Biological Control of Cycad Scale, *Aulacaspis yasumatsui*, Attacking Guam's Endemic Cycad, *Cycas micronesica*

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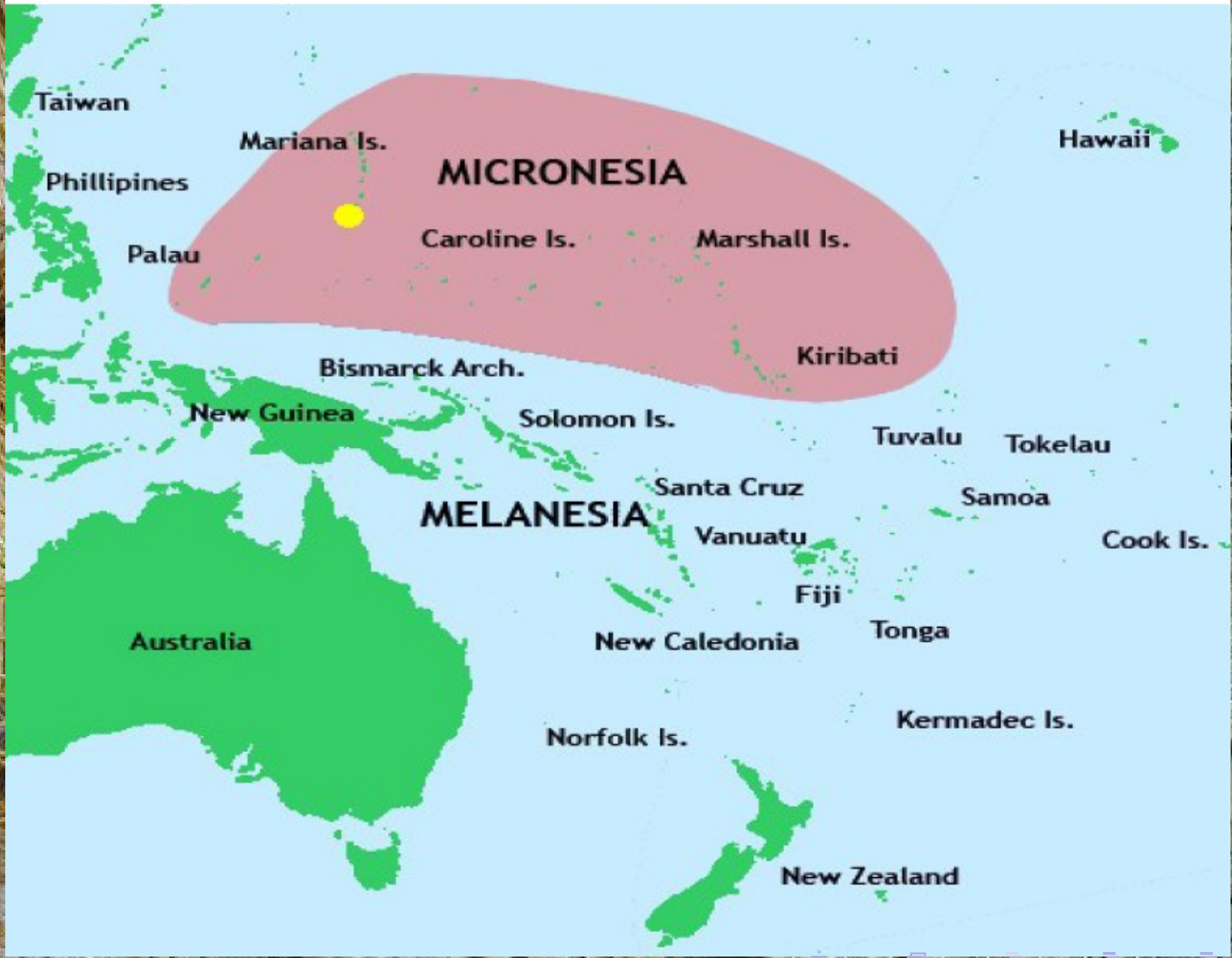
Where is Guam?



Major Biological Invasions on Guam

- Brown Treesnake (arrived around 1945)
  - Killed most of Guam's birds and small mammals. Caused 7 bird extinctions.
- Asian Cycad Scale (detected 2003)
  - Threatens survival of Guam's endemic Cycas micronesica, listed as most numerous tree in the 2002 Guam Forest Survey
- Coconut Rhinoceros Beetle (detected 2007)
  - Threatens Guam's coconut palms, listed as 2nd most numerous tree in 2002 Guam Forest Survey
- Little Fire Ant (detected 2011)
  - Threatens most animals remaining in Guam's forests

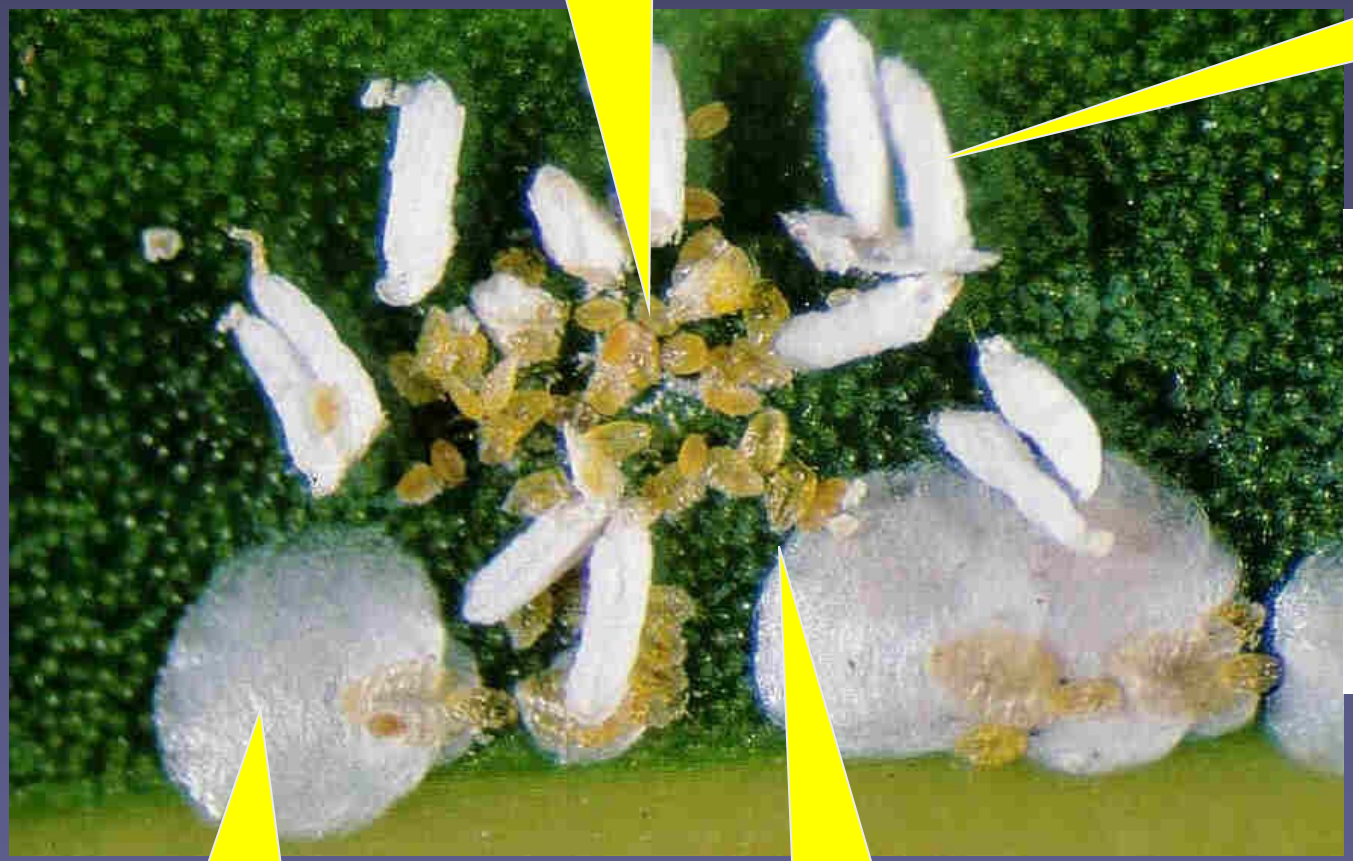
Asian Cycad Scale
Aulacaspis yasumatsui Tagaki 1972
DIASPIDIDAE

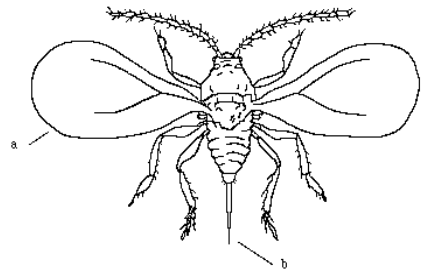
Asian Cycad Scale Chronology

1996 – Scale detected in Florida on cycads growing in a botanical garden

- 1998 – Scale detected in Hawaii
- 2003 – Scale detected on cycads used for landscaping in Tumon hotel district on Guam
- 2004 – Scale spreads to *Cycas revoluta* and *C. micronesica* throughout of Guam
- 2006 – Scale infests *C. micronesica* on Rota

Scale Morphology & Life History





Adult male


HYATT


HYATT

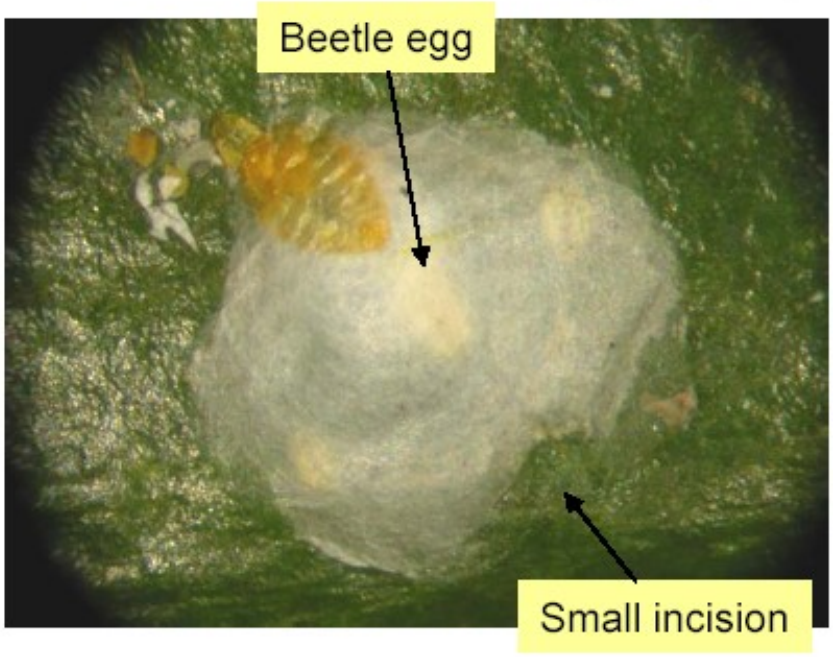
Biocontrol Attempts

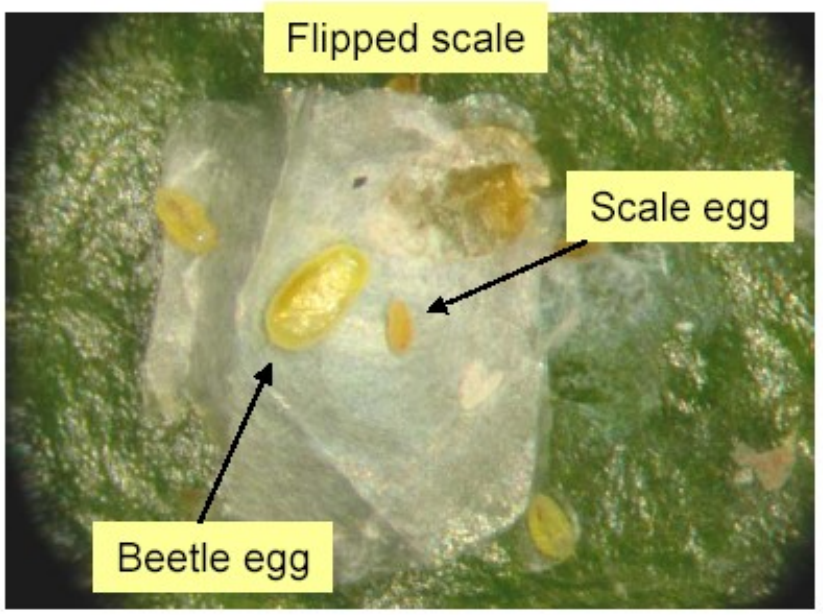
- COCCINELLIDAE: *Rhyzobius lophanthae* imported from Hawaii 2004
  - Single attempt; Established Immediately
- APHELINIDAE: *Coccobius fulvus* from China via Florida starting in 2005
  - Several attempts; lab colony died; field releases did not establish
- APHELINIDAE: *Aphytis lignanensis* imported from Hawaii 2012
  - Single attempt; lab colony died prior to field release

Rhizobius lophanthae (COCCINELLIDAE), 'purple scale destroyer'

- both adults and larvae feed on Diaspidids (armored scales)
- introduced from Australia to California in 1892; from California to Hawaii in 1894
- Released on Guam in 1925 & 1926, but was never recovered

Top view of the Asian Cycad scales





Photos courtesy of Stacey Chun, University of Hawaii, Hilo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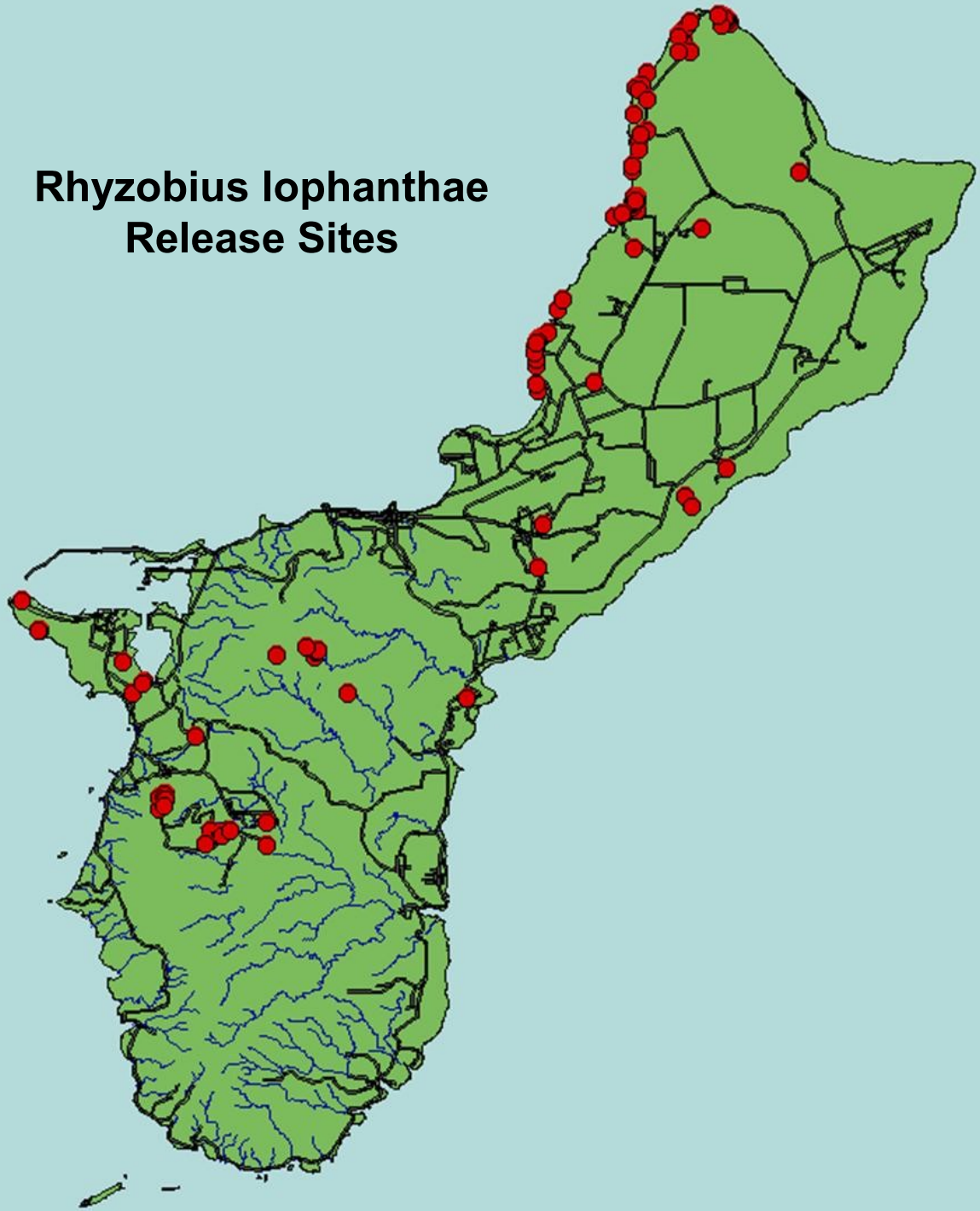
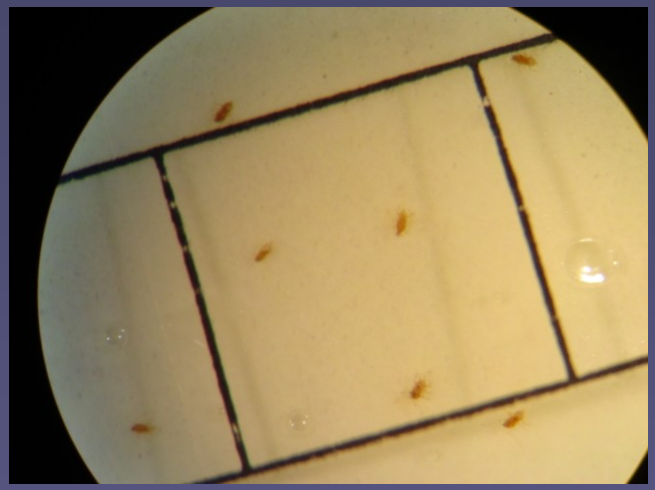
EXIT
BIO-CONTROL QUARANTINE
GUAM

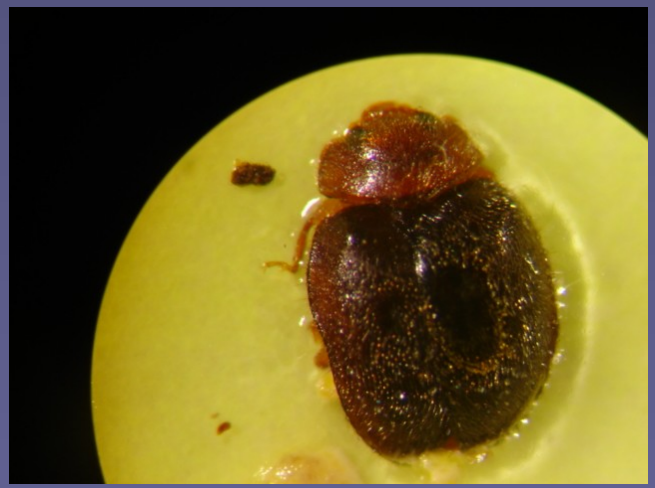

Rhyzobius lophanthae
Release Sites


Sticky Traps

Stereoscope

Aulacaspis yasumatsui
Adult males & Crawlers



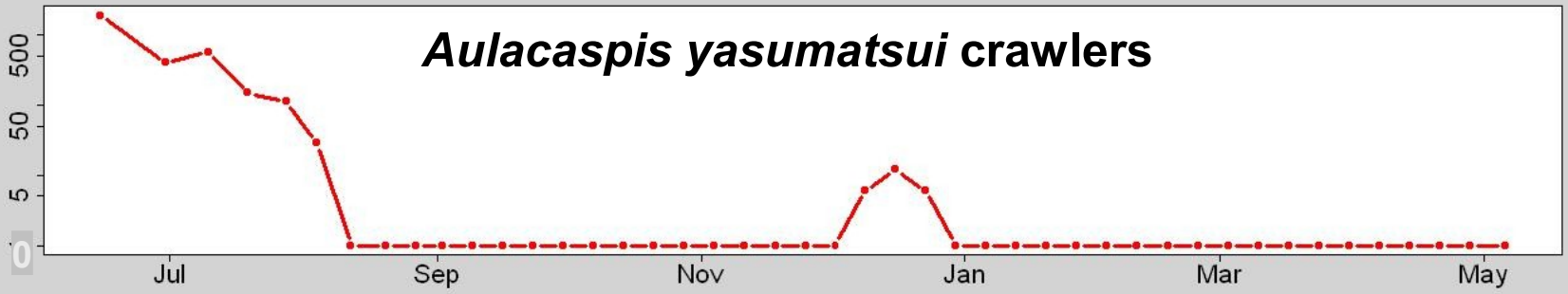


Rhyzobius lopanthae
Adults

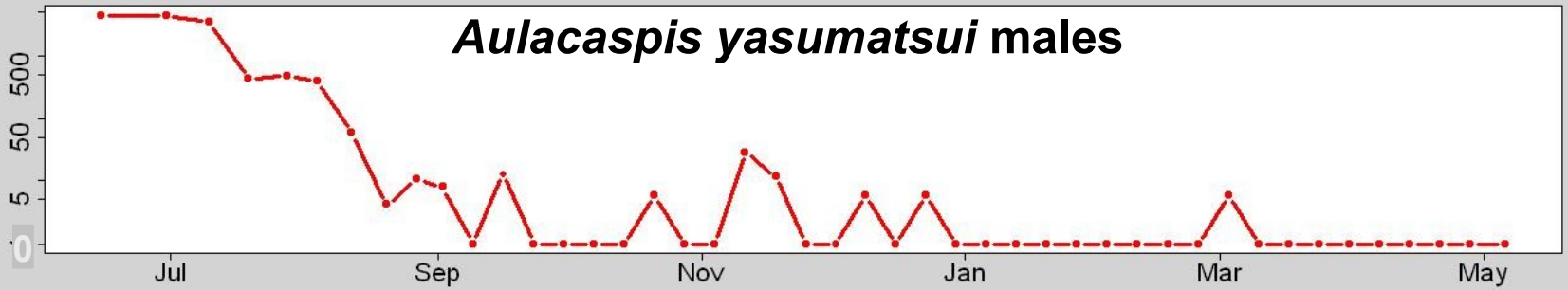
Insects per m^2 per day on Sticky Traps

Ritidian Pt.; June 2005 - May 2006

1,868



4,404



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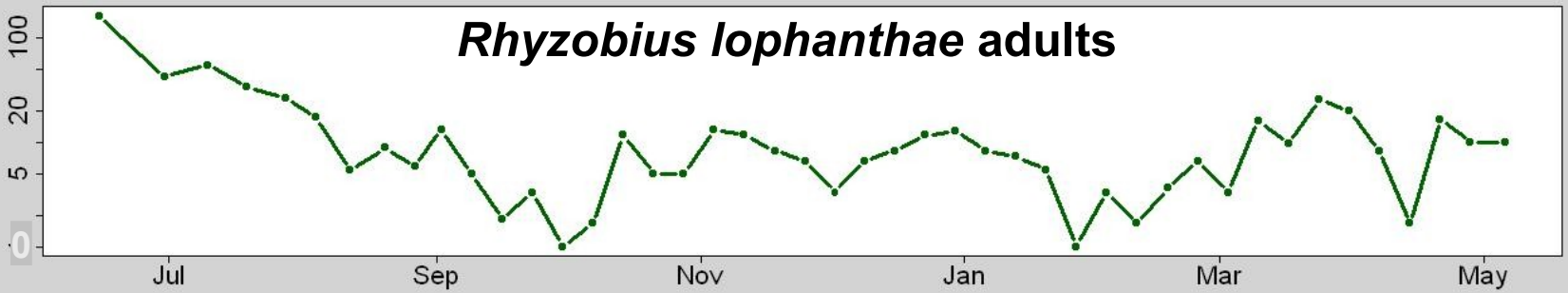

Current Rhyzobius lophanthae Status

- *R. lophanthae* is ubiquitous on Guam. It is almost impossible to find Asian cycad scale which is not being attacked by larvae and adults.

So the biocontrol program was a success and the cycads must be recovering by now, right? ...

Current *Cycas micronesica* Status

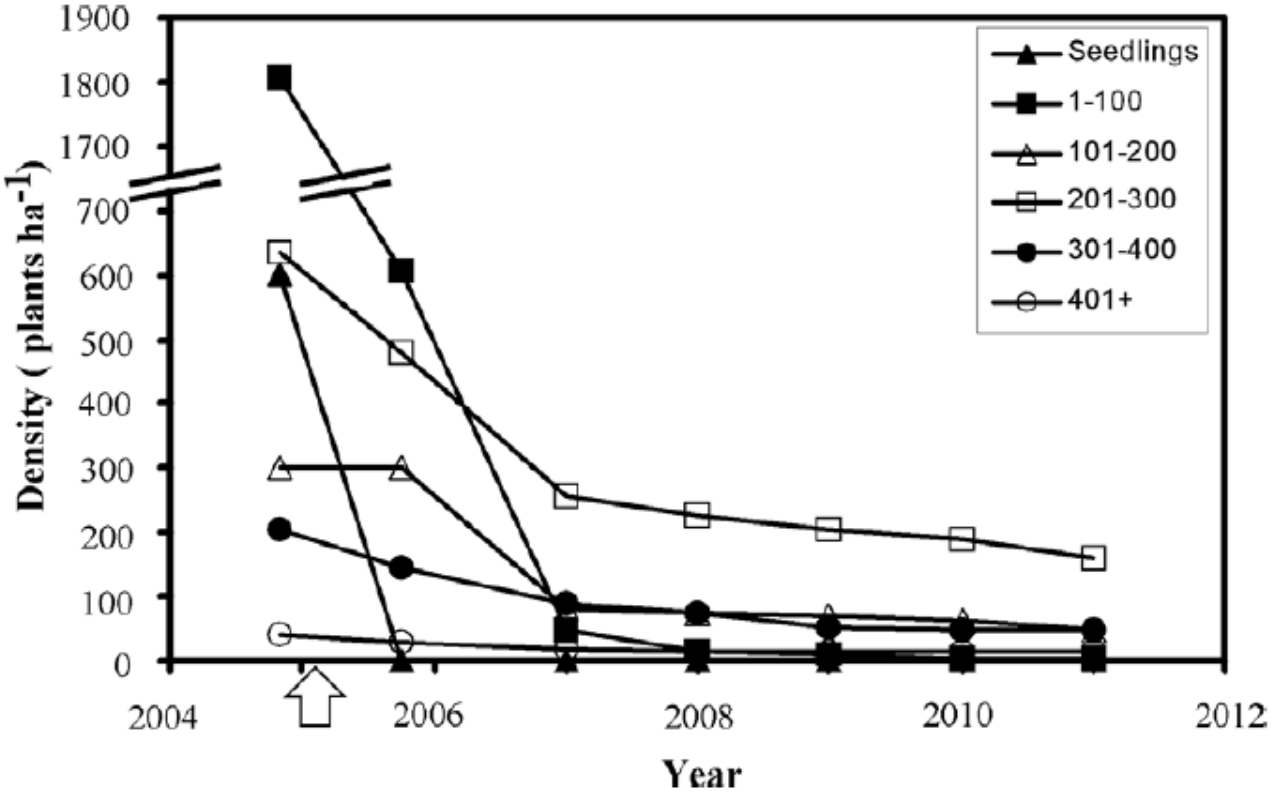

Figure 2. The influence of plant height size categories (cm) on survival of *Cycas micronesica* following the establishment of *Aulacaspis yasumatsui* in western Guam. The x-axis refers to January of each calendar year. Arrow on x-axis marks the initial infestation of *A. yasumatsui* in the study habitat.

Marler, T.E. and J.H. Lawrence. 2012. Demography of *Cycas micronesica* on Guam following introduction of the armoured scale

Current *Cycas micronesica* Status

The *C. micronesica* population is still in decline.

- In 2006, *C. micronesica* was placed on the IUCN Red List of Threatened Species and it remains on this list
- No reproduction on Guam has been observed since 2005.
- Only 7% of the original plants survive as of January 2013.
- Local extirpation predicted in 2019 if current trend persists.

Failure Analysis

R. lophanthae fails as a stand-alone biocontrol agent for Asian Cycad Scale because:

- *R. lophanthae* is too big to reach a significant proportion of the scale insects which live in small cracks and voids within plant structures
  - Marler, T.E. and A. Moore 2010. Cryptic scale infestations on *Cycas revoluta* facilitate scale invasions. Hort. Sci. 45: 837-839.
- *R. lophanthae* does not prey on scale insects living beneath trichomes on *C. revoluta*
  - Marler, T.E. 2012. Boomeranging in structural defense: Phytophagous insect uses cycad trichomes to defend against entomophagy. Plant Signaling & Behavior 7:1484 –1487.
- *R. lophanthae* predation decreases with proximity to the ground.
  - Marler, T.E., R. Miller, and A. Moore 2013. Vertical stratification of predation on *Aulacaspis yasumatsui* infesting *Cycas micronesica* seedlings. HortScience 48: 60–62.

Current Cycad Scale Biocontrol Objectives

- We are currently attempting to introduce a parasitoid in the hope that its smaller size will allow it to attack scale insects which escape beetle predation by hiding in small spaces within the plant structures.
- *Aphytis lignanensis* has been chosen as a candidate because it coexists with *R. lophnathae* in Hawaii and Texas.

Concluding Comments

- The predaceous lady beetle, *R. lophanthae* has failed as a stand-alone biocontrol agent for Asian cycad scale, even though it established readily and has become ubiquitous.
- Presence of *R. lophanthae* has thwarted our attempts to establish parasitoids as biocontrol agents for Asian cycad scale.
- If you wish to introduce predators and parasitoids, it may be easier to establish parasitoids first, then predators.

Invasive species aren't all bad.
They provide job security for biologists.