Insect Pests

Landscape Conference
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Topics to Be Covered

- Basic Entomology
  - What is an insect? Why so many insect pests?
  - Major types of development
  - Types of mouthparts
- ID of Pests & Beneficials
  - Moths=caterpillars
  - Beetles=grubs
  - Flies=maggots
  - Aphids
  - Mealybugs
  - -Scale insects
  - -Whiteflies
  - -Thrips
  - -True Bugs
  - -Bees & Wasps
- Biological and Chemical Controls

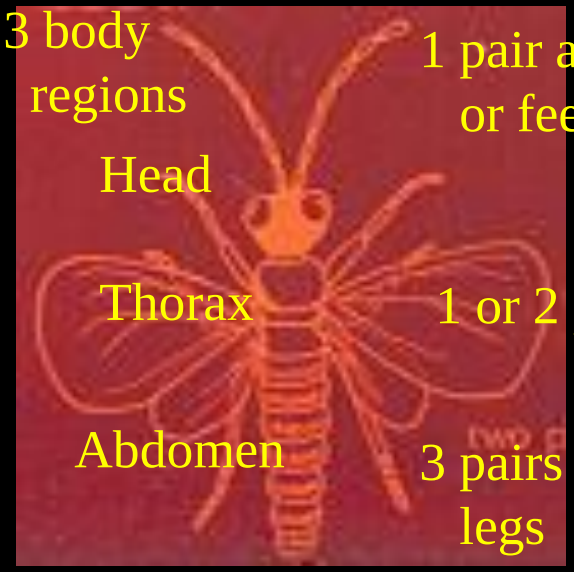
The Hawaiian Islands

"Invasive Species Capital of U.S."

* Worst-case example of invasive species problem in the U.S and probably the entire world.
* Hawai'i's lush vegetation, warm temperatures and high humidity not only welcome tourist but provide a tropical paradise for the more than 1,000 alien plants, vertebrates, and invertebrates that have been accidentally introduced from all corners of the world over the past 65 years.

20° N

What is an Insect?



*Hard, oily, waxy exoskeleton requiring molting for growth.
*Open circulatory system (no blood vessels).
*Highly adaptable to the environment (land, water, air).
*Accounts for 90% of known animals w/ 10+ million species.

Two Major Types of Insect Development

I. Complete Metamorphosis

II. Gradual Metamorphosis

Complete Metamorphosis

Beet armyworm

Insects with Complete Metamorphosis

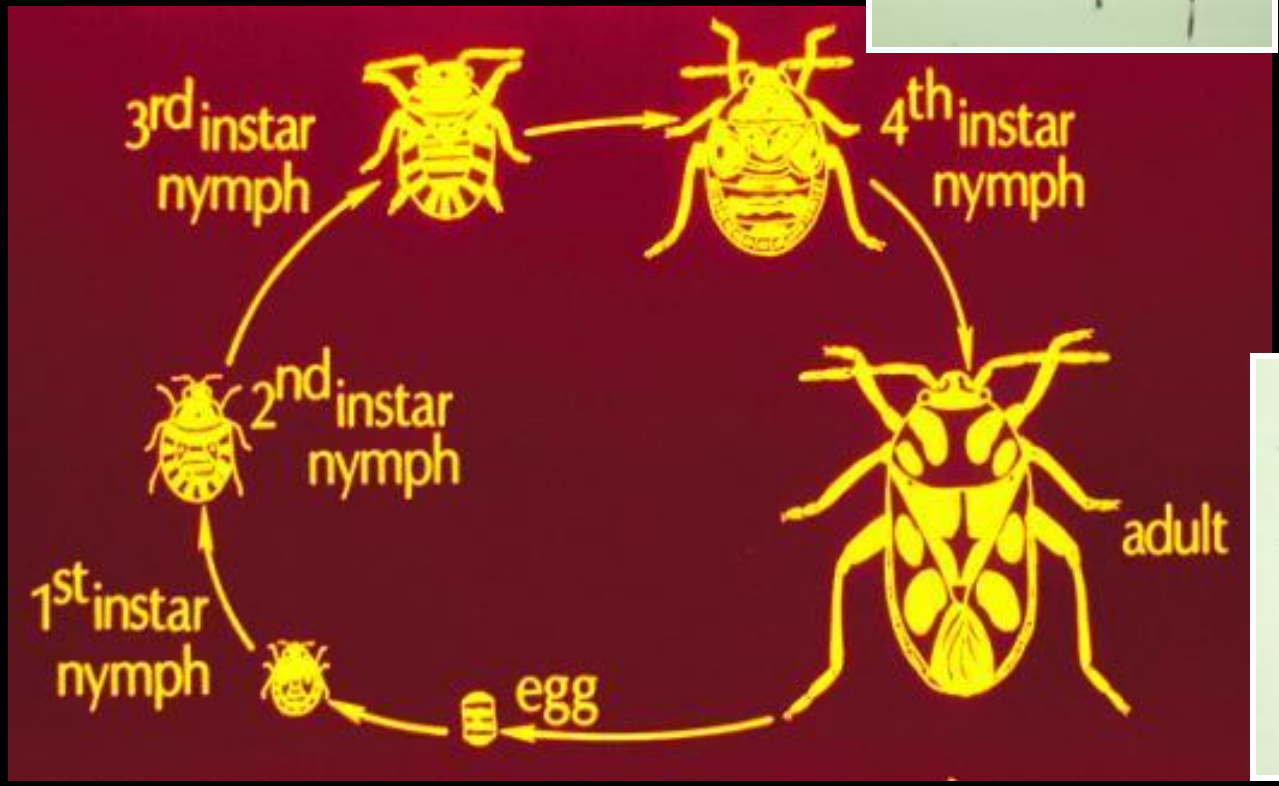
- Butterflies, Moths=caterpillars
- Flies=maggots
- Bees and Wasps=(larvae)
- Beetles=grubs

Complete Metamorphosis

Complete life cycle in as short as 9 days

Gradual Metamorphosis

Stink bug

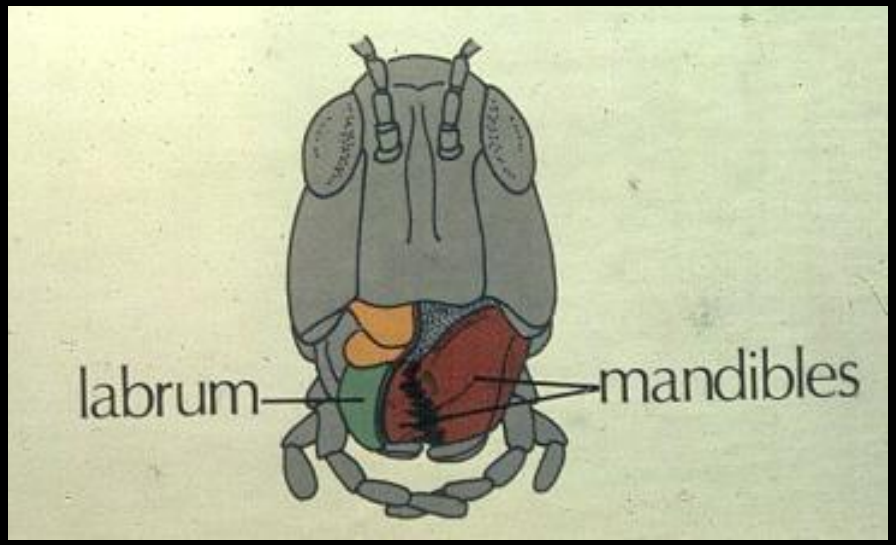


Insects with Gradual Metamorphosis

- Cockroaches, Grasshoppers, Crickets
- True Bugs (lacebugs, stinkbugs)
- Planthoppers (leafhoppers)
- Aphids, Mealybugs & Armored scales (males complete), Soft Scales, Whiteflies

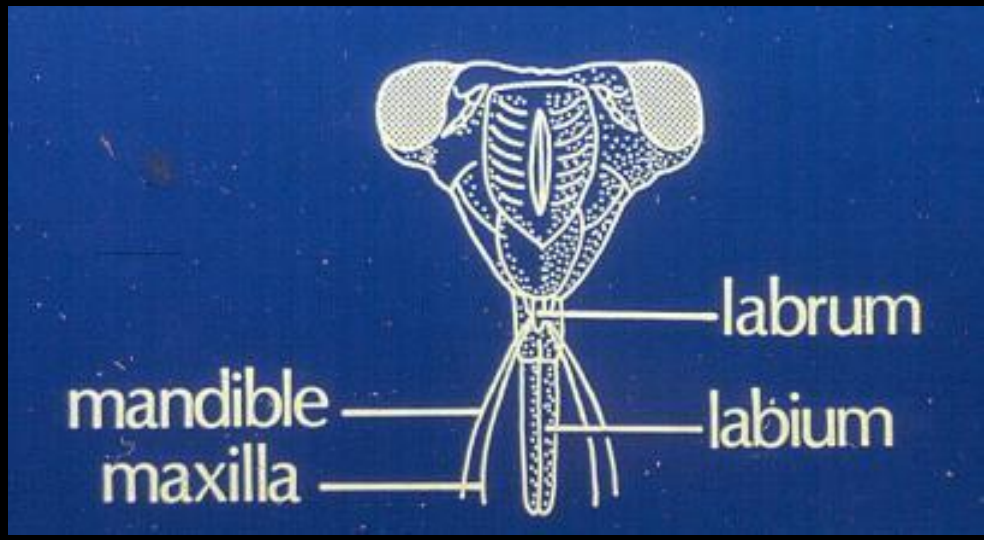
Two Major Types of Mouthparts

Chewing Mouthparts



Mandibles are like teeth for chewing.

Sucking Mouthparts



Mouthparts modified to function like an hypodermic needle for sucking plant juices or blood.

Examples of Insects with Chewing Mouthparts

Green garden looper

Walking stick

Katydid

Chinese Rose Beetle

Fuller Rose Beetle

Chinese Rose Beetle

Complete Metamorphosis

Chewing Mouthparts

Grubs

Pupa

Adult

Grubs do not attack live plant tissue, but preferably live in loose rich soil, leaf litter, or compost.

This beetle is nocturnal in habit. During the day they remain under leaf litter and emerge at dusk. Peak feeding and mating activity occurs about 30 minutes after sunset. It also prefers to feed on leaves with feeding or other types of damage, because these leaves release ethylene gas which serves as an attractant to beetles.

Green Garden Looper

Complete Metamorphosis

Chewing mouthparts (caterpillars)

Younger instars

Older instar

Pupa in silken cocoon

Adult

Monkeypod Caterpillars

Monkeypod-
Kiawe caterpillar
Melipotis

Monkeypod moth
Polydesma

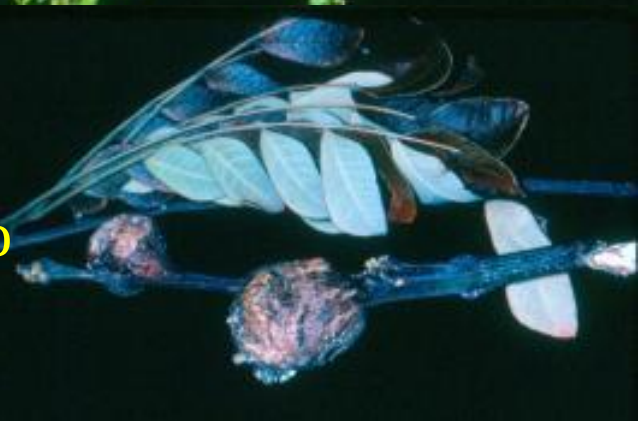
Black Witch, *Ascalapha odorata*

caterpillar

pupae

Monkeypod caterpillars

*In the 1970's defoliated monkeypods.
*Eggs laid in crevices of the bark.
*At dusk, caterpillars migrate to up the tree to feed in the canopy at night.
*At dawn, caterpillars migrate down the tree and hide during the day in cracks and crevices in the bark or down into the soil.
*Caterpillars pupate in the bark.
*Egg to adult in 50 to 60 days.
*Continued nightly eating of the sprouting leaves caused swellings or "galling" of the monkeypod. (Insects of Hawaii 7: 395, 1958)
*Control by spraying tree trunk not canopy with insecticides or treat burlap or carpet attached to tree trunk that provides hiding habitat for caterpillars between bark and carpet/burlap.



Banana Moth

Complete Metamorphosis

Chewing mouthparts (caterpillars)

Adult

Damage

Caterpillar

cocoon

Banana Moth

- First discovered in Hawaii in 1982.
- Most related species feed only on decaying matter.
- Begin feeding on damaged, dead tissue and then attack living plant tissue.
- Bores into stem and feeds internally on the cortex and pith.
- Most noticeable symptom is the present of frass and debris bonded by silky secretions.

Banana Moth Damage

New Guinea Sugarcane Weevil

Damage to coconut crown

Black (Coffee) Twig Borer

Complete Metamorphosis
Chewing Mouthparts

Dieback symptom

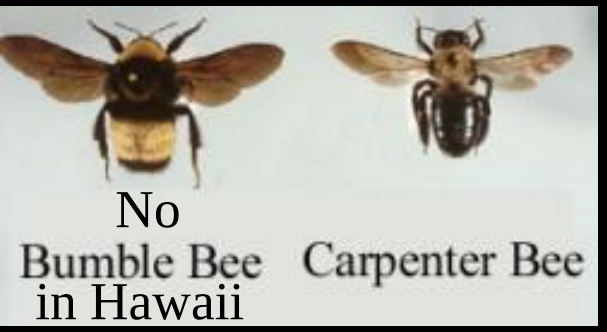
Adults

Pinhole
to gallery

Eggs

Grubs

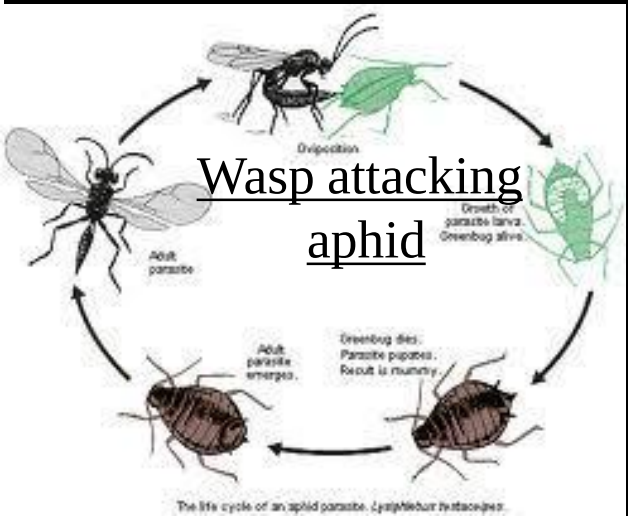
Pupae



Bees and Wasps
Hymenoptera

Parasitic wasp

Leafcutting Bee



Frit Fly *Oscinella frit* , DIPTERA: Chloropidae

Complete Metamorphosis

Sponging mouthparts

Problem in turf. The adult fly lays its eggs on the shoots of young grasses and the emerging maggots burrow into the young shoots, causing withering of the affected plants. Up to 3 generations of Frit Fly can occur in one year.

http://www.escience.bayercropscience.co.uk/bcsweb/es/bcs_uk_greenws.nsf/id/BA85825F18A5856AC125749B002EC24F?open&ccm=200050

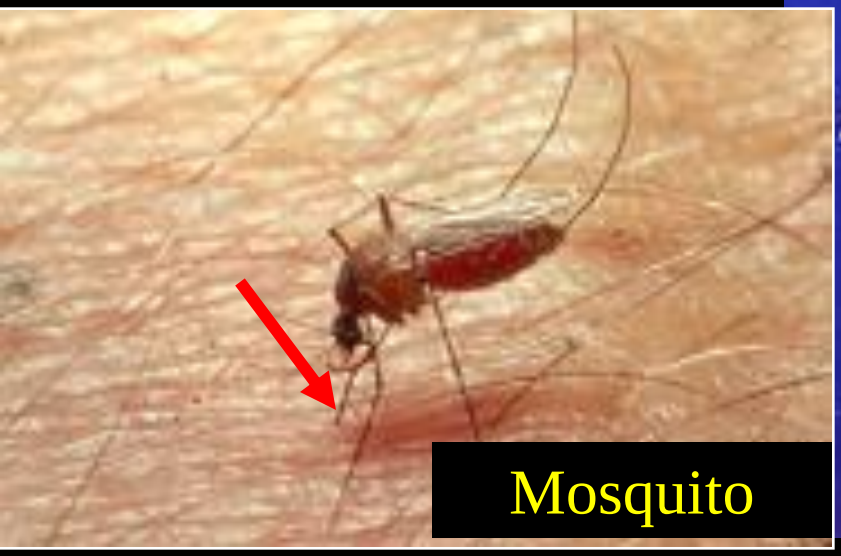
Beneficial Flies

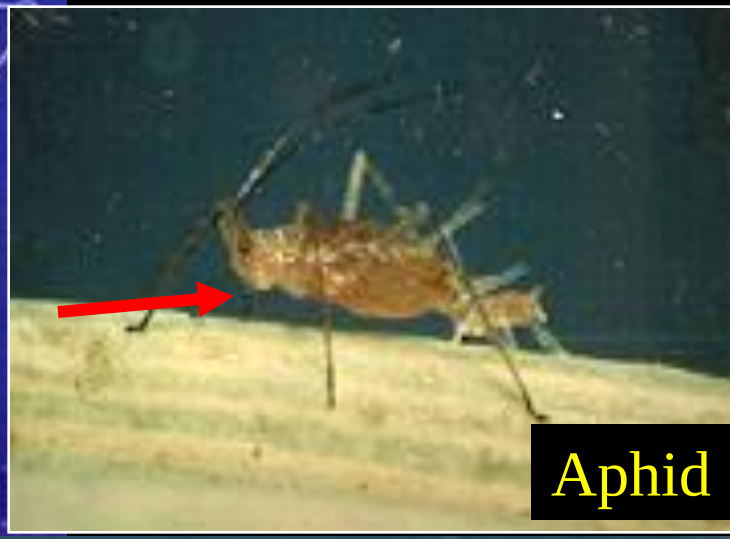
Flies are excellent biological control agents.

Tachinid fly

Syrphid (Bee fly)

Examples of Insects with Sucking Mouthparts


Mosquito


Aphid


Stinkbug


Stink bug feeding damage to macadamia

Aphids

Incomplete Metamorphosis
Sucking mouthparts

Cornicles: Emits defensive fluids

Orchid aphids

Banana aphids

Oleander Aphid

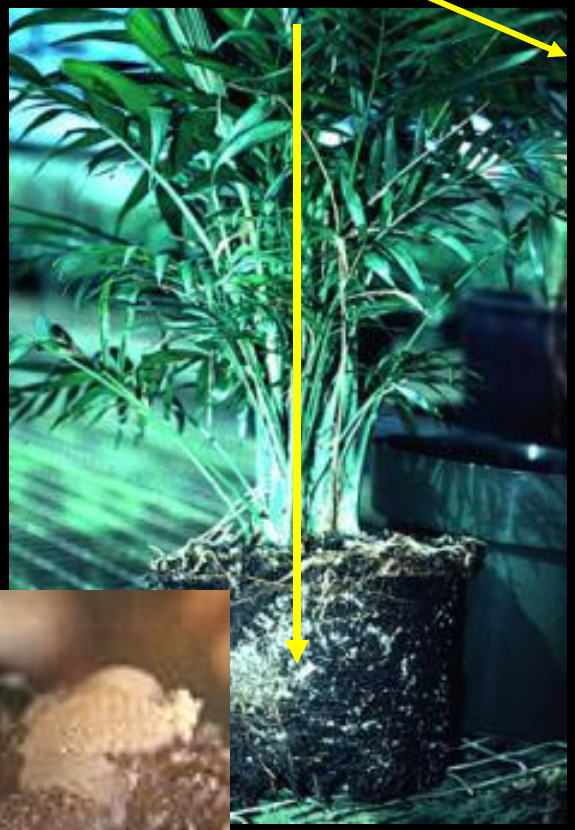
Aphid damage to day lily

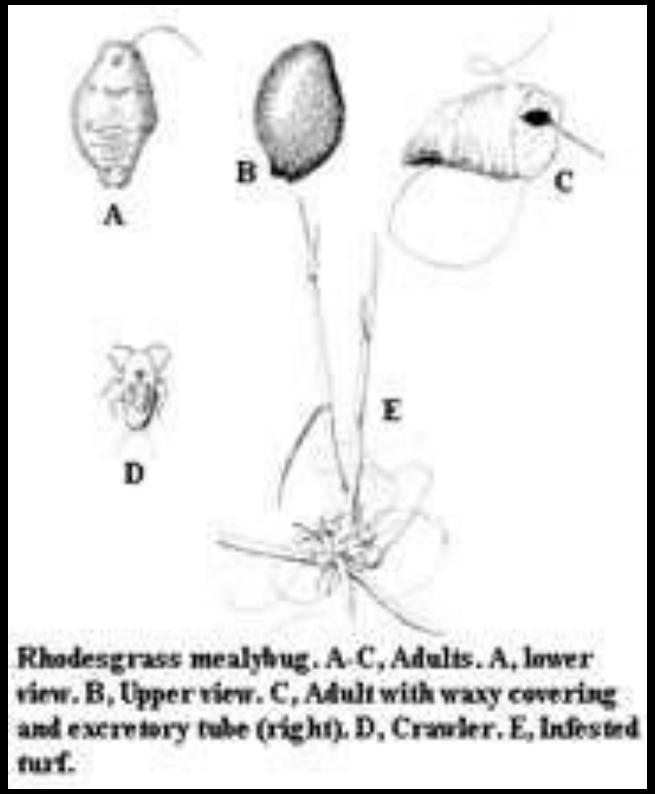
Mealybugs

Rhodegrass mealybug
Zoysia root mealybug

Foliar

Root





Rhodesgrass mealybug. A-C, Adults. A, lower view. B, Upper view. C, Adult with waxy covering and excretory tube (right). D, Crawler. E, Infested turf.

Coconut Mealybug,
Nipaecoccus nipae

Hosts: avocado, banyan, breadfruit, canna, fig, grape, guava, palms, Pritchardia

Male cocoon

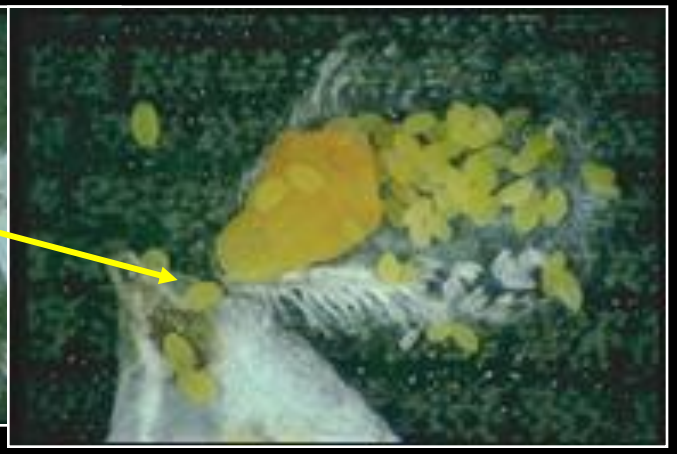
Female

Scale Insects

Armored

Soft

Cockerell
or Magnolia
White Scale

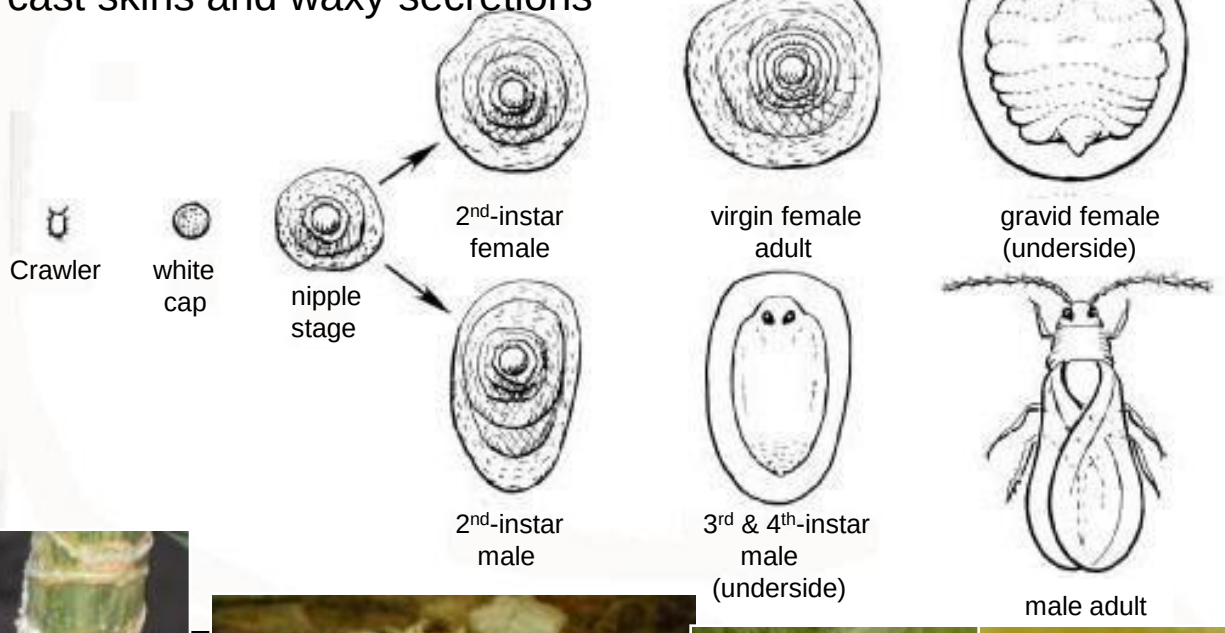


Green scale

Development of Armored Scales

Crawler to adult is about one month

Armored covering formed by cast skins and waxy secretions

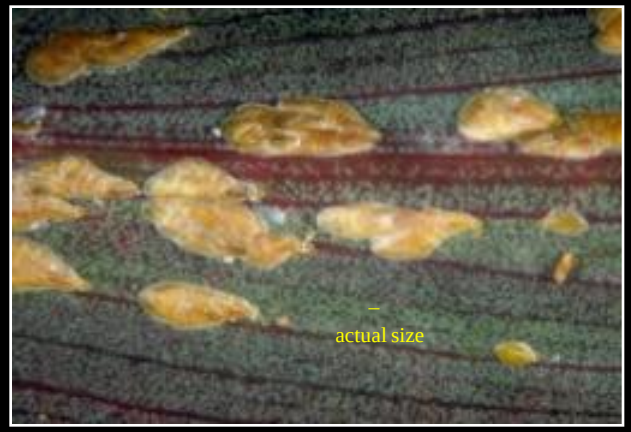


Hibiscus Snow Scale

Armored Scales in the Landscape

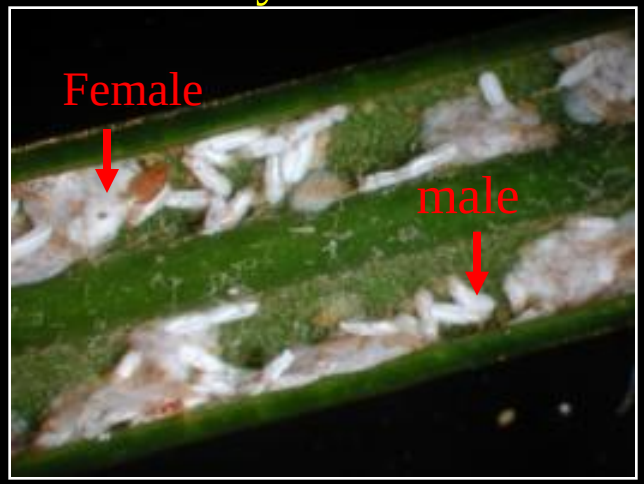
Coconut Scale

Ti Scale



Black Thread Scale

Cycad Scale



Mining Scale

Soft Scales in the Landscape

Hemispherical Scale

Wax Scale

Green Scale

Nigra Scale

Whiteflies: *Major pests of vegetable and ornamental crops.

*Difficult to control chemically because of resistance to common insecticides.

*Most species under excellent biological control.

Infestation on leaf

Adult

Nymphal stage

Egg track - spiraling whitefly

Sooty Mold

Sooty mold is caused by a sweet substance called honeydew excreted by aphids, mealybugs, soft scales and whiteflies. Plants with sooty mold indicates severe infestations of one of the above insects.

Ecological Control Strategies

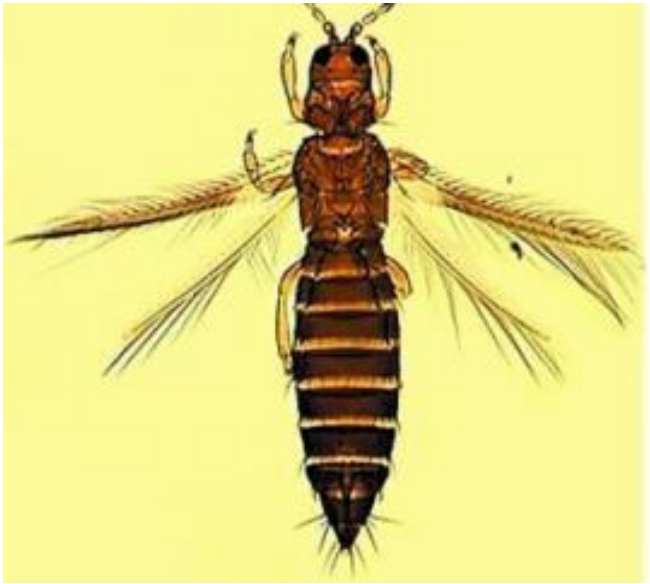
Ant Control

Ants feed on sweet honeydew excreted by aphids, mealybugs and soft scales. Ants nurture these pests by protecting them from predators and “cleaning house”. Controlling ants will reduce these pests.

Thrips

Complete metamorphosis
Rasping-sucking mouthparts

Wings fringed with hair (setae)



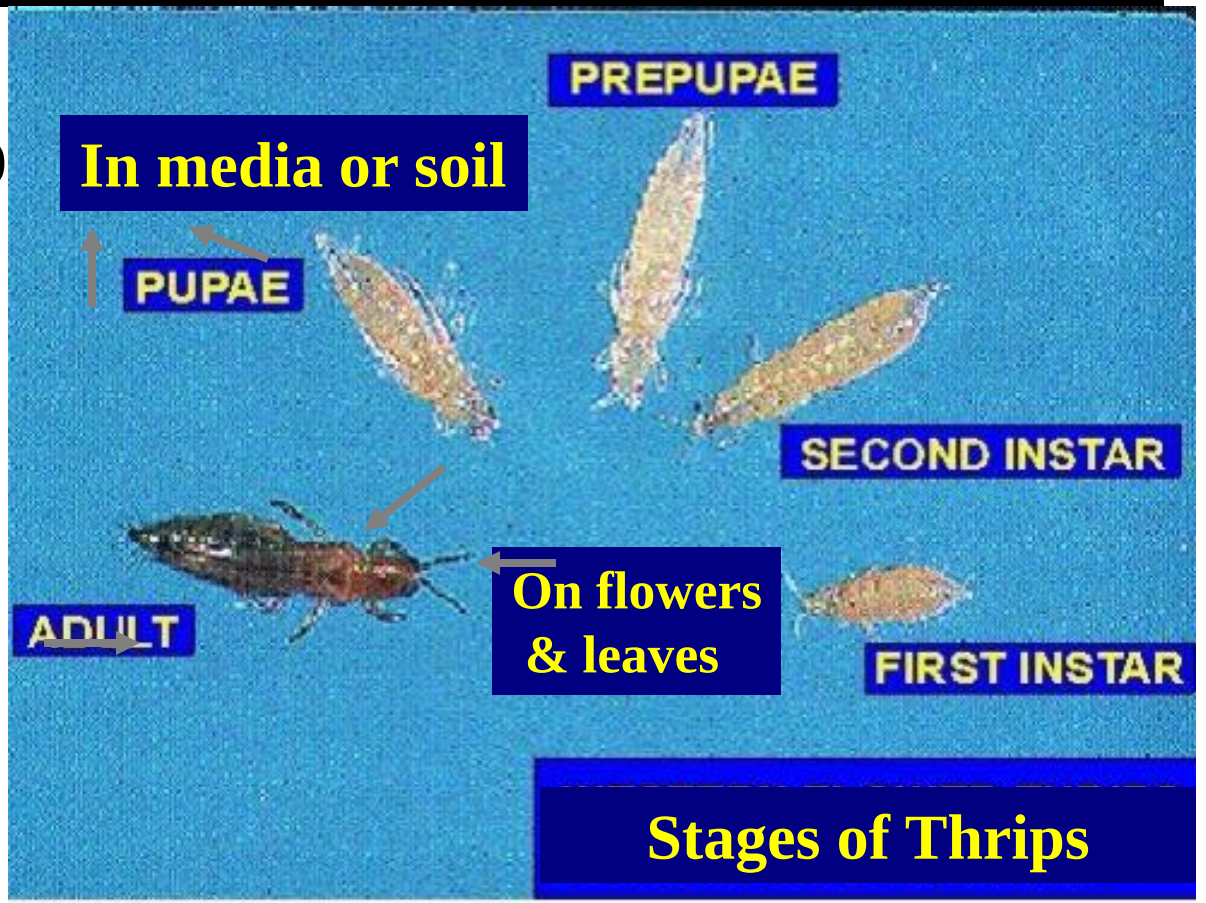


Photo by R. Mau

Thrips Feeding Damage

Anthurium

Ti-leaf

Orchid

Break!

Biological Control in Hawaii

*Hawaii's government has been practicing classical biological control by purposely introducing and releasing natural enemies, for over a 100 yrs.

*Early attempts to control pests (rats & armyworms) through the introduction of animals (mongoose & mynah bird) into Hawaii were made by private citizens in 1865.

*In 1890, 25 years later, procedures of biological control were regulated and supported by the Hawaiian government.

*Of the 243 natural enemies purposely introduced (1890-1985), 86.4% have been recorded to prey on or attack about 200 pest species.

*No purposely introduced species, approved for release in the past 35 years, has attacked any native or other desirable species.

Funasaki et al. 1988

Plumeria at Keahole Ag Park (09/2010)

Immature Lady Beetle

Adult Lady Beetle

Biological Control Strategies for Scales, mealybugs and whiteflies

Pathogenic fungi
and parasitic wasps

Ladybug

Immature ladybugs

Spiraling Whitefly in Hawaii

Parasitic wasp, very effective against spiraling whitefly in windy, coastal areas in Hawaii, discovered in 2007. (Kumashiro HDOA)

Parasitized Whitefly Nymph

Parasitoid Emergence Hole

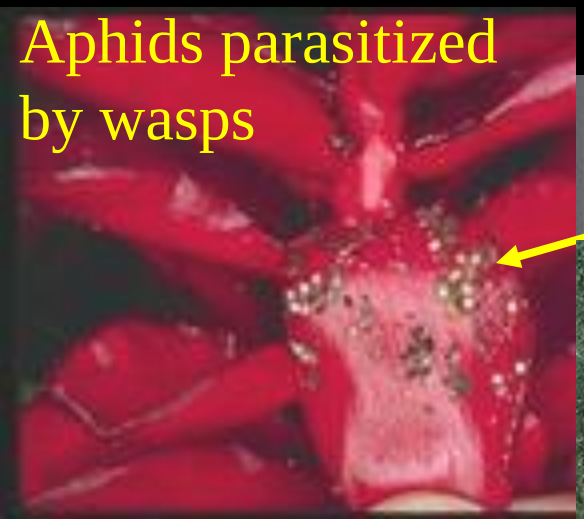
Eulophid parasitic wasp, *Aleuroctonus vittatus*

Spiraling Whitefly heavily parasitized by parasitic wasps
(Note 4th Instar pupae with round exit holes)

Biology and Control of Aphids

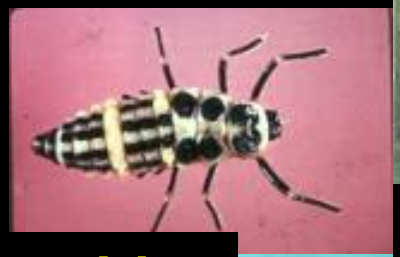
*No male aphids occur in Hawai ʻi.
*One aphid develops into an entire colony of aphids.
*Aphids transmit serious plant viruses, such as the papaya ring spot virus, banana bunchy top virus, and cucumber mosiac virus.
*Aphids easily develops resistance to insecticides.
*Aphids are under excellent biological control in HI by:

Aphids parasitized by wasps



Mummified aphids

Syrphid maggot



Ladybug

Lacewing

Pseudoscorpion

Live Biological Control Agents for Sale in Mainland U.S.

Parasite for Aphids

Parasite for whiteflies

Ladybeetle for mealybugs

Nematodes for Root weevils

Predatory Mite

*Importation and sale in Hawaii require Hawaii Dept. of Ag permit and approval because of possible contamination of the host pest, or hyperparasites.

*Most of these parasitic wasps & predators already occur naturally in HI.

*Capture these biocontrol agents that naturally occurs in HI and release into interiorscapes without natural enemies of pests.

Conservation of Natural Enemies

*Recognize the natural enemies and know when the pest is parasitize. Most Important!!!
*Avoid plantings in windy or ocean front areas, or extremely hot environments. Modify conditions to encourage natural enemies.
*Avoid use of broad spectrum insecticides:
Organophosphates: Dursban, Malathion,
Carbamates: Sevin (carbaryl)
Pyrethroids: Talstar (bifenthrin)

Biological or Microbial Insecticide

Bacteria - *Bacillus thuringiensis – caterpillars*
B.t. israelensis – mosquitoes, fungus gnats

Fungi - *Paecilomyces fumosoroseus* – whiteflies,
Preferal aphids, thrips, mealybugs
Humidity is 80% or higher for 8 - 10 hours
Temp is between 68˚ and 82˚ F

- *Beauvaria bassiana* – whiteflies, thrips, aphids
BotaniGard coffee berry borer
High humidity and free water enhance activity.
Sunlight kills fungal spores.

Nematodes - *Steinernema carpocapsae* – banana moth,
Nematac borers (weevil), soil-
High humidiy required. dwelling insects.

Evolution of Insecticides

1940-50's

Chlorinated hydrocarbons

DDT, Chlordane, Dieldrin, Mirex, Heptachlor

1960-70's

Organophosphates & Carbamates

Dimethoate, Diazinon, Dursban, Orthene, Sevin

1980-90's

Pyrethroids (synthetic)

Mavrik, Tame, Tempo, Decathlon, Talstar

1990-2000's

Reduced-Risk Insecticides

Natural Conserve, Avid, Neem *B.t.*, fungi, oil, soap	**Insect Growth Regulators** Distance, Enstar, Talus	**Neonicotinoids** Merit, Marathon, Optigard Flex, Safari, TriStar, Discus
	Tetronic Acid Kontos, Movento	

NEONICOTINOID INSECTICIDES

Foliar

Acetamiprid

Arena®
INSECTICIDE
grubs

Clothianidin

More Water Soluble
Effective against armored scales

Dinotefuran

Landscape

imidacloprid

Nursery

imidacloprid

Termite

imidacloprid

ADMIRE® PRO
Systemic Protectant

Fruits & Vegetables

imidacloprid

Neonicotinoid Insecticides

Systemic Insect Control

Insecticide is taken up via roots

Sucking insects

- Aphids
- Lace Bugs
- Leafhoppers
- Mealybugs
- Plant Bugs/Hoppers
- Psyllids
- Scale Insects
- Spittlebugs
- Thrips
- Whiteflies

Chewing insects

- Beetles
- Borers
- Mole Crickets
- Gall Wasps
- Grubs
- Leafminers
- Termites
- Weevils

Efficacy of Neonicotinoids against Melon Aphids and Papaya Mealybug on Native *Hibiscus* sp.

Melon Aphid, *Aphis gossypii*
Papaya Mealybug, *Paracoccus marginatus*

Efficacy of Neonicotinoids against Melon Aphids and Papaya Mealybug on Native *Hibiscus* sp.

Control
Pretreatment

Control
7 WAT

Merit 2.5G
Pretreatment

Merit 2.5G
7 WAT

Papaya Mealybug on Native *Hibiscus* sp

Coretect Pretreatment

Coretect 7 WAT

Safari 2G Pretreatment

Safari 2G 7 WAT

*Drench application must be applied to the feeder roots that has adequate soil moisture.

* Subsequently must be irrigated to assure uptake.

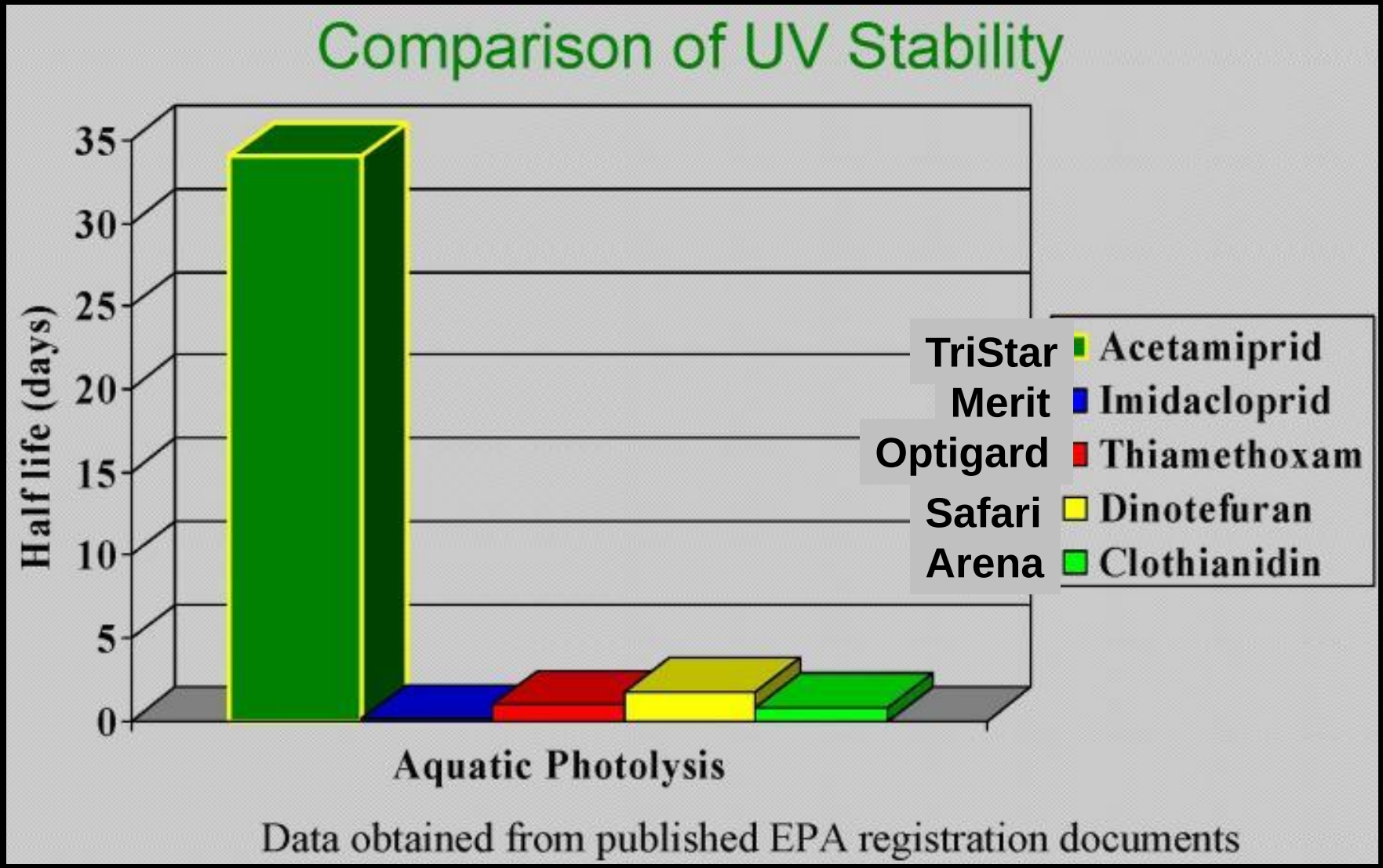
*Liquid fertilizer added to insecitcide may assist uptake.

*Competition by groundcovers or turf contributes to effective uptake.

Other Systemic Applications:

*Bark spray- thin bark trees

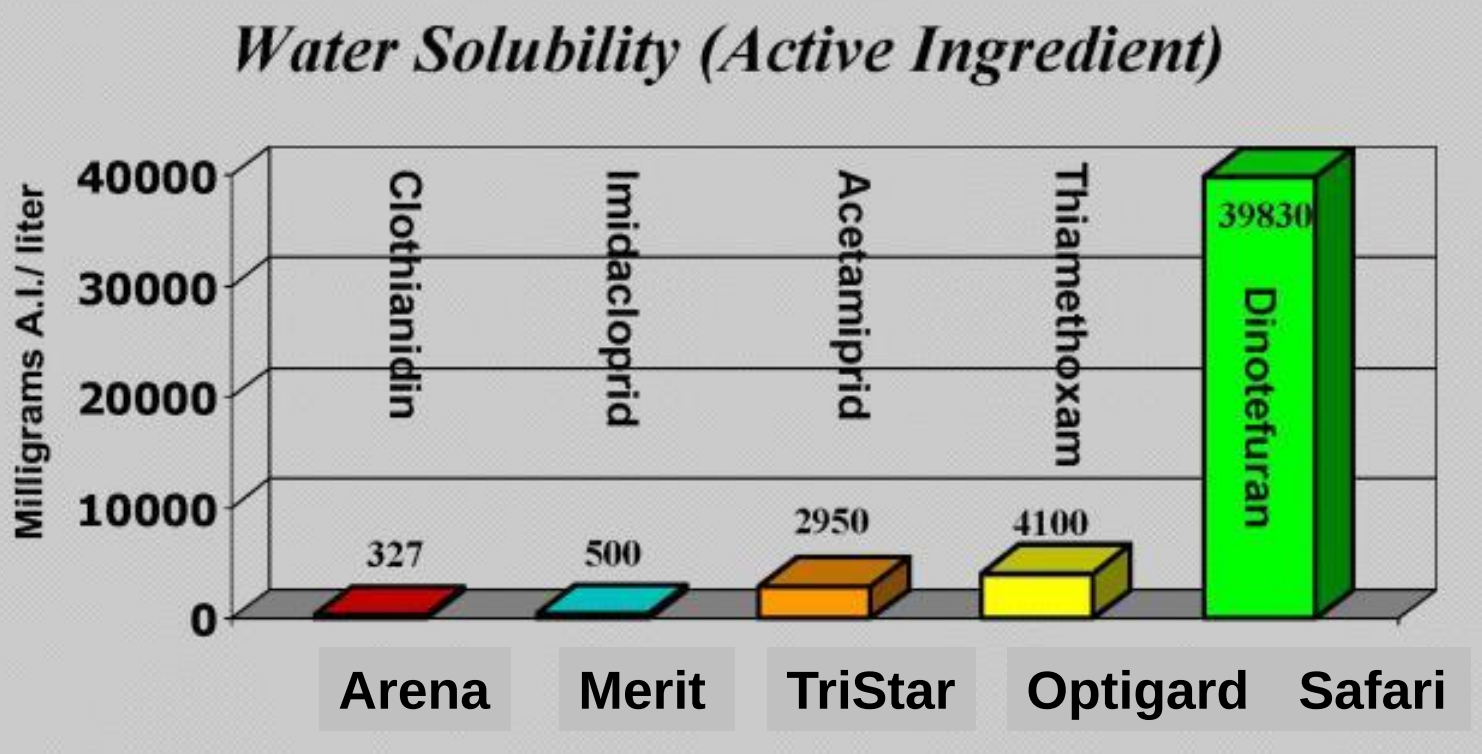
*Injection arborjet



TriStar is registered for foliar use only and the most uv stable of all neonicotinoids.

Slide Credit: R. Fletcher

Relative Water Solubility of Neonicotinoids:



Information sources

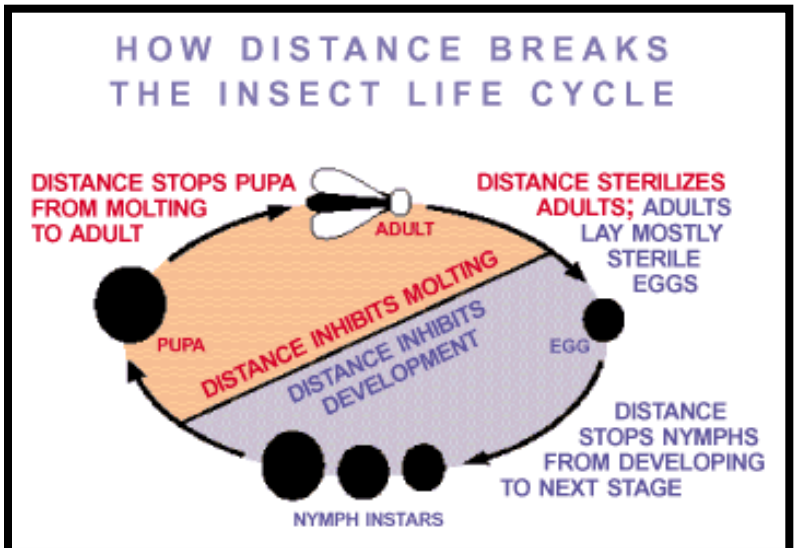
Clothianidin (Celero), Acetamiprid (Tristar), Dinotefuran (Safari) – EPA Pesticide Fact Sheet
Imidacloprid (Marathon), hiamethoxam (Flagship) – MSDS for Products

Slide information courtesy J. Chamberlin

Distance® Insect Growth Regulator
Esteem, Knack (JH mimic)

*Good control of whiteflies and armored scales.
*Also controls fungus gnats, shore flies; suppresses aphids and mealybugs.
*Directly inhibits egg and larval development, and adult reproduction.
*Exhibits translaminar movement in plant leaves, providing gradual and long-term insect control (compared to contact insecticides) on the underside of leaves as well as the top.

Highly effective against Armored Scales
8-12 oz/100 gal
2nd application in 14-28 days
No more than 4 X per year



Distance (Juvenile Hormone mimic) is effective against whiteflies

Untreated — 27 Days After Treatment — Treated

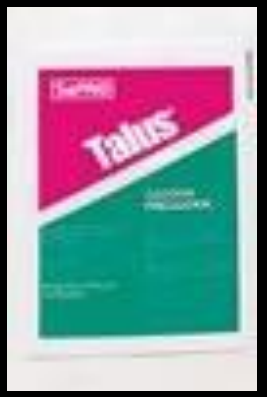
Also effective against fungus gnats and armored scales

Buprofezin

Insect growth regulator

Talus = ornamentals, Sepro

Applaud = food crops, Nichino



*Inhibits chitin synthesis which interrupts molting, suppresses oviposition & reduces egg viability.

*High level of activity against most homopteran insect pests including whiteflies, mealybugs, soft scales, armored scales, leafhoppers and planthoppers.

*Vapor activity allows buprofezin to reach the undersides of leaves and new growth.

Whiteflies	Mealybugs	Soft Scales	Armored Scales
Silverleaf	Longtailed	Black	Coconut
Greenhouse	Citrus	Brown	Cockerell
Sweet potato	Mexican	Hemispherical	Fern
Ash	Obscure	Wax	Boisduval
	Comstock	Tessellated	White peach
			Cycad

Pests of Ornamentals in Hawaii

Oils

*Horticultural oils (petroleum, vegetable & essential) are effective in controlling insects by suffocation.
*Safe to the environment and nontarget organisms.
*No development of resistance.
*Major disadvantage like soap is plant injury.
*Essential plant oils include cedar, lavender, citrus (citronella, lemon, orange) peppermint, eucalyptus, etc.
*Neem oil works as an oil only as the oil fraction from the neem seed is free of the insect growth regulator & repellent, azaditrachtin (Azatin).
*Limonene, refined from citrus oil is thought to be a nerve poison causing excessive motor nerve acitivity.

Horticultural Oils against Spider Mites

"For spider mites, a low rate of horticultural oil, 0.5%, can be exceptionally effective and is compatible with predaceous mites. Nurseries that adopted the use of low dosage oil for managing mites, while at the same time avoiding use of acephate or pyrethroids, essentially saw their spider mite problems disappear."

Richard Cowles, Entomologist
The Connecticut Agricultural Experiment Station
July 20, 2013

Insecticidal Soaps and Detergents

*Soaps and detegents destroy the oily & waxy exoskeleton insects.

*Broad-spectrum against most insects causing them to drown in water.

*Major disadvantage to injury to plant tissue, especially at higher rates >1-2%.

*Do not apply under hot conditions (>90 F).

*Soaps and detergents act strictly as contact insecticides, with no residual effect. To be effective, sprays must be applied directly to and thoroughly cover the insect.

*Certain brands of hand soaps and liquid dishwashing detergents can be effective for this purpose.

*Dry dish soaps and all clothes-washing detergents are too harsh to be used on plants. (Cranshaw Colorado State)

Insecticide Toxicity to Natural Enemies

Common name (trade name)	Class	Selectivity (affected groups)	Predator Mites	General Predators	Parasites	Duration of impact to natural enemies
carbaryl (Sevin)	carbamate	Broad (insects, mites)	Moderate/ High	High	High	Long
chlorpyrifos (Dursban)	OP	Broad (insects, Mites)	Moderate	High	High	Moderate
fenpropathrin (Tame) similar To (Talstar)	Pyrethroid	Broad (insects, Mites)	High	High	High	Moderate Long for Talstar
Imidacloprid (Merit as a Drench)	Neonico-tinoid	Narrow (sucking, insects)	-	Low	Low	-
Imidacloprid (Merit as a Foliar)	Neonico-tinoid	Narrow (sucking, insects)	-	Moderate	High	Short to moderate
Insecticidal Soap (M-Pede)	soap	Broad (insects, Mites)	Moderate	Moderate	Moderate	Short to none

http://www.ipm.ucdavis.edu/PMG/r302900111.html

Summary

*Don’t blame mongoose and mynah bird on Hawaii Dept. of Ag.

*Biological Control in Hawaii has controlled over 200 invasive pests.

*Biological Control has provided sustainable control of many invasive pests with no negative environmental impact.

*Avoiding the use of broad-spectrum insecticide, such as OP’s carbamates and pyrethroids, will conserve natural enemies.

*Use more selective insecticides and application methods, such as drench application of neonicotinoids (Merit, Safari), insect growth regulators (Distance,Talus), biological insecticides (Bt) to avoid negative effects on natural enemies.

*Use of commercial biological control agents in mass numbers is only effective in enclosed greenhouses and requires permit.

*Biological or microbial insecticides (fungi, nematodes) requires very specific environmental conditions (very humid, moist conditions) for effectiveness.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