MAINTAINING OUR EXPORT ORNAMENTAL MARKETS

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http://www.ctahr.hawaii.edu/haraa/index.asp
Who Regulates Agricultural Imports & Exports to/from Hawai‘i?

USDA, Customs & Border Patrol
HDOA (orchids)
USDA (plants)
HDOA

foreign

US
HDOA
HDOA (plants)
USDA

inter-island
HDOA
• 15-20 new species of arthropods and mollusks arrive annually
• reasons: transportation hub, island ecosystem with many diverse habitats, mild climate, lack of predators, dependent on imports

image: Michael Markieta
Interceptions on Cut Flowers and Foliage
January 2011 – June 2012

Most Prevalent Species:

Ants:
- Ochetellus glaber
- Pheidole megacephala
- Technomyrmex albipes

Mealybugs:
- Nipaecoccus nipae
- Planococcus citri
- Pseudococcus longispinus

Armored Scales:
- Abgrallaspis cyanophylli
- Pinnaspis buxi
- Pseudaulacaspis cockerelli

Soft Scales:
- Ceroplastes rubens
- Saissetia coffeae
- Parasaissetia nigra
California Department of Food and Agriculture  
Sacramento, CA  
Division of Plant Health and Pest Prevention Services  
Interior Pest Exclusion Program

**High Risk Pest Exclusion Reports**
- Foreign Plant Shipments
- Hawaii
- Florida
- Incoming Nursery Stock 008s
- Weekly 008 Reports **NEW**
- Monthly High Risk Interception Reports
- Monthly Nematodes Sample Results
- Parcel Facility Locations
- Suspended Out of State Shippers
- Weekly A and Q Report

**Hawaii Reports**
- A, B, Q Weekly Reports (Hawaii Origin Nursery Stock)
- Approved Nursery Stock Shippers (QC 650)
- Weekly A & Q Interceptions on Cut Flowers, Fruits & Vegetables
FedEx Distribution Center Near San Francisco Airport, San Mateo County

Dec 24, 2010

Inspectors Mike, Erin Herbst

- Numerous inspectors on Christmas Eve
- Roses from South America: "low risk"
- Cleanly packed - no shredded newspaper
- Very clean (no pests)
Flowers and foliage from Hawai‘i are considered “high risk”.

Sphaerobolus stellatus

Fungal spore mass

a snail

20/15 vision

hand lens
Inspection at FEDEX Distribution Center in Oakland

With Ken Peek, Senior Agricultural Biologist, December 21, 2010
Hawaiʻi Basil Inspected in HNL Rejected at SFO Airport

USDA-APHIS-PPQ “RELEASED” stamped shipments of cut flowers and vegetables from sources not under Compliance Agreements are inspected prior to shipment by federal inspectors to determine compliance with federal quarantines.
Basil Inspection at Air Cargo Facility at San Francisco Airport
March 2013

leafminer

beating basil on table surface
Rejection of maile from Hawaiʻi that originated from the Cook Islands
San Diego County Ag Inspectors

A. Hara gave a presentation to inspectors regarding pest management for potted foliage plants in Hawai‘i to assure pest-free shipments to California.

March 2013
TAKE-AWAY MESSAGES FROM CDFA INSPECTORS

• California considers Hawai‘i “high-risk” for quarantine pests, similar to Florida.

• USDA, Limited Permit Stamps, State Certifications on boxes do not prevent inspections.

• Boxes with Origin Inspection stickers are not inspected as frequently.

• Rubber stamp permits and certificates are often illegible, prompting inspection.

• Invite personnel from CDFA to discuss CA’s origin inspection programs for cut flowers, produce and potted plants with HI inspectors and growers/shippers.

• Public outreach program is needed on shipping clean fresh flowers and foliage to CA (esp. non-growers who ship - florists, weddings, college lu`au, graduations).

smudged State Certification stamp versus legible Origin Inspection sticker
PEST MANAGEMENT OF ORNAMENTAL CROPS

Systems Approach to Quarantine Security

Systems Approach to Nursery Certification (SANC)

Integrated Pest Management (IPM)
DRACAENA FIELD STOCK

lower leaves stripped

canes cut to various heights, potted, grown under shade
HIBISCUS SNOW SCALE

Scientific name: *Pinnaspis strachani* (Cooley)
Order: Hemiptera  Family: Diaspididae (armored scale)
Common names Hibiscus snow scale, lesser snow scale

**HOST PLANTS**

*Hibiscus snow scale* is 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
- hibiscus
- indigenous hi’aloa
- jacaranda
- lychee
- mango
- Mexican creeper
- native cotton (ma’o)
- oleander
- pandanus
- pikake
- plumeria
- poinciana
- sweet potato
- ti
- wisteria

**DESCRIPTION**
The adult female’s armor is tough, flat, irregularly oyster shell- or pear-shaped, white or dirty white. The female body is flat, yellow, and an elongated oval shape without wings, legs, or eyes. Males pupate under armor that is white, long and narrow with three ridges running lengthwise. Adult males emerge with wings, eyes, and legs.

**Damage**

Armored scales feed on plant juices and cause loss of vigor, deformation of infested plant parts, yellowish spots on leaf surfaces, loss of leaves, and even death of the plant. Scales can be seen on the underside of leaves beneath a yellowing area, on plant canes or branches.
Efficacy of Insecticidal Dips to Control Hibiscus Snow Scale on Tip Cuttings of *Dracaena deremensis* ‘Janet Craig Compacta’

- **Pest:** hibiscus snow scale (*Pinnaspis strachani*)
- **Host Plant:** Dracaena ‘Janet Craig Compacta’
- **Purpose:** Efficacy of insecticidal dips as a pre-planting treatment for *Dracaena* tip cuttings
- **Treatments:** 30 canes in each treatment, 3 canes planted in 10 pots per treatment
  - Control
  - Kontos (spirotetramat)
  - Safari 20 SG (dinotefuran)
- **Observations:** Plants were checked at 1 and 2 WAT for phytotoxicity, and at 6 WAT for product efficacy.
- **Results:** At 6 WAT, no live scales were found among pots planted with canes dipped in Safari 20 SG.

**Note:** There was evidence of parasitism in each treatment group: 27% of untreated canes, 47% of Kontos-treated, and 50% of Safari-treated canes.
Efficacy of Foliar or Top Dressing Applications to Control Hibiscus Snow Scale on Potted *Dracaena deremensis* ‘Janet Craig Compacta’

- **Pest:** hibiscus snow scale (*Pinnaspis strachani*)
- **Host Plant:** *Dracaena* ‘Janet Craig Compacta’
- **Purpose:** Efficacy of insecticidal top dressing or foliar applications on rooted 6-wk old potted *Dracaena*.
- **Treatments:** 21 canes in each treatment: 3 canes in 7 pots per treatment
  - Control
  - Kontos (spirotetramat) foliar
  - Safari 20 SG (dinotefuran) foliar
  - Safari 2 G (dinotefuran) granular top dressing
  - Distance (pyriproxyfen) foliar
- **Observations:** Plants were checked twice a week for phytotoxicity at 1 and 2 WAT, and at 4 and 6 WAT for pesticide efficacy.
- **Results:** Only Safari 20SG (foliar) provided efficacy to meet quarantine requirements.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Infestation Rate, % (pots per treatment with live scales)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>100</td>
</tr>
<tr>
<td>Kontos (foliar)</td>
<td>57</td>
</tr>
<tr>
<td>Safari 20SG (foliar)</td>
<td>0</td>
</tr>
<tr>
<td>Safari 2G (top dress)</td>
<td>43</td>
</tr>
<tr>
<td>Distance (foliar)</td>
<td>14</td>
</tr>
</tbody>
</table>
Efficacy of Three Granular Insecticides to Control Hibiscus Snow Scale on *Dracaena* ‘Warneckii’

- **Pest**: hibiscus snow scale (*Pinnaspis strachani*)
- **Host Plant**: Dracaena ‘Warneckii’
- **Purpose**: Efficacy of three granular insecticides against hibiscus snow scale in potted *Dracaena*
- **Treatments**: 32 canes in each treatment: 4 canes in 8 pots per treatment
  - Control (untreated)
  - Safari 2G (dinotefuran)
  - Precise (acephate)
  - Marathon 1%G (Imidacloprid)
- **Observations**: Plants were checked at 1 and 2 WAT for phytotoxicity, and at 10 WAT for pesticide efficacy.
- **Results**: Safari 2G effectively controlled hibiscus snow scale in all treated pots.

Note: Untreated plants exhibited a decrease in scale populations at 10 WAT due to a high number of predacious insects, which were not visible among other treatments.
**COCONUT MEALYBUG**

**Scientific name:** *Nipaecoccus nipeae* (Maskell)
**Order:** Hemiptera  
**Family:** Diaspididae
**Common Name:** Coconut mealybug

**DESCRIPTION**
Adult females range between 1.5 and 2.5 mm long, are oval, reddish-brown to orange and covered with yellowish-orange pyramid-shaped wax filaments. Males emerge from very thin, white cottony wax cocoons as adults with wings, eyes, and legs.

**HOST PLANTS**
Coconut mealybug is known to infest ornamentals and fruit trees, including:
- avocado
- bananas
- banyan tree
- Chamadorea
- citrus
- coconut
- coffee
- Cycas
- Dracaena
- ginger
- grape
- hibiscus
- Heliconia
- lady palm
- orchids
- parlor palm
- potato
- pygmy palm
- queen palm
- Raphis palm
- sago palm

Palm mealybugs are soft-bodied, oval, and pink, measuring 0.5mm as immature nymphs and growing to 8.0 mm when mature. Their bodies are covered by white, waxy material, with short filaments radiating from the margins of the body. Adult male mealybugs are tiny two-winged fly-like insects.

**LIFE CYCLE/BEHAVIOR**
**Egg to Reproducing Adult:** approximately 1-2 months
Males and females cannot be readily distinguished from each other during the first two instars, but the third instar female begins to resemble the adult. When present, immature males change within a pupal cocoon during the third instar prior to emerging as a winged adult.

**REFERENCES:**

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**PALM MEALYBUG**

**Scientific name:** *Palmiculitor palmarum* (Maskell),
**Order:** Hemiptera  
**Family:** Pseudococcidae
**Common Name:** Palm mealybug

**HOST PLANTS**
Palm Mealybugs are known to infest ornamentals and fruit trees, including:
- avocado
- banana
- Chamaedorea
- citrus
- Dracaena
- gardenia
- ginger
- grape
- Heliconia
- hibiscus
- kentia palm
- lady palm
- orchids
- parlor palm
- potato
- pygmy palm
- queen palm
- Raphis palm
- sago palm

**DESCRIPTION**

Palm mealybugs are soft-bodied, oval, and pink, measuring 0.5mm as immature nymphs and growing to 8.0 mm when mature. Their bodies are covered by white, waxy material, with short filaments radiating from the margins of the body. Adult male mealybugs are tiny two-winged fly-like insects.

**DAMAGE**
- Mealybugs weaken plants by feeding on plant juices then excreting honeydew upon which sooty mold grows.
- Black sooty mold growth reduces photosynthesis, causes defoliation, and occasionally death of a young plant.
- Honeydew also attracts ants that can farm and protect mealybugs from predators and parasitoids.

**LIFE CYCLE/BEHAVIOR**
**Egg to Reproducing Adult:** approximately 1-2 months
- Adult female mealybugs lay from 300 - 600 eggs in a compact, cottony, waxy sac protected beneath their posterior ends for 1-2 weeks and die shortly thereafter.
- Within 7-10 days eggs hatch into nymphs (crawlers) that move about searching out places to settle and feed on the plant.
- Male crawlers will pupate and emerge as winged adults.

[http://entweb.okstate.edu/ddd/Insects/mealybugs.htm]
Efficacy Of Granular and Drench Insecticides on Palm Mealybugs in Potted Rhapis Palms

- **Pest**: Palm mealybug *Palmiculutor palmarum*
- **Host Plant**: Rhapis palm *Rhapis excelsa*
- **Purpose**: Efficacy of drench or granular insecticides on palm mealybug in rhapis palms
- **Treatments**:
  - Control
  - Safari 2G (dinotefuran)
  - Safari 20 SG (dinotefuran)
  - Kontos (spirotetramat) (drench)
- **Observation**: Plants checked at 1 and 2 WAT for phytotoxicity and 6,8,10 and 12 WAT for efficacy.
- **Results**: Among Kontos–treated pots, 2 had a live mealybug at 8 and 12 WAT. None of the pots treated with either Safari treatment had live mealybugs from 6-12 WAT.
BANANA MOTH

Scientific name: *Opogona sacchari* (Bojer)
Order: Lepidoptera   Family: Tineidae
Common name: banana moth, sugar cane borer

**DAMAGE**
Banana moth caterpillars feed voraciously on living and decaying plant tissues, which can cause extensive damage and even plant collapse in the advanced stages of infestation.

As they feed, caterpillars excrete "frass," fine powdery indigestible woody tissue held together with silk produced by the caterpillar.

**HOST PLANTS**
Banana moth is known to infest ornamentals and fruit trees, including:
- bamboo
- kentia palms
- banana
- maize
- cacti
- Maranta
- capsicum
- Philodendron
- Chamaedorea
- pineapple
- coconut palms
- Pritchardia
- coffee
- rhapis palms
- Dracaena
- sugarcane
- ficus
- ti
- Heliconia
- yucca

Pupal casings have 2 bent hooks at the abdominal end and can be seen protruding from feeding tunnels (circled).

**LIFE CYCLE/BEHAVIOR**
Eggs to Reproducing Adult: approximately 40-45 days.
- Upon hatching, the young larvae(caterpillars) bore into weakened or dead tissue of the plant, eventually producing characteristic piles of excrement or frass (fine, powdery indigestible plant material held together with silk).
- Maturing pupae work themselves partially out of the infested plant tissue to allow emergence of the adult.
- Adult moths are nocturnal, and are attracted to damaged, stressed plants where they lay their eggs that hatch in about a week. Males are also attracted to lures containing female sex pheromone ([(E, Z)-2,13-octadecadienyl]).

**BEST MANAGEMENT PRACTICES FOR BANANA MOTH**

<table>
<thead>
<tr>
<th>OPTIONS AVAILABLE</th>
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<tbody>
<tr>
<td><strong>MONITORING TECHNIQUES</strong></td>
</tr>
<tr>
<td>- Visually inspect plants for frass.</td>
</tr>
<tr>
<td>- Set out pheromone traps 2-4 ft. off the ground 100' apart to monitor banana moth populations in and around the nursery. Pheromone lures are available from <a href="http://www.pherobank.com">www.pherobank.com</a>.</td>
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<table>
<thead>
<tr>
<th>SELECT BEST CONTROL METHOD</th>
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</thead>
<tbody>
<tr>
<td>- Minimize attracting egg-laying banana moths by avoiding conditions that stress plants (over-pruning, poor nutrition, overcrowding, over- or underwatering, stem and trunk wounds).</td>
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<tr>
<td>- Clear exterior perimeter of shade house of banana moth host plants.</td>
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<tr>
<td>- Remove and properly discard or destroy infested plants or plant parts.</td>
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<tr>
<td>- Mass-trapping male moths with pheromone lures could possibly disrupt reproduction and reduce population.</td>
</tr>
<tr>
<td>- Spray treatments of chloropyrifos (a restricted use pesticide, RUP) or pyrethroids at 2-week intervals for 2-3 applications.</td>
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<tr>
<td>- <em>Bacillus thuringiensis</em> (B.t.) may be used as a preventative treatment prior to infestations becoming extensive; however, effective applications of B.t. to the site of boring/feeding is very difficult.</td>
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<tr>
<td>- Applications of entomogenous nematode such as <em>Steinernema carpocapsae</em> may also reduce populations of banana moth.</td>
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<tr>
<th>TREATMENT BEFORE MARKET</th>
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<tr>
<td>- Hot water treatments at 120° F for 10 minutes (all stages)</td>
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<tr>
<td>- Hot air treatments at 111° F for 30 minutes (eggs, larvae)</td>
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<thead>
<tr>
<th>FINAL INSPECTION</th>
</tr>
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<tbody>
<tr>
<td>- Visually inspect for pupal casings, caterpillar feeding damage and frass.</td>
</tr>
<tr>
<td>- Remove infested plant material.</td>
</tr>
</tbody>
</table>

**PRECAUTIONARY STATEMENT / DISCLAIMER:** These recommendations are provided only as a guide. Please read and follow all label directions.
AMBROSIA BEETLES

Scientific names: Xyleborus perforans, X. affinis, X. ferrugineus
Order: Coleoptera   Family: Curculionidae
Common names: island pinhole borer, ambrosia beetle, sugarcane shot hole borer

HOST PLANTS
Ambrosia beetles are known to infest ornamentals and fruit trees, including:
- anthurium
- avocado
- brush box
- Dracaena
- cacao
- Christmas berry
- citrus
- coconut palms
- coffee
- ti
- eucalyptus
- guava

Damage
Sawdust tubes are extruded from tunnels bored by adult beetles.
Pinholes with staining and sawdust tubes are signs of ambrosia beetle damage.

DAMAGE
Adult females are slightly larger (2 to 3 mm) than males (1.5 mm). They are stout bodied, dark reddish brown, and have a hunched-back appearance, with their heads completely hidden when viewed from above.

LIFE CYCLE/BEHAVIOR
Egg to Reproducing Adult - approximately 50-55 days
- Adult females bore into host plant trunks and branches, excavating tunnels or galleries.
- Gallerieries are inoculated with a symbiotic fungus ("ambrosia") on which adults and larvae feed.
- Matings, egg laying and larval development are completed within these galleries.
- Mature females leave infested plants and fly to new hosts; flightless adult males remain within the infested plant.


BEST MANAGEMENT PRACTICES FOR AMBROSIA BEETLE

OPTIONS AVAILABLE

MONITORING TECHNIQUES
- Visually inspect plants for sawdust strings from gallery excavation and stains from ambrosia fungus near beetle tunneling.
- Check plantings near water sources, which may be more susceptible to ambrosia fungi infection.
- Set out ethanol traps 1-5 feet off the ground, 30-50 feet apart to monitor ambrosia beetle populations in the nursery.

SELECT BEST CONTROL METHOD
- There are no effective treatments once beetles bore into plant trunks or stems; preventative measures include:
  - Keep plant stock healthy to minimize attracting ambrosia beetles.
  - Remove and properly discard or destroy infested plants or plant parts.
  - Use pyrethroids or chlorpyrifos (a restricted use pesticide, RUP) as preventative dips or trunk treatments every two weeks in 3 to 4 applications to reduce infestations (systemic insecticides are not as effective because beetles do not feed on plant material).

TREATMENT BEFORE MARKET
- Remove infested plant material.

FINAL INSPECTION
- Visually inspect for evidence of ambrosia beetle infestation (sawdust).

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LURES FOR MONITORING AND POPULATION REDUCTION

Banana moth pheromone lures attract adult males

Lindgren funnels with ethanol lures attract and trap ambrosia beetles
New Microbial Insecticide (MBI 203)

- Discovered by Dr. Phyllis Martin (USDA-ARS); developed by Marrone Bio Innovations
- New species of *Chromobacterium subtsugae* isolated from forest soil in U.S. Activity from compounds produced by the bacterium; is not a live product.
- Active by ingestion and contact (potent anti-feeding agent).
- Death in 2-5 days for chewing insects and 4-7 days for sucking insects.
- Toxic to multiple orders of insects (sucking and chewing insects (Lepidoptera, Coleoptera) and flies).
- LOW RISK to non-target mammals, fish, birds, parasitic wasps, honeybees, lacewings, ladybeetles
- GRANDEVO (registration pending for HI)
LITTLE FIRE ANT

Scientific name: *Wasmannia auropunctata* (Roger)
Order: Hymenoptera  Family: Formicidae
Common name: little fire ant

**DESCRIPTION**
- Little fire ant (LFA) workers are approximately 1.5 mm in length, reddish to golden brown, and move very slowly. They can be identified by looking for distinctive characteristics under magnification.
  - 2 grooves on the front of the head where the antennae can lay at rest (antennal scobes).
  - antennae end in two-segmented clubs
  - long, pointy spines on the upper abdomen (propodeum)
  - 2 nodes (petiole and post-petiole)

Queens are winged, dark brown and approximately 3 times the size of workers, 4.5-5.0 mm in length. Nests may have multiple queens who lay eggs that develop into sterile workers or reproductive adults.

Adult males are winged, dark brown with yellowish antennae and legs, and approximately 4.5 mm in length with a slender body. At their posterior ends are very conspicuously curved genitalia.

**BEST MANAGEMENT PRACTICES FOR LITTLE FIRE ANTS**

<table>
<thead>
<tr>
<th>OPTIONS AVAILABLE</th>
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<tbody>
<tr>
<td><strong>MONITORING TECHNIQUES</strong></td>
</tr>
<tr>
<td>- Inspect all incoming propagative materials and plants before moving them into the nursery.</td>
</tr>
<tr>
<td>- Survey nursery/field stock for LFA using peanut butter smeared thinly on wooden chopsticks placed every 10 ft along perimeters and within shadehouses or fields. After 30-45 min, retrieve and inspect the sticks for foraging ants. (Refer to UH CTAHR publication IP-24 for more details.)</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>SELECT BEST CONTROL METHOD</th>
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</thead>
<tbody>
<tr>
<td>- Inspect all field/nursery stock movement.</td>
</tr>
<tr>
<td>- Treat with an approved bait insecticide and survey 2-3 weeks after treatment. Repeat these steps until ants are no longer found when surveying.</td>
</tr>
</tbody>
</table>
  - Granular baits:
    - *Amdro* (0.73% hydramethylnon)
    - *Extinguish Plus* (0.365% hydramethylnon, 0.250% S-methoprene)
    - *MaxForce Complete* (1.0% hydramethylnon)
    - *ProbaIt* (0.73% hydramethylnon)
    - *Tal-Star* (7.96% bifenthrin)
  - Tango - IGR (insect growth regulator) (S-methoprene)
  - Contact / residual sprays to kill foraging workers |

<table>
<thead>
<tr>
<th>TREATMENT BEFORE MARKET</th>
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<tbody>
<tr>
<td>- Hot water shower at 113°F for 10 minutes will kill adult LFA.</td>
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<tr>
<td>- Apply approved ant bait to kill ant colony.</td>
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<table>
<thead>
<tr>
<th>FINAL INSPECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Visually inspect plants for LFA on plants or pots.</td>
</tr>
<tr>
<td>- Place a wooden chopstick with peanut butter in pots for 30-45 minutes to ensure that no LFA are present.</td>
</tr>
</tbody>
</table>

**Precautionary statement / Disclaimer:** These recommendations are provided only as a guide. Please read and follow all label directions.
BAITING ALONG BORDERS FOR LITTLE FIRE ANTS (LFA)

Recommendations:
- Apply baits every 3-4 weeks.
- **Survey with peanut butter every 2-3 weeks and reapply baits as needed.**
- Extinguish Plus and Tango (IGR, S-methoprene - interferes with egg dev and queen reprod)
- **Rotate** ant baits with different AI (may become repellent)

ANT BAIT APPLICATIONS

- 3/13/12 Amdro
- 4/2/12 Extinguish Plus
- 4/28/12 Amdro
- 5/4/12 Amdro
- 5/20/12 Amdro
- 6/23/12 Extinguish Plus
- 7/28/12 Amdro
- 8/19/12 Extinguish Plus
- 11/12/12 Extinguish Plus
- 1/13/13 Amdro
- 3/9/13 Extinguish Plus (ground), Tango (trees)
WHITEFOOTED ANT

Scientific names: Technomyrmex albipes, T. difficilis, T. vitiensis
Order: Hymenoptera, Family: Formicidae
Common name: whitefooted ant

DESCRIPTION
Adults have different body types according to their role in the colony
- Adult workers are females, wingless, 2 to 4 mm (< ¼") long, and dull black with yellowish-white lower legs.
- Queens are larger, winged early in life, and lay fertile and infertile eggs throughout their lives.
- Males are wingless, short-lived, and function only in reproduction.

DAMAGE
- Damage by whitefooted ants (WFA) is usually indirect since they tend honeydew-producing insects (mealybugs, aphids, soft scales, whiteflies), protecting them from control by natural enemies.
- Although WFA are strongly attracted to sweet foods, such as plant nectar and honeydew, they also feed on decaying plant and animal tissue.
- WFA are a nuisance to homeowners as they forage indoors and outdoors, attracted by food and electrical contacts.

LIFE CYCLE / BEHAVIOR
The lifespan of worker ants is not known, but queens can live more than a year.
- Eggs are tiny (.5 mm), white or yellowish, oval, and are found, along with other developmental stages, in the nest constructed of dirt and plant debris (such as red ginger flowers).
- Young larvae are legless, pale, and shaped like a crook-necked gourds (heads at smaller, narrow end).
- Larvae develop into pupae without cocoons; both pupae and larvae are often mistaken for eggs.
- Whitefooted ants are very difficult to control because they do not exchange baits orally. If the majority of workers feed on the bait and die, the rest of the colony will eventually die of starvation.

HABITAT
- White-footed ants are often found in forested areas, between 1,000 to 5,000 feet elevation, where annual rainfall exceeds 60 inches; however, these ants occur down to sea level in Hawaii (HDOA).
- WFA nest in vegetation, as well as in houses and other structures, preferring to be near moisture and food sources, and where they are protected from predators.

WFA can be found nesting in trees, under bark, in branch crotches, undersides of leaves, and rotting logs.

References:

BEST MANAGEMENT PRACTICES: WHITE-FOOTED ANT

<table>
<thead>
<tr>
<th>OPTIONS AVAILABLE</th>
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<tbody>
<tr>
<td>MONITORING TECHNIQUES</td>
</tr>
<tr>
<td>- Inspect all incoming propagative materials for ants before introducing into them into the nursery.</td>
</tr>
<tr>
<td>- Limit plant overcrowding to slow the spread of ants in the field.</td>
</tr>
<tr>
<td>- Survey nursery/field stock with sugar water or liquid sugary baits plus borax (sodium tetraborate decahydrate) for presence of white-footed ants.</td>
</tr>
<tr>
<td>SELECT BEST CONTROL METHOD</td>
</tr>
<tr>
<td>- Inspect all field/nursery stock for ants before movement.</td>
</tr>
<tr>
<td>- Use contact pyrethroid insecticides, such as bifenthrin, which are effective on workers.</td>
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<tr>
<td>- Incorporate bifenthrin in pot media when planting.</td>
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<tr>
<td>- Keep area free of any plant debris where ants can hide.</td>
</tr>
<tr>
<td>- Use baits containing borates, which can kill workers by starvation (the toxicant cannot be orally transferred between workers but may eventually end up in eggs).</td>
</tr>
<tr>
<td>TREATMENT BEFORE MARKET</td>
</tr>
<tr>
<td>- Place liquid sugary baits around holding area to monitor for ants.</td>
</tr>
<tr>
<td>FINAL INSPECTION</td>
</tr>
<tr>
<td>- Visually inspect all plants for ants before shipment.</td>
</tr>
<tr>
<td>- Treat with a pyrethroid insecticide before shipping to assure there are no live ants.</td>
</tr>
</tbody>
</table>

Precautionary statement / Disclaimer: These recommendations are provided only as a guide. Please read and follow all label directions.
WHITE-FOOTED ANT: FIELD BAIT ATTRACTION @ 45 MIN OF EXPOSURE

<table>
<thead>
<tr>
<th>Product</th>
<th>Number of Ants @ 45 min:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peanut Butter</td>
<td>0.2</td>
</tr>
<tr>
<td>Maxforce Quantum</td>
<td>17.0</td>
</tr>
<tr>
<td>Maxforce Complete</td>
<td>0.6</td>
</tr>
<tr>
<td>Terro</td>
<td>12.8</td>
</tr>
<tr>
<td>Optiguard Gel</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Peanut Butter
Maxforce Quantum (imidacloprid)
Maxforce Complete (hydramethylnon)
Terro (borax)
Optigard Gel (thiamethoxam)
CUBAN SLUG

Scientific name: Veronicella cubana
Common names: Cuban snail
Clade: Heterobranchia

Semi-Slug

Scientific name: Parinarion sp.
Common names: Semi-slug
Subclass: Pulmonata

GARDEN SLUG

Scientific name: Deroceras reticulatum (formerly Agriolimax meticulatus)
Subclass: Pulmonata
Family: Agriolimacidae
Common name: Gray garden slug

HOST PLANTS
Garden slugs prefer succulent foliage or flowers, pests primarily of seedlings and herbaceous plants, ripening fruits, and foliage plants.

Description
The gray garden slug is variable in color: creamy to light coffee colored, rarely blackish with spots. Eggs are white, slightly transparent, similar to other slug eggs (~1mm diameter).

Damage
Feeding habits are similar to other slugs. Small irregular holes with smooth edges are commonly found on plants. Slime trails will be visible.

Slime and feeding trail on algae growing on a pot is evidence of a garden slug in a nursery.

M. striatum and slime trail on Dracaena.

Two Cuban slugs

Weeds, culled plants and debris harbor slugs.

Dorsal view of semi-slug

Deroceras sp. feeding on JC Compacta

M. striatum is a slender slug (up to 45 mm long) usually having 5 regular and straight black longitudinal dorsal bands with the outer 2 dissolving into dots or absent. Upper tentacles are dark.
# BEST MANAGEMENT PRACTICES FOR SLUGS

## OPTIONS AVAILABLE

### MONITORING TECHNIQUES
- Sanitation is the safest and cheapest method to control slugs.
  - Remove debris and stored material where slugs can hide and breed.
  - Remove culled and rotting plant material that slugs can feed on, hide in and breed.
  - Control weeds and algae or moss on walkways and benches where slugs might hide.
  - Check benches in early morning to hand collect slugs.
  - Natural predators include toads, some predacious beetles and their larvae, planaria (flatworms) and the rosy predator snail (*Euglandina rosea* (Ferussac)).

### SELECT BEST CONTROL METHOD
- Create barriers to keep slugs off benches such as:
  - Copper screens
  - Copper hydroxide
- Use repellents to reduce slug populations:
  - Copper hydroxide, also used as a fungicide (*Kocide, Champ*)
  - Bordeaux mixture, a fungicide, containing lime and copper sulfate
  - Spinout (copper hydroxide, Sepro), used as a root growth regulator, as a pot or groundcover treatment.
- Limit watering to reduce moisture, such as using drip irrigation instead of overhead sprinklers.
- Molluscicides with metaldehyde effectively control slugs.
  - In a lab trial, *Deadline* remained effective longer (for 14-21 days) than other products (4% metaldehyde) under wet conditions.

### TREATMENT BEFORE MARKET
- Hot water shower treatments before shipping controls slugs:
  - Cuban slug: 113°F for 13 minutes
  - Semi-slug: 113°F for 3 minutes
  - Garden slug: 113°F for 3 minutes

### FINAL INSPECTION
- Visually inspect all plants for eggs and slugs before shipment.

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GARDEN SLUGS ON AGED COPPER SCREEN

7 hours after release: No slugs crossed the copper screen barrier

GARDEN SLUGS ON NYLON MESH SCREEN

4 hours after release: All slugs crossed the nylon screen barrier

CONTROL: GARDEN SLUGS WITHOUT SCREEN

2 hours after release: All slugs migrated to lettuce
COQUI FROG

Scientific name: *Eleutherodactylus coqui*

Order: Anura  Family: Leptodactylidae

Common names: Puerto Rican tree frog, coqui frog

**LIFE CYCLE**

- **EGGS**
  - Egg diameter averages 4 mm
  - Hatch in 14-17 days
  - Clusters of eggs (average 28 eggs) are laid every 2 to 4 weeks year-round
  - No free-swimming tadpole stage

- **FROGLET**
  - Can live up to a week after hatching on yolk reserve
  - Able to reproduce at 8-12 months old
  - Males begin calling from 6 months of age

- **ADULTS**
  - Females (upper left) grow up to 2” in length, while males (lower right) grow up to 1.5” long
  - Entirely terrestrial
  - Adults may live 4-6 years
  - Males guard eggs to prevent drying and predation

**BEHAVIOR**

- As amphibians, coqui frogs need to keep their skin moist and can tolerate cold better than hot temperatures and direct sunlight.
- They are nocturnal and retreat during the day to sites that provide shade and moisture, such as crevices and rock walls (pictured, top), irrigated nursery facilities, thick vegetation (circle), ground cover, and leaf litter (left).
- Coqui frogs “hitchhike” from infested areas on plants, construction, landscaping and gardening materials, trash, and vehicles (tire wells, truck beds) and are spread along roadways to refuse stations, construction sites, nurseries, garden shops, and residences.
- While adult males can be detected by their call, the presence of eggs, juveniles (<6 months), and adult females often go undetected for months until males mature and begin calling.


**BEST MANAGEMENT PRACTICES FOR COQUI FROGS**

<table>
<thead>
<tr>
<th>OPTIONS AVAILABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MONITORING TECHNIQUES</strong></td>
</tr>
<tr>
<td>- Use sound-activated recorders to detect calling males on-site at night on a monthly basis.</td>
</tr>
<tr>
<td>- Set out PVC lures (pictured)</td>
</tr>
<tr>
<td>- Use 3/4” diameter pipe (8-9” length) with a tee joint. Do not glue. “Weather” the pieces first to reduce PVC odor. Mount no higher than 2-3 ft off the ground at 2-3 ft intervals.</td>
</tr>
<tr>
<td>- Check the PVC lures at least every 2 weeks; remove nesting adults and eggs.</td>
</tr>
<tr>
<td>- Conduct visual inspection routinely</td>
</tr>
<tr>
<td>- Scan plants, media, and leaf litter beneath plants for adults and eggs.</td>
</tr>
<tr>
<td>- Inspect buildings and nurseries before bringing them onto your property.</td>
</tr>
<tr>
<td>- Inspect your vehicle (tire wells, truck beds) for hitchhiking frogs after leaving infested areas.</td>
</tr>
<tr>
<td><strong>SELECT BEST CONTROL METHOD</strong></td>
</tr>
<tr>
<td>- Minimize retreat and nesting sites</td>
</tr>
<tr>
<td>- Avoid stockpiling discarded plant material.</td>
</tr>
<tr>
<td>- Re-landscape with less broad-leaved plants.</td>
</tr>
<tr>
<td>- Install screening barriers (pictured) to keep frogs out of designated areas (fine mesh screen at a 90° angle that frogs cannot cross).</td>
</tr>
<tr>
<td>- Hot water “sprech” (spray + drench)</td>
</tr>
<tr>
<td>- Set hot water heater to 120°F and “sprech” plants for adults and eggs.</td>
</tr>
<tr>
<td>- Chemical “sprech” with weekly monitoring for frogs</td>
</tr>
<tr>
<td>- Natural pyrethrins with piperonyl butoxide (PBO), or 8% citric acid as contact spray</td>
</tr>
<tr>
<td>- 16% citric acid as contact spray (may burn sensitive plants, including orchids; can be rinsed off 1 hour after application to minimize phytotoxicity but will reduce effectiveness on treated eggs by 15%).</td>
</tr>
<tr>
<td>- Continue to inspect and listen for frogs weekly after spraying.</td>
</tr>
<tr>
<td><strong>TREATMENT BEFORE MARKET</strong></td>
</tr>
<tr>
<td>- Hot water shower</td>
</tr>
<tr>
<td>- 109-113°F for 5 min for eggs, juveniles, adults</td>
</tr>
<tr>
<td>- Place treated plants in a coqui-free holding area to prevent re-infestation prior to transport.</td>
</tr>
<tr>
<td><strong>FINAL INSPECTION</strong></td>
</tr>
<tr>
<td>- Use sound-activated recorders (pictured) to detect calling males in shipments at night for at least two nights prior to movement/sale.</td>
</tr>
<tr>
<td>- Use visual inspection for frogs and eggs in cryptic areas and plant parts.</td>
</tr>
</tbody>
</table>
Mahalo

WORK SUPPORTED BY:

HI Department of Agriculture and USDA Farm Bill "Systems Approach to Pest Management Practices – Potted Foliage Plant Production – Phase I" (Agreement 11-8510-1475-CA)

USDA NIFA e-IPM Coordination and Support Program "University of Hawaii Extension IPM" (20104153421394)

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