

# Coconut Rhinoceros Beetle, *Oryctes rhinoceros*

## A Major Threat to Hawaii's Coconut and Palm Trees



*Crop Production Services  
Seminar & Tradeshow  
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*Arnold H. Hara  
University of Hawaii at Manoa  
College of Tropical Agriculture & Human Resources  
875 Komohana St. Hilo, Hawaii  
E-mail: [arnold@hawaii.edu](mailto:arnold@hawaii.edu)*

# Topics to Be Covered

## \***Coconut Rhinoceros Beetle**

- Known serious threat to Hawaii because of a severe CRB infestation in Guam since 2007
- Discovery in Hawaii in Dec 2013
- Attempt to eradicate the infestation
  - +Control strategies
    - =Physical Control (tub grinding infested mulch, bird netting)
    - =Chemical (pyrethroids and neonicotinoids)
    - =Heat (steam and hot water)
    - =Composting (In-vessel - heat and ammonia toxicity)

## \*"Oahu's Banyan Trees Are Under Attack, Many Are Dying"

*By Denby Fawcett 05/13/2014 CIVIL BEAT*

"Two major insects are attacking and killing Oahu's banyan trees."

**Lobate Lac Scale** (Serious pest in Florida began 10 years ago)

**Ficus Stem Gall Wasp** (new to science)

# LIFE CYCLE OF THE COCONUT RHINOCEROS BEETLE (CRB)

Adult females lay eggs in dead coconut palms, decaying organic matter or mulch.



Grubs (larvae) hatch in 8 to 12 days from whitish brown eggs (<math><1/4\text{''}</math> long) laid in organic matter.

Adults live 4 to 9 months; each female lays 50 to 140 eggs during her lifetime.



1-1/4 to 2-1/4" long



Beetle feeding damage: hole bored into trunk (below); leaves with V-cuts (right)



Grubs feed on decomposed organic matter for 82 to 207 days, and grow from  $\frac{1}{4}$ " to 4" long (3 instars).

Adult beetles remain in pupae for 17- to 22 days, then emerge and fly to palm crowns to feed on exuded sap.



Grubs enter non-feeding prepupal stage for 8 to 13 days usually in the soil; pupal stage lasts 17 to 22 days.



Egg to egg-laying adult  
**(132 to 282 days)**

# Coconut Rhinoceros Beetle (CRB)

Native range: Southeastern Asia

\*CRB was introduced throughout the Pacific, primarily as a result of the increased sea traffic during World War II.

\*Prior to discovery in Hawaii, CRB was discovered in Guam on Sep 2007.

Female with  
shorter horn  
than male

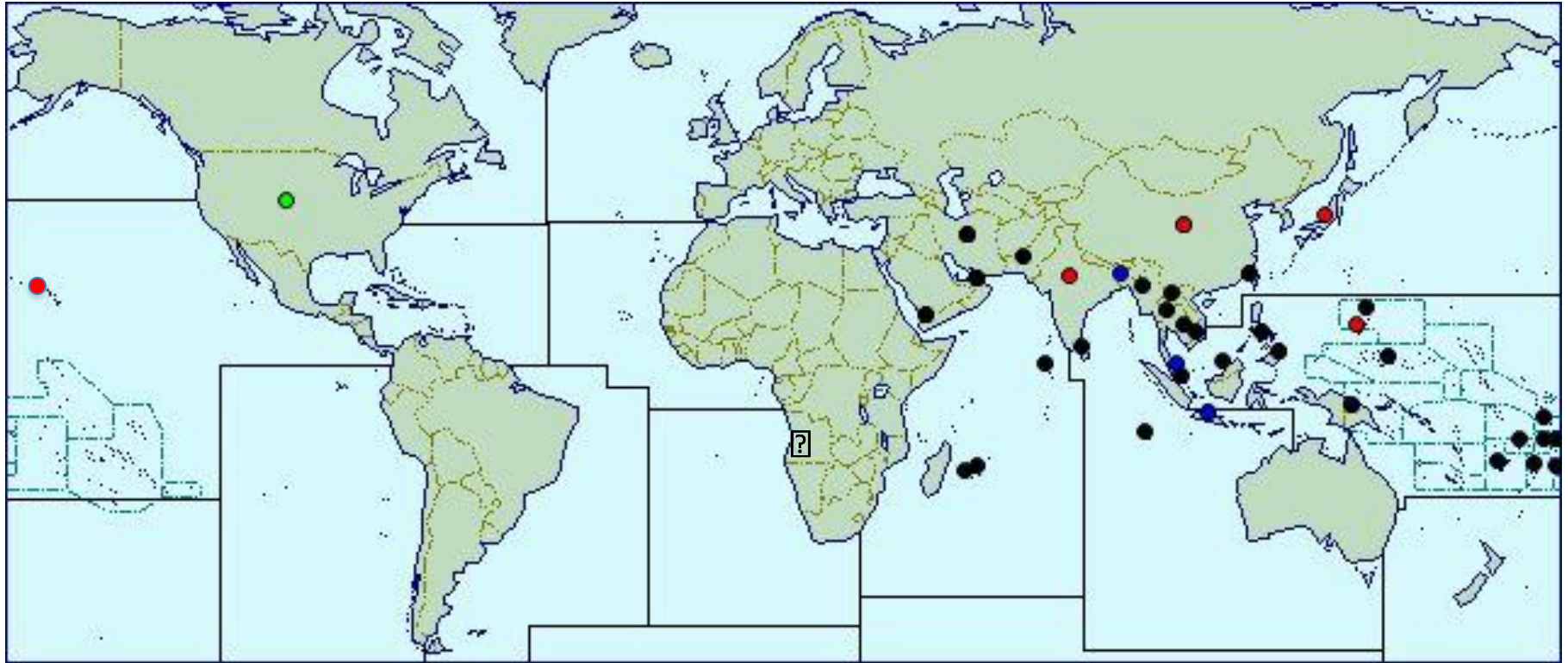


Female  
with fuzzy  
orange  
rear

**Bores into live coconut and palms trees and feeds on exuding sap.**



# Distribution of Coconut Rhinoceros Beetle (CRB)



**Africa:** Mauritius, Mayotte, and Reunion; **Asia:** Bangladesh, Brunei, Burma, Cambodia, Chagos Archipelago, China, Cocos Islands, India, Indonesia, Japan, Laos, Malaysia, Maldives, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam; **Middle East:** Iran, Oman, Pakistan, and Yemen; **Oceania:** American Samoa, British Indian Ocean Territory, Fiji, Guam, Niue, Palau, Papua New Guinea, Samoa, Tokelau, Tonga, Wallis and Futuna.

## **Known Hosts**

Preferred larval habitat is rotting *Cocos nucifera* (**coconut**) wood, followed by *Artocarpus* spp. (breadfruit), *Calophyllum inophyllum* (**kamani**), *Mangifera* spp. (**mango**), and *Pandanus* spp. (**hala**). The larvae of *O. rhinoceros* feed on rotting organic matter.

Adults feed on several species of palm as well as coconut.

Hosts of adults include:

### **Major hosts**

*Cocos nucifera* (coconut), *Elaeis* spp., and *Elaeis guineensis* (African oil palm).

# Minor hosts for adults

*Acanthophoenix rubra* (barbel palm), *Agave sisalana* (sisal agave), *Agave americana* (American agave), *Aiphanes horrida* (= *A. caryotifolia*) (ruffle palm), *Ananas* spp. (**pineapple**), *Ananas comosus* (pineapple), *Areca* spp. (**areca palm**), *Areca catechu* (betel-nut palm), *Arecastrum plumosa*<sup>1</sup>, *Arenga* spp. (arenga palm), *Arenga pinnata* (sugar palm), *Borassus* spp. (borassus palm), *Borassus flabellifer* (palmyra palm), *Caryota urens* (**fish-tail palm**), *Casuarina equisetifolia* (Australian pine), *Clinostigma samoense* (= *Cyphokentia samoensis*), *Colocasia* spp. (**taro**), *Corypha* spp. (gebang palm), *Corypha umbraculifera* (talipot palm), *Corypha utan* (= *C. elata*) (buri palm), *Cyathea* spp. (**tree fern**), *Dictyosperma album* (red palm), *Dypsis pinnatifrons* (= *D. gracilis*), *Heterospathe elata* var. *palauensis*, *Hydriastele palauensis* (= *Gulubiopsis palauensis*), *Hyophorbe lagenicaulis* (= *Mascarena lagenicaulis*) (**bottle palm**), *Latania* spp., *Livistona* spp. (livistona), *Livistona chinensis* (**Chinese fan palm**), *Metroxylon* spp. (metroxylon), *Metroxylon amicarum* (= *Coelococcus carolinensis*) (Caroline ivory-nut palm), *Metroxylon sagu* (**sago palm**), *Musa* spp. (**banana**), *Normanbya* spp., *Nypa* spp., *Nypa fruticans* (nipa palm), *Oncosperma* spp., *Pandanus* spp. (**pandanus palms**), *Pandanus tectorius* (Tahitian screwpine), *Phoenix* spp. (**date palm**), *Phoenix dactylifera* (date palm), *Phoenix sylvestris* (wild date palm), *Pinanga* spp., *Pinanga insignis* (= *Pseudopinanga insignis*), *Pritchardia pacifica* (Fiji fan palm), *Raphia farinifera* (= *R. ruffia*) (raffia palm), *Raphia vinifera* (**bamboo palm**), *Roystonea regia* (royal palm), *Saccharum* spp. (**sugarcane**), *Stevensonia* spp., *Thrinax* spp. (thatch palm), *Verschaffeltia splendida* (Seychelles stilt palm), and *Wodyetia bifurcata* (**foxtail palm**).

# Coconut Rhinoceros Beetle (CRB) damage symptoms in Guam

\*Primary damage is adults boring from the petioles of fronds into the crown cutting through developing unopen fronds feeding on the exuded sap.

\*V-shape cut on open fronds.  
\*Similar to mechanical pruning damage to unopened fronds



Visited Guam in Sept 2013 because of a serious CRB threat to HI

Active adult boring hole thru petiole



Active adult boring hole in petiole; "Wet look"



Coconut fibers caused by adult boring







**Beetles bore into frond stem and growing tips with their legs (tarsi, circled below) that are lined with very sharp, prickly spines, to feed/suck on plant sap, not on foliage itself.**

Small  
mouthparts



Damage to emerging Foxtail palm frond



Boring with exposed coconut fiber





# Major Breeding Site in Coconut Trimming Debris, Asan, Guam





# Major Breeding Site with all CRB stages, Asan, Guam





# Asan Beach Guam



Dead  
Coconut  
Tree with  
CRB



Adults and  
grubs found  
in rotting  
coconut trunk  
terminal



# Joint Base Pearl Harbor-Hickam Military Facility



## Mamala Bay Golf Course

09/13 – CRB trap deployed at Hickam as part of USDA pest survey for coconut pests not yet in Hawaii.

12/23/13 - One coconut rhinoceros beetle (CRB) was caught in a trap about one mile from the infested mulch pile at the edge of the golf course. Infested mulch included all stages of CRB





# Mamala Bay Golf Course (Hickam Air Force Base)

- \*Coconut trees on golf course with CRB feeding damage.
- \*Golf course is near the international runway w/military and commercial flights landing and taking-off overhead.





# Boring damage to folded new terminal growth: Damage is semi-circular





Area of attack by adult beetle



Less recent adult boring hole



Old boring holes through trunk



Adult boring hole thru frond petiole





# Adults and grubs found at the Mamala Bay (Hickam) Golf Course



Infested mulch pile was covered with bird netting to prevent adult emergence (January 11, 2014).

# Evolution of THE CRB TRAP

A



Aggregation  
Pheromone

**FIRST CRB ADULT  
TRAPPED IN  
HONOLULU, HI**

A) Original design bucket covered with burlap; CRB pheromone lure affixed to bucket lid; entry holes just below the rim prevents beetle escape.

B) Single bucket, BLACK vane, pheromone lure, solar UV light

C) Collection cup, black vane, pheromone lure, solar UV light (lighter, easier to deploy)

B



C





## More Efficient CRB Trap in Guam

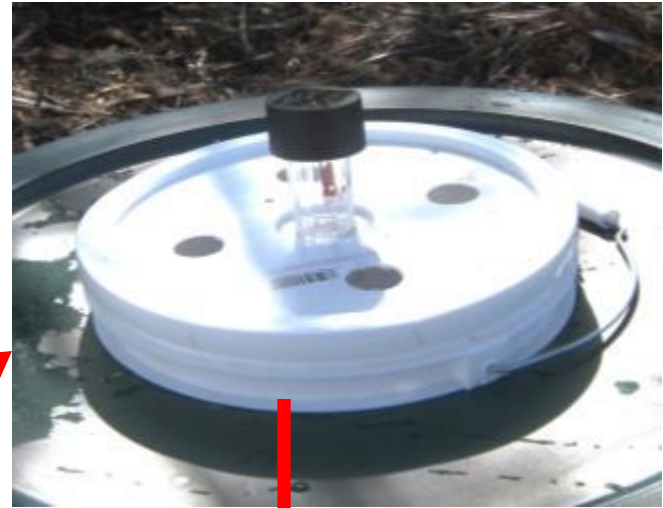
50 gal steel barrel filled with rotting coconut debris, live CRB, grubs & aggregation pheromone. Ultraviolet LED light over trap. Chicken wire allows CRB to enter but cannot fly out.

(Moore & Quitugua, per. com. 09/13)





# Latest Bucket Trap Design by University of Guam



Lid with UV light and entry holes

CRB (L) Oriental Flower Beetle (R)



pheromone lure

## Oriental flower beetle

In Hawaii since 2002.

Adult beetles active during the day (diurnal)

Adult feeds on pollen, nectar, plant sap. May damage flowers of papaya, mango, coconut.



Body up to 1" length

Adult moss green to reddish-black with white or metallic flecks

Crawls straight or  
flips on its back

## Coconut Rhinoceros Beetle

Adult beetles active at night (nocturnal)



Body length  
up to 2.5"  
Largest beetle  
In Hawaii.



Curls into a C-shape,  
crawls on its side



## Coconut Rhinoceros Beetle Infestation

2/21/14

-Double ground mulch (2000 cu yd)  
with tub grinder.

Tub grinder



Mulch after double grinding

Grounded mulch spread and  
covered with plastic and bird  
netting.





# Steaming Ground Mulch



\*Tarp steaming tested but penetration was slow, but has potential for smaller mulch volume.



In collaboration with Dominican University of California



# Thermal Mortality of CRB

Conducted in collaboration with Dr. Michael Melzer (UH-CTAHR, PEPS)

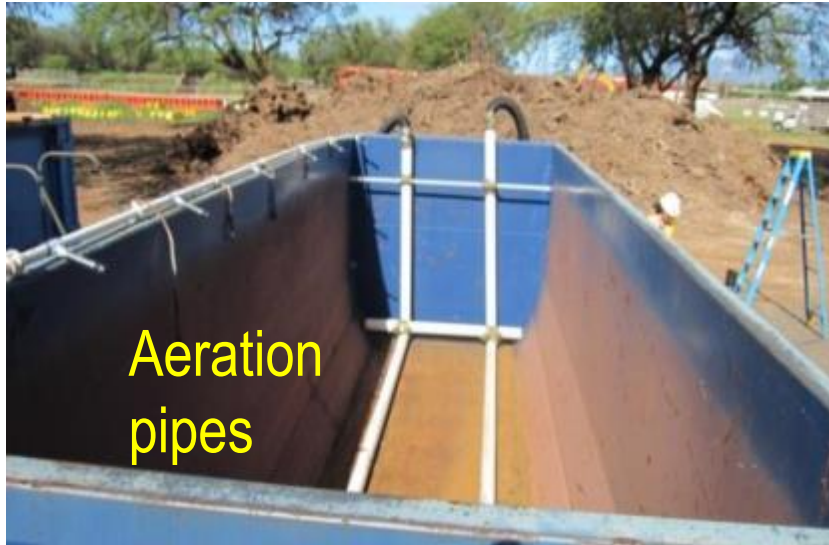
100% Mortality  
Between  
122 F for 10 min  
to 131 F for 5 min



CRB grub borrowing into media



# In-Vessel Composting to Heat Treat CRB-Infested Mulch



**Composting Recipe.** During composting, the limiting nutrient is often nitrogen and the target range for nitrogen is a carbon to nitrogen ratio in the range 30:1 to 60:1. If the nitrogen concentration is inadequate, the compost will not heat up. Nitrogen a concentrated solution of urea and ammonium nitrate (total nitrogen 3.54 pounds per gallon) is used. Temperature rises to 170 F and maintained for 4 days. Ammonia is also toxic.

**CRB grubs = 100% mortality at 131 F for 5 min**



Vessels covered with air blowers operating (tarp is inflated).



# Insecticide Control

Conducted in collaboration with Derek Arakaki (HDOA)

- \*Studies in Guam indicated that cypermethrin (Demon) and the insect growth regulator, pyriproxyfen (NyGard) were effective against CRB.
- \*Quick tests in Hawaii conducted with bifenthrin (Talstar), clothianidin (Arena), cypermethrin with and without the synergist, piperonyl butoxide (pbo).
- \*Tests conducted by spraying insecticides directly on adults and grubs and by treating mulch infested with adults and grubs.

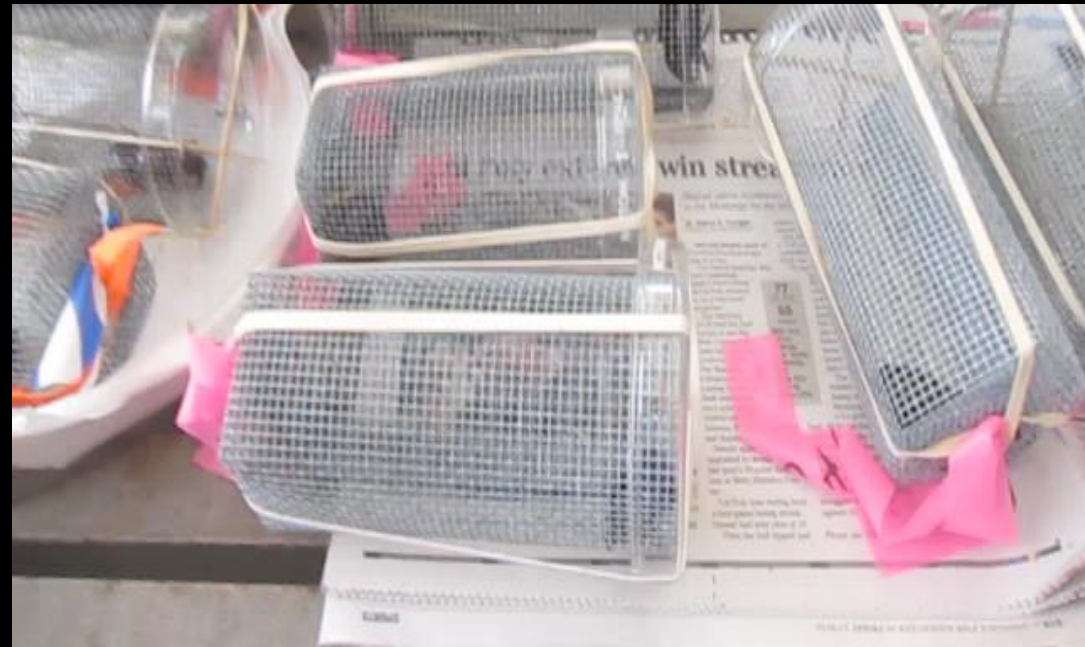


PRODUCT	ACTIVE INGREDIENT	APPLICATION RATE	Number Treated	
			LARVAE	ADULTS
Talstar P Professional Liquid	7.9% bifenthrin	direct contact 0.435 fl oz/gal (2 ml per insect)	10	10
Talstar Xtra GC Granular	0.05% Zeta-cypermethrin 0.20% bifenthrin	mulch treatment 2.1 g /sq ft mulch, wetted with 40 ml water	15	4
Talstar Xtra GC Granular	0.05% Zeta-cypermethrin 0.20% bifenthrin	direct contact 2.1 g/5 fl oz water (1 ml per insect)	10	8
Arena 50 WGD	50.0% clothianidin	direct contact 0.008 g/6 fl oz water (2 ml per insect)	10	5
Demon WP	40.0% cypermethrin	direct contact 0.33 fl oz/gal (0.1%) (1 ml per insect)	10	---
Demon WP + Exponent (synergist)	40.0% cypermethrin + 91.3% piperonyl butoxide	direct contact 0.66 fl oz/gal (0.2%) + 0.33 fl oz/gal (2 ml per insect)	10	10





45 minutes after treatment, Talstar treated beetles were more active than untreated.



2 h 15 min after treatment, beetles were laying on backs with legs twitching or no movement. However, all treated beetles recovered from poisoning after 48-72 hr.

- \*Pyrethroids did not kill all grubs; no grubs were killed by neonicotinoid insecticides.
- \*Adults were paralyzed by pyrethroids but recovered after 48-72 hours.
- \*Addition of piperonyl butoxide (pbo), a synergist, killed adults and grubs

Pyrethroid- treated adults are initially paralyzed (on backs with legs twitching) but recover after 48-72 hrs.



Live grubs used in tests

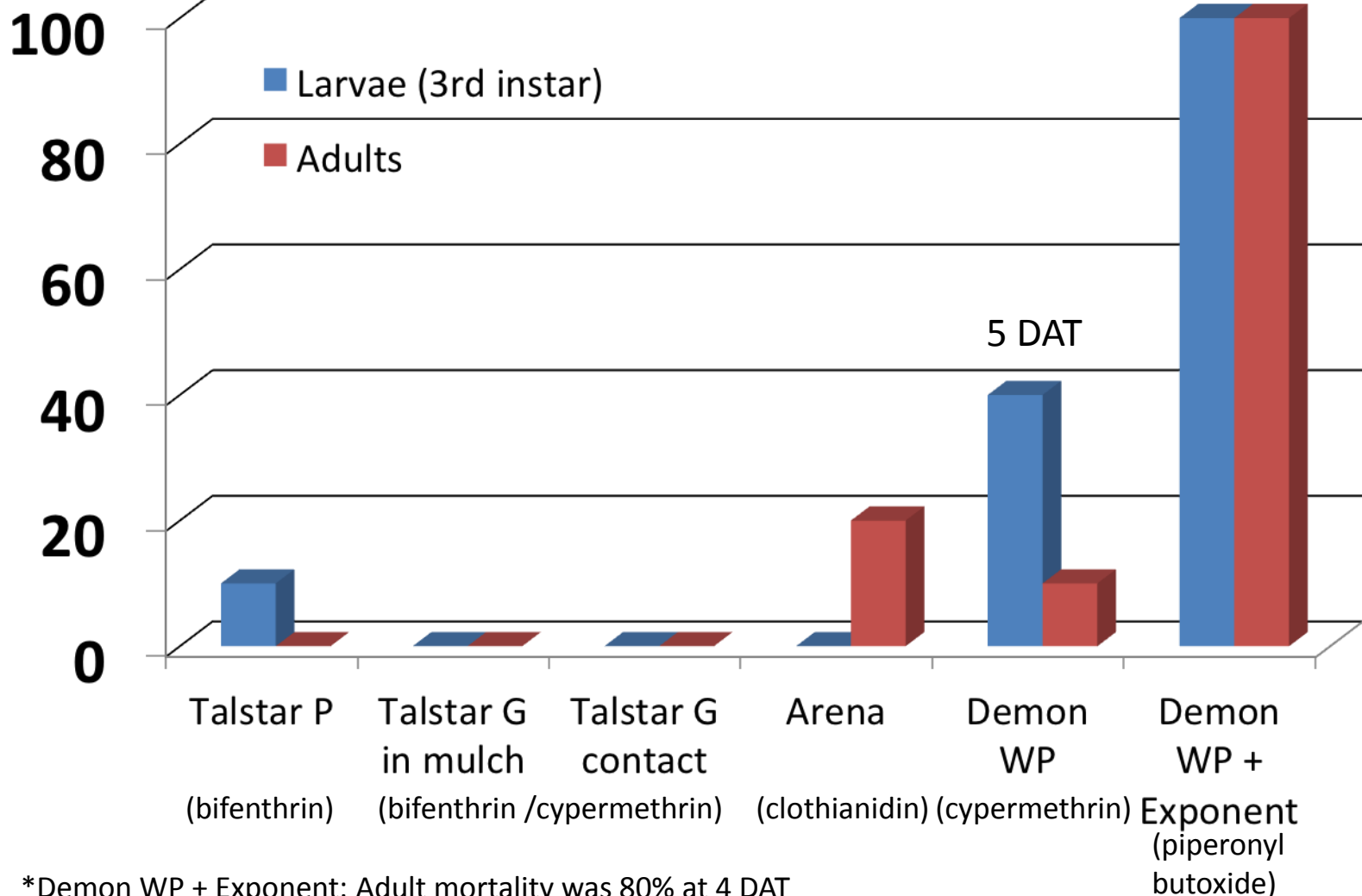




# EFFICACY OF PESTICIDES ON *Oryctes rhinoceros* LARVAE AND ADULTS

## 72 HAT (unless otherwise noted)

Mortality, %



\*Demon WP + Exponent: Adult mortality was 80% at 4 DAT

# Insecticide Treatment Needed in Crown Area to Prevent Adult Attack

Symptoms of CRB Attack: V-cut with associated lateral boring thru fronds





“Two major insects are attacking and killing Oahu’s banyan trees.”

**Ficus Stem Gall Wasp** (new to science)

**Lobate Lac Scale** (Serious pest in Florida  
began 10 years ago)

Banyan Stem-Galling Wasp, a New Insect in Hawaii  
Hawaii Department of Agriculture (HDOA), Plant Pest Control Branch - August 28, 2012

**Insect species:** undetermined at this time. Specimens being sent to insect specialists for identification. Belongs to the family Agaonidae (fig wasps).

**Description:** a black wasp, about 1/16th inch or (2mm) in length (Fig. 3).

**First found in Hawaii:** July 13, 2012 (samples of infested stems submitted to HDOA by an arborist from the East-West Center, University of Hawaii).

**Host:** Chinese banyan, *Ficus microcarpa*, family Moraceae (Fig. 1). Tree is native from Ceylon to India, southern China, Ryukyu Islands, Australia, and New Caledonia.

**Island Distribution:** Oahu (widespread), Hawaii Island (Hilo), and Maui (Kahuku, Wailuku).

**Biology:** The female wasp lays its egg in the young stems. The wasp larva hatches and feeds within the tissue (Fig. 4). As the larva develops, the stem becomes swollen and forms a gall. The larva pupates and the wasp adult eventually emerges (Fig. 5), leaving a distinctive exit hole in the woody tissue (Fig. 2).

**Damage:** Some leaf drop and dieback of stems, causing canopy to thin out, although our surveys indicate varying degrees of infestation and damage.



Figure 3. Stem-galling wasp (1/16th inch)



1. Chinese banyan, *Ficus microcarpa*.



4. Wasp larva in gall (1/16th inch)



2. Galls in green stem tissue (left side in each picture) and old galls in woody tissue with wasp exit holes (right side).



5. Adult wasps in dissected stem galls.



## Injected with Ace-Jet using Tree I.V. (09/12/12)

Kennedy  
Theatre



- \*40 inch diameter breast height.
- \*Injected with 90 g of AceJet (acephate 97.4%) in 400 ml water.
- \*3/8 inch drill bit w/ fast drilling
- \*Bicycle pumped to 50 psi.
- \*Better uptake during mornings with cooler temperatures.
- \*Acephate has quicker knock-down compared with imidacloprid.





# Injection Systems Evaluated

**Wedgle Direct-Inject**  
TREE TREATMENT SYSTEM

**NEW!**  
**FORESTRY PACK**  
OPTION AVAILABLE  
CLICK HERE

**Dose Adjustment -**  
Preset to release a 1 ml dose of chemical with each full stroke of the handles. Can be adjusted to deliver 1/2 ml dose where needed.

**Manual Operation -**  
You control the pressure needed to inject the tree.

**Patented Wedgie™ Tip -**  
Releases chemical where it can be easily absorbed by the tree.

A detailed view of the Wedgle Direct-Inject tree injection tool. It features a dark brown cylindrical tank at the top, connected to a silver metal body with two black handles. A long, thin needle is attached to the bottom. The tool is shown against a white background.

Sidewinder Tree Injector



Mauget Tree Injectors



# Recent Stem and Leaf Gall Wasp Studies

By B. Bhandari and Z. Cheng

UH-CTAHR

Dept. of Plant and Environmental Protection Sciences

- \*Emamectin benzoate injected with the Arborjet Quikjet was most effective against the stem gall wasp.
- \*Imidacloprid and emamectin benzoate were 40-50% effective against the leaf gall wasp (Cheng, personal communication).
- \*Imidacloprid was effective against the Lobate Lac Scale.

# Lobate lac scale

## *Paratachardina pseudolobata*

- \*First time in Florida on a hibiscus in August 1999. First in Hawaii Oct 2012 on Ficus, Moanalua Park.
- \*Occurs in Florida, Bahamas and Christmas Island.
- \*Produces honeydew which supports sooty mold growth.
- \*Host range of over 307 species of woody plants including Fabaceae (Acacia), Malvaceae (Hibiscus) Moraceae (Ficus), Myrtaceae (Eugenia, guava), rose, gardenia, Phoenix palm.
- \*Belongs to the lac scale family from which shellac is produced.



**“The potential for further spread of this scale is especially high for warm areas into which there is a significant movement of living plants e.g., from Florida to Puerto Rico, and other localities of the Caribbean Region, California and HAWAII.” (Howard et al. 2002).**



## *Paratachardina pseudolobata* lobate lac scale

- Adult females are x-shaped, dark red-brown, and ~ 1/16<sup>th</sup> inch in length and width and height.

- To the untrained eye, scales can blend in with the bark of the plant and be difficult to spot.

- Immature scales are bright red, flat, oval, and around 1/64<sup>th</sup> inch long.

- Over 300 recorded hosts in over 50 plant families were recorded in Florida.

- Prefer woody stems. Usually not found on stems more than 3/4 inch in diameter.

- On Oahu, it has been found on various ficus and hibiscus species, mango, Tahitian gardenia, and golden rain tree



Adult females on hibiscus branch. Inset: immature scale (magnified).



Infested hibiscus stem showing scales and black sooty mold starting to build up (a good indicator of an infestation).



Badly infested *Ficus benjamina* tree showing dieback of large branches and defoliation.

- In the continental U.S., it is only known to occur in Florida. Also found in Puerto Rico, Cuba, The Bahamas, and Christmas Island (Australia).

-First found on Oahu in October 2012 in the Moanalua area. Likely to be found island-wide. Not yet found on other islands.

- These insects produce copious amounts of honeydew, which can lead to thick layers of sooty mold covering branches and foliage.

If you suspect that you have the lobate lac scale, please call:

**Maui:**  
873-3949  
**Kauai :**  
274-3072  
**Big Island**  
**Hilo:**  
974-4146  
**Kona:**  
323-7579  
**Oahu:**  
973-9525

\*One drench application of Merit 75 WP (imidacloprid) to large Indian Laurel Tree, *Ficus retusa*, eradicated lobate lac scale for over a year (523 days).

\*Foliar applications of imidacloprid and bifenthrin (Talstar) were also highly effective against crawler and adult stages of lobate lac scale.

*(Research in Florida by Howard & Steinberg 2005)*

Hawaii Dept. of Agriculture  
Plant Pest Control Branch

Walter Nagamine, Darcy Oishi,  
Bernarr Kumashiro, Janis Garcia



**Belongs to the lac scale family from which shellac is made.**





**Red Imported Fire Ant infestation at Miramar Marine Air Station, San Diego, CA**

**Will it establish at Kaneohe Marine Air Station?????**



**Red Imported Fire Ant**



02/14

Conclusions

?



# THANK YOU!

## Research Support Staff:

Ruth Niino-DuPonte

Susan Cabral

Kyle Onuma

Jorden Zarders

## Collaborators:

Derek Arakaki, HDOA, PPC

Chris Kishimoto, HDOA, PQ

Michael Melzer, UH-CTAHR

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