



Hawai'i Landscape Plant Pest Guide: Sucking Insects

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Aphids

Identification and Damage

- Aphids have a pair of cornicles, tube-like structures protruding backward at the rear of their bodies. These distinguish aphids from other insects.
- Females give birth to living young; no males are present. Adults generally remain wingless until high population densities are reached, when they grow wings to migrate to new food sources. They are not strong fliers but may be carried considerable distances by light winds.
- Flight activity peaks late morning and late afternoon.
- Dry weather conditions are favorable to aphids. Heavy rainfall decreases population sizes.
- Aphids pierce plant tissues and suck the sap. They prefer feeding on undersides of leaves but will also feed on other leaf surfaces, flower buds, and stems.
- Infected leaves often are misshapen and cupped downwards and may appear wrinkled. Heavy infestations may result in fruit and flower drop and wilting. Young plants may have reduced or stunted growth.
- Aphids excrete honeydew
- Aphids vector many plant viruses and other diseases that cause more damage than direct feeding injury.

What to Do

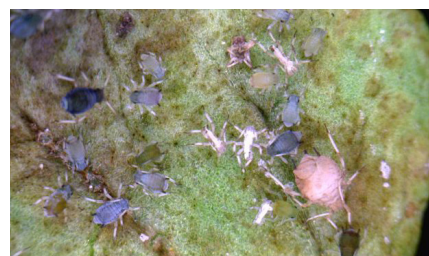
- Many beneficial insects are parasites or predators of aphids. Tiny parasitic wasps target specific aphid species, laying their eggs to hatch within the aphid and emerge as adults. Predators include adult and nymphal lacewings, assassin bugs, ladybeetles, and larval stages of hoverflies and midges.
- Insecticidal soaps and oils and newer systemic insecticides are highly effective against aphids. Follow resistance-management strategies provided on the insecticide label to prevent resistance development by aphids.



Cotton aphids infesting hibiscus bud



Fringed aphids in all stages



Parasitized, mummified aphids



Syrphid and aphids

Aphids - Types

Banana aphid (*Pentalonia nigronervosa*)

- Preferred host: banana
- Secondary hosts: many tropical and subtropical food and ornamental plants, including edible and floral ginger (red, pink, kahili, torch), Xanthosoma (ape), cardamom, heliconia, tomatoes, taro, and *Calla* and *Costus* spp.
- Transmits *Banana Bunchy Top Virus*.



Banana aphid

Cotton or melon aphid (*Aphis gossypii*)

- The most common and destructive aphid.
- Transmits papaya ringspot virus and watermelon and cucumber mosaic disease.
- Preferred hosts: fruits, vegetables, and ornamentals (asparagus, avocado, banana, burdock, cucurbits (squash family), eggplant, flowering ginger, green beans, guava, hibiscus, orchid, papaya, peppers, potato, protea, spinach, taro, tomato, ti).
- Significant weed hosts: lamb's quarters, shepherd's purse, *Malva* and *Bidens* spp.



Cotton aphid

Fringed orchid and palm aphids (*Cerataphis* spp.)

- Preferred hosts: Pritchardia palm (loulou) and various orchids, including vanilla.
- Newly born fringed aphid nymphs search for a suitable feeding area, settle and molt, becoming sedentary, folding their legs under and secreting a waxy fringe. Often tended by ants, which cover them with protective debris.
- Secondary hosts: many tropical and subtropical food and ornamental plants, including edible and floral ginger (red, pink, kahili, torch), Xanthosoma (ape), cardamom, heliconia, tomatoes, taro, *Calla* and *Costus* spp.
- Transmits *Banana Bunchy Top Virus*.



Green peach aphid (Photo credit: Whitney Cranshaw, Colorado State University, Bugwood.org)

Green peach aphid (*Myzus persicae*)

- Primarily transmits *Papaya Ringspot Virus*.

Oleander aphid (*Aphis nerii*)

- Primarily transmits *Papaya Ringspot Virus*.



Oleander aphids

Orchid aphid (*Macrosiphum luteum*)

- Preferred hosts: orchids of the genera *Oncidium*, *Cattleya*, *Lycaste*, *Brassia*, *Epidendrum*, *Laelia*, and *Catasetum*.



Orchid aphid

Mealybugs - Foliar Mealybugs

Identification and Damage

- All stages of female foliar mealybugs (adults, nymphs) use their piercing-sucking mouthparts to feed, injecting a toxin and sucking plant sap, causing chlorosis, stunting, deformation, and leaf and fruit drop. Heavy infestations may reduce plant vigor and growth.
- Foliar mealybugs excrete honeydew (see Honeydew publication).
- Mealybugs can spread plant diseases. The citrus mealybug is a vector of *Cacao Swollen Shoot Virus*; the pineapple mealybug is a vector for *Pineapple Wilt Virus*.
- When eggs hatch, the first instars, or “crawlers,” are the most mobile, dispersing to suitable host plants.
- Adult males are usually tiny, winged, and short lived, living only to reproduce. Pupating and adult males do not feed. Adult females are wingless; some species are more active than others.
- Some species lay eggs within egg sacs; others give birth to live young.

What to Do

- With small infestations, prune and discard affected plant parts. Infested material should be removed from area and destroyed, not used as mulch.
- Use high-pressure water to dislodge mealybugs from sturdy plants.
- Foliar mealybug predators include lacewings, midge larvae, and 4 species of ladybeetles. The mealybug destroyer (*Cryptolaem montrouzieri*), its larval stage resembling an adult female mealybug, is especially voracious. These larvae have longer legs and move to prey on insects, while mealybugs are less mobile. Mealybug destroyers are present in fewer numbers than mealybugs in a colony.
- Several species of tiny parasitic wasps provide excellent mealybug control in most situations in Hawai'i.
- Chemical control is hard since mealybugs are protected by waxy masses. All pesticides require full coverage, including undersides of leaves. Horticultural oils and insecticidal soaps also require thorough coverage and repeat applications.
- Systemic insecticides can provide excellent control applied as a drench (imidacloprid, dinotefuran, spirotetramat), trunk or bark spray (dinotefuran or imidacloprid with a penetrating surfactant), or foliar application (acetamiprid, dinotefuran, spirotetramat). An insect growth regulator (buprofezin) should be used as a foliar spray in rotation with the other types to prevent resistance.
- Control ants tending and protecting mealybugs.



Papaya mealybug infestation



Mealybug destroyer (circled) among mealybugs



Ants tending mealybugs



Papaya mealybug

Mealybugs - Foliar Mealybugs - Types

Coconut mealybug (*Nipaecoccus nipae*)

- Hosts: avocado, banana, banyan, breadfruit, canna, citrus, coffee, Dracaena, fig, ginger, grape, guava, heliconia, orchids, and palms.

Papaya mealybug (*Paracoccus marginatus*)

- Preferred hosts in Hawai'i: papaya, hibiscus, and jatropha.
- Secondary hosts: avocado, beans, citrus, eggplant, mango, peppers, peas, plumeria, sweetpotato, and tomato.

Longtailed mealybug (*Pseudococcus longispinus*)

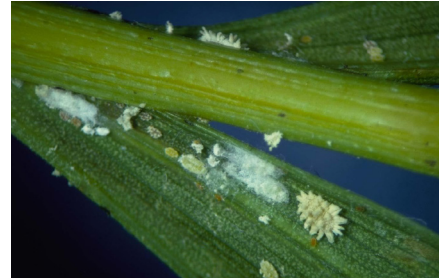
- Wide host range: air plant, asparagus, avocado, banyan, begonia, betel-nut, caladium, coconut and other palms, coffee, citrus, cycads, dracaena, gardenia, floral ginger, guava, heliconia, hibiscus, kamani, lilies, macadamia, mango, orchids, philodendron, pigeon pea, pineapple and other bromeliads, potato, sugarcane, soybeans, and ti.

Citrus mealybug (*Planococcus citri*)

- Attacks foliage, stems, and fruit of its host; may also attack plant roots.
- Damage by root feeding causes leaves to wilt and turn yellow as if affected by drought. Roots become stunted and encrusted with greenish-white fungal tissue (*Polyporus* sp.), under which mealybugs are visible; then the plant may die.

Mealybug (*Delottococcus confusus*)

- Hosts in Hawai'i: King and mink protea
- Hosts elsewhere: other *Protea* and *Leucadendron* species.



Coconut mealybug



Longtailed mealybug



Citrus mealybug on red ginger



Delottococcus confusus on protea

Mealybugs - Root Mealybugs

Identification and Damage

- Root mealybugs prefer dark, protected spaces, such as between a pot's interior wall and the contained root ball.
- No males of the three species discussed here have been observed in Hawai'i, but male pineapple mealy-bugs have been found elsewhere.
- Newly hatched crawlers are highly mobile.
- Plant damage is not specific. The most common symptoms are slow growth, lack of vigor, and subsequent plant death.
- Potted palms and other slow-growing species are more susceptible to infestation because they spend more time growing in the same pot and location.

What to Do

- Hawai'i has no known natural enemies of rhizoecus and coffee root mealybugs, but several parasitoid wasps and ladybeetles attack pineapple mealybugs.
- Root matting promotes root mealybugs. Inspect roots of newly purchased or suspected plants, especially slow-growing ones, by removing them from their pots. Avoid pot-bound plants by re-potting when necessary or using pots with inner coatings of copper hydroxide (Spinout®), which prevents root matting.
- Root mealybugs can be spread by irrigation water, re-use of previously infested pots or media, and crawlers moving from infested plants. Prevent irrigation water from infested plants from running onto clean areas.
- Use clean pots and media; remove pots and inspect for root mealybugs every one to two months.
- Pineapple mealybugs are tended by several species of ants; control ants to help prevent serious mealybug infestations.
- For potted plants, hot water dips or drenches (120°F for 15 min) are as effective as insecticides against mealybugs, as well as against burrowing nematodes.
- Dipping or drenching the root ball of infested plants in dinotefuran, chlorpyrifos, imidacloprid, or spirotetramat is more effective than topically applying granular formulations of insecticides.
- If using granular insecticides, such as bifenthrin, mix into potting media.
- Watering plants before treatment significantly reduces phytotoxicity.



Rhizoecus root mealybug
(*Rhizoecus hibisci*)



Pineapple mealybug (*Dysmicoccus brevipes*) tended by ants (*Pheidole megacephala*). Pineapple mealybugs attack foliage and roots of potted plants, especially if plants are root-bound.



Periodically check roots of potted plants for mealybug infestation.

Root Mealybugs - Types

Coconut mealybug (*Nipaecoccus nipae*)

- Hosts: avocado, banana, banyan, breadfruit, canna, citrus, coffee, *Dracaena*, fig, ginger, grape, guava, heliconia, orchids, and palms.

Papaya mealybug (*Paracoccus marginatus*)

- Preferred hosts in Hawai'i: papaya, hibiscus, and jatropha.
- Secondary hosts: avocado, beans, citrus, eggplant, mango, peppers, peas, plumeria, sweet potato, and tomato.

Longtailed mealybug (*Pseudococcus longispinus*)

- Wide host range: air plant, asparagus, avocado, banyan, begonia, betel-nut, caladium, coconut and other palms, coffee, citrus, cycads, dracaena, gardenia, floral ginger, guava, heliconia, hibiscus, kamani, lilies, macadamia, mango, orchids, philodendron, pigeon pea, pineapple and other bromeliads, potato, sugar cane, soybeans, and ti.

Citrus mealybug (*Planococcus citri*)

- Attacks foliage, stems, and fruit of its host; may also attack plant roots.
- Damage by root feeding causes leaves to wilt and turn yellow as if affected by drought. Roots become stunted and encrusted with greenish-white fungal tissue (*Polyporus* sp.), under which mealybugs are visible; then the plant may die.

Mealybug (*Delottococcus confusus*)

- Hosts in Hawai'i: King and mink protea
- Hosts elsewhere: other *Protea* and *Leucadendron* species.

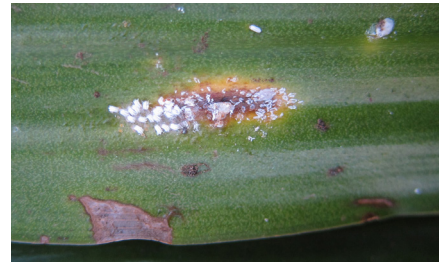
Scale Insects – Armored Scales

What to Do

- Since armored scales are spread chiefly through the movement of nursery stock, only use plant material that is free of scales. Space plants so the crowns are not touching. As plants grow, prune to maintain spacing and allow maximum coverage when using insecticides.
- Many species of beneficial insects naturally control populations of armored scales through predation and parasitism. Predators include thrips and lady beetles; some are general predators and other target specific scale insect species. Look for armor covering that appears chewed, with no scale insect underneath. Tiny parasitic wasps lay eggs in developing scales; wasp larvae absorb nutrients from the scale and eventually emerge as adults.
- Use hot water dips at 120°F for 6 minutes.
- Scrape and scrub with soapy water to remove scale insects and crawlers from plants by mechanical control. Removing scale insects is especially important on export plant materials, since intact armored scales are considered a sign of a live scale infestation.
- Armored scales are very difficult to control with contact insecticides, as all stages except crawlers are protected by the armor.
- Horticultural oils effectively smother crawler and other armored scale stages.
- Certain systemic insecticides such as dinotefuran, and insect growth regulators such as pyriproxyfen and buprofezin, are effective against armored scales.
- Armored scales have many effective natural enemies controlling them; therefore, broad-spectrum chemical insecticides should be used conservatively to minimize their effects on parasitoids and predators.



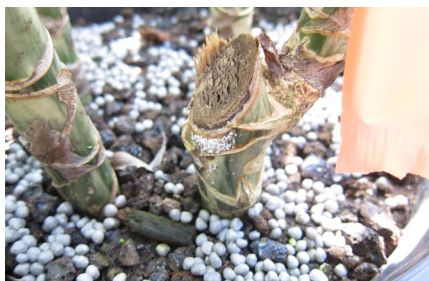
Leaf damage from hibiscus (lesser snow) scale visible on upper leaf surface



Hibiscus (lesser snow) scale under leaf



Cycad scale



Hibiscus (lesser snow) scale on dracaena cane



Hibiscus (lesser snow) scale closeup



Exposed female cycad scale and nymphs

Scale Insects – Armored Scales - Types

Coconut scale (*Aspidiotus destructor*)

- Cause distinct yellowing at feeding sites on host plant.
- Primary host: coconuts.
- Secondary hosts: avocado, banana, bird of paradise, breadfruit, ginger, guava, mango, mock orange, mountain apple, other palms, papaya, pandanus, plumeria, and sugarcane.

Hibiscus (lesser snow) Scale (*Pinnaspis strachani*)

- Known to infest over 150 ornamentals and fruit trees, including avocado, bird of paradise, carambola, cherimoya, chinaberry, citrus, coconut palm, croton, cycads, dracaena, ferns, geranium, indigenous hi'aloa, hibiscus, jacaranda, lychee, mango, Mexican creeper, native cotton (ma'o), oleander, pandanus, pikake, plumeria, poinciana, sweetpotato, ti, and wisteria.

Black thread scale (*Ischnaspis longirostris*)

- Often feed parallel to veins on undersides of leaves, petioles, and fruit.
- Hosts: African iris, banyan, coconut and other palms, coffee, ficus, ixora, lychee, mango, monstera, pandanus, sago palm, and star jasmine.

Cycad scale (*Aulacaspis yasumatsui*)

- Infests roots, trunk, leaves, and petioles
- Primary hosts: cycads, especially sago palms, and to a lesser extent, queen sago and zamia.

Ti scale (*Pinnaspis buxi*)

- Primary host: ti.
- Secondary hosts: anthurium, banana, coconut palm, dendrobium, hibiscus, monstera, orchids, pandanus, persimmon, and philodendron.
- Ti scale lack males.

Boisduval scale (*Diaspis boisduvalii*)

- Primary hosts: orchids (cattleya, dendrobium, epidendrum, oncidium, vanda).
- Secondary hosts: anthurium, banana, bird of paradise, cactus, coconut palm and other palms, cycads, dracaena, and pandanus.

Cockerell or magnolia white scale (*Pseudaulacaspis cockerelli*)

- Resemble flecks of white paint on upper and lower leaf surfaces.
- A yellow (chlorotic) patch caused by feeding is visible on the opposite side of the leaf where the female scale is present.
- Infests over 100 plant species, including azalea, bird of paradise, coconut and other palms, cycads, koka (Javanese bishopwood), kukui, mango, oleander, and plumeria.



White peach scale



White peach scale, closeup



Coconut scale on leaf surface



Coconut scale on underside of leaf



Mining scale. Inset: armor upturned to expose insect

Mining scale (*Howardia biclavis*)

- Infest bark, leaves, and fruit, burrowing beneath the epidermal plant tissue layer, which becomes an integral part of their armor.
- Recorded hosts: acacia, allamanda, bougainvillea, cassia, ficus, ebony, gardenia, hibiscus, ixora, jasmine, kelumpang, lantana, lychee, mango, papaya, plumeria, poinsettia, pulasan, sapodilla, and sapote.

Oleander scale (*Aspidiotus nerii*)

- Primary hosts: oleander, orchid vine, palm, peach, pear; native plants *Diospyros sandwicensis*, *Platydesma* spp., and *Santalum haleakalae*.

White peach scale (*Pseudaulacaspis pentagona*)

- Infests bark, roots, and leaves of host plants
- Primary hosts: alata, Erythrina, hibiscus, papaya, passionfruit, peach, persimmon, plumeria, privet, pummelo, soybean, and sweetpotato.



Magnolia white scale on bird of paradise. Inset: underside of leaf.



Oleander scale



Oleander scale close-up



Black thread scale



Ti scale

Scale Insects – Soft Scales

Identification and Damage

- Do not have an armored covering. Body (1–6 mm long) is usually smooth in outline and dome shaped; varies in color.
- Retain legs and antennae throughout adult life.
- Excrete honeydew (see Honeydew publication).
- Adult soft scales suck plant sap.
- For most soft scales, the first developmental stage (“crawler”) is the most active dispersal stage; once settled and feeding, most immature soft scales (“nymphs”) are still capable of limited movement, while mature females are primarily sedentary once feeding and ovipositing begin.
- Female soft scales are always wingless; adult males, when present, can be winged or wingless.
- In some soft scale species, reproduction occurs without male fertilization (parthenogenically) either by eggs or birthing live young. For other species, males have been observed rarely, but they do not feed and are short lived.
- Heavy infestations can cause loss of plant vigor, spotting or yellowing of the foliage, reduction in fruit set, and plant death. Some scales pass toxins from their saliva to the plant, causing deformed or retarded plant growth, loss of leaves, and possible plant death.

What to Do

- Usually spread via movement of infested plant material. Inspect all plant material carefully before transporting and planting.
- Provide infested trees with optimum amount of water, mulch, and fertilizer to enhance vigor. Prune, bag, and dispose of heavily infested branches. However, if heavy infestations are highly parasitized with emerging parasitic wasps and predators (e.g., ladybeetles), branches should be left on the ground to allow natural enemies to emerge (3–4 weeks) and reproduce on the infested plants above.
- Many soft scale species are effectively controlled by their natural enemies, so chemical treatments are usually not necessary. Inspect soft scales for evidence of parasitism (e.g., emergence holes, parasitoid within scale insect). Parasitoids include many species of tiny wasps and flies that lay their eggs to develop in or on certain stages of scale insects. Insect-attacking fungi such as *Verticillium* and *Paecilomyces* provide good control of soft scales in wet, humid environments, as a relative humidity of above 80% for 8–10 hours is required for infection. Predators, including ladybeetles, voraciously feed on soft scales.
- Soft scales are often tended by ants; controlling ants will make the scales more vulnerable to predation. If natural control is insufficient in widespread attacks, trees may be banded to keep off attendant ants.
- Applications of horticultural oil (to tolerant plants) and certain systemic insecticides may be necessary in heavy infestations. Imida-cloprid can be applied as a foliar spray, trunk injection, or soil treatment. Another insecticide, dinotefuran, is available only to professional applicators and is effective on cycad scales and soft scales.



Immature barnacle scale



Soft scales on cycad



Nigra scale on ti leaf



Cottony cushion scale



Green scale

Scale Insects – Soft Scales - Types

Barnacle (wax) scale (*Ceroplastes cirripediformis*)

- Hosts: avocado, banana, banyan, breadfruit, canna, citrus, coffee, Dracaena, fig, ginger, grape, guava, heliconia, orchids, and palms.

Hemispherical scale (*Saissetia coffeae*)

- Preferred hosts in Hawai'i: papaya, hibiscus, and ja-tropha.
- Secondary hosts: avocado, beans, citrus, eggplant, mango, peppers, peas, plumeria, sweet potato, and tomato.

Cottony cushion scale (*Icerya purchasi*)

- Wide host range: air plant, asparagus, avocado, banyan, begonia, betel-nut, caladium, coconut and other palms, coffee, citrus, cycads, dracaena, gardenia, floral ginger, guava, heliconia, hibiscus, kamani, lilies, macadamia, mango, orchids, philodendron, pigeon pea, pineapple and other bromeliads, potato, sugar cane, soybeans, and ti.

Nigra scale (*Parasaissetia nigra*)

- Attacks foliage, stems, and fruit of its host; may also attack plant roots.
- Damage by root feeding causes leaves to wilt and turn yellow as if affected by drought. Roots become stunted and encrusted with greenish-white fungal tissue (*Polyporus* sp.), under which mealybugs are visible; then the plant may die.

Green scale (*Coccus viridis*)

- Feeds along main vein of the leaf and near tips of green shoots.
- Wide host range of vegetables, fruits, and ornamentals.
- Economically important hosts: Annona (cherimoya, atemoya, sugar apple), anthurium, avocado, cacao, coffee, flowering ginger, gardenia, guava, ixora, lime, orange, and plumeria.

Stellate scale (*Vinsonia stellifera*)

- Found on leaves.
- Female's round body is covered with translucent wax resembling points of a star.
- Host in Hawai'i: mango
- Hosts outside of Hawai'i: anthurium, citrus, coconut, and orchids.

Red wax scale (*Ceroplastes rubens*)

- Found on twigs, stems, and leaves; prefers upper surface of leaves.
- Hosts: citrus, mango, and ornamentals such as flowering ginger and maile.

Soft brown scale (*Coccus hesperidum*)

- Found on stems, leaves and green twigs; feeds along the veins of leaves
- Secretes more honeydew than other species of soft scales
- Wide host range consisting of vegetable, fruit and ornamental crops.



Green scale



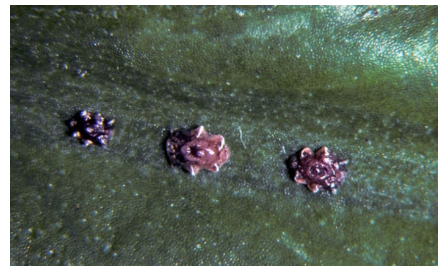
Brown soft scale (note: parasitoid emergence holes on two scales, left and center). Photo credit: Whitney Cranshaw, Colorado State University, Bug-wood.org



Stellate scale



Stellate scale with eggs

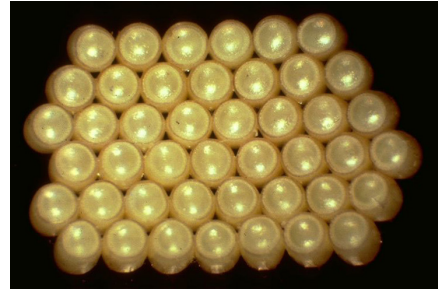


Red wax scale

Southern Green Stinkbug (*Nezara viridula*)

Identification and Damage

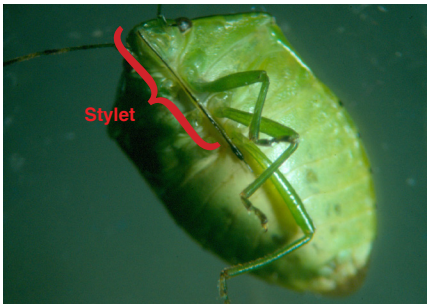
- Immature stinkbugs resemble immature ladybird beetles; however, they do not have wings and emit a strong, characteristic odor when disturbed. Nymphs darken from red to reddish brown to green.
- Adults are winged, shield-shaped, . to . in long, $\frac{5}{16}$ in wide, and apple or jade green. They are very active fliers.
- Tiny ($\frac{1}{20}$ -in) cylindrical eggs are deposited on the undersides of leaves in clustered rows. Eggs are initially yellow-white and become red-orange.
- Adults and most nymphal stages prefer succulent plant tissue, like developing flowers or fruit, but will also feed on other plant parts.
- Plant damage, often not visible immediately after feeding, includes premature dropping of flower buds, seed damage, distorted pod development, spotting or pitting of macadamia nut kernels, and premature dropping of nuts.
- The stinkbug's saliva breaks down plant cells, resulting in soft and spongy tissue under an otherwise intact surface.
- Host crops include beans, citrus, crucifers, cucurbits, macadamia nuts, mango, orchids, peppers, potatoes, and tomatoes.
- Weed hosts include spiny amaranth, castor bean, cheese weed (*Malva parviflora*), popolo berry (*Solanum americanum*), rattlepod (*Crotalaria*), and spiderweed.



Eggs



Nymph



Stinkbug's piercing mouthpart



Damage to macadamia nuts kernels caused by SGS



Adult

Spiraling Whitefly (SWF) (*Aleurodicus dispersus*)

Identification and Damage

- SWF increase during warm, dry weather and are reduced during heavy rains and cool temperatures.
- Prolonged drought may weaken trees, leading to higher-than-usual SWF population.
- Only the adult disperses beyond the leaf on which the egg is laid.
- Most abundant in coastal areas and elevations below 1,000 feet. Most active during the morning hours. Mating occurs in the afternoon.
- SWF causes damage in three ways:
- Direct feeding damage caused by piercing and sucking sap from foliage by immature and adult whiteflies results in premature leaf drop but is usually not sufficient to kill plants.
- Whiteflies produce honeydew (see Honeydew publication). Nymphs also produce white, waxy, fluffy material that is an unsightly nuisance.
- SWF can transmit plant viruses that cause over 40 diseases of vegetable and fiber crops worldwide. Even a small population of SWF can be devastating.
- Preferred host: plumeria. Secondary hosts in Hawai'i: many vegetables, ornamentals, and fruit and shade trees, including *Annona* (cherimoya, atemoya, sugar apple), avocado, banana, bird-of-paradise, breadfruit, citrus, coconut, eggplant, guava, kamani, Indian banyan, macadamia, mango, palm, paperbark, papaya, pepper, pikake, poinsettia, rose, sea grape, ti, and tropical almond.

What to Do

- Healthy plants without water stress are better able to tolerate SWF infestations.
- Apply a strong stream of water onto the underside of infested leaves to dislodge.



Spiraling whitefly pupa



SWF nymph and pupa



Characteristic SWF pattern on leaf



Plumeria leaf infested with SWF



Spiraling egg-laying pattern

- Introduced ladybeetles and whitefly parasitoids control SWF in Hawai'i. The ladybeetle feeds on all stages of whiteflies, although the majority of the prey are nymphs, as well as many scales, mealybugs, and aphids. Tiny parasitic wasps, *Encarsia* spp. (Aphelinidae) and *Aleuroctonus vittatus* (Eulophidae), are highly effective against SWF. Heavy infestations are now only observed where these natural enemies are not present due to use of broad-spectrum insecticides or under windy ocean-salt conditions.
- Systemic insecticides applied as a drench or bark spray treatment (imidacloprid, dinotefuran, acetamiprid, thiamethoxam) and foliar-applied insect growth regulators (pyriproxyfen, buprofezin) are effective and have minimal negative effects on biological control agents.
- Thoroughly spray underside of infested leaves with a dilute solution of liquid dishwashing detergent (do not use a brand with degreasers), no more than 1 Tbsp/gal of water. Sensitive plants such as ferns may suffer "burning"; if so, reduce solution to 1 tsp/gal. Repeated weekly applications are needed. Soaps will effectively control younger nymphs but are less effective on eggs, older nymphs, pupae, and adults.



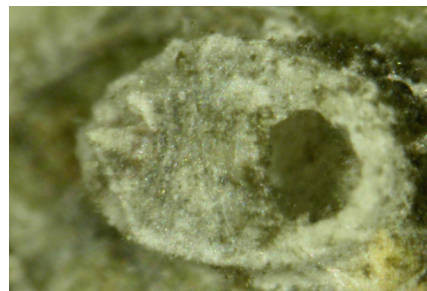
Giant whitefly (left) and spiraling whitefly (right).
Photo credit: Hawai'i Department of Agriculture



SWF pupae with parasitoid emergence holes (upper left) and a mealybug destroyer (right)



Parasitized whitefly pupa



Whitefly parasitoid emergence

Thrips

Identification and Damage

- Adult thrips are tiny, about $\frac{1}{16}$ to $\frac{1}{25}$ of an inch in length. Although winged, adults of some species are weaker fliers than others and are dispersed by wind or through movement of infested plants.
- Higher temperature and humidity and new growth of host plants during the summer months increase feeding and breeding.
- Thrips prefer to feed on very young, succulent fruits, flowers, and foliage, leading to scarring, light-colored streaks, bronzing, and deformities, including galling, as the plant tissue matures.

What to Do

- The minute pirate bug, *Orius* sp., preys on all stages of thrips as well as on aphids and mites.
- Avoid broad-spectrum insecticides that will impact this predator.
- Some control measures are dependent on type of thrips.

Thrips - Types

Aroid thrips (*Psyllothrips luteolus*)

- Host plants: Dieffenbachia, Epipremnum (pothos), Philodendron, Spathiphyllum, other related aroid species.

Myoporum or Naio thrips (*Klambothrips myopori*)

- Hosts: plants in the genus Myoporum, such as native plant naio.
- Chemical treatments include dinotefuran drench and spinosad foliar application.

Western flower thrips (*Frankliniella occidentalis*)

- WFT feeds on over 250 different crop plants (fruits, vegetables, and ornamentals).
- Feeding by adults and larvae results in silvered or necrotic patches on leaves, deformity, and/or premature drop of flowers and fruits.
- Damage also occurs when adult females insert their saw-like ovipositor to lay their eggs into host plants.
- WFT is a vector for serious plant diseases, including *Tomato Spotted Wilt Virus*, which affects over 1,000 species of plants.



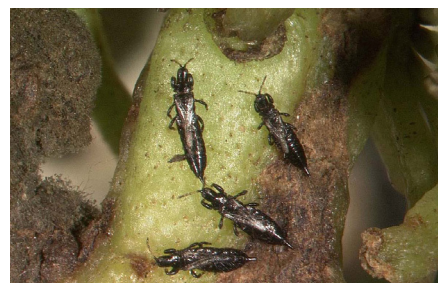
Aroid thrips damage to Syngonium



Leaf galls from myoporum thrips damage



Myoporum thrips nymph



Myoporum thrips adults

Melon thrips (*Thrips palmi*)

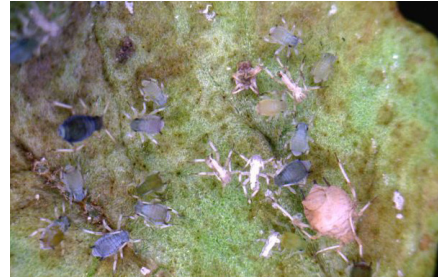
- Melon thrips cause damage to many vegetable, fruit, and ornamental crops, including avocado, beans, cabbage, cantaloupe, carnation, chili, chrysanthemum, citrus, cucumber, eggplant, hibiscus, lettuce, mango, melon, okra, onion, orchids, pea, pepper, potato, pumpkin, soybean, squash, and watermelon.

Chilli thrips (*Scirtothrips dorsalis*)

- More than 100 recorded hosts, including peppers and roses.
- Hosts in Hawai'i: African daisy, cucumber, joyweed, false heather, and *Myoporum* sp.
- Among insecticides, chlorfenapyr is the most effective against *S. dorsalis* adults and larvae, followed by spinosad and imidacloprid.



Western flower thrips



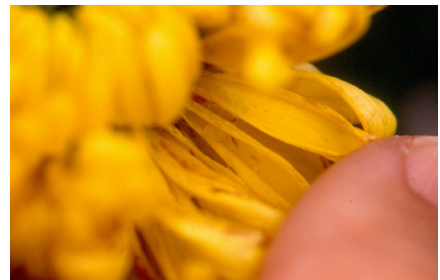
Damage by Western flower thrips



Aroid thrips damage to Syngonium



Aroid thrips damage to Aglaeonema



Damage by Western flower thrips



Damage caused by chilli thrips



Chilli thrips adults and nymphs



Melon thrips