

Biological Control of Cycad Aulacaspis Scale on Guam

Aubrey Moore, Thomas Marler, Ross H. Miller, and R. Muniappan*

INTRODUCTION

Cycad aulacaspis scale (CAS), *Aulacaspis yasumatsui*, was first detected on ornamental cycads in Guam's Tumon hotel area during the last quarter of 2003. It quickly spread to nearby populations of wild *Cycas micronesica*. Surveys of the rapidly expanding infestation revealed there were no parasites or predators attacking the scales. A predator and an insect parasitoid were released on Guam during 2005 to establish biological control of the CAS which has infested most of the island's wild and cultivated cycads since its accidental introduction in 2003. Table 1 shows a timeline of CAS invasion and subsequent biological control efforts on Guam.

THE PREDATOR

The predator is a tiny black lady beetle, *Rhyzobius lophanthae* (Blaisdell) (Coleoptera: Coccinellidae). This beetle, previously known as *Lindoris lophanthae*, has been effective in controlling scales in the past. It was originally collected in Australia and imported into California in 1892, and from there it was sent to Hawaii in 1894. It was released on Guam in 1925 and 1926, but apparently it did not establish (Swezey 1942). Both adults and immatures of *R. lophanthae* feed on armored scales (Diaspididae) (Fig. 1). Today, this species can be purchased from insectaries on the U. S. mainland as the "scale destroyer," "singular lady beetle," or the "purple scale predator."

During the early stages of the CAS outbreak, we contacted the Hawaii Department of Agriculture (HDOA) for advice and learned that they had observed heavy predation of CAS by *Rhyzobius lophanthae*. HDOA staff on Maui kindly offered to collect adult beetles for us, and about 100 beetles were hand-carried to Guam in November 2004. The beetles were unpacked in the University of Guam's USDA-approved biocontrol quarantine facility and observed for one month to make sure that they were not carrying any insect diseases or parasites. After passing quarantine, the beetles were housed in rearing cages for mass rearing. Beetles were fed by placing infested cycad fronds in their cages every week.

The first field release of *Rhyzobius lophanthae* was made on 16 February 2005 in the Guam National Wildlife Refuge, which is located at Ritidian Point, Guam's northern tip. Ten adult beetles were released on each of three scale-infested fronds of *Cycas micronesica* enclosed by sleeves (Bioquip Products Inc., Rancho Dominguez, CA; Cat. No. 1461G). The beetles were confined to the sleeves to ensure that they mated and laid eggs. The sleeves were removed after one week.

Presence of the beetles was not evident for three months after the initial release, which is about three generations for this beetle. Adult beetles became very numerous in mid May. The beetle population at the release site peaked in about June 2005 and adults began to disperse. For example, we counted 57 beetles within one minute on 7 July on a scale-infested cycad at Urunao Beach, about 1 km from the original release site.

In June 2005, we placed twelve yellow sticky traps (Advanced Pheromone Technology Inc., Marylhurst, OR) in the vicinity of the beetle release site to monitor scale and beetle populations. These traps are 76 mm x 102 mm bright yellow plastic cards attached to 1.2 m aluminum stakes. The cards are coated with a sticky substance which traps any insects landing on them. We were able to count adult *Rhyzobius lophanthae* lady beetles, male scales,



Fig. 1. *Rhyzobius lophanthae* adult feeding on *Aulacaspis yasumatsui* (photo by Ross Miller).

*College of Natural and Applied Sciences, University of Guam, Mangilao, Guam 96923

and scale crawlers under a microscope. The lady beetles and male scales are probably attracted to the bright yellow traps, whereas crawlers are passively blown onto the traps by the wind. Trap results to date indicate that both the scale population and *R. lophanthae* lady beetle populations at the original release site crashed during July and August 2005 (Fig. 2). On 12 August, Moore was unable to find a sample of live scales within about half an hour of searching within the release site. The cycads all appeared to be very heavily infested and were still encrusted with white scale coverings, which remain attached to the plant even after death of the scales. However, close examination with the aid of a hand lens showed that almost all scales had been attacked by beetle larvae or adults.

Following establishment of *Rhyzobius lophanthae* at the Ritidian release site, adult beetles were dispersed throughout most of the cycad-growing areas of Guam by a team technical assistants. Between 28 June 28 26 October, more than 7,450 beetles were released on infested cycads at 115 sites (Fig. 3). At first, beetles for release were harvested from the mass rearing cages. However, after the beetles became numerous at the Ritidian release site, field-collected beetles were also redistributed.

At the onset of Guam's rainy season in July 2005, many of the cycads at the release site that had been damaged by scale began to put out new leaf growth. We were encouraged by the appearance of this new foliage and hoped that the residual population of lady beetles would patrol the pristine new leaves and keep them free of scales.

Unfortunately, much of the new foliage at the Ritidian release site was completely defoliated by another invasive insect. While engaged in scale surveys, Moore led a group of students

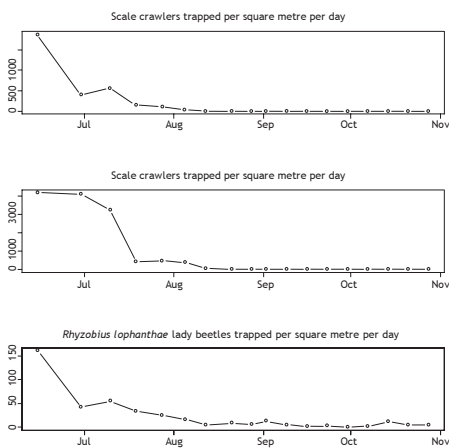


Fig. 2. Sticky trap catch at the Ritidian Point release site, July-November, 2005.

from the University of Guam's 4-H entomology program through the Ritidian release site on 13 July 2005. During the trip, the group noticed lycaenid butterflies landing on cycads, which Moore recognized as the cycad blue butterfly, *Chilades pandava* (Horsfield) (Lepidoptera: Lycaenidae) (Fig. 4). The caterpillars of this butterfly feed exclusively on young cycad foliage. In 1996, Moore had found this same species feeding on ornamental cycads on Saipan, an island 200 miles north of Guam. However, it had not previously been found on Guam. Within a few weeks of the discovery of cycad blue butterflies, Marler and research assistant Maren Roe observed caterpillars defoliating new growth on cycads which had been showing signs of recovery from severe scale infestation. They noted that almost all of the caterpillars were attended by one or more ants (Fig. 5). The cycad blue butterfly and other lycaenids have developed a symbiotic relationship with ants wherein the butterfly caterpillars provide the ants with droplets of a sweet solution excreted from special glands on their backs. In exchange, the ants protect the caterpillars from attack by parasites and predators. It should be noted that all of Guam's ant species are the result of accidental introductions, as with the cycad blue butterfly and CAS.

THE PARASITOID

The wasp, *Coccobius fulvus* (Compere & Annecke) (Hymenoptera: Aphelenidae), is a solitary endoparasitoid of scale insects. It is a native of South and Southeast Asia. In the 1980s it was introduced into California from India to



Fig. 3. *Rhyzobius lophanthae* release sites on Guam.

control *Pinnaspis strachani* and into New England from China to control *Unaspis euonyomi* (Meyerdirk, 2002). In 1998 *C. fulvus* was imported from Thailand into Florida for control of CAS (Baranowski and Rosen, 2001).

An application to import *Coccobius fulvus* into Guam from Florida was submitted to USDA-APHIS in May 2005. In July we were informed that a permit was not needed, as the proposed import falls under "within country" movement. Dr. Ru Nguyen, an entomologist with the Florida Department of Agriculture and Consumer Services, maintains a culture for *C. fulvus* from China and was kind enough to send a few shipments to Guam. The first shipment of 500 adult parasitoids was received on 29 August 2005. Of this shipment, 250 parasitoids were released in a cage with a potted CAS-infested *Cycas revoluta* plant and the other 250 parasitoids were released on CAS-infested *C. micronesica* plants in the field at Marbo Caves on the east coast of the island. This site was selected because it was free of the previously released *Rhyzobius lophanthae*. Another shipment of 250 parasitoids received on 2 September 2005 was released at the Marbo Caves site, as the attempt to culture this species in the quarantine laboratory was not progressing satisfactorily.



Fig. 4. Adult male cycad blue butterfly, *Chilades pandava* (photo by Thomas Marler).



Fig. 5. Cycad blue butterfly, *Chilades pandava*, caterpillar with attendant ant, *Anoplolepis gracilipes* (photo by Thomas Marler).

To determine the field establishment of this parasitoid, a CAS-infested frond of *Cycas micronesica* from the Marbo Caves area was collected on 29 September 2005 for examination under a binocular microscope. One exit hole of the parasitoid was observed on this frond. Four exit holes of the parasitoids were found when the same procedure was repeated on 7 October 2005; however, no exit holes were found on a sample examined on 4 November 2005. We cannot declare whether the parasitoid has established or failed to establish at this stage. Additional field releases of this parasitoid may be needed for successful establishment.

CYCAD SOCIETY SUPPORT

At the present time, it is far from certain that Guam's cycads will survive the current attack by CAS and cycad blue butterflies. Rapid establishment of a complex of effective biological control agents is currently the only feasible long-term strategy for protecting these plants. The Cycad Society has generously supported these efforts with a \$2,500 grant. We believe the widespread distribution of *Rhyzobius lophanthae* is a direct result of our extensive efforts at redistribution. The Cycad Society funds will be used for redistribution of *Coccobius fulvus* and any other biological control organisms from the initial sites of establishment. These efforts will be crucial for achieving rapid, widespread island distribution.

ACKNOWLEDGMENTS

Thanks to Mach Fukada, Neil Reimer, Ken Teramoto, Pat Conant, and John Brown for assistance in collection and importation of *Rhyzobius lophanthae* beetles from Maui, to Jesse Bamba for beetle rearing, and to Anne Brook, Nenita Dumaliang, Rudy Estoy, Maren Roe, Kristine Bataclan, and others for dispersing beetles throughout Guam. Also, thanks to Dr. Ru Nguyen for shipping us the parasitoid.

REFERENCES

- Baranowski, R.M. and H.B. Glenn. 2001. Classical biological control of cycad scale in South Florida. Unpublished Note. 1pp.
- Meyerdirk, D.E. 2002. Control of cycad scale, *Aulacaspis yasumatusi* (Homoptera: Diaspididae). USDA Environmental Assessment.
- Sweezy, O. H. 1942. Insects of Guam I. *Bishop Museum Bulletin* 172.
- Table 1. Timeline of CAS invasion and subsequent biocontrol efforts.**
- 10/12-03 *Cycas revoluta* and *C. micronesica* plants infested in the Tumon Bay hotel district on Guam.
- 1-9-04 *C. revoluta* foliage sample sent to USDA-APHIS in Honolulu for identification of scale insects.
- 2-04 Tentative identification made by Thomas Watanabe, USDA-APHIS Plant Inspection Station, Honolulu International Airport. Watanabe identified two scale species on the foliage sample: *Aulacaspis yasumatsui*, the cycad aulacaspis scale, and *Pseudaulacaspis cockerelli*, the false oleander scale. Insect specimens were

forwarded to USDA-APHIS taxonomists and to Gillian Watson at the California Department of Food and Agriculture for confirmation.

- 6-10-04 Requested permit from USDA-APHIS and Guam Department of Agriculture for importation of *Rhyzobius lophanthae* from Hawaii to Guam.
- 8-17-04 Permission to import *Rhyzobius lophanthae* from Hawaii granted by USDA-APHIS.
- 11-12-04 About 100 adult beetles, field-collected on Maui, hand-carried from Maui to Guam by John Brown of the University of Guam.
- 2-16-05 Ten adult beetles released in each of three sleeves on infested *C. micronesica* at Ritidian Point in northern Guam.
- 5-20-05 Numerous adult *R. lophanthae* observed at the Ritidian Point release site; no larvae observed.
- 7-7-05 Extensive feeding damage to scales by *R. lophanthae* observed at Ritidian release site; larvae and adults numerous. At Urunao Beach, about 1 km from the original release site, 57 beetles counted within one minute.
- 7-13-05 Adult cycad blue butterflies, *Chilades pandava*, detected at the Ritidian Point beetle release site.
- 8-12-05 Live scales very hard to find at the Ritidian Point release site.
- 8-29-05 First field release of *Coccobius fulvus* on infested cycads at Marbo Caves site.
- 9-14-05 Severe defoliation of new *C. micronesica* foliage by *Chilades pandava* caterpillars observed at Ritidian Point; caterpillars being tended by three species of exotic ants.