

EXOTIC INVASIVE PEST INSECT CRITICALLY THREATENING GUAM'S VULNERABLE FLORA, FAUNA & ISLAND ECOSYSTEM

Jody Haynes, Montgomery Botanical Center, Miami, Florida 33156

*Dr. Thomas Marler, College of Natural and Applied Sciences - AES, University of Guam,
Mangilao, Guam 96923*

INTRODUCTION

Guam is an island and U.S. territory in the western Pacific. Guam, Puerto Rico, and Florida are the only places controlled by the U.S. where native cycads grow. Guam is also the only place in the U.S. where there are native populations of cycads in the genus *Cycas* (Puerto Rico and Florida have only *Zamia* species). *Cycas micronesica*, known on Guam as fadang, is distributed from the Mariana Island group south into the western Caroline Islands. Taxonomy is complicated in this species, with several distinct, recognizable taxa requiring further study occurring in the region of Yap, Palau, and the Philippines. (See <http://plantnet.rbgsyd.gov.au/cgi-bin/cycadpg?taxname=Cycas+micronesica> for more information on this cycad species.)

As an island, Guam's ecosystem is much more susceptible to perturbances than continental ecosystems. One example of a disruption that might have a significant negative impact on an island ecosystem is the introduction of an exotic plant or animal. Not having co-evolved with the alien invader, such an ecosystem may not have the proper defense mechanisms to keep the invasive species in check. Just such an event happened when the brown tree snake, *Boiga irregularis*, was accidentally introduced to Guam via cargo transported by U.S. military ships during World War II. This exotic reptile rapidly increased in numbers, preying primarily on birds. Its density has been estimated at up to 13,000 snakes per square mile, and this snake has virtually wiped out 12 species of endemic forest birds on Guam. Because many of the island's plant species are dependent on the various bird species, the plants are now at risk of decline or extinction because of the loss of the birds. (See <http://www.invasivespecies.gov/profiles/bts.shtml> for more information on this invasive pest reptile.)

A more recent example of an accidental—albeit preventable—introduction of an invasive pest organism to Guam occurred in 2003 when the cycad aulacaspis scale (CAS), *Aulacaspis yasumatsui*, found its way to the island as a passenger on king sago (*Cycas revoluta*) nursery plants imported from the U.S. mainland. CAS is a species of armored scale insect from Thailand, where it preys on native cycads of the genus *Cycas*. Because it evolved in Thailand, pest populations are kept under control in that country by natural predators. The young CAS insects, called crawlers, are capable of movement and can be carried short distances on air currents. When they find a suitable host plant, they insert their mouthparts into the plant and start feeding. Shortly thereafter they begin to secrete a white, waxy covering over themselves. This covering protects them in many ways—including from pesticide sprays—making them difficult to control. Female insects remain attached to the plant until their death. Male insects emerge shortly before death and fly in search of females for mating before they die. CAS reproduces very rapidly and can cover a large cycad within a matter of weeks. Unless the infestation is treated, death can occur in less than a year. (See <http://www.montgomerybotanical.org/Pages/CASlinks.htm> for more information on this pest insect.)

CAS was accidentally introduced into South Florida in 1995. It quickly spread throughout the state, and within a few years it had devastated the king sago nursery industry in Florida, resulting in economic losses in the millions of dollars. CAS insects are sometimes difficult to see because they tend to hide in plant roots and under leaf bases on the stems. As a result, hitch-hiking insects have been spread to several

islands in the Caribbean—such as Puerto Rico, the Cayman Islands, and the U.S. Virgin Islands—and even to such far-away places as Hawaii, Hong Kong, Singapore, and, most recently, Guam. CAS has also been intercepted in Europe, but it has not become established there.

GUAM INVASION TIMELINE

February 2000: Dr. Thomas Marler wrote an article about CAS for the *Pacific Daily News*, Guam's local newspaper (Attachment 1). In the article, Marler pointed out the threat to Guam's native cycad and suggested that local nurseries and landscape companies stop importing king sago nursery plants in an effort to reduce the likelihood of CAS reaching Guam. Unfortunately, this warning was not heeded.

October 2003: Small, white insects were first noticed on king sago plants in urban landscapes near Tumon Bay on Guam's west coast. Marler collected some insects in December 2003 and sent them off to various experts to be identified.

March 2004: The white pest insects were positively identified as CAS. Marler immediately wrote another article in the *Pacific Daily News* alerting the residents of Guam about this newly introduced pest (Attachment 2). In this article, Marler again warned that CAS could potentially affect the fadang population of Guam if not controlled and provided advice on how residents could combat the pest. Marler also cautioned against movement of king sago or any other cycad nursery plants from Guam to Rota, Saipan, or any other neighboring island.

September 2004: Marler announced that wild fadang plants in the jungles of Ypao Point on the south end of Tumon Bay had begun to die from CAS infestations. Marler stated that the infestation at Ypao Point was isolated from other jungle habitats by the urban environments of Tumon Bay and Tamuning. He also warned that inaction could allow CAS to enter the jungles on the north end of the bay, which are not so contained, and from there this pest could potentially sweep across the entire island. Once again, Marler's warnings went unheeded.

May 2005: Marler wrote yet another newspaper article on CAS, only this time it was to announce that the pest had begun killing fadang plants in other parts of Guam (Attachment 3). In an e-mail to Jody Haynes (Cycad Biologist at Montgomery Botanical Center in Miami, FL) dated 5-31-05, Marler stated the following:

Probably more than half of the original [non-native] king sago population is already dead and more are dying weekly. Most of these planting sites are being replaced by palms. The *Cycas micronesica* plants are starting to drop off in the forests at alarming rates. I have had to abandon two of my primary sites for long-term research because every plant is infested in those two habitats. We have introduced the [lady] beetle from Hawaii and it has established in one habitat. We are now using collections from that habitat to disperse it as much as possible. Other biocontrol efforts are also underway. I have a new hire to work on mapping of the scale and biocontrol insect population spread. I will be hiring another soon for mitigation work, focusing on the use of Safari [which is a growth regulating pesticide made by Valent that was recently approved for use on Guam].

In this e-mail, Marler also stated that the scale is still contained on Guam but that it may be just a matter of time before it hops to one of the other islands. Marler then requested aid from Montgomery Botanical Center in the form of taxonomic expertise as well as support for the efforts being made by Anne Brooke, Wildlife Biologist at the Guam National Wildlife Refuge, with the U.S. Fish & Wildlife Service (USFWS) to have an emergency "threatened" or "endangered" status declared for *Cycas micronesica*. In

Brooke's correspondence with the USFWS, she countered the agency's reticence at listing yet another species as threatened or endangered by stating that "the scale is moving so fast that there may be no cycads left to be listed."

JUSTIFICATION OF NEED

This situation on Guam is critical and we are desperately in need of emergency funding. This section will highlight the primary reasons justifying the need for emergency support.

1. The first reason is the very nature of this epidemic and the fact that this anthropogenic alien invasion is quite unique. Among the areas affected by this invasive pest insect, Guam is unfortunately the first to also have a susceptible native plant species. In fact, this is the first known case throughout human history where an alien insect has escaped from gardens to begin killing cycad plants in their native habitat. As predicted, CAS is now spreading through Guam's forests, killing fadang plants at an alarming rate.
2. A second reason for funding this project is that fadang plants provide crucial food for other organisms. The fleshy, aromatic covering of fadang seeds is a preferred food item for the endangered Mariana fruit bat, *Pteropus marianus marianus*. Fadang is so resistant to most types of disturbance that its seeds are sometimes the only bat food item available in the forest following the destructive winds of a passing cyclone. Fewer than 100 Mariana fruit bats remain on Guam and it is unknown what effect the loss of fadang will have on these endangered bats. (For more information on Guam's fruit bats, refer to the following website: <http://www.fws.gov/pacific/pacificislands/wesa/marianabatindex.html>.)

We have only just begun our herbivory surveys of *Cycas micronesica*. In our preliminary work, we have identified the indigenous stem borer, *Dihammus marianarum* (Coleoptera: Cerambycidae), as a common cycad consumer. When these surveys are completed, there may be other native arthropod cycad consumers. Thus, the loss of this host species may also lead to the loss of several native species.

3. A third reason this project deserves emergency status is that cycad plants are part of a tripartite symbiotic system of organisms. As with many species of plants, cycad roots are invaded by mycorrhizal fungi. However, cycads also produce coralloid roots that are host to nitrogen-fixing cyanobacteria. Work in *ex-situ* sites reveals that any available genotype of cyanobacteria can invade coralloid roots. This is also probably true for mycorrhizae. Thus, determining the genetic variation of cycad mycorrhizae and cyanobacteria in the native habitat is needed to shed light on conservation of these important organisms. Loss of *Cycas micronesica* from Guam's various populations could easily result in the permanent loss of local genotypes of these other organisms that make up this complex, interconnected system.
4. A fourth reason for considering this a top priority for emergency funding is the nature of cycad pollination dynamics. We now know that cycads are pollinated almost exclusively by obligate insect pollinators (Norstog & Nicholls, 1997; Whitelock, 2002). We are attempting to identify the insect(s) which co-evolved with Guam's cycad population as the pollinators. At the present time, so many of the habitats are infested with CAS that it is difficult to find individual cycads suitable for pollination studies. The probability of one or more endemic, obligate insect pollinators occurring on Guam is highly likely. These beneficial insects will also be lost along with Guam's cycad population should we continue to stand by and let the CAS epidemic continue unchecked.
5. Another issue requiring consideration is the sustainability and general health of Guam's environment. In his most recent newspaper article, Marler quoted David Limtiaco, Chief of Forestry in Guam's

Department of Agriculture, as follows: “Scientists use the phrase ‘ecosystem function’ as one of the ways to describe...health benefits provided by forests. And the consequences of human actions that reduce ecosystem function are generally more severe on small islands like Guam.” Aubrey Moore, entomologist at the University of Guam, was also quoted as saying, “[c]ascading negative impacts on the environment are actually quite common when humans accidentally introduce an alien organism to an island environment. The environmental damage spreads from one structural or functional component to another as each successive component is compromised.” According to Moore, this new threat to Guam’s cycad populations has a significant potential for causing a cascading ecological disaster similar to that caused by the brown tree snake because of the population density of fadang. Fadang is the most common forest plant species in the categories of mid- and upper-canopy, so its loss will alter the physiognomy of the forest dramatically and permanently.

These plants are not just a dominant component of Guam’s ecosystem; they are the most abundant arborescent species in Guam’s forests. As such, they have been supporting the coastal and riparian environments of Guam for all of these years. Considering their ability to fix nitrogen and input this essential nutrient into the ecosystem, no doubt they profoundly influence the chemistry of all terrestrial, aquatic, and marine habitats within and around which they reside. Thus, the exact long-term effects of the loss of fadang plants on all wildlife in Guam’s island ecosystem are unknown, but the prognosis is grim at best.

Our height increment data indicate that many of Guam’s coastal cycad plants are hundreds of years old. These plants have survived the Spanish-American War and two world wars; they have survived innumerable tropical cyclones; they have survived the invasion of intentionally introduced feral deer and pig populations and the accidental introduction of various insect species. Some of these individual plants “watched” Ferdinand Magellan and his fleet sail along Guam’s coast on 6 March 1521. And they endured the Spanish-Chamorro Wars that decimated the indigenous human population. Truly, the remaining plants comprise a long-lived botanical and cultural treasure, one that is in danger of disappearing forever. We simply cannot elect to continue to watch this tragedy without attempting to intervene. The impending cascade of detrimental effects is looming too large to justify apathy.

CURRENT & PROPOSED PEST MONITORING/CONTROL & GERMPLASM PRESERVATION EFFORTS

Since CAS was first observed in “the wild” on Guam, various efforts have been initiated to monitor the spread and provide control of the insects. A predatory beetle was introduced from Hawaii, and it has become established in one habitat. Collections from that habitat are now being used to disperse it as widely as possible to other infested populations, and other biocontrol efforts are also underway. A new full-time assistant has begun mapping the spread of the CAS and the biocontrol insect populations using GIS techniques. Another assistant will soon be hired for mitigation work, focusing on the use of an insect growth regulator called Safari to control the CAS insects on king sago plants in commercial and private landscapes within the major cities surrounding the affected area(s). Research is also being conducted to attempt to identify the specific pollinator insect species in a number of cycad populations.

Immediate efforts will need to include the following:

1. Formulating an immediate salvage plan for affected populations and both short-term and long-term conservation plans for the species on Guam.
2. Alerting the residents, governments, and conservation organizations of the region via print and other media of the importance of controlling this invasive insect pest on Guam and keeping it from spreading to other nearby islands where *Cycas micronesica* also resides.

3. Mounting an expedition to collect seeds from the various *Cycas micronesica* habitats and populations on Guam and the surrounding islands for the purpose of establishing a population-based *ex-situ* conservation germplasm collection at Montgomery Botanical Center.
4. Quickly upgrading the conservation status of *Cycas micronesica* via the U.S. Fish & Wildlife Service and the IUCN Red List.
5. Collecting predatory beetles in the habitat where they are established on Guam and re-releasing them throughout the island.
6. Sending an expert biocontrol entomologist to Asia to collect additional predatory insect species that may be useful in continuing biocontrol efforts. This will then be followed by intensive experiments aimed at determining the effectiveness of control and the prey specificity of each new potential insect predator.
7. Testing growth regulators that are sprayed on or injected into cycads for effectiveness of suppression of the CAS population in the urban environment and the urban-wildland interface.
8. Continuing GIS mapping of CAS and predatory beetle populations on Guam and the neighboring islands of Rota and Saipan.
9. Surveying additional islands for CAS—including Tinian, Yap, and Palau—and increasing the frequency of surveys on Rota. (Rota carries the highest risk of secondary invasion by CAS for two reasons: [1] it is the closest island to Guam and the many daily flights are just a few minutes in duration; [2] it has the second largest population of *Cycas micronesica*.)

Longer term research efforts should also include 1) studies on the interactions of various wildlife species with the cycads, 2) molecular genetic analyses of wild cycad populations on Guam and throughout the native range of *Cycas micronesica*, and 3) molecular studies of mycorrhizal fungi and cyanobacteria symbionts associated with the cycads, both within and among the various cycad habitats on Guam.

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ATTACHMENTS

Attachment 1. Newspaper article: “Looking out for scale insects.” Gardening section, *Pacific Daily News*. T. Marler, Feb. 13, 2000. (p. 7)

Attachment 2. Newspaper article: “Alien insect attacking Guam’s native flora.” Lifestyle section, p. 20, *Pacific Daily News*. T. Marler, Mar. 13, 2004. (p. 8)

Attachment 3. Newspaper article: “A landscape in danger: Experts advise fighting back to combat Asian Cycad Scale.” Lifestyle section, *Pacific Daily News*. T. Marler, Jun. 5, 2005. (p. 9)

Attachment 4. Photos of cycad aulacaspis scale (CAS) on *Cycas micronesica* plants in habitat on Guam.

Figure 1. Sick and dying plants infested with CAS. (p. 11)

Figure 2. Closeup of CAS-infested and dying plants. (p. 11)

Figure 3. CAS-infested seeds. (p. 12)

Figure 4. CAS-infested male cone. (p. 12)

Attachment 5. Jody Haynes’ Curriculum Vitae. (p. 13)

Attachment 6. Dr. Thomas Marler’s Curriculum Vitae. (p. 16)

Attachment 1. Newspaper article: “Looking out for scale insects.” Gardening section, *Pacific Daily News*. T. Marler, Feb. 13, 2000.

GARDENING

Looking out for scale insects

By Thomas Marler

For *Pacific Sunday News*

Gardeners, environmentalists, fadang plants take heed. A voracious scale insect has been marching throughout the landscapes of southern Florida for the past few years, and very recently found its way to Hawaii, which means it's not far from Guam.

The tiny insect was a stowaway in the mid-1990s, hiding on cycad plants that were transported from Asia to Florida as landscape plants. And because the insect's natural enemies were not along for that fateful trip, the population of the tiny insect in Florida virtually exploded. The very recent jump of the scale insect to Hawaii, also by way of cycad plants, brings the threat a little closer to home.

Scale insects are pros at hiding among the nooks and crannies of nursery plants. If they were to find their way to Guam on board imported cycad plants, what we know of them indicates that they would be quite happy to claim Guam as their new home.

Scale insects damage plants by feeding through their tiny piercing and sucking mouths.

Plants can coexist with some scales, but other scales can severely damage the health of or even kill plants. The cycad scale from Asia is among the more voracious types, and their feeding can literally kill mature cycad plants.

Richard Baranowski has been conducting research on methods of biologically controlling the



Heidi Hirsch/For *Pacific Sunday News*

Potential target: The Guam cycad is one of the island's most interesting indigenous plants, and makes a beautiful addition to any yard. Its survival in the wild may depend on keeping the cycad scale from finding its way to the island.

scale's population.

"We first released a predaceous beetle in 1997, then released a parasitic wasp in 1998," says Baranowski, a professor with the University of Florida's Tropical Research and Education Center in hem Florida. "The scale pop-

ulations rapidly declined due to the release of these bio-control agents."

But a bothersome characteristic of the scale is that it feeds on roots as well as leaves. Hiding among plant roots may have been the means by which the scale made

it to Florida and Hawaii unnoticed.

According to Baranowski, this characteristic is also a reason that the bio-control agents are not completely effective.

"The bio-control agents can't get to the scales located below ground, so after the above-ground

scales are killed, the beetles and wasps move out of the area," Baranowski says. The scale insects below ground are then free to gradually build up their population again to begin another feeding frenzy.

Although the urban landscapes of Hawaii and Florida are now plagued with the pest, neither state has an indigenous cycad species that is susceptible to the scale. So the scale has not been an ecological problem.

But here on Guam we boast of our indigenous fadang, or the Guam cycad.

And unfortunately, Guam's cycad is very closely related to the cycads that are known to be the most susceptible to attack by the scale. So if the scale were to arrive on Guam, it would no doubt threaten the natural population of plants throughout the island.

All importers of nursery plants would demonstrate admirable environmental stewardship by refraining from importing cycad plants from Florida or Hawaii until we learn more about the insect and its natural enemies. The most common cycad that is imported is the King sago, also called the Sago palm, and this cycad is a known host of the scale. For now, ensuring that no new cycad plants are brought to Guam is likely our only means of protecting the indigenous cycad population.

Thomas Marler is an associate professor with the University of Guam.

Attachment 2. Newspaper article: “Alien insect attacking Guam’s native flora.” Lifestyle section, p. 20, *Pacific Daily News*. T. Marler, Mar. 13, 2004.

LIFESTYLE




Photo courtesy of Thomas Marler

Ypao point: The Asian cycad scale has begun killing fadang plants in the Ypao Point jungle habitat.

Cycad scale attacking Guam plants

By Thomas Marler
For Pacific Daily News

Botanical history was made this month.

New infestations of the Asian cycad scale insect were first noticed on Guam’s king sago plants late last year. By March we knew that our native cycad, the fadang, was more susceptible to the alien pest than is the imported king sago cycad plant. By summer both fadang and king sago plants in the landscapes of Tumon Bay were beginning to die.

But this tiny insect began killing cycad plants in Florida gardens in 1996, then in Hawaii and many other locations shortly thereafter. So no history-making news there, although we can now add Guam to the list of locations that the sap-sucker is killing cycad plants growing in gardens.

This month’s history-making news is not about our yards; it is about our natural jungle habitats. Fadang plants in the jungles of Ypao Point on the south end of Tumon Bay have begun to die from Asian cycad scale infestations. The death of these fadang plants begins the first known case worldwide where an alien insect has escaped from gardens to begin killing cycad plants in their native jungle habitat. Guam may find itself in the news for many interesting reasons, but this news is not welcome.

▲ See **Cycad**. Page 24

LIFESTYLE

Cycad: Spray garden plants regularly

▲ Continued from Page 23

No doubt, this alien insect is about to change the look of Guam’s managed and natural landscapes if we continue to watch it happen without acting. All evidence to date confirms that fadang plants have less than a year to live once infested with this insect. You might call them “dead plants standing.”

King sago plants are beginning to die in large numbers, yet managers of the island’s landscapes have not begun serious attempts to control the pest. A common misconception about the severity of the insect’s damage may be causing the apparent complacency.

“Many of the landscape managers who have called our company believe a king sago plant will fully recover if the dead leaves are just pruned off,” says Rose Pelkey, president of Total Chemical Resources Inc. “But cutting the leaves and letting new ones re-grow will not work long-term.”

Solutions

Experts at the University of Guam are working to import the scale’s natural enemies to curb the epidemic of cycad killing. But that is not going to happen overnight, and judicious spraying may be our only means of saving our cycad plants while we wait.

Pelkey says most insecticides will kill the scale insects if the plants are sprayed often. Insecticide oils and soaps are some of the environmentally friendly spray ingredients that work well. A weekly spray regimen is recommended to stay ahead of the insect population.

The most effective insecticide tested to date is being sold under the trade name of Distance. It appears to work well for up to six months.

If saving your own king sago plants is not enough motivation to begin the chores of weekly insecticide sprays, then consider doing so out of a sense of accountability. We are the reason this new enemy is here, as it arrived among the many shipments of plants that we import to satisfy our lust for pretty landscapes.

Yin may go with yang and Jack may go with Jill. But this alien insect does not go with our indigenous plants. Controlling the scale population in our yards is not just a nice thing to do, it is arguably an obligation.

Thomas Marler is a professor with the College of Natural and Applied Sciences, University of Guam.

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Pacific Daily News, Saturday, September 25, 2004
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guampdn.com Pacific Daily News, Saturday, September 25, 2004

Attachment 3. Newspaper article: “A landscape in danger: Experts advise fighting back to combat Asian Cycad Scale.” Lifestyle section, *Pacific Daily News*. T. Marler, Jun. 5, 2005.

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A landscape in danger

Experts advise fighting back to combat Asian Cycad Scale

By Thomas Marler
For Pacific Sunday News

Today we find ourselves in the middle of an environmental disaster that was entirely avoidable.

In the late 1990s, a plant killer spread across several states, and it was predicted that it would eventually make its way to Guam unless something was done to stop it.

Experts had recommended a simple step to reduce the impending risk to Guam's environment: stop importing king sago nursery plants. King sago is also called sago palm, but is actually not a palm. This beautiful landscape plant is a member of a plant category called cycads. The plant killer is a tiny white insect called a scale, and it hides on king sago nursery plants to travel long distances. Most plant lovers on Guam have watched in horror as this insect continues to kill the popular king sago landscape plants throughout the island.

The University of Guam is holding an informational meeting Friday to discuss the history of this insect's migration to Guam and methods for protecting landscape plants in Guam's yards. The ecological tragedy that is unfolding as a result of this new alien insect invasion will also be discussed.

While plant lovers across several states are lamenting the loss of their beautiful king sago plants because of this scale insect, Guam residents have more serious concerns that should call us into action. Among the geographic areas that have acquired this alien pest in recent years, Guam is unfortunately the first to have a susceptible native plant species. Indeed, Guam's own native cycad is called fadang. As predicted, the alien scale insect is now marching across Guam's forests killing fadang plants like some horrific biological bulldozer.

If nothing is done to slow down the killing now under way, the appearance of these forest areas will endure a permanent change in the near future. But taking steps to keep the beauty of our forests from declining is not our only crisis to consider. Maintaining undeveloped forests is also crucial for sustaining general health of Guam's environment.

ADVERTISEMENT

Photo courtesy of Thomas Marler

Before, after: This king sago plant on San Vitores Road became infested with Asian Cycad Scale last year. The photograph on the left first appeared in the Pacific Daily News on March 13, 2004. The scale insects have killed this once beautiful plant, as shown on the right photograph taken last week.

IF YOU GO

- What: Informational meeting on the Asian Cycad Scale
- Where: University of Guam Agriculture Building, Room 127
- Date: Friday
- Time: 9 a.m. to noon
- More information: Call Dr. Aubrey Moore at 735-2086

WHAT IS IT?

The Asian Cycad Scale is a disease caused by scale insects. The scale insects are difficult to find because they hide in plant roots and stems. The scale insects hatch into a "crawler" stage capable of movement. When they find a suitable spot on a plant, they insert their mouthparts, called stylets (drinking straw), into the plant and start feeding. Shortly afterward they begin to create a white covering over themselves. They will stay this way until they die.

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"Scientists use the phrase 'ecosystem function' as one of the ways to describe these health benefits provided by forests," says David Limtiaco, chief of forestry at the Department of Agriculture. "And the consequences of human actions that reduce ecosystem function are generally more severe on small islands like Guam."

Brown tree snake

Take the human introduction of the brown tree snake to Guam. We've all heard of the loss of most bird species as a result of this human mistake. But many Guam residents are surprised to learn that many of the island's plant species are dependent on these bird species for various reasons, and now the plants are in greater risk because of the loss of the birds.

"Cascading negative impacts on the environment are actually quite common when humans accidentally introduce an alien organism to an island environment," says Aubrey Moore, entomologist at the University of Guam. Moore is taking the lead in organizing the informational meeting this coming Friday. "The environmental damage spreads from one structural or functional component to another as each successive component is compromised." For example, the brown tree snake posed no direct threat to Guam's native plants. The real threat came after the loss of birds. And now that many plant species are showing signs of problems, we may learn that problems start arising for many native and beneficial insects that rely on these plants for survival.

According to Moore, the new threat to Guam's cycad population is a particular red flag for another cascading ecological disaster because of the population density of fadang. A recent study of Guam's northern forests revealed that fadang is the most numerous plant species among the larger forest species.

University of Utah cycad specialist Irene Terry is currently conducting fadang research on Guam, and shares the concerns expressed by Limtiaco and Moore.

"This was not the ideal time for me to come for this research, but this alien scale insect was rapidly expanding into the various habitats in the northern part of the island," says Terry. Now that she is on island, Terry is alarmed at the extent of the pest epidemic and the detrimental effects on Guam's fadang population. "I now know if I had come later in the year as originally planned, the exploding scale infestations would have ruined my ability to effectively study what is going on in fadang pollination and reproduction," Terry says.

Terry will be at the informational meeting Friday to discuss general cycad information and share why learning more about Guam's fadang plants is so important for her own research goals and for understanding of all the world's cycads.

This new alien insect pest that never should have made it to Guam is now threatening what our island home has to offer for advancing worldwide understanding of plant biology. Limtiaco, Moore and Terry are among the many biologists who urge quick action to minimize the continued spread of the Asian Cycad Scale and to protect Guam's beautiful cycad plants from this new threat.

Thomas Marler is professor with the College of Natural and Applied Sciences, University of Guam.

Originally published June 5, 2005



Photo courtesy of Thomas Marler

Vital signs: University of Utah cycad specialist Irene Terry measures the temperature of part of a female fadang plant in Guam's northern forests this week. Terry says careful action may ensure the Asian Cycad Scale killing Guam's fadang plants does not get transported to any other island.

Attachment 4. Photos of cycad aulacaspis scale (CAS) on *Cycas micronesica* in habitat on Guam.



Figure 1. Sick and dying *Cycas micronesica* plants infested with CAS in habitat on Guam.



Figure 2. Closeup of CAS-infested and dying *Cycas micronesica* plants in habitat on Guam.



Figure 3. CAS-infested seeds of *Cycas micronesica* in habitat on Guam. (The immediate effect of CAS will likely be a reduction in the reproductive ability of affected populations.)



Figure 4. CAS-infested male cone of *Cycas micronesica* in habitat on Guam.

Attachment 5. Jody Haynes' curriculum vitae.

Curriculum Vitae
JODY L. HAYNES

PERSONAL INFORMATION:

Full Name: Jody Lee Haynes
Date of Birth: 31 December 1964
Place of Birth: Omaha, Nebraska

PROFESSIONAL INFORMATION:

Position: Cycad Biologist
Institution: Montgomery Botanical Center
Address: 11901 Old Cutler Road
Miami, FL 33156-4242

Phone: (305) 667-3800 ext. 114 / **FAX:** (305) 661-5984 / **E-mail:** jhay@montgomerybotanical.org

EDUCATION:

- Ph.D. student, 1994-96, Biological Sciences, Florida International University; primary interest in molecular evolutionary genetics
- Ph.D. student, 1992-94, Biological Sciences, Mississippi State University; no degree; transferred to Florida International University
- Master of Science, 1992, Biological Sciences, University of New Orleans
- Bachelor of Science, 1989, Biological Sciences, University of Nebraska-Lincoln

PRIOR EMPLOYMENT:

- Florida Yards & Neighborhoods Program Extension Agent, University of Florida/Miami-Dade County Extension, Homestead, 2000-2003
- Research Biologist, University of Florida Tropical Research & Education Center, Homestead, 1996-2000
- Adjunct lecture, laboratory, and independent study instructor, Miami-Dade Community College-Homestead Campus, 1997-2000. *Courses:* General Biology, Energy in the Natural Environment
- Adjunct lecture instructor, Miami-Dade Community College-Kendall Campus, 1997-98. *Courses taught:* General Biology, Energy in the Natural Environment

RECENT GRANTS RECEIVED:

- MBC Panama and Costa Rica Cycad Expeditions (2005): \$9,000 from private donor
- MBC Florida Cycad Expedition (2005): \$4,000 from private donor
- MBC Cycad Savannah Test Plot Experiment (2004): \$10,000 from Stanley Smith Horticultural Trust
- MBC Panama Cycad Expedition (2004): \$5,000 from private donor
- MBC Honduras Cycad Expedition (2003): \$9,000 from private donor
- UF/Miami-Dade County FYN program: \$103,000 in 2002 and \$12,000 in 2001 from Miami-Dade County

RELEVANT PUBLICATIONS, PRESENTATIONS & WEBSITES:***Refereed Publications***

- Bonta, M., O. Flores Pinot, D. Graham, J. Haynes & G. Sandoval. *In press*. Ethnobotany and conservation of tiusinte (*Dioon mejiae* Standl. & L.O. Williams, Zamiaceae) in northeastern Honduras. *Journal of Ethnobiology*.
- Haynes, J.L. *In press*. Overview of the cycad flora of Honduras. *Proceedings of the 7th International Conference on Cycad Biology*.
- Haynes, J.L. & M.A. Bonta. *In press*. An emended description of *Dioon mejiae* Standl. & L.O. Williams (Zamiaceae). *Proceedings of the 7th International Conference on Cycad Biology*.
- Ploetz, R.C., R. Schnell & J.L. Haynes. 2002. Variable response of open-pollinated seedling progeny of avocado to *Phytophthora* root rot. *Phytoparasitica* 30:262-268.
- Taylor, A.S., J.L. Haynes, G. Holzman & J. Mendieta. 2005. Variability and structure of natural populations and implications for *Zamia* species in western Panama. *Proceedings of the 7th International Conference on Cycad Biology* (in press).

Non-refereed Publications

- Haynes, J. 2005. Historical overview of the World List of Cycads. *Montgomery Botanical Center Occasional Paper Series*, No. 1, 34 pp.
- Haynes, J. 2005. The tree dioons (Zamiaceae). *Montgomery Botanical Center Occasional Paper Series*, No. 2, 16 pp.
- Haynes, J. 2005. Biogeographic and phylogenetic parallels in *Dioon* and *Ceratozamia*. *The Cycad Newsletter* 28(2): 8-9.
- Haynes, J. 2005. In the company of giants: One botanist's humbling encounters with ancient dioons. *The Cycad Newsletter* 28(1):6-9.
- Haynes, J. 2004. Phenology of *Bowenia* in South Florida. *The Cycad Newsletter* 27(4):12.
- Haynes, J. 2004. Phenology of *Encephalartos ferox* in South Florida. *The Cycad Newsletter* 27(3):10.
- Haynes, J. 2004. Phenology of *Zamia splendens* in South Florida. *The Cycad Newsletter* 27(2):11.
- Haynes, J. 2004. Phenology of *Lepidozamia peroffskyana* in South Florida. *The Cycad Newsletter* 27(1):12.
- Haynes, J. 2003. Cultivation and phenology of *Cycas panzihuaensis* in South Florida. *The Cycad Newsletter* 26(4):12.
- Haynes, J. 2003. Phenology of *Ceratozamia hildae* in South Florida. *The Cycad Newsletter* 26(2):11.
- Haynes, J. 2002. Year of the golden cycads. *The Cycad Newsletter* 25(4):10-12.
- Haynes, J. 2001. *Cycads in the South Florida Landscape*. University of Florida/Miami-Dade County Extension publication.
- Haynes, J. 2001. *Healthy Palms in Healthy South 'Florida Landscapes'*. University of Florida/Miami-Dade County Extension publication.
- Haynes, J. 2000. *Landscape Drought Recommendations*. University of Florida/Miami-Dade County Extension publication.
- Haynes, J. & M. Bonta. 2003. *Montgomery Botanical Center Honduras 2003 Cycad Expedition Final Report*. Unpublished report submitted to AFE-COHDEFOR, Tegucigalpa, Honduras, 160 pp. (English & Spanish).
- Haynes, J., J. McLaughlin & L. Vasquez. 2002. *Native Landscape Plants for South Florida*. University of Florida/Miami-Dade County Extension publication.
- Haynes, J. & A. Ordenes. 2002. Florida Yards & Neighborhoods: A case study in nonpoint source pollution education. *Proceedings of the 7th Annual Virgin Islands Nonpoint Source Pollution Conference*.
- Holzman, G. & J. Haynes. 2004. Cycads of the sand: The beach-dwelling zamias of Bocas del Toro, Panama. *The Cycad Newsletter* 27(4):3-6.
- Tang, W. & J. Haynes. 2005. *IUCN/SSC Cycad Specialist Group – Subgroup on Invasive Pests Report & Recommendations on Cycad Aulacaspis Scale, Aulacaspis yasumatsui Takagi (Hemiptera: Diaspididae)*. Submitted to IUCN/SSC Cycad Specialist Group Chair, August 2005.

PowerPoint Presentations

- Redescription of *Dioon mejiae*: Toward a Taxonomic Standard*. Presented at the 7th International Conference on Cycad Biology (CYCAD 2005), Xalapa, Veracruz, Mexico (2005)
- Cycad Flora of Honduras*. Presented at the 7th International Conference on Cycad Biology (CYCAD 2005), Xalapa, Veracruz, Mexico (2005)
- The Cycad Program at Montgomery Botanical Center: Past, Present, Future*. Montgomery Botanical Center (2003)
- Jurassic Park Place: Dramatic, Non-Traditional & Innovative Uses for an Ancient & Unique Plant Group (Cycads)*. University of Florida/Miami-Dade County Extension (2002)
- Low-maintenance Landscape Plants for South Florida*. University of Florida/Miami-Dade County Extension (2001)
- Cycads in the South "Florida Landscape."* University of Florida/Miami-Dade County Extension (2000)

Educational Websites

- Montgomery Botanical Center (<http://www.montgomerybotanical.org>), 2005-present
- The Cycad Society (<http://www.cycad.org>), 2003-present
- Virtual Cycad Encyclopedia (http://www.plantapalm.com/vce/vce_index.htm), 1999-present
- Virtual Palm Encyclopedia (http://www.plantapalm.com/vpe/vpe_index.htm), 1998-present

WORK & VOLUNTEER EXPERIENCE:

- Field expedition experience in Central America: Honduras 2003 & 2005, Panama 2004 & 2005, Mexico 2005
- Invited member of IUCN/SSC Cycad Specialist Group – Subgroup on Invasive Pests; invited to lead the next phase of work regarding the global accumulation of information and control recommendations of *Aulacaspis yasumatsui* Takagi, an invasive insect pest of cycads, 2005-present
- Invited member of the IUCN/SSC Cycad Specialist Group; participated in several cycad conservation projects, 2003-present
- Served on the Board of Directors and as the Secretary of The Cycad Society, 2001-present
- Served on the Board of Directors of the South Florida Palm Society from 1999-2002, and as the Corresponding Secretary from 1999-2000 and the Recording Secretary from 2000-2001
- Assisted with the organization and incorporation of the Palm & Cycad Societies of Florida, 1998; served as Editor and Webmaster since the organization's inception; also served as Corresponding Secretary from 1998-2001, and as President for the 2001-02 term
- Greenhouse and field experimental research experience, 1997-2000
- Molecular genetic laboratory experience, Mississippi State University & FIU, 1993-96
- Lecture and laboratory teaching experience, 1989-2000

Attachment 6. Dr. Thomas Marler's curriculum vitae.

Curriculum Vitae
THOMAS E. MARLER

College of Natural and Applied Sciences, University of Guam, UOG Station, Mangilao, Guam 96923
Office Telephone: (671) 735-213 / FAX: (671) 734-4600 / E-mail: tmarler@uog.edu

PRESENT APPOINTMENT:

Aug. 2002 - present: Professor, Tropical Horticulture & Botany, University of Guam
Aug. 1996 - Aug. 2002: Assoc. Professor, Tropical Horticulture & Botany, University of Guam
May 1991 - July 1996: Asst. Professor, Tropical Horticulture & Botany, University of Guam

Research: Tropical botany, native plant conservation, environmental stress physiology, root biology

Education: Teach Environmental Plant Physiology, Environmental Biology/Ecology, Tropical Fruit Science, Introduction to Agriculture & Life Sciences; Direct graduate students in Environmental Science Program and Biological Science Program; Curricula development for K-12 teachers

Community Service: Developed interpretive program for 50-acre eco-tourism facility; Publish relevant newspaper articles and extension bulletins; Create and facilitate workshops on tropical fruit growing for home gardeners; Facilitate trainings for commercial farmers; Travel to other islands in Micronesia to train extension and other resource persons; Secure funds for extension workshops and publications

Germplasm: Establish field collections, and maintain tropical fruit, nut, spice, beverage, and cycad species for education and research purposes

Editing: Associate Editor, *HortScience*, refereed journal published by the American Society for Horticultural Science, Jan. 1998 – present; Member, editorial board of *Micronesica*, refereed journal covering biological sciences pertaining to the Western Pacific.

EMPLOYMENT EXPERIENCE:

Sept. 1988 – April 1991: Adjunct Faculty, Florida International University, Miami, FL
Sept. 1988 – April 1991: Research Horticulturist / Curator, Fairchild Tropical Garden, Miami, FL
1987: Adult Education Instructor, Santa Fe Community College, Gainesville, FL
1984 – 1988: Extension Assistant, Department of Fruit Crops, University of Florida, Gainesville, FL
1982 – 1984: Teaching Assistant, Department of Horticulture, Mississippi State University, Starkville, MS
1981: Nursery Projects Coordinator, Philippine Rural Life Center, Mindanao, Philippines

EDUCATION:

Ph.D. 1988 University of Florida
M.S. 1984 Miss. State University
B.S. 1982 Miss. State University

PROFESSIONAL SOCIETIES:

Association for Tropical Botany
Amer. Soc. Horticultural Science
Amer. Soc. Plant Physiologists
Inter-American Soc. Tropical Horticulture
Intl. Soc. of Root Research
Florida State Horticultural Society

CONSERVATION PROJECTS FUNDED:

- Surveillance for new threats to cycads in the Mariana Island. \$18,980. June 2005 – May 2006. USDA APHIS PPQ Cooperative Agricultural Pest Survey.
- Conservation of *Tabernaemontana rotensis* in Andersen Air Force Base, Guam. \$30,000. Feb. 2005 – Jan. 2006. U.S. Department of Defense. (Rare indigenous species proposed for listing as endangered.)
- Phenology and toxicology of the Guam cycad. \$162,593. Oct. 2001 – Sept. 2005. USDA CSREES Special Grant in Tropical/Subtropical Agricultural Research.
- Yoga Tree Recovery for Readiness. \$67,000. March 2000 – March 2003. U.S. Department of Defense. (Conservation of *Elaeocarpus joga*, a very rare endemic tree species.)

- Protecting Guam's cultural and biological resource - the ifit tree. \$66,170. Oct.1993 – Sept. 1995. U.S. Department of Defense Legacy Resource Management Program. (Conservation of *Intsia bijuga*, a very rare indigenous species.)

RELEVANT REFEREED PUBLICATIONS:

- Marler, T.E. 2005. Age influences photosynthetic capacity of *Cycas micronesica* leaves. *The Botanical Review* (in press).
- Marler, T.E., V. Lee, and C.A. Shaw. 2005. Cycad toxins and Neurological Diseases in Guam: Defining Theoretical and Experimental Standards for Correlating Human Disease with Environmental Toxins. *HortScience* (in press).
- Marler, T.E., V. Lee, and C.A. Shaw. 2005. Spatial variation of steryl glucosides in *Cycas micronesica* plants – within and among plant sampling procedures. *HortScience* (in press).
- Marler, T.E. and R. Munippan. 2005. Pests of *Cycas micronesica* Leaf, Stem, and Male Reproductive Tissues with Notations on Current Threat Status. *Micronesica* (in press).
- Shaw, C.A., J.M.B. Wilson, R. Cruz-Aguado, S. Singh, E.L. Hawkes, V. Lee, and T. Marler. 2005. Cycad-Induced Neurodegeneration in a Mouse Model of ALS-PDC: Is the Culprit Really BMAA or Is a Novel Toxin to Blame? *The Botanical Review* (in press).
- Marler, T.E. 2004. Leaf physiology of shade-grown *Cycas micronesica* leaves following removal of shade. *The Botanical Review* 70:63-71.
- Hirsh, H. and T. Marler. 2002. Damage and recovery of *Cycas micronesica* after Typhoon Paka. *Biotropica* 34:598-602.
- Marler, T.E. 2002. Conservation of local genotypes when planting native plants on Guam. *Micronesica* Suppl. 6:55-60.
- Marler, T.E. 2001. Tropical cyclones and perennial species in the Mariana Islands. *HortScience* 36:264-268.
- Marler, T. E. and B. Wood. 2001. Recovery dynamics of perennial species following tropical cyclone damage. *HortScience* 36:240-242.
- Marler, T.E. and H. Hirsh. 1998. Guam's *Cycas micronesica* population ravaged by Supertyphoon Paka. *HortScience* 33:116-118.
- Marler, T.E. and L.E. Willis. 1997. Leaf gas exchange characteristics of sixteen species of cycad. *J. Amer. Soc. Hort. Sci.* 122:38-42.

RELEVANT NEWSPAPER PUBLICATIONS:

- Marler, T. 5 June 2005. A landscape in danger. *Pacific Sunday News*, p. 17-18. Covers ecological issues caused by CAS invasion of Guam's environment.
- Marler, T. 25 Sept. 2004. Cycad scale attacking Guam plants. *Pacific Daily News*, p. 23,24. Initial reporting of the death of endemic cycad plants in Guam's forests.
- Marler, T. 13 March 2004. Alien insect attacking Guam's native flora. *Pacific Daily News*, p. 20. Initial reporting of the confirmed identification of CAS on Guam.
- Marler, T. 13 March 2004. Fighting back. *Pacific Daily News*, p. 20. Overview of some issues on managing the CAS outbreak.
- Marler, T. 31 Jan. 2004. Large scale infestation. *Pacific Daily News*. p. 20. Description of the epidemic nature of king sago cycad plant CAS infestations and that samples had been sent for positive identification.
- Marler, T. 13 Feb. 2000. Looking out for scale insects. *Pacific Sunday News*, p. 24. Initial warning about risks of an ecological disaster if CAS was accidentally introduced to Guam.
- Marler, T. 13 Feb. 2000. Mobile, pesky scale insects bane of island's flora. *Pacific Sunday News*, p. 24. General article on scale insects.