

EFFECTS OF THE PARASITIC WASP, *COCCOBIUS FULVUS*, ON CYCAD AULACASPIS SCALE, *AULACASPIS YASUMATSUI*, AT MONTGOMERY BOTANICAL CENTER, MIAMI, FLORIDA

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Abstract. *Aulacaspis yasumatsui* (cycad aulacaspis scale) has been a continual pest of cycads since its introduction into Florida in 1995, attacking many species of cycads including popular ornamentals like *Cycas rumphii* and *C. revoluta*. It is now a threat to both the cycad nursery industry and native cycad populations. It has been reported from Florida, Texas, Puerto Rico, U.S. Virgin Islands, Hawaii, and Guam. Previous research indicates that some available pesticides can help manage this pest. However, they are often not as effective at controlling *A. yasumatsui* on particularly large or dense plants, where it is difficult to reach the scale with foliar sprays of pesticides. A study was conducted at Montgomery Botanical Center, Miami, Florida to evaluate the effectiveness of the parasitic wasp, *Coccobius fulvus*, as a biological control agent. Results indicated that the number of parasitoids increased as the number of scale increased despite regular releases of the wasp and that the use of *C. fulvus* alone as a biological control agent does not provide adequate control of *A. yasumatsui*. However, the amount of control achieved (51% parasitized scale) may be adequate when combined with appropriate chemical controls as part of an integrated pest management program.

As early as 1995, cycad growers in southern Miami became aware of a scale pest heavily infesting their plants (Walters et al., 1997). Initially thought to be the common pest, Magnolia white scale (*Pseudaulacaspis cockerellii* Cooley), observers noticed at least two differences. The scale infestations were much heavier than they had been in the past and the infestations were concentrated on the under sides of leaves rather than on the upper sides of leaves where Magnolia white scale is typically found (Weissling et al., 1999). This prompted concerns at both Montgomery Botanical Center (MBC) and Fairchild Tropical Botanic Garden which were located in the initial area of infestation.

Staff from both botanical centers elected to have the scale identified. The scale was identified in 1996 as *Aulacaspis yasumatsui* Takagi (cycad aulacaspis scale; CAS) by Dr. Avas B. Hamon, Division of Plant Industry, Florida Department of Ag-

riculture and Consumer Services, Gainesville Fla., and the identification was confirmed by Dr. Douglas R. Miller, Systemic Entomology Laboratory, USDA-ARS-SEL, Beltsville, Md. (Howard et al., 1996).

CAS is native to Thailand where it is found on cycads, but is kept under control by natural predators and parasitoids (Weissling et al., 1999). It is a member of the armored scale group as it produces a heavy covering that protects the adult female and her eggs (Weissling et al., 1999).

Since its introduction into southern Florida, CAS has spread rapidly up the state. By 1999 it had spread to other places outside the United States including Hawaii, as well as Hong Kong and the Cayman Islands (Weissling et al., 1999). In 2004, CAS was reported from the island of Guam where it has infested not only imported ornamental cycads, but also their native cycad, *Cycas micronesica* (Marler, 2004a, b).

Initial management tools were chemicals that had worked well for controlling Magnolia white scale. They included horticultural and fish oils as well as other pesticides like malathion and dimethoate (Walters et al., 1997). Management of CAS proved particularly difficult due to the intensity of the infestations and their location on the under sides of leaves where it was difficult to reach the scale with foliar applications of pesticides (Howard et al., 1996; Weissling et al., 1999). In addition, malathion and dimethoate have been observed to cause phytotoxicity on new cycad leaves (Emshousen and Mannion, 2004). A newer pesticide, pyriproxifen, (sold as Distance) has been shown to provide good control of CAS where adequate spray coverage is possible (Emshousen and Mannion, 2004). However, an additional control measure is needed to manage the scale in hard-to-reach places such as particularly tall or dense plants. An introduced biological control agent may provide that missing part of the management plan for CAS.

The biological control agent is the parasitic wasp, *Coccobius fulvus*, a native of the region of Thailand where CAS is naturally found. It parasitizes the adult female scale, which helps keep the scale population under control. The wasp was collected in Thailand by Dr. R. M. Baranowski during a trip to Bangkok and Nakhon Sawan, where it was seen feeding on CAS (Holly Glenn, Tropical Research and Education Center, Homestead, Fla., personal communication). It was brought to the Tropical Research and Education Center (TREC) Arthropod Containment Facility in Homestead where it was reared and observed to be an effective parasitoid of CAS (Glenn, pers. comm.).

The wasp was first released in Florida in 1998 when 200 individuals were released at TREC. They quickly established in the area of initial release, and this became the source location for future releases which eventually numbered 14,000 wasps at 22 sites (Glenn, pers. comm.). As of 1999, the wasp was dispersing from original release sites and had been found more than three miles away (Glenn, pers. comm.).

Our objective was to examine the effectiveness of the parasitic wasp, *Coccobius fulvus*, as a biological control agent for control of CAS.

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Study Plants. Five groups of three replications (three plants) were selected for inclusion in the study. Plants were selected based on past observations of routinely heavy scale infestations. Study plants were located at Montgomery Botanical Center, Miami, Fla. They included the following species: *Cycas bougainvilleana* K.D. Hill, *C. thouarsii* R. Br. ex Gaudich, *C. panzihuensis* L. Zhou and S.Y. Yang, and *C. revoluta* Thunb.

Release Method. In week one of the study, one vial containing 100 wasps was opened to release the wasps on each plant in the first group of three plants. Wasps were released on the same three plants in weeks two and three of the study. In week four of the study, wasps were released in the same manner on the three plants in the second group of study plants. Wasps were again released on all three plants in the second group once per week in weeks five and six of the study. Releases were staggered in this manner until each group of three plants had undergone three releases of the wasp.

Chemical Treatment. In order to learn how the wasp would be affected by chemical applications, a single treatment was done with pyriproxifen, a product that has been used to manage CAS. Pyriproxifen (Distance) was applied with a foliar spray according to the label rate (12 oz product /100 gal) to all study plants once at month 6 of the 8-month study.

Data Gathered and Analyzed. One week after the third release of the wasp, 10 leaflets were removed at random from each plant. The number of live scale insects (males and females) and parasitized scale were recorded. Each plant was sampled twice more during the 8-month study. Each time a plant was sampled, 10 leaflets were removed and number of live scale and parasitized scale were recorded and percent parasitized scale was calculated.

Average percent parasitized scale was 51% (Table 1). This would not be considered a high enough percent parasitized scale for biological control to be a successful method to control CAS alone. However, percentage of parasitized scale was significant enough to consider biological control to be a valid part of an integrated pest management program. If the wasp is released in an area where CAS is treated only with those chemicals compatible with the wasp, the wasp could be an important component of a long-term CAS management program.

Our results also indicate that number of parasitoids rise and fall with the number of total scale (males and females). Results indicated that there was, at best, approximately one parasitoid present for every 10 scale (Fig. 1). This relationship held true during much of the 8-month study as the scale population rose and fell. This relationship indicates that the population of parasitoids will never be enough to control the population of CAS alone, but will be consistently parasitizing a percentage of the scale all the time.

Researchers have observed in the past that the wasp seems to control the scale very well when the scale population is high, but that control drops when the scale population declines. Our results confirm past observations on the efficiency of the wasp as a biological control agent.

The results of the chemical application of pyriproxifen on study plants were inconclusive. There was very little scale observed and almost no female scale observed both immediately before and after the chemical application. Earlier observations in other trials indicate that pyriproxifen is compatible with the parasitic wasp (*C. Mannion*, pers. comm.). Further investigation is needed to confirm this.

Table 1. Number of parasitized scale per number females and percent parasitized scale for 8 months. Number parasitized scale and percent parasitized scale is for a single replication of 10 leaflets.

Date	Number parasitized scale per number of females	Percent parasitized scale	Date	Number parasitized scale per number of females	Percent parasitized scale
12/12/2003	66/182	36	3/19/2004	0/0	¹ —
12/12/2003	4/5	80	3/19/2004	0/0	¹ —
12/12/2003	15/32	47	3/19/2004	0/0	¹ —
12/24/2003	66/199	33	3/19/2004	0/0	¹ —
12/24/2003	11/27	41	3/19/2004	0/0	¹ —
12/24/2003	88/140	63	3/19/2004	0/0	¹ —
12/31/2003	0/0	— ¹	3/26/2004	4/10	40
12/31/2003	10/10	100	3/26/2004	0/0	¹ —
12/31/2003	10/10	100	3/26/2004	0/0	¹ —
1/9/2004	184/322	57	4/19/2004	0/0	¹ —
1/9/2004	18/18	100	4/19/2004	7/48	15
1/9/2004	27/27	100	4/19/2004	0/34	0
1/21/2004	74/78	95	5/6/2004	0/44	0
1/21/2004	13/56	23	5/6/2004	0/0	¹ —
1/21/2004	18/52	35	5/6/2004	0/0	¹ —
2/6/2004	59/87	68	7/9/2004	0/10	0
2/6/2004	46/95	48	7/9/2004	0/0	¹ —
2/6/2004	32/36	89	7/9/2004	0/8	0
2/20/2004	26/52	50	7/16/2004	0/0	¹ —
2/20/2004	7/18	39	7/16/2004	0/11	0
2/20/2004	109/218	50	7/16/2004	0/5	0
3/5/2004	33/33	100	7/23/2004	0/0	¹ —
3/5/2004	46/46	100	7/23/2004	0/0	¹ —
3/5/2004	127/142	89	7/23/2004	0/0	¹ —

¹— no female scale present.

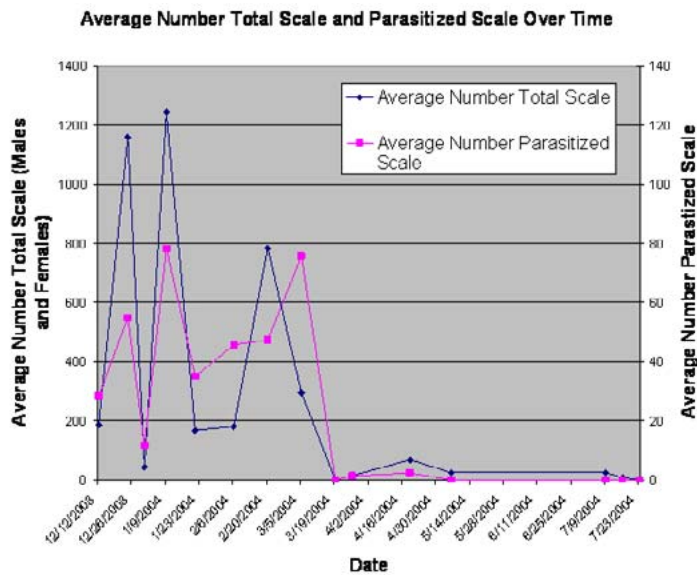


Fig. 1. Average number total scale and average number parasitized scale during the 8-month study. Average number is the average of three replications. Each replication included a sample of 10 leaflets.

CAS is a serious pest of cycads. It has had a detrimental impact on the ornamental cycad industry and is now also a concern for native cycad populations around the world. It is

important at this time to use an approach to control CAS that will be effective in the long-term. Insects can acquire resistance to chemicals over time. The most effective control for CAS will likely involve several types of control methods including cultural, chemical and biological control. Our study suggests that while the parasitic wasp does not provide a high enough level of control to be effective against CAS alone, it could be an important part of a long-term integrated pest management program to control CAS.

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