extension Service publications on ornamental plant pests for your state.

**Thrips simplex* (Morison), Thripidae, THYSANOPTERA

DESCRIPTION

Adult—The head and central area of the body have a distinct network of lines. The body is dark brown with the posterior end much lighter; the legs are uniformly yellow; the wings are hyaline and narrow, but with a broad base; and the antennae are slender with a characteristic needle-like tip. The mature adults are about 1.3 to 1.8 mm long. The male is similar to the female thrips, but slightly smaller.

Egg—The eggs are very small, banana-shaped, and white.

Larva—The first larval instar is white; the second instar is yellow. Both instars have red eyes.

Pupa and Prepupa— The pupa and prepupa do not move about freely. These stages are yellowish with red eyes. Pupae are slightly larger, with longer wing pads, and antennae bent back over body. They become darker with age.

BIOLOGY

Distribution—Although the greenhouse thrips is limited to tropical areas outside, it is found throughout the world in greenhouses. This thrips probably originated in Central and South America.

Host Plants—The greenhouse thrips has over 100 hosts, principally greenhouse and ornamental plants, but also a few crops and tropical plants. Some of the hosts are azalea, begonia, croton, cyclamen, ferns, fuschia, grape vines, orchids, palm, and rose.

Damage—This thrips feeds almost entirely on the foliage, and large populations cause severe damage. Greenhouse thrips usually injure inner leaves and fruit. Damaged leaves appear silvery or bleached and, if the damage is severe enough, turn yellow and drop. Fruit that has been attached is brown, cracked, and has noticeable sunken areas. Dark spots of excrement are often noticeable on the leaves and fruit.

Life History—Each female deposits 25 to 50 eggs in slits in the leaves. Under optimum conditions the time for development is 17 to 20 days for the eggs, about 13 days for the two larval instars, and about 5 days for the prepupal and pupal stages. The adults can live 7 weeks on plants growing in the greenhouse. All stages can be found throughout the year in greenhouses. Greenhouse thrips move relatively slowly and rarely fly. They prefer a cool, shady, and fairly moist atmosphere. These thrips feed in colonies on the foliage and fruit. They select neither the youngest nor the oldest leaves on which to feed. Often the fruit is preferred to the leaves. Since males are not common, reproduction is usually by parthenogenesis (laying unfertilized eggs). Males were first found in 1940.

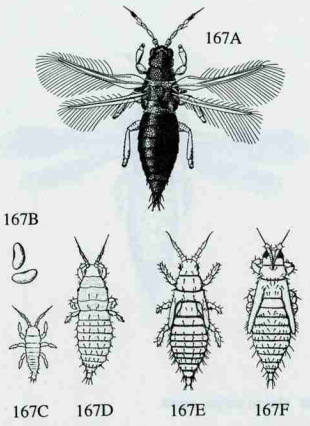
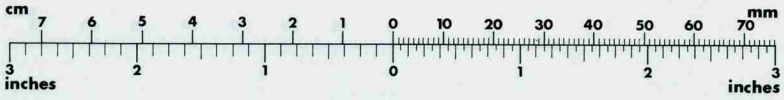


Fig. 167 Greenhouse thrips. A, Adult. B, Eggs. C-D, Larvae. E, Prepupa. F, Pupa.

CONTROL

For specific insecticides and rates, consult the current Cooperative Extension Service publications on ornamental plant pests for your state.



**Heliothrips haemorrhoidalis* (Bouché), Thripidae, THYSANOPTERA

THRIPS
Melon thrips*

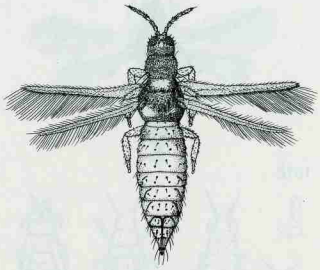


Fig. 168 Melon thrips adult.

DESCRIPTION

Adult—Melon thrips have a clear yellow body without darker blotches but with thick, blackish body setae. Antennal colors variable. The pronotum has two pairs of major setae and posterior angles and antennal segments 3 and 4 each have a forked sense cone.

Egg—No description available.

Larva—No description available.

Pupa and prepupa—No description available.

BIOLOGY

Distribution—The melon thrips was first established in the United States in Hawaii around 1982. An established field population was first discovered in the continental United States in 1991 in Florida. It has been distributed in South and Southeast Asia, Pacific Islands, and Caribbean Islands.

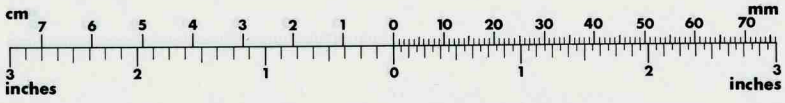
Host Plants—The melon thrips has an extremely wide range of host plants, including nearly all kinds of vegetables, many fruit trees and weeds, and several flowering plants such as chrysanthemums and carnations. They quickly build up heavy infestations causing severe injuries.

Damage—Immature thrips and adults feed on leaves, (first along midribs and veins), stems (near growing tip), flowers (all parts), and fruits (on the surface). Severe damage results from sucking plant sap leaving silvery scars from empty cells. Heavy feeding results in a silvered or bronzed appearance and will kill the plant.

Life History—The melon thrips eggs are deposited within plant tissues singly. Larvae have two stages, that feed on plant tissues. The second instar larvae, when mature, fall to ground, where they molt to prepupae and pupae in the soil. After emergence, the adults move to the growing parts of the plants such as young leaves, flowers, or young fruits, where they feed and lay eggs. Adults are usually found on young leaves, while larvae are found on lower or older leaves. Few thrips are found on flowers or fruits. At higher temperatures generation times are shorter. The average development times are: 80.2 days at 15° C, 40.7 days at 20° C, 24.8 days at 25° C, and 20.5 days at 30° C. The reproductive rate reaches maximum at 25° C. The adults reproduce sexually and parthenogenetically.

CONTROL

Chemical insecticides have not been consistent in controlling this pest. None cause more than 80 percent mortality. Several predators attack the melon thrips, including predaceous mites in the genera *Amblyseius* and *Phytoseius* (Acarina: Phytoseiidae), insidious flower bugs, and several species of predaceous thrips, ants, and rove beetles. For specific insecticides and rates, consult the current Cooperative Extension Service publications on ornamental plant pests for your state.



* (common name not approved by ESA) *Thrips palmi* Karny, Thripidae, THYSANOPTERA

DESCRIPTION

Adult—Adult females of onion thrips are about 1.1 to 1.2 mm long, yellow, with brownish blotches on the thorax and the median portion of abdomen. Antennae are gray with the first segment lighter than other segments. Males are rare.

Egg—The eggs are very small, about 0.2 mm long, kidney-shaped, and white. They are deposited within plant tissues.

Larva—The first instar larva is white, about 0.35 to 0.38 mm long. The second instar larva is yellowish, about 0.7 to 0.9 mm long.

Pupa and Prepupa—The pupa and prepupa are similar to the second instar larvae in color and shape, except for having small wing pads.

BIOLOGY

Distribution—Onion thrips have been found in most countries throughout the world.

Host Plants—Onion thrips are extremely polyphagous. They inhabit leaves, shoots, and flowers of many plants. It prefers to feed on onions, but feeds on many field crops, vegetables, various flowers, and bedding plants. It may cause heavy damage to chrysanthemums and carnations.

Damage—Generally feeding of onion thrips cause yellowing or dropping of leaves, buds, or flowers. High infestation results in stunted growth, brown blisters, white blotches, silvery whitish areas or feeding scars. Young terminal leaves frequently show malformation when heavily attacked, with crinkly surfaces, sunken and raised thin areas, marginal erosion, margin curling inwardly, and a chlorotic yellowish appearance with grayish color along all large veins. Young buds may be killed as soon as they come out. In addition, they freely feed within flowers, attacking the tender portions.

Life History—Onion thrips have six to ten generations depending on temperature. Adults and larvae overwinter in the soil or plant litter on the ground. Pupae and prepupae overwinter in the soil. The average length of development is: 6 to 8 days for eggs, 10 to 14 days for larvae, 5 to 9 days for prepupae and pupae, and about 20 days for a generation. It may take as long as 35 days for a generation if temperature is at 15° C. The lower developmental threshold is about 11.5° C and using this threshold as a base, development required 191 degree days. Adults reproduce parthenogenetically throughout the season, rarely reproduce sexually, and resulting in that most adults in the field are female. The average adult life is around 32 days, and pre-oviposition, oviposition and post-oviposition periods are 6.1, 22.5, and 3.9 days, respectively. The average number of eggs laid by an unmated female is 37.4 (20 to 200).

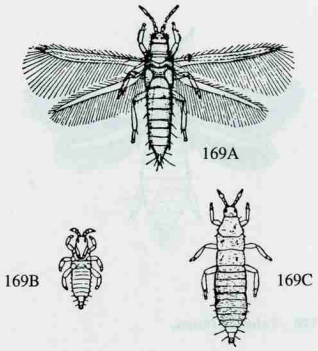


Fig. 169 Onion thrips. A, Adult. B, First larva. C, Second larva.

CONTROL

The application of chemical insecticides is the common control measure. The onion thrips problem in an integrated pest management program can be solved by using selective pesticides or by using selective treatments such as soil drenches. A Combination of selective chemical insecticides and a predaceous mite in the genus *Amblyseius* (Acarina: Phytoseiidae) have been successfully used to control this thrips. For specific insecticides and rates, consult current Cooperative Extension Service publications on ornamental plant pests for your state.

**Thrips tabaci* Lindeman, Thripidae, THYSANOPTERA

THRIPS
Tobacco Thrips*

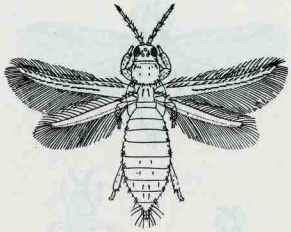


Fig. 170 Tobacco thrips.

DESCRIPTION

Adult—The female tobacco thrips is dark brown or black, slender, and about 1 mm long. Each 8-segmented antenna has several yellowish middle segments; the rest of the segments are much darker. Males are usually yellow.

Egg—The white egg cannot usually be seen because it is inserted into the plant tissue.

Larvae—Both stages of tobacco thrips larvae are very light yellow.

Prepupa and Pupa—After the larval stages, tobacco thrips develop through two resting stages, the prepupa, and pupa. Each stage is yellowish and slugish. These stages are spent in a close hiding place, usually on the ground. The antennae are directed toward the front of the insect in the prepupal stage and are held back over the head and thorax in the pupal stage.

BIOLOGY

Distribution—This thrips is found throughout the United States and Canada east of the Rocky Mountains.

Host Plants—Many plants are attacked by the tobacco thrips, especially gladioli, many ornamentals, cotton, and peanuts.

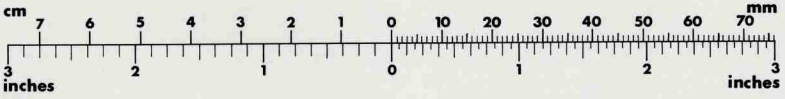
Damage—Plants infested with tobacco thrips have silvery outlines traced around the veins, and if the damage is severe, the leaves become yellow. These thrips also leave small black spots on the underside of the leaves.

Life History—In greenhouses and on field-grown flowers, the tobacco thrips is most often found in the fall. This insect is often mistaken for the much more destructive gladiolus thrips; however, the tobacco thrips adult is larger and the antennae are lighter in color than those of the gladiolus thrips.

As is common for many thrips, the tobacco thrips can reproduce parthenogenetically, but males are usually present. Eggs are inserted completely into the leaves. In 6 days the eggs hatch into active young. Two larval stages, a prepupal and a pupal stage, occur within 2 weeks. An entire life cycle can be completed in about 18 days. Adult thrips live 3 to 5 weeks, and each female deposits about 55 eggs during this time. The adults will have either long or short wings. The longwinged forms usually appear in late spring outside and migrate to a new host. Outside, the tobacco thrips overwinter as short-winged adults in sheltered areas. Excessively rainy conditions reduce the thrips population. Usually the tobacco thrips are not found grouped together in folded leaves or under the bracts of the flower spikes as are gladiolus thrips.

CONTROL

For specific insecticides and rates, consult current Cooperative Extension Service publications on ornamental plant pests for your state.



Frankliniella fusca (Hinds), Thripidae, THYSANOPTERA

DESCRIPTION

Adult—Western flower thrips is about 1 mm long, with the female larger than the male. The female varies from yellow to dark brown, and has a more rounded abdomen. The male is always pale yellow and has a narrower abdomen.

Egg—Yellowish eggs cannot be seen because they are laid into the plant tissue.

Larva—The larvae develop through two instars and are distinctly yellow. Second instars become whitish prior to molting.

Prepupa and **Pupa**—Both prepupa and pupa are yellowish, quiescent non-feeding stages. The antennae and wing pads are typical for most thrips species.

BIOLOGY

Distribution—The distribution was thought to be limited to west of the Mississippi River prior to 1980. However, this thrips has become the most prevalent species attacking greenhouse flowers throughout the United States and Canada, and many countries in Europe and Asia.

Host Plants—This thrips feeds on almost any flowering plant. Carnations, chrysanthemums, gerberas, geraniums, marigolds, pansies, and roses are the major host plants.

Damage—The western flower thrips feeds on the flowers and foliage by inserting its modified left mandible into the tissue, and sucking the fluids from cells. Oviposition and feeding scars reduce the aesthetic quality and marketability of ornamental plants. When thrips feed on developing tissues, affected cells are unable to expand, and mature leaves and petals are distorted. When thrips feed on expanded tissue, effected cells become filled with air, which imparts a silvery appearance. This thrips also is an important vector of tomato spotted wilt virus and impatiens necrotic spot virus.

Life History—Females lay eggs in tender plant tissue. The eggs hatch in 2 to 14 days, depending on temperature. First-instar larvae begin feeding on egg eclosion. Second-instar larvae also feed on plant tissue, usually in flowers. These larvae are found in the protection of perianth of the flower or within developing terminal foliage. Late in the second instar they stop feeding and move down the plant to pupate. Thrips develop through two quiescent, non-feeding pupal stages in the soil, plant litter or in a protected area on the plant. Adults emerge and resume feeding on flowers, buds, and terminal foliage. The entire life cycle from oviposition to adult emergence can take 12 days in hot weather to 44 days in cool weather.

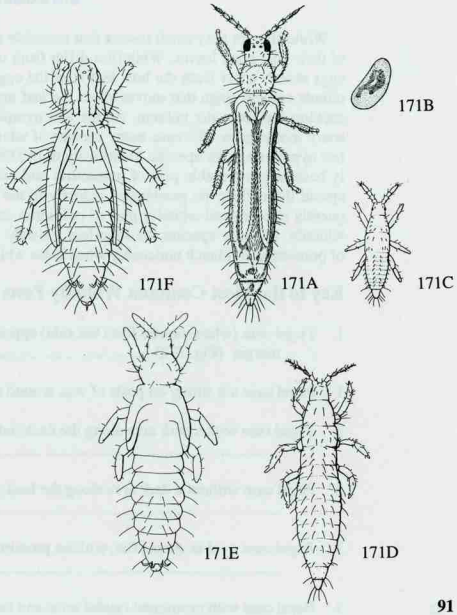


Fig. 171 Western flower thrips. A, Adult. B, Egg. C-D, Larvae. E, Prepupa. F, Pupa.

CONTROL

The thrips are difficult to manage with pesticides because of their thigmotactic behavior causes them to feed deep in the flowers and buds where they are sheltered from chemicals. Chemical managment of western flower thrips has received much attention, but control remains difficult. Natural enemies have been investigated and biological control programs using insidious plant bugs and predaceous mites in the genus *Amblyseius* have been used in greenhouses. Screening has been shown to effectively exclude western flower thrips. For insecticide rates, consult current Cooperative Extension Service publications on ornamental plant pests for your state.

* *Frankliniella occidentalis* (Pergande), Thripidae, THYSANOPTERA

Introduction to Whiteflies

Whiteflies are very small insects that resemble tiny white moths. Whiteflies usually feed on the lower surface of their host plant leaves. Whiteflies differ from most insects in the way they mate (side by side) and that their eggs absorb water from the host leaf after the eggs are inserted into the lower surface. From the egg hatches a minute crawler stage that moves about the leaf until it inserts its microscopic, threadlike mouthparts to feed by sucking sap from the phloem. Adults and nymphs excrete honeydew, a sticky, viscous liquid in which dark sooty molds grow. Because many species of adult whiteflies are similar in appearance, entomologists use the last nymph stage for specific identification. In 1986, a whitefly very similar to the sweetpotato whitefly suddenly became a noticeable pest of poinsettias and commercial vegetables in Florida and California. This whitefly spread throughout the greenhouse industry in the United States in the next few years and is now the most frequently encountered whitefly pest of poinsettia and gerbera daisy. In 1994, Bellows and Perring described this whitefly as a new species, the silverleaf whitefly. The silverleaf whitefly causes the leaves of melons and stems of poinsettias to blanch noticeably when these whiteflies are abundant.

Key to the Most Common Whitefly Pests of Flowers and Foliage Plants

1. Pupal case (when viewed from the side) appears to be sitting on closely set posts of wax around the margin (Fig. 172) 2

1.' Pupal case not sitting on posts of wax around the margin 3

2. Pupal case with a dark area along the back; adult with gray bands across the wings (Fig. 173A, B) ..... **Bandedwinged whitefly**, p. 94

2.' Pupal case without a dark area along the back; adults without bands across the wings ..... **Greenhouse whitefly**, p. 96

3. Pupal case oval in shape, flat, without prominent caudal setae or caudal projections ..... **Citrus whitefly**, p. 95

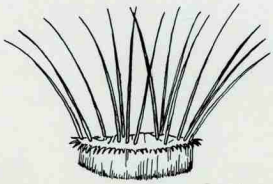
3.' Pupal case with prominent caudal setae and caudal projections, plump, not flat 4

4. On azalea; pupal case without large dorsal setae, even if leaves are hairy ..... **Azalea whitefly**, p. 93

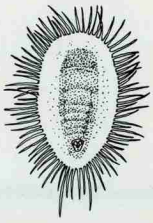
4.' Not on azalea; pupal case with large dorsal setae if leaves are hairy or without large dorsal setae if leaves are smooth 5

5. Thoracic tracheal folds relatively wide, wax at marginal opening of tracheal folds relatively wide, the posterior wax slightly wider than the bases of the caudal setae, fourth anterior submarginal setae present; does not cause white stem symptom on poinsettia nor silverleaf symptom on squash ..... **Sweetpotato whitefly**

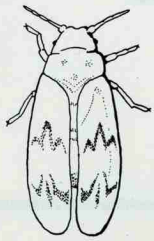
5.' Thoracic tracheal folds relatively narrow, wax at marginal opening of tracheal folds relatively narrow, the posterior wax no wider wider than the bases of the caudal setae, fourth anterior submarginal setae absent; causes white stem symptom on poinsettia and silverleaf symptom on squash ..... **Silverleaf whitefly**, p. 97



172



173A



173B

DESCRIPTION

Adult—About 1.5 mm long, the adult is light yellow with the antennae and legs slightly lighter in color. Most of the body is covered with a white, waxy bloom. The eyes appear dark brown. As usual, the small moth-like adults fly about readily when infested plants are disturbed.

Egg—Azalea whitefly eggs are typical of other whiteflies in their irregular cylindrical shape that is somewhat pointed at one end and rounded at the other (base end). The base end has a tiny protuberance that is inserted into the leaf tissue. The eggs are 0.1 mm wide and 0.22 mm long. Color ranges from translucent creamy to dark gray tipped fading to paler gray at the base.

Nymph—The tiny nymphs, are oval and light in color without any form of wax secretions.

Pupa—The pupal case is light yellow to an orange yellow in color, without any form of wax secretions and about 0.84 mm long. The marginal areas appear lighter in color than the mid-dorsal area. Some marginal indentations may be present when the pupal case has grown against the leaf hairs.

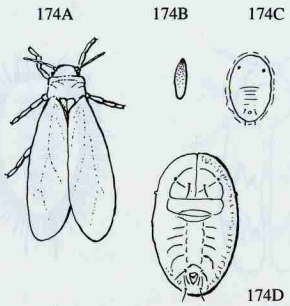


Fig. 174 Azalea whitefly. A, Adult. B, Egg. C, Crawler. D, Pupa.

BIOLOGY

Distribution—This whitefly has been spread worldwide wherever azaleas grow. The first records in the United States were on plants received from Holland in 1910. Without a doubt azalea whiteflies occur in all southeastern states.

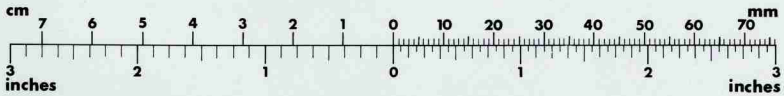
Host Plants—Azalea whiteflies infest all species of azaleas.

Damage—Infested plants become unthrifty, honeydew, and sooty mold detract from a healthy appearance. Unless controlled, large clouds of whiteflies take to the air when heavily infested plants are disturbed.

Life History—Little is known about this whitefly and its life cycle. Presumably it is very similar to other whitefly species. This whitefly overwinters as nymphs on azalea leaves. Adults emerge in early spring in North Carolina and lay eggs on the undersides of azalea leaves. The eggs are creamy and translucent, but turn gray as they age.

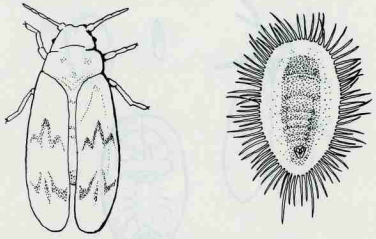
CONTROL

For specific chemical controls see your state Cooperative Extension publications on ornamental plant pests.



* *Pealius azaleae* (Baker & Moles), Aleyrodidae, HOMOPTERA

WHITEFLIES
Bandedwinged Whitefly*



175A 175B

Fig. 175 Bandedwinged whitefly. A, Adult. B, Pupa.

DESCRIPTION

Adult—Mature adult bandedwinged whiteflies have zig-zag bands across the front pair of wings. The hind pair of wings are unmarked. With the exception of the front banded wings this whitefly is very similar to greenhouse whitefly.

Egg—The eggs are about 0.12 mm long and 0.10 mm wide. Eggs are placed randomly or in circles on the leaf underside. Newly deposited eggs are pale yellow and turn pale pinkish just before hatching.

Nymph—Young nymphs are 0.37 mm long, and as nymphal stages progress become just over one-half mm long. They are translucent white, with a yellow spot on each side of the abdomen. When the first instar nymph first settles down it begins to secrete a wax fringe that will become the side walls of the pupal case. As growth occurs the nymphal stages will secrete a marginal fringe of translucent setae, and the dorsal medial area of the integument becomes brown.

Pupa—The pupal case is just short of 1 mm long and 0.5 mm wide. The translucent marginal setae are of two lengths and the marginal palisade of wax rods is very distinct. The dorsal medial region is dark brown and uneven; the operculum is yellowish brown.

BIOLOGY

Distribution—Arizona, California, Colorado, District of Columbia, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Mexico, New York, North Carolina, Pennsylvania, South Carolina, Texas, Utah, and Virginia. In northern areas this whitefly probably survives the winter only in greenhouses, but in warmer areas lives outdoors on weed hosts.

Hosts—Originally described on *Abutilon theophrasti*, but is now considered a polyphagous feeder. Some common weed hosts are *Ambrosia*, *Bidens*, and *Sida*. Some important ornamental hosts include *Euphorbia* (poinsettia), *Geranium*, *Hibiscus*, and *Petunia*.

Damage—Infested plants become chlorotic and unthrifty from sap removal. Honeydew and sooty mold also detract from the aesthetics of the crop. Unless controlled, bandedwinged whitefly can be very damaging to a floriculture crop.

Life History—Bandedwinged whitefly reproduces much like the more studied greenhouse whitefly. Temperatures will greatly affect the time required for a complete generation. It is known that eggs will hatch in about 12 days at early April temperatures of a Kentucky greenhouse.

CONTROL

Controls after establishment of major infestations will be very similar for all whiteflies in a situation. Prevention of greenhouse invasion from out-of-doors in the fall will make controls much easier in late fall to early winter. Part of this prevention will have to involve sanitation with respect to weed hosts around the greenhouse, both indoors and outdoors. Also, the proper disposal of rejected and remaining infested plants in the fall is important.

Chemical controls will be similar regimens for nearly all whiteflies. Biological controls would perhaps be an important alternative on perimeter plants, and on plants that have a longer growing season. For specific chemical control recommendations, see your state Cooperative Extension publications on ornamental plant pests.

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* *Trialeurodes abutilonea* (Haldeman), Aleyrodidae, HOMOPTERA

DESCRIPTION

Adult—The adult is a tiny, moth-like, four-winged, mealy-white insect with a wing span of less than 4.3 mm. Most often they rest on the undersides of leaves and fly about when plants are disturbed.

Egg—The citrus whitefly lays yellow eggs with a nearly smooth surface. The eggs are about 0.25 mm long, elliptical, and most frequently laid on young tender leaves.

Nymphs—The first instar is the only mobile nymphal stage. After the first instar the nymphs are flattened, oval, and similar in appearance to soft scale insects. Nymphs are translucent, oval in outline, and very thin. The leaf color will show through the thin nymphal body, therefore nymphs are difficult to see.

Pupa—The pupal case is very similar to nymphs, but is slightly thickened and more opaque. The red eye spots of the adult are very prominent in developing pupal cases.

BIOLOGY

Distribution—Reported from Virginia southward and around to Texas, then westward to California.

Host Plants—The primary host plant is citrus of all types, but many ornamentals are also hosts. The most common are *Allamanda*,. banana shrub, Boston ivy, chinaberry, English ivy, gardenia, lilac, pear, osage orange, and privet.

Damage—Direct damage is caused by the removal of sap. Indirect damage is caused by the excretion of copious amounts of honeydew where sooty molds grow. This black mold will contribute to poor aesthetics and perhaps interfere with photosynthesis.

Life History—Winter or colder periods are passed as late nymphal stages on the undersides of leaves. These may be on some remaining plants or weeds growing under benches. In the spring or when heat is applied adults will emerge and deposit eggs on the undersides of new plant growth. These eggs will hatch in 8 to 24 days, depending on the temperature. The nymphal stage will last from 23 to 30 days. Overall the life cycle from egg to adult will vary from 41 days to more than 300. The adult will live as long as 27 days.

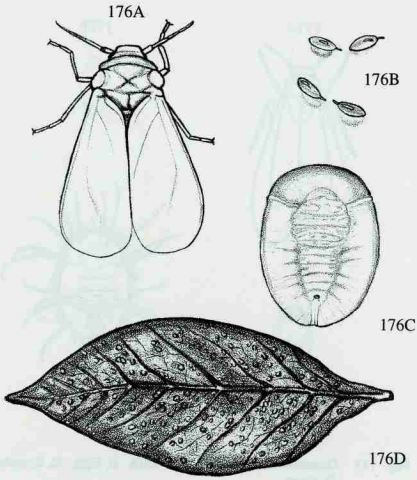
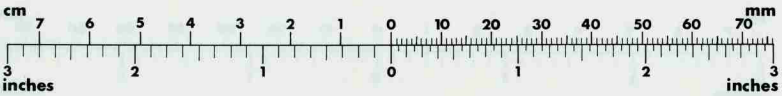


Fig. 176 Citrus whitefly. A, Adult. B, Eggs. C, Pupa. D, Infested gardenia leaf.

CONTROL

Controls are difficult because the eggs and nymphs are located on the underside of leaves, and they may also be resistant to some aerosol chemicals. Adult control usually will involve multiple applications as the nymphs mature and all have emerged as adults. Some of the new synthetic pyrethroids make controls much more successful. However, chemicals must be alternated to lessen the chance of a chemical-tolerant or resistant population developing. In some states biological control using *Encarsia lahorensis* has been very successful. This parasitoid should be functional in the Gulf Coast states and warmer areas of other states. For specific chemical control recommendations see your state Cooperative Extension publications on ornamental plant pests.



* *Dialeurodes citri* (Ashmead), Aleyrodidae, HOMOPTERA

WHITEFLIES
Greenhouse Whitefly*

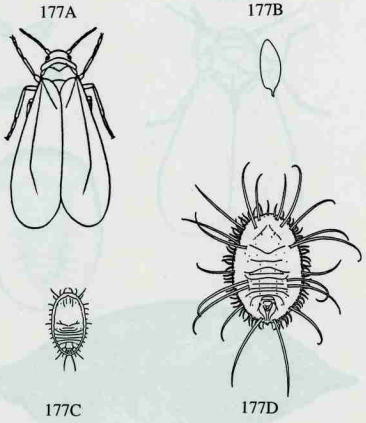


Fig. 177 Greenhouse whitefly. A, Adult. B, Egg. C, Crawler. D, Pupa.

DESCRIPTION

Adult—About 1.5 mm long, the adult is a white insect that resembles a tiny moth.

Egg—The small oblong eggs, pale green to purple, are deposited on the lower leaf surface, often in a circle or a crescent.

Nymph—The first instar nymph is mobile and similar to a scale insect crawler. Later nymphal stages are yellowish with red eyes, and are immobile. They resemble soft scale insects, but have an orifice on the back through which honeydew is expelled.

Pupa—The oval pupa is pale green to black when parasitized. The normal color, when empty, is clear-glassy with a fringe of glassy setae, and with some long glassy setae on the dorsal surface. The pupal case sits upon a vertical palisade of closely appressed wax rods (these are readily visible in side view).

BIOLOGY

Distribution—Greenhouse whiteflies are worldwide pests of greenhouse-grown ornamentals and vegetables. First discovered in England in 1856, they were found in the northeastern United States in 1870. Tropical Central or South America are suggested origins of the greenhouse whitefly.

Host Plants—Greenhouse whiteflies infest a wide variety of ornamental and vegetable crops, and they can survive outdoors during the growing season, particularly in sheltered locations. Even trees may be infested (redbud, Kentucky coffee berry, and avocado).

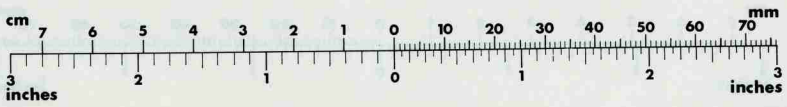
Damage—Infested plants become chlorotic and unthrifty. Honeydew and sooty mold further detract from the appearance of the crop. Unless controlled, greenhouse whiteflies may completely destroy the commercial value of floricultural crop.

Life History—Greenhouse whiteflies reproduce relatively slowly (one generation every 30 to 45 days), but each may lay up to 400 eggs and live as long as 2 months. Adults are usually found on the lower surface of new leaves. The new crawlers move about the plant for a day or two, often from leaf to leaf before inserting their mouthparts to feed. Once this occurs they probably do not move again until mature. The crawlers molt into nymphs and then into pupae. Finally, a new generation of whitish yellow adults emerges. They are soon covered by a white waxy bloom.

CONTROL

Lower greenhouse temperatures used in the culture of some bedding and potted plant varieties tend to encourage infestations, because naturally occurring parasitic wasps (*Encarsia formosa*) are reproductively inhibited at temperatures below 24°C (75°F).

Control of whiteflies is difficult because the eggs and immature forms are resistant to many aerosol and insecticide sprays. One must make regular applications of pesticides to control emerging adults until the last of a whole generation of immature whiteflies has emerged. However, some of the synthetic pyrethroid and synthetic insect growth-regulator pesticides are extremely effective and need not be applied as often. For specific chemical control recommendations, see your state Cooperative Extension publications on ornamental plant pests.



* *Trialeurodes vaporariorum* (Westwood), Aleyrodidae, HOMOPTERA

DESCRIPTION

Adult—The silverleaf whitefly is slightly smaller (about 0.96 mm in the female and 0.82 mm in the male) and slightly yellower than most other whitefly pests of flowers. The head is broad at the antennae and narrow towards the mouth parts. The wings are held roof-like at about a 45° angle, whereas other whiteflies usually hold the wings nearly flat over the body. Hence, the silverleaf whitefly appears more slender than other common whiteflies.

Egg—The eggs are inserted on end in the undersides of new leaves. The eggs are whitish to light beige with the apex tending to be slightly darker.

Nymph—The nymphal stages appear glassy to opaque yellowish and may or may not have dorsal spines, depending on leaf characteristics. The body is flattened and scale-like with the margin relatively near the leaf surface. There is not a marginal palisade of waxy spines.

Pupa—The pupa or fourth nymphal instar will be somewhat darker beigeish yellow and opaque and 0.6 to 0.8 mm long. Pupae are relatively more plump compared to previous nymphal stages. The apex of anterior and caudal spiracular furrows have smalls amount of white wax deposits. The caudal setae are prominent, and the caudal end is somewhat acute. Dorsal spines are present when the host leaf is hairy and absent when the host leaf is smooth.

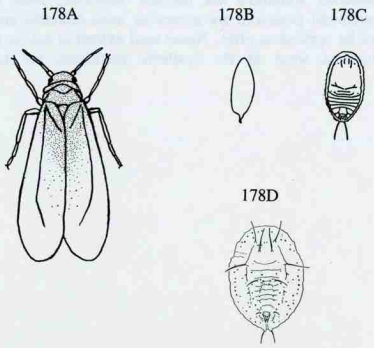


Fig. 178 Silverleaf whitefly. A, Adult. B, Egg. C, Crawler. D, Nymph.

BIOLOGY

Distribution—Silverleaf whitefly probably occurs around the world in tropical and subtropical areas and in greenhouses in temperate areas. It has been reported from California, Florida and it occurs in North Carolina.

Host Plants—Alfalfa, beans, brocolli, *Citrus*, *Ficus*, *Lantana*, lettuce, melons, cotton, grape, sweet potato, and poinsettia are definite hosts of the silverleaf whitefly. Gerbera daisies are probably hosts.

Damage—Direct damage is caused by the removal of sap, and indirect damage as a disease vector. The silverleaf whitefly is a vector for several important virus diseases of lettuce and melons in the southwestern United States. Both the adult and nymphal stages contribute to direct damage. Chlorotic spots sometimes appear at the feeding sites on leaves, and heavy infestations cause leaves of cucurbits and stems of poinsettias to blanch ("silver") and wilt. The excretion of honeydew and the subsequent development of sooty mold fungi also reduces the appearance, photosynthesis, and other physiological functions of the plant. Even though the silverleaf whitefly is considered an economic pest, economic thresholds have not been generated for this pest on ornamental plants.

Life History—(The following information was observed with whiteflies that were undoubtedly silverleaf whiteflies although at the time they were thought to be sweetpotato whiteflies.) Developmental times from egg deposition to adult emergence appears to be primarily controlled by temperature, humidity, and host plant. These times will vary from 16 to 38 days depending on these factors. The number of eggs laid by each female over her lifetime varies considerably, but appears to be around 80 to 100. There have been reports (in Israel) that repeated applications of insecticides have produced a highly fecund (300 eggs/females) strain of silverleaf whitefly. Apparently, at temperatures above 36°C eggs fail to hatch. "Crawlers" hatch from the eggs and crawl about until they insert threadlike mouthparts into the underside of the leaf to feed. They tuck their legs and antennae underneath and settle down closely to the leaf surface.

Crawlers molt into scalelike nymphs that also suck out sap. Nymphs molt a second and third time. The fourth stage eventually becomes a nonfeeding pupa. The adult whitefly develops within the pupa. Adults emerge from the pupa through a T-shaped slit about a month from the time the egg was laid. Females live about two weeks.

CONTROL

Control of silverleaf whiteflies is difficult because the eggs and older immature forms are resistant to many aerosol and insecticide sprays (in addition, the adults are extremely resistant to dry pesticide residue). For good control, the pesticide mixture must be directed to the lower leaf surface where all stages of the whiteflies naturally occur. One must make regular applications of pesticides to control crawlers and

* *Bemisia argentifolii* Bellows and Perring, Aleyrodidae, HOMOPTERA

second stage nymphs until the last of a whole generation of immature whiteflies has hatched. However, some of the pyrethroid pesticides are somewhat more effective and need not be applied as often. Neem seed extract is not as acutely toxic as some of the synthetic pesticides, but has the advantage of being toxic to young nymphs, inhibiting growth and development of older nymphs, and reducing oviposition by adults. For specific chemical control recommendations, see your Cooperative Extension publications on ornamental plant pests.

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