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College of Natural & Applied Sciences
WESTERN PACIFIC TROPICAL RESEARCH CENTER

GL#34-18-1564

Speaker Benjamin J.F. Cruz

February 6, 2018

FEB 23, 2018 3

Time: _____ [ ] AM [ ] PM File No. _____

Received By: _____

Dear Colleagues,

Please find enclosed copy of our 2017 Impact Report of the Western Pacific Tropical Research Center (WPTRC). This report highlights the key issues and projects that are relevant to the island and regional communities that we serve.

Research conducted by WPTRC scientists primarily affects the Western Pacific region that spreads across thousands of miles and includes numerous islands. We are proud of our achievements and we are glad that our work provides research support for farmers and others who are working in the agricultural and environmental sectors.

I hope you will find our 2017 Impact Report interesting and informative to read.

Sincerely yours,

Lee S. Yudin, Ph.D.
Director, Western Pacific Tropical Research Center

Rachael T. Leon Guerrero, Ph.D.
Associate Director, Western Pacific Tropical Research Center

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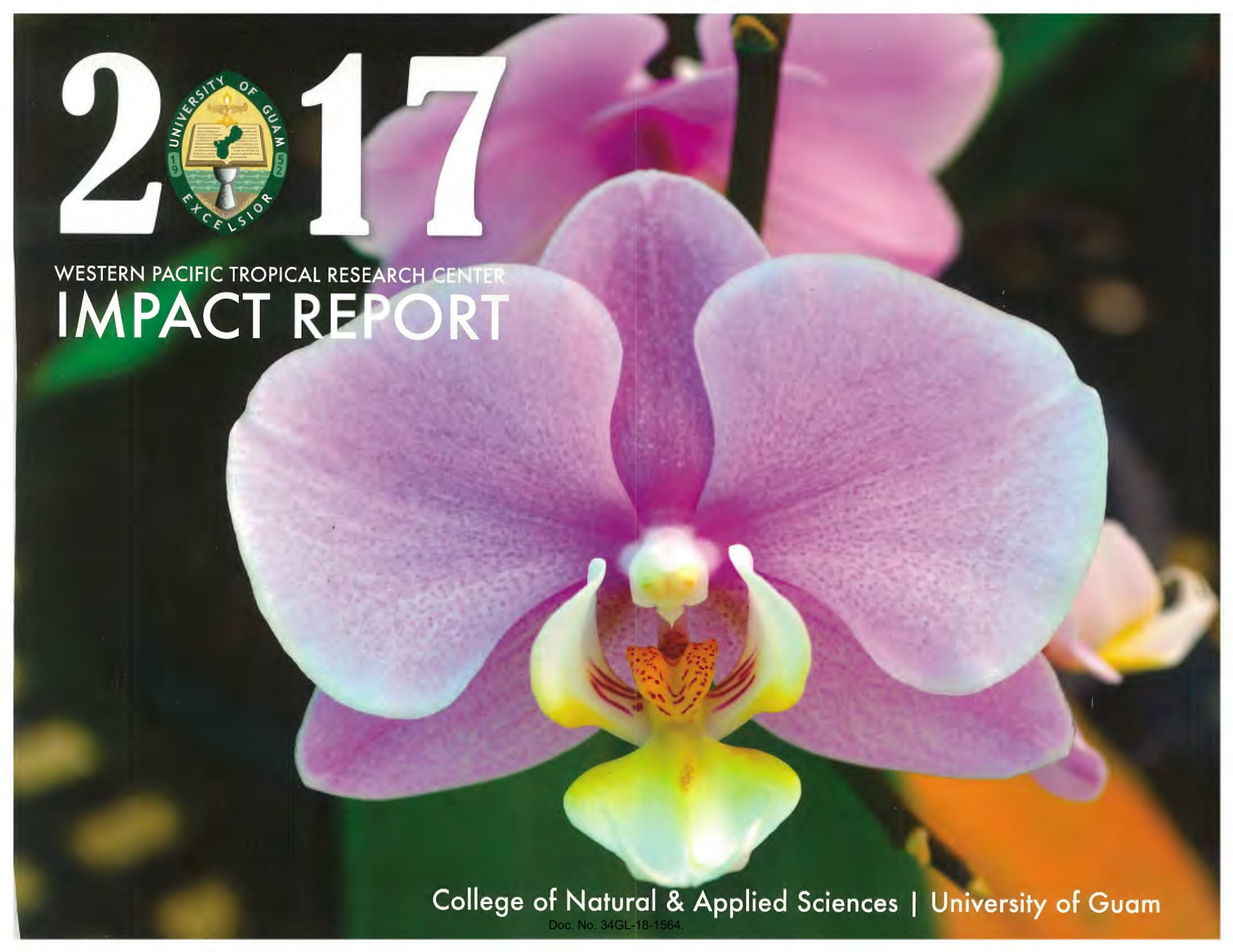
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2017

WESTERN PACIFIC TROPICAL RESEARCH CENTER

IMPACT REPORT



College of Natural & Applied Sciences | University of Guam

Doc. No. 34GL-18-1564.

Buenas yan Hafa Adai,

If we, who are currently engaged in our island's sustainability, are not fully committed toward the improvement of our future, then our children will inherit an island that will be more dependent on outside food imports than ever before. The cost of fruits and vegetables on Guam has increased greatly over the years and hence makes it even harder for many of our lower income families to provide healthy diets for their families. In a book I read recently, the author points out that sugar is now replacing "gunpowder" in the amount of deaths per capita per year. We are substituting highly processed foods that contain processed sugars for fresh fruits and vegetables and the increase in health issues like diabetes is growing exponentially in our young and older populations.

In this year's impact report, there is a wide range of topics from "new cucumber research to address an old nemesis" to "green roofs on Guam." There are current articles that address the better use of compost for leafy lettuce and for the protection of Guam's water supply. There are three unique articles that help in workforce training (in vitro orchid's), fresh water shrimp potentials, and healthier life style choices – underlining my view of better food choices for our families on Guam. This year we have articles that are proactive in geo-health and building capacity for forest inventory in the region. And finally, updates with invasive species pests and possible controls. The selected publications that are found in the back pages are there for those interested in learning more about the impacts found in our report.

Again, I want to personally acknowledge all those individuals who have contributed to the 2017 WPTRC Impact Report and especially to my administrative staff who raise the expected standards for all of us to follow. Collectively, we are making a difference in our community, and that is exactly what Land-Grant institutions are all about – improving the lives of the people we serve one day at a time.

Si yu'us ma'ase (thank you),

Lee S. Yudin
Dean/Director
CNAS/WPTRC

Hafa Adai,

It's been another productive year for the Western Pacific Tropical Research Center, and the projects highlighted in this year's Impact Report demonstrate the variety of important issues being studied at the University of Guam.

In 2017, we continue to address the challenge to Guam's environment and natural resources, our tropical agriculture industry, and we are studying the growing problem of child obesity. We also strive to extend our current capabilities beyond the boundaries of Guam to become an internationally recognized tropical research center. WPTRC may be a small research unit with limited financial, logistical, and human resource support; but we focus on our opportunities, such as: our proximity to Asia, clean ocean water for aquaculture research, partnerships with other entities in Micronesia, commitment by the U.S. government to preserve native species on Guam, and interest by other research entities to collaborate.

The hardworking faculty and staff of WPTRC continue to remain competitive in securing extramural funding. In 2017, we collaborated with multiple off-island scientists and institutions, provided employment to the local community, and offered students to opportunity to gain valuable research experience.

WPTRC is here to serve our stakeholders, so please feel free to contact my office if you have any questions or need additional information.

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Doc. No. 34GL-18-1564.

Credits

This report is dedicated to the memory of **David Nelson**, a former student whose dedication to agriculture continues to inspire us.

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Healthy Phalaenopsis *orchid from the Guam Department of Agriculture tissue culture laboratory.*

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Eating a fresh leafy-green salad gives one a feeling of health and vitality. That is because leafy lettuce is a good source of vitamins A, C, K, B6, thiamin, riboflavin, folate, iron, potassium, manganese, and protein. An impressive list from a few leaves.

Although lettuce, *Latuca sativa*, is typically a cool-season crop, there are varieties such as StarFighter and New Red Fire that can take the heat and humidity found at 13 degrees latitude. Extension Horticulturist, Joe Tuquero, conducted variety trials of these two lettuce varieties, which were grown in pots with 13 different compost treatments. For both trials, lettuce seedlings were nursed in planting trays for two weeks and then individually transplanted into one-gallon pots. Lettuce heads were harvested at 26 and 30 days and the shoots were measured for fresh weights.

The average fresh weights of StarFighter were higher when grown in compost treatment WFC100, which consisted of wood chips, food waste and chicken manure. StarFighter showed good results with three other compost treatments: WFC50 (wood chips, food discards, chicken manure); WF100 (wood chips and food discards); WC100 (wood chips and chicken manure). This variety grew poorly in all other compost treatments.

New Red Fire results matched those of StarFighter. Superior average fresh shoot weights resulted in the WFC100 compost combination. New Red Fire also displayed vigorous growth when grown in WF25, WFC50, and WC100.

13 Compost Treatments: PM = Potting Mix (Sunshine Mix#4), W = Wood chips, F = Food Discards, C = Chicken Manure

Treatment Name	Compost Mix	Percent of Compost Material per Treatment
WFC25	PM+W+F+C	PM = 75, W = 18, F = 6, C = 1
WFC50	PM+W+F+C	PM = 50, W = 35.5, F = 12, C = 2.5
WFC100	W+F+C	PM = 0, W = 74, F = 24, C = 5
WF25	PM+W+F	PM = 75, W = 18, F = 7, C = 0
WF50	W+F+C	PM = 50, W = 36, F = 14, C = 0
WF100	W+F	PM = 0, W = 72, F = 28, C = 0
WC25	PM+W+C	PM = 75, W = 22.5, F = 0, C = 2.5
WC50	PM+W+C	PM = 50, W = 45, F = 0, C = 5
WC100	W+C	PM = 0, W = 90, F = 0, C = 10
W25	PM+W	PM = 75, W = 25, F = 0, C = 0
W50	PM+W+	PM = 50, W = 50, F = 0, C = 0
W100	W	PM = 0, W = 100, F = 0, C = 0
PM100	PM	PM = 100, W = 0, F = 0, C = 0



StarFighter and New Red Fire lettuce potted with varying compost treatments.

These trials highlighted the different growth responses to the growing media. It was clear that the compost mix consisting of renewable resources such as wood chips, food discards, and chicken manure (no potting mix added) resulted in the most vigorous growth of both lettuce varieties.

Funded by USDA NIFA Hatch

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Doc. No. 34GL-18-1564.

Pika pepper trials

Guafi: Local, non-hybrid variety.





Doc. No. 34GL-18-1564.

One very important ingredient in Chamorro cuisine is the chili pepper. They are used to make the hot pepper paste dinanche and finadene, the ubiquitous hot pepper, soy sauce, lemon or vinegar condiment for everything on Guam. For people who really appreciate some fire in their food, the more "pika" the better.

In order to test which pepper plants, *Capsicum annuum*, grow best in the hot humid conditions on Guam, Extension Horticulturist, Joe Tuquero, conducted a variety trial using five different varieties. Plants were transplanted into the cobbly clay loam soil at the Yigo Research & Education Center in December 2016 and harvested February 10 through April 28, 2017.

Plantings included the local non-hybrid varieties Hachon and Guafi, with hybrid non-local varieties Ascent F1 and Red Air F1. Thai Yellow, a non-hybrid heirloom variety was also included in the trial.

Farming in the tropics has its own set of difficulties and this field trial had trials of its own. Prior to harvesting, the entire field became infected with Anthracnose fruit rot, which was controlled using weekly applications of environmentally safe neem oil, derived from the seeds of the neem tree, *Azadirachta indica*. Due to the use of neem oil for controlling the fungus, more marketable than non-marketable fruits were harvested.

Ascent F1: Hybrid variety.



Red Air F1: Hybrid variety.



Thai Yellow: Non-hybrid, heirloom variety.



Hachon: Local, non-hybrid variety.



Average Size and Weight of Individual Fruit

Cultivar/ Variety	Average Length (cm)	Average Width (mm)	Average Weight (g)
Ascent	3.80	9.52	1.78
Guafi	5.71	9.91	2.90
Hachon	4.98	8.26	5.03
Red Air	4.21	9.62	2.19
Thai Yellow	7.32	18.27	10.31

Ascent, Red Air and Guafi produced high numbers of harvested fruits compared to Hachon and Thai Yellow. Both F1 hybrids produced harvest-ready fruits approximately three weeks before the non-hybrid plants. Many hybrid varieties are bred for their early harvest traits, demonstrated by the results of this trial.

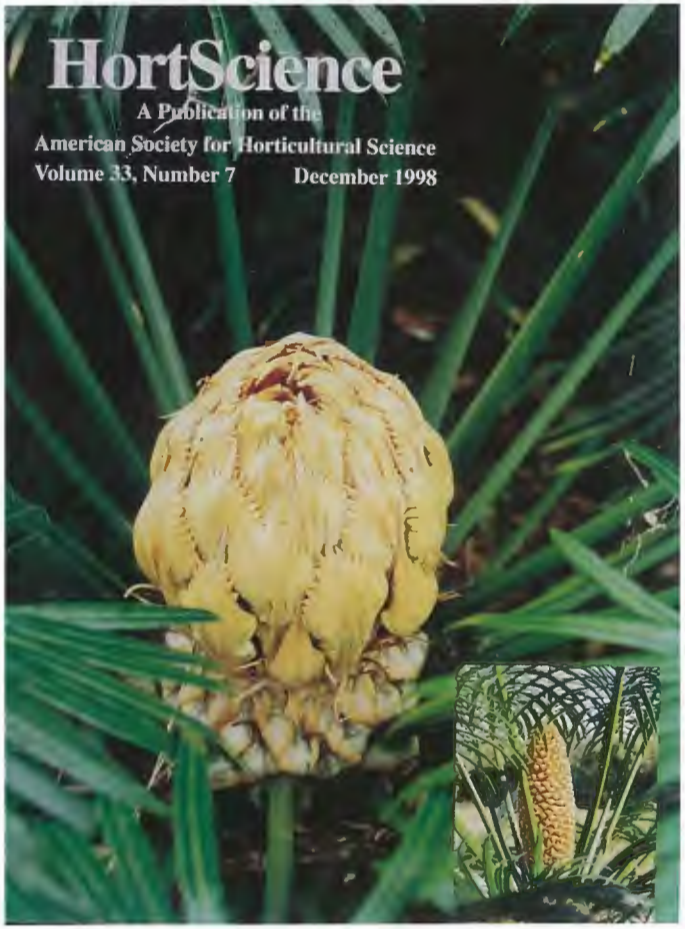


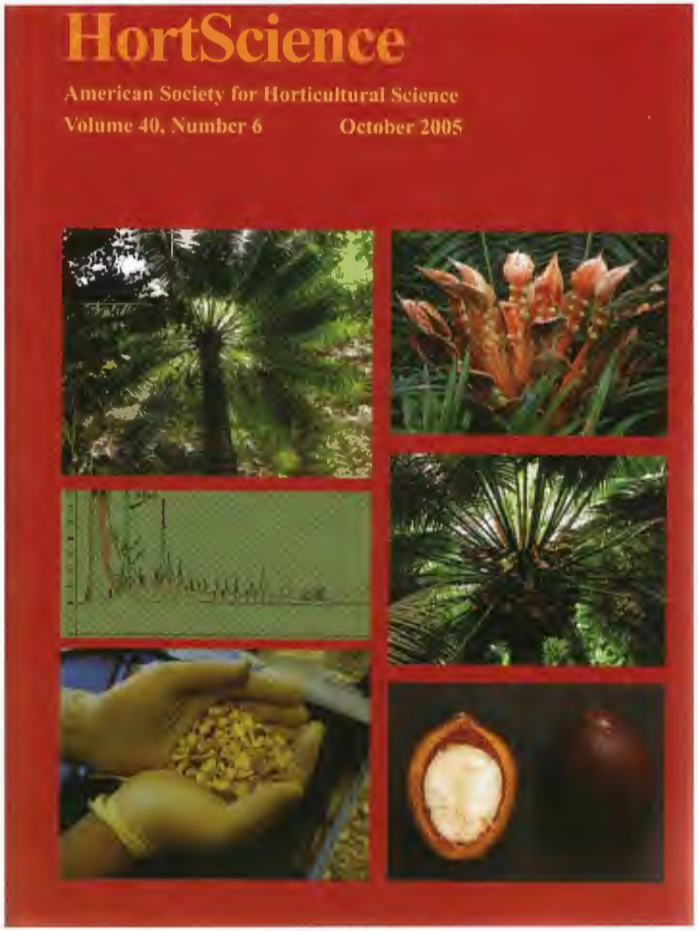
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Doc. No. 34GL-18-1564.

Marler selected for expanded journal service







WPTRC professor Thomas Marler has been selected by the American Society for Horticultural Science to serve as the editor for the newly founded plant conservation section of their popular journal *HortScience*. Scientific journals form the foundation of how expanding knowledge from research institutions is initially communicated. The editorial process relies on experts to determine suitability of prospective publication submissions through rigorous reviews.

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"For this process to function, science journals depend on the help of international experts to serve as editors of various sections that comprise the journal's content," said M. LeRon Robbins, editor-in-chief for *HortScience*. In effect, these editors serve as a gatekeeper of the submissions within their area of expertise, ensuring that new submissions pass the test of originality and worthiness.

Founded 115 years ago, the American Society for Horticultural Science is the largest organization dedicated to advancing the horticultural sciences globally. *HortScience* has been a vehicle for communicating original research for more than 50 years.

According to Robbins, Marler is the only current editor who has been on the editorial board even longer than himself. "The American Society for Horticultural Science appreciates greatly Dr. Marler's almost two decades of dedicated scientific editorial service to the Society and to the profession," said Robbins. "It's a demanding, time-consuming, and often thankless job, so many section editors last in the job for only two to four years."

Marler's recent research and publications on endangered species caught the eye of the journal's decision-makers, enabling their invitation for him to spearhead the new "Conservation and Restoration" section. Twenty different plant species officially categorized as Threatened or Endangered by the International Union for Conservation of Nature have been included in the 56 journal





Above and left: A collection of cover articles from the Marler lab that have been published on endangered species.

articles that have been generated by Marler's lab in the past five years.

According to Marler, scientists from insular institutions like UOG gain immense benefits from staying heavily involved in journal editing. Scientists are at risk of becoming isolated from the global agenda if they are unwilling to follow through with publishing their Guam-derived data. Local scientists should arm themselves with continually expanding communication skills so that Guam is projected onto the international scene in the process.

"I commend research institutions like the Western Pacific Tropical Research Center whose administrators encourage their researchers to serve as editors and reviewers of scientific journals," said Robbins. "Research is complete only after results are published, and supportive administrators are a key link in getting the publishing job done."

Further reading:
Marler, T.E. 2017. Horticultural research crucial for plant conservation and ecosystem restoration. *HortScience* 52(12):1648-1649. DOI: 10.21273/HORTSCI12423-17.

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Doc. No. 34GL-18-1564.



Beetle discovery highlights co-extinction risks

WPTRC scientist Thomas Marler observes typhoon damage on a *Cycas edentata* plant in the Philippines, with a young male cone shown in the background.

Exploratory field work of WPTRC scientist Dr. Thomas Marler has led to the discovery of a small Philippine beetle that is new to science. The finding led to the insect's description this year with the new name *Cycadophila samara*. The publishing team used sequences from a mitochondrial gene fragment and traditional morphological diagnostics in the robust study. The results of the project have led to a total of 21 described species in the genus which form tight bonds with co-occurring Cycas plants in their respective native ranges.

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The newly named Philippine species, for example, forms an obligate mutualism with the prominent coastal tree species *Cycas edentata*. The beetle requires male cones of the plant as brood sites for providing larval food, and the plant requires the pollination services of the beetle to produce viable seeds. In effect, the next generation of each organism depends on the services of the other organism.

"These coastal Cycas plants in the Philippines are closely related to Guam's *Cycas micronesica*," said Marler. The Guam plant species, which also has its own insect pollinator species, has become threatened with local extinction due to the invasions of several pests. "The objectives of the field work were to learn more about the threats to Cycas populations and habitats throughout the Philippines in hopes of developing better conservation strategies here on Guam."

The northwest Samar habitat where the beetle was discovered has been exploited by Marler to generate several publications. In addition to the beetle description, this was one of several sites used to learn more about responses of Cycas habitats to typhoon damage. According to Marler, the direct study of biological relationships in the context of natural disturbances like typhoons and human-caused disturbances such as land use conversion is of paramount importance to improving conservation plans.

The native plant populations in this study site have been devastated since Marler initially visited the habitat 10 years ago. Unchecked conversion of the habitats to constructed coastal aquaculture ponds has killed most of the *Cycas edentata* population. These developments augment the ongoing environmental destruction on Guam to highlight the importance of studying the biological relationships that sustain ecosystem function before those relationships are lost.

A phenomenon called "co-extinction" is occurring as extinction rates have increased in recent years. This phenomenon occurs when the population of one organism is faced with a direct threat, but a second organism also succumbs due to the fact that it depends on the threatened organism. The direct demise of the first organism essentially dictates an indirect demise of the second organism. Marler's regional research has provided valuable contributions to global efforts to combat biodiversity loss. As extinction rates continue to climb, direct field work that leads to the addition of case studies from western Pacific island nations will continue to benefit this global agenda.

Further Reading:

Marler T.E. and U.F. Ferreras. 2015. Disruption of leaf nutrient remobilization in coastal Cycas trees by tropical cyclone damage. *J. Geography and Natural Disasters* 5:1421-1427.

Skelley P., G. Xu, W. Tang, A.J. Lindström, Marler T.E., J.S. Khuraijam, R. Singh, Radha P., and Rich S. 2017. Review of Cycadophila inhabiting Cycas in Asia, with descriptions of a new subgenus and thirteen new species. *Zootaxa* 4267 (1):1–63.

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The newly described *Cycadophila samara* is a small beetle that forms a mutualism with Philippine *Cycas edentata* plants. A distinguishing feature of this beetle is the broad orange band on the wings. Source: Zootaxa.



The *Cycas edentata* cone provides a brood site for *Cycadophila samara* larvae, enabling one more generation of the beetle pollinator.

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WPTRC research contributes to the field of geohealth



Barren scars frequently develop in Guam's savanna grasslands. WPTRC research has revealed the attempts to restore the barren surfaces by planting exotic *Acacia* trees may lead to unnatural changes in the biogeochemical cycle.

Geohealth is a new discipline in science that delves into the various links between human well-being and ecosystem health. Recent research by WPTRC scientist Thomas Marler has contributed to this emerging field of science. Studies with invaded patches of *Leucaena leucocephala* in Tinian and forest fragments created by planting *Acacia* trees in southern Guam have shown that the alien tree species impose unnatural changes in soil chemical traits.

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The research revealed that the sustained cover of these trees may influence ecosystem function in ways that are degradative to the environment.

For example, the phenomenon called "nitrogen mineralization" is the biological process whereby the nitrogen that is locked up in materials such as leaf litter is converted from unavailable forms into forms that plants can utilize. In healthy habitats this mineralization proceeds at a speed that enables plant uptake as nitrogen becomes newly available. Mineralization is one of the processes that were shown to be drastically altered by the presence of the alien tree species.

"Mineralization underneath the *Leucaena* cover was three times greater than underneath adjacent native forest sites," said Marler. "Similarly, mineralization in *Acacia* forest fragments was ten-fold greater than in adjacent savanna grasslands."

These unnaturally high rates of mineralization increase the risk of nitrate pollution. Two environmental traits of the Mariana Islands interact with the high mineralization rates to increase the risk of pollution. One is the high annual rainfall that can cause nitrate losses through surface runoff or by leaching the nitrate below the root zone. But for the *Acacia* plantings, the acidic soils that are selected for these tree-planting projects also add a second risk factor. Acidic soils exhibit an abundance of available aluminum, which is known to influence plant nutrient uptake. Recent evidence reveals that the speed of nitrate uptake by trees is reduced by excessive aluminum availability. "Therefore, the reduction in plant uptake of nitrate in the *Acacia* stands as a result of aluminum relations could increase nitrate watershed discharge into streams and increase the ecosystem damage," said Marler.

In terms of sustainably restoring Guam's eroding southern mountain slopes, the activities that agencies and advocacy groups implement need to consider all of the nuanced changes that may occur as a result of the activities. Focusing on a reduction of soil erosion alone may not allow truly successful restoration if the means by which erosion is mitigated leads to a decline in ecosystem health. According to Marler, the world has many examples of where choices based on narrow interests can result in negative public health impacts. Too often our ability to document these negative impacts starts after the environmental degradation is so far advanced that mitigation of the damage is difficult to achieve.

Active restoration approaches such as planting of *Acacia* trees on Guam's eroding soils are increasingly being used to reverse degradation of ecosystems throughout the world. This increased investment into restoration has created a need to develop formal efforts to document both positive and negative treatment effects. Supporting applied research and monitoring the environment are essential if we want to get ahead of the self-inflicted damage.

"The creation of a subdiscipline like geohealth is important because the international coalition of researchers studying the subdiscipline can better harmonize the increases in knowledge that accrue over time," said Marler. WPTRC research is adding to these global efforts and may aid in placing the spotlight on the geohealth agenda with more success.

Further reading:

Marler T.E., N. Dongol, and G.N. Cruz. 2016. *Leucaena leucocephala* and adjacent native limestone forest habitats contrast in soil properties on Tinian Island. *Communicative & Integrative Biology* 9:e1212792, DOI:10.1080/19420889.2016.1212792.

Marler T.E. 2017. Soil chemistry following afforestation of barren coastal soils in Southern Guam does not conform to that of continuously vegetated surfaces. *Journal of Coastal Zone Management* 20:2, DOI: 10.4172/2473-3350.1000444.

Funded by USDA NIFA Hatch

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Green roofs for Guam

Unattractive, gray, mold-covered concrete roofs on Guam could undergo beneficial transformations that would save a significant amount of money, increase functionality, attractiveness and in some cases increase the value of the house. Concrete structures that dominate on Guam are exceptionally strong but also absorb a large amount of heat. The heat builds up during daylight hours and remains in the building material

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for quite some time after sunset. In fact, in a residential house the average roof temperature is often 10˚F warmer than the average daily temperature.

On Guam, uncovered roofs heat up daily, especially during the hot sunny dry season when rains are infrequent. In the relatively normal dry season of 2016 and 2017, the inside temperature of a typical concrete house, on the underside of the roof, reached 110˚F almost every day for weeks. In the wet season rainwater removed a sizeable amount of heat from the roof but the inside temperature, measured on the underside of the roof, still reached close to 100˚F and remained warmer than the walls at all times. Concrete roofs work like huge radiators. To escape the heat, air conditioning is frequently used and in many cases the AC unit runs day and night. On Guam, typical energy consumption for an air-conditioned residential house maintained at 77-78°F oscillates around 1,000 kWh per month at cost around 30 cents per kWh.

Concrete roofs can carry a load of growing media (soil) and vegetation. This layer of soil covered by plants would be quite effective in reducing the "radiator effect" by shielding the roof from the hot sun, which would decrease the roof temperature considerably. The temperature of plant surfaces (such as turf grass) does not rise more than several degrees above the air temperature and sometimes (on dry windy days) it could be even cooler than the air above it. Data obtained on Guam indicate that a roof covered with turf grass, can easily reduce roof temperatures by 20°F when compared to a white, well-maintained concrete roof and by more than 25°F when a roof is covered by black algae, which is quite common on Guam. To provide the desired cooling effect, vegetation needs to be established on about 80-90% of the roof surface – usually about 1000-1200 ft^2 on an average residential house. Abundant tropical rainfall and the selection of appropriate plant species may eliminate or greatly reduce the need for irrigation, making roof vegetation relatively easy to grow and maintain. For example, Japanese turf grass grew very well and needed about 50 gallons of water per day over the period of a few of the driest months. If succulents (plants tolerating drought) are used, the cooling effect would be somewhat less but water would be needed only when soil is very dry.

Constructing an extensive (minimal maintenance) type of green roof is not difficult. The growing medium (soil mixed with gravel and lava) needs to be only 4-5 inches thick and must be placed on some type of drainage layer. Waterproof membranes, which are absolutely essential on wooden roofs converted to green roofs, are not needed on Guam because moisture coming from the soil does not excessively damage concrete. Building foundations that touch moist soil for many years usually show less cracks and less exposed rusted rebar than roofs exposed to the salt present in the air. If the choice is made to establish a green roof, the cost of materials, growing medium and vegetation could range from less than a thousand to several thousands dollars depending how much of one's own time and labor is invested. As a construction guide, Dr. Greg Wiecko recommends reading *Small Green Roofs: Low-Tech Options for Greener Living,* by Nigel Dunnett, Dusty Gedge, John Little, Edmund C. Snodgrass.

Overall, the internet is a good source of information about green roofs. However, it is important to remember that examples from tropical locations such as Singapore or Hong Kong need to be followed. Plants that are most suitable for hot but dry climates (such as in Arizona or Nevada) or temperate climates may not be suitable for Guam.

Funded by USDA NIFA

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According to the World Health Organization, the increased use of synthetic fertilizers and the disposal of animal waste from farms are two of the major contributors to elevated nitrate levels in groundwater supplies around the world over the last 20 years.

Guam relies heavily on its underground aquifer for water sources in the northern part of the island. Soil scientist, Dr. Mohammad Golabi, wanted to find out whether the application of composted organic waste to crops would have any potential adverse effects on Guam's underground aquifer. Dr. Golabi and research assistant, Ferdinand Galsim, utilized CNAS Research & Education Center plots to conduct experiments and compare the application of composted organic waste with commercial fertilizer in order to evaluate the environmental impact.

Soil water (leachate) was collected from below the root zones (2 ft. & 4 ft.) to gauge the chemical movement (e.g., N, P) through the soil matrix of the study plots. The concentration of nitrate (N) and phosphate (P) was higher in the plots that utilized commercial fertilizers. On the other hand, compost-applied soil releases nutrients (N, P) much slower than commercial fertilizers, which gives plants more time to absorb the nutrients, hence preventing chemicals from reaching below the root zone. "We have found that on the plots where compost was applied there was less nutrient/chemical leaching below the root zones indicating that the chance of nitrogen and phosphate reaching the groundwater was slim. This planting method protects ground water from contamination by nitrates and phosphates which are provided by compost for plant growth," said Golabi.



Research assistant, Ferdinand Galsim, and soil scientist, Dr. Mohammad Golabi, collecting leachate using suction cup lysimeters.

In a related study, evaluating the agronomic value of using composted organic waste for crop growth, Dr. Golabi and his team found that the corn planted in plots utilizing compost, were better in quality and had a slightly higher yield than plots treated with commercial fertilizers.

The results of this research will help farmers make informed decisions for improving soil health and enhance crop quality and yield, while preserving the quality of water resources. Water resource managers and regulatory agencies can also use this data to make environmentally informed decisions specifically in regard to Guam's underground water supply.


Corn grown with compost (above left) had larger kernels than corn grown with fertilizer (right).

Funded by USDA NIFA Hatch and Hatch Multistate

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Building the capacity for forest inventory research in the region



Gregorio (Goro) Borja III hiking to an FIA plot in the Alaskan alpine.

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Since the 2013, Guam Forest Inventory and Analysis (FIA) project, Dr. McConnell's lab at the University of Guam has been actively involved in building capacity for its own staff and regional foresters by participating in training opportunities and helping neighboring island nations conduct their own inventory programs. This work has been conducted in partnership with the US Forest Service, local forestry departments and many regional NGOs. Staff have participated and assisted with Forest Inventory and Analysis programs in Guam, Palau, CNMI, Pohnpei, Yap, Chuuk, and Alaska.

Over the past two years, John Horeg, Gregorio Borja, and Gary Baxter have spent close to three months per year working in Alaska alongside US Forest Service staff. Beginning with a five-week intensive training followed by an even more intense ten-week field season in a very rugged part of the U.S.

This opportunity gave the them a chance to re-calibrate their skills in a fast-paced environment. They are currently preparing for a unique research project in the Republic of the Marshall Islands where they will travel to 13 atolls on a live-aboard sailboat in January 2018.

The FIA Program is a forest census designed to assess the current condition of America's forests and project how forests are likely to appear in the future. This enables an evaluation of whether the current forest management practices are sustainable in the long run and an assessment of whether current policies will allow the preservation of forests for future generations. FIA reports target the following: the status and trends in a forest area and location; the species, size, and health of trees; total tree growth, mortality, and utilization rates by various products; and forest land ownership. FIA collects and monitors changes in forest condition and area in all fifty states, territories, as well the U.S.-affiliated Pacific Islands.

UOG staff members now have the capacity to lead field crews and are certified to conduct forest data collection using the skills and protocols learned through working with the U.S. Forest Service. This opportunity has also opened the door to forming close working relationships with other community partners and to participate in efforts such as the Micronesia Conservation Trust's Micronesia Challenge.

Through this partnership with the US Forest Service, the University of Guam strengthens its position for research and support for building sustainability in the region.

Funded by US Forest Service



Gary Baxter putting on his flight suit to get ready for a helicopter flight to an FIA plot in Alaska.



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Doc. No. 34GL-18-1564.



New cucumber research to address an old nemesis



Doc. No. 34GL-18-1564.

The disease anthracnose, caused by the fungus *Colletotrichum orbiculare*, has likely been on Guam from the start of the cultivation of this popular crop; however, it wasn't until 1979 that is was officially reported.

Using gene sequencing, California Dept. of Food and Agriculture Plant Pest Diagnostic Center confirmed Guam's anthracnose pathogen and identified its strain as CBS 570.97+LARS73. Spots or lesions of the disease are easily seen on leaves but also occur on stems and fruits. These spots produce copious amounts of spores, which are easily spread across a field by wind driven rain. In addition to spreading the disease, it is within drops of water that spores germinate and infect the plant.

Dr. Robert Schlub launched a project in 2017 to reduce the impact of anthracnose on Guam through the identification and promotion of resistant cultivars. Dr. Schlub's approach is to screen for resistance by inoculating seedlings and then rating their disease severity level. He says, "The advantages of using seedling inoculation over natural field screening include less experimental error and less required space and labor." The project's objectives include the following: selection of test cultivars, year-one, authoritative identification of Guam's anthracnose pathogen, year-two, and screening of cultivars and relay of findings to Guam farm community, year-three.

During this first year, Extension Associate Meghan Borja solicited the opinion of University of Guam Cooperative Extension & Outreach agents, researchers, and local growers regarding which cucumber cultivars to include in the seedling screening trial. This resulted in the identification of five varieties commonly used amongst local farmers. Fifteen additional varieties were selected based on seed company information such as seed cost and availability, tolerance or resistance to anthracnose, fruit type, and high temperature hardiness. Through experimentation it was determined that an inoculum spore concentration of 40,000/ml was best suited for lesion development and that inoculum harvested from leaf lesions was preferable to those collected from agar cultures. Preliminary results indicated that some of the test cultivars do exhibit resistance or tolerance to Guam's anthracnose pathogen.

Also involved in the project is Dr. Brian Marx of Experimental Statistics at Louisiana State University. He provided input into the experiment design of the trial and will be providing analyses of the data.

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Extension Associate, Meghan Borja, examines cucumber leaves for the fungus *Colletotrichum orbiculare*.

Funded by USDA NIFA Hatch

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Doc. No. 34GL-18-1564.



Shrimp and their salinity preferences

Doc. No. 34GL-18-1564.

Euryhaline organisms, such as Penaeid shrimp, are able to flourish in both fresh and salt water. The CNAS Guam Aquaculture Development and Training Center, under the leadership of Dr. Hui Gong Jiang, is currently working with the ninth generation of *Penaeus vannamei* shrimp families they have been raising since 2007. The data are in on shrimp families and the ideal salinity for growing into the best shrimp they can be.

Jiang's team was looking to understand how gene expression would be affected in ten shrimp families raised in different salinities. Tissue samples randomly taken from the gills, muscles and hepatopancreas of five individuals from the ten families were analyzed for total RNA extraction, for cDNA synthesis and gene expression studies.

Preliminary data showed significant effects of both family and salinity on gene expressions of certain energy and metabolic related enzymes. Low salinity stress conditions lead to a higher expression of Na^+-K^+-ATPase in the gills. Na^+-K^+-ATPase is a transmembrane enzyme that is responsible for pumping sodium out of cells while pumping potassium into cells. It recruits energy from ATP and is very important for cell physiology and maintaining osmotic homeostasis. These results indicate that the Na^+-K^+-ATPase gene in shrimp could be turned on by the salinity stress at various degrees depending on the family genic backgrounds.

The two fastest growing families at both salinity levels exhibited the highest trypsin expression in muscles. Trypsin is an important hydrolyzing protein. It is an indicator for shrimp growth and when high levels of trypsin are found in the hepatopancreas they are considered a sign of good digestion and absorption. High levels of trypsin in the muscles can lead to a softening of the muscle tissue and may be the turnover of muscle tissue deposition. These families also had a higher ATP synthase expression in the hepatopancreas in seawater than in low salinity water. They expressed higher ATP in muscles in low salinity water than in seawater. These results confirmed that there was a higher energy demand process that occurred in the muscles of most shrimp families when they are coping with low salinity environments.

With the results of these important details of gene expression, a more complete picture emerges allowing for an accurate comparison of the families with the corresponding production performance.

Specific Growth Rate of 10 Families at Two Salinities

Day / Family	30th day		44th day		58th day		73th day		
	32ppt	2ppt	32ppt	2ppt	32ppt	2ppt	32ppt	2ppt	
1	2.06	1.46	1.91	2.18	1.39	1.72	1.42	0.82	
2	2.17	1.62	1.66	2.03	1.92	2.09	1.01	0.90	
3	4.28	3.81	3.08	3.29	2.04	2.23	1.99	1.83	
4	3.02	2.32	2.07	2.11	1.88	2.42	1.68	1.07	
5	5.22	5.19	4.57	3.78	2.25	3.16	2.62	1.75	
6	3.94	3.73	3.45	3.83	1.81	2.61	2.57	1.95	
7	3.67	2.87	3.19	3.01	1.08	2.44	1.08	< 1.75	
8	3.54	3.27	3.01	2.94	2.33	2.56	1.50	< 1.64	
9	4.60	4.29	4.43	4.15	2.50	3.34	2.50	2.18	
10	3.71	3.53	3.58	2.84	1.80	2.70	1.73	1.36	
Mean	3.62	3.21	3.10	3.02	1.90	2.53	1.81	1.53	
CV (%)	27.57	36.46	32.04	25.05	22.46	18.88	32.87	30.44	

Funded by USDA NIFA Hatch and government of Guam

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Doc. No. 34GL-18-1564.

In vitro orchid program and local workforce training



Doc. No. 34GL-18-1564.

Dendrobium and *Phalaenopsis* orchids are highly desired by local businesses that accommodate the 1.5 million Asian tourists visiting Guam every year. Decades of foreign imports, mostly from non-reputable sources, resulted in an alarming number of orchid diseases. Surveys indicated that imported orchids tested positively for harmful plant viruses.

Beginning in 2012, the Western Pacific Tropical Resarch Center, in collaboration with Guam Department of Agriculture, initiated an orchid tissue culture program in order to develop the sustainable production of orchids on island, to provide training for a local workforce, and to increase the competitiveness of local nurseries with foreign imports.

"We have concentrated our efforts on the production of several of the most common varieties of certified, disease-free *Dendrobium* and *Phalaenopsis* orchids and made them available to local nurseries," said Alicja Wiecko, principal investigator of the project.

Two main objectives of this project were to increase the competitiveness of local nurseries with those selling the cheaper, imported plants, and to develop the sustainable production of orchids on Guam. Among the reasons for the limited production of orchids on island was their health. Over the last two decades, Guam Customs and Quarantine officers have detected an alarming number of diseased orchids in shipments to Guam. Surveys conducted



indicated that the majority of imported orchids, over 70%, tested positive for harmful viruses.

Within three years of initiating this program, the general public and local nurseries were able to purchase inexpensive disease-free orchid varieties in quantities of several thousand per year. Asian imports have been greatly reduced and replaced by local production. This ability to produce healthy plants locally keeps the island safe from accidental importation of viruses.

An additional goal of this project was to train employees in developing the necessary skills of tissue culture propagation, which would give them a competitive edge in the job market. This goal was fully achieved with four technicians and numerous students acquiring tissue culture skills that are rare on a small



island. One entrepreneur is getting ready to start his own tissue culture lab that may be staffed with technicians trained in this highly successful program.

Funded by USDA Agriculture Marketing Service

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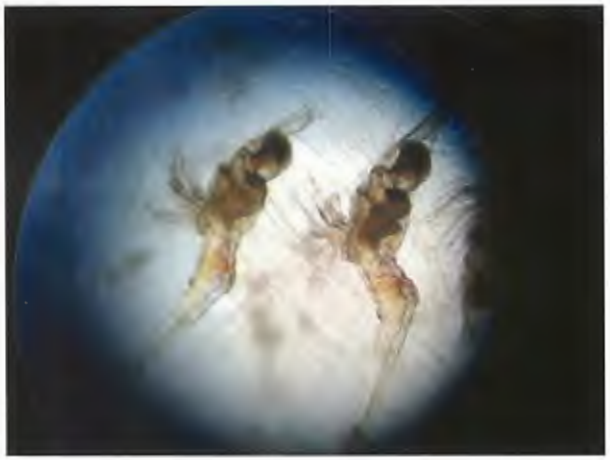
Fresh start for freshwater shrimp

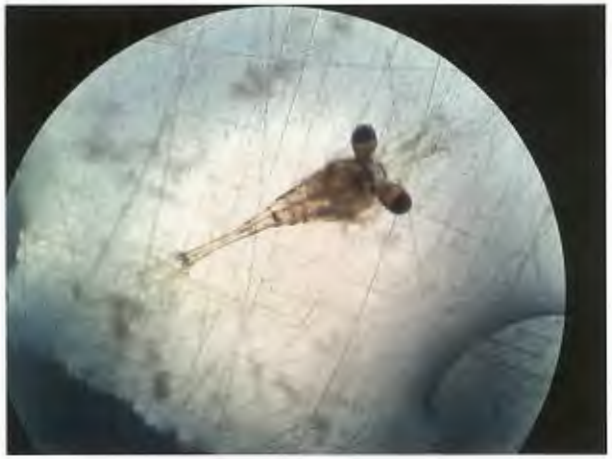
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Freshwater shrimp are making a comeback as a focus of study at the CNAS Guam Aquaculture Development and Training Center. "Guam's tropical climate is very conducive for raising freshwater shrimp and we are focusing on the species *Macrobrachium rosenbergii* (de Man). We will be making the information we gather on raising this freshwater species available to aquaculture farmers in the region," said Dr. Hui Gong Jiang.

Macrobrachium rosenbergii (de Man), the giant freshwater prawn, is the most popular freshwater prawn cultured worldwide. To ensure the successful production of this economically important aquaculture species, it is pivotal to find a supply of healthy broodstock produced by a reputable hatchery.

There are several common disease problems related to the production of this species. In addition to nutritional and environmental factors, it has been discovered that several infectious pathogens could adversely affect the health status of *M. rosenbergii*. Adopting an integrated approach of implementing biosecurity and health management practices is the most effective way of preventing pathogens from being introduced and spreading within the hatchery. These practices would impede an epizootic by blocking both vertical and horizontal transmissions among broodstocks and larvae populations in general.





Postlarvae *Macrobrachium rosenbergii* (above) and fully mature specimen (below).

Both the freshwater prawns and saltwater shrimp at the hatchery recently received a clean bill of health from the Aquaculture Pathology Laboratory at the University of Arizona. Dr. Gong and her graduate students completed a health surveillance sampling and the PCR diagnostic results from the pathology lab verified the animals are free of all major shrimp/prawn pathogenic agents including WSSV, IHHNV, TSV, YHV, IMNV, MrNV, NHP-B, BP, HPV, EHP, APHND/EMS.

Dr. Gong and her team continue to maintain the highest standards for all the animals housed at the hatchery, which keeps them in the forefront of aquaculture research in the region.

Funded by USDA NIFA Hatch and government of Guam



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Food Friends and Mighty Moves

Shaping a healthy lifestyle begins at an early age and ultimately can prevent obesity and chronic diseases. "Food Friends' Fun with New Foods and Get Movin' with Mighty Moves" curricula aim to promote healthful habits and school-readiness to confront the rise in obesity and chronic disease prevalence. This program, called FFMM for short, has been implemented in the Guam Department of Education (GDOE) pre-kindergarten (pre-K) classrooms. It takes a multi-faceted approach to health with physical and nutritional components while focusing on children and secondary influences, teachers and parents of preschoolers.

Even the pickiest preschoolers try healthful new foods after exposure to Food Friends. Mighty Moves gets kids up and active, developing gross motor skills, with the goal of creating physical activity habits that last a lifetime.

FFMM was developed and practice-tested by Colorado State University Researchers. Dr. Tanisha Aflague and Dr. Rachael Leon Guerrero, are examining the effectiveness of FFMM for Guam. Additionally, data from this research will be used to identify needed adaptations to the curricula. In Year 1 (2015-2016), teachers from four GDOE pre-K classrooms participated in a feasibility study that informed implementation in the following year. Teachers received training on how to incorporate the FFMM curricula into their classrooms and supplemental technical support throughout Year 2.

A total of 66 children enrolled in four GDOE pre-K classrooms received lessons from the FFMM curricula in the pilot program. Preliminary data from the program's second year (2016-2017) showed that following exposure to new and familiar foods as part of the "Food Friends" lessons, 89% of the children were willing to try a new vegetable and 96% were willing to try a new fruit. This was captured using a validated interview-administered survey tool, *Adapted WillTry,* tested among children in Guam.



After completing the "Mighty Moves" curriculum in the four GDOE classrooms, teachers recorded children's abilities using the Brigance® screening form, which showed 23% of the students improved in gross motor skills and 15% improved in following verbal direction.

Aflague and Leon Guerrero are currently in Year 3 of the project. There are a total of 177 students receiving FFMM lessons this school year (2017-2018) who will be compared to children the same age who did not receive the FFMM curricula in the same school year. Teachers and parents will be provided opportunities to give feedback on the implementation of FFMM.

Funded by USDA NIFA Hatch

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Little fire ants found on Guam between the leaf sheaths of a banana pseudostem.

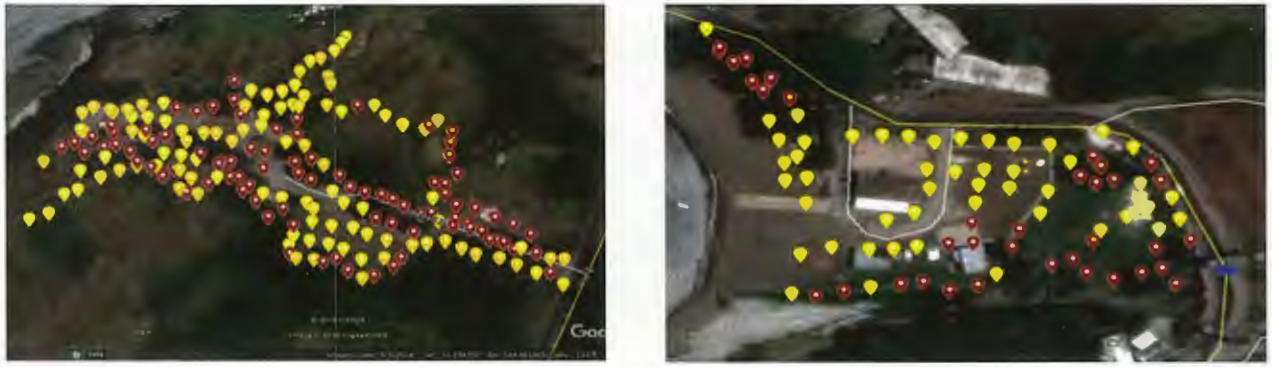
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Dr. Ross Miller and his merry band of one, Dave Mantanona, have been placing chopsticks with peanut butter around Guam to detect the presence of *Wasmannia auropunctata*, the little fire ant. First found on Guam in 2011, Miller's lab has experienced success in eradicating this invasive ant from various forest, residential and park habitats.

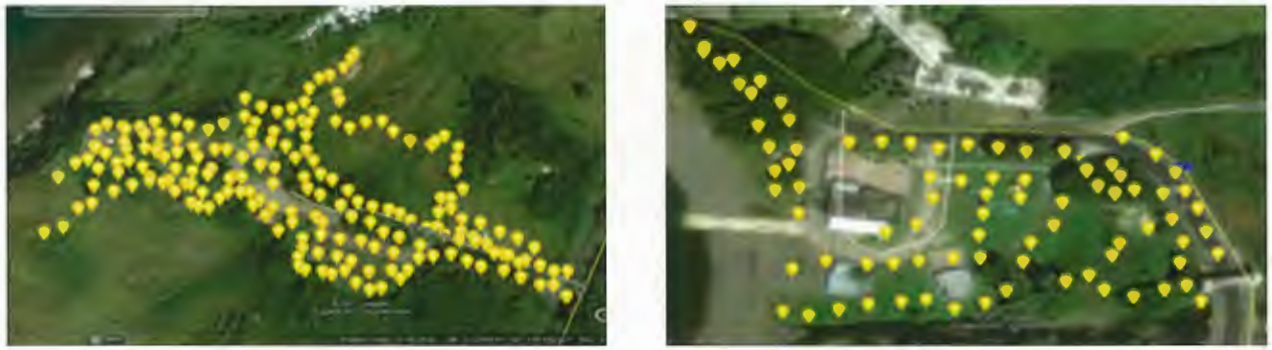
Using techniques developed by Casper Vanderwoulde and his staff at the Hawaii Ant Lab and adapting them for Guam, Miller's lab has eradicated LFA from approximately 19 sites around the island. Infested areas are treated with a low toxicity granular bait called Siesta™. A second insecticide that interrupts the growth cycle of the ants, Tango®, is sprayed on tree trunks and leaves. One week later the team conducts a follow-up survey to check the effectiveness of the treatments, and then six weeks later both insecticides are reapplied and the site is again surveyed. Each site receives six to eight repeat treatments over a period of a year.

The area maps to the right show the efficacy of the treatments in eradicating pockets of little fire ant infestations on Guam. The red flags indicate LFA caught on peanut butter bait prior to treatment and the yellow flags indicate bait with no LFA present.

Mantanona is also assisting National Park Service staff with surveys and treatment of LFA infested sites in the Pacific National Park near Asan Point. This park is widely used by Guam residents, so it is important to keep adults, children, and pets safe from the painful sting of LFA.



Mapping of LFA at two sites in Umatac village: Fort Soledad and the Magellan Monument & Community Center Park showing the results of the initial delimiting survey (above). Flags in red indicate bait on which LFA were collected; yellow flags indicate sampling sites where no LFA were collected on the bait.



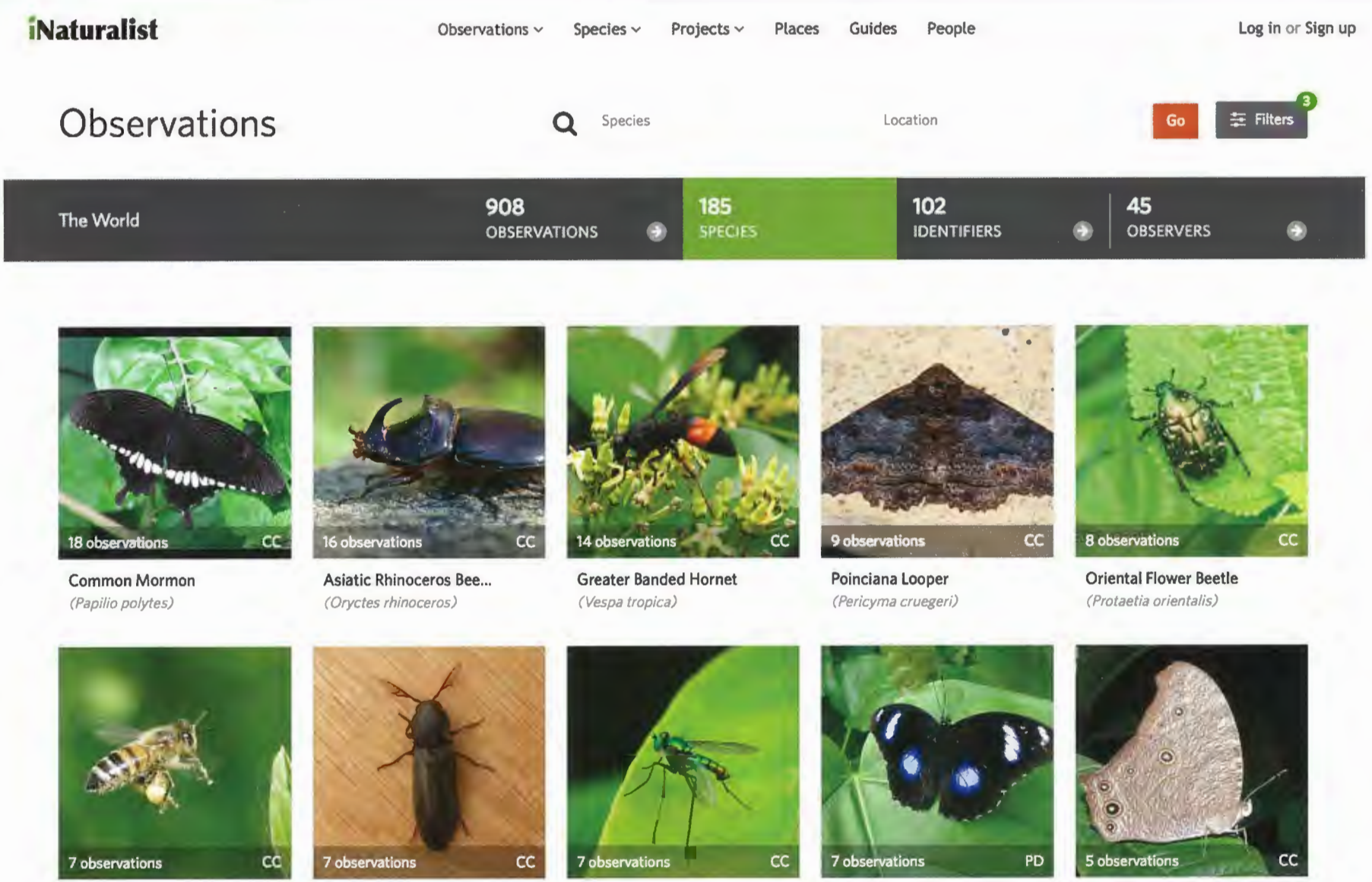
Chopsticks smeared with peanut butter were placed in a grid at approximately 5 m spacings. After the sixth treatment of insecticides (above), surveys showed a major reduction in the number of LFA.

"This invasive ant is spread by humans moving it around the island when sharing potted plants or indiscriminately dumping green waste or garbage," said Miller. He would like everyone to remember that invasive species are everyone's responsibility!

Funded by US Forest Service

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What's that bug? There's an app for that!

Doc. No. 34GL-18-1564.

Want to know the name of that strange insect that just landed in front of you? There's free cell phone app for that called iNaturalist.

iNaturalist allows you to use your phone to snap pictures of any animals or plants and upload them to an online database connected to a global network of nature lovers who are willing to help you identify them. Locations and times of the observations are recorded automatically.

CNAS entomologist, Dr. Aubrey Moore, has been using iNaturalist quite a bit lately for several different uses:

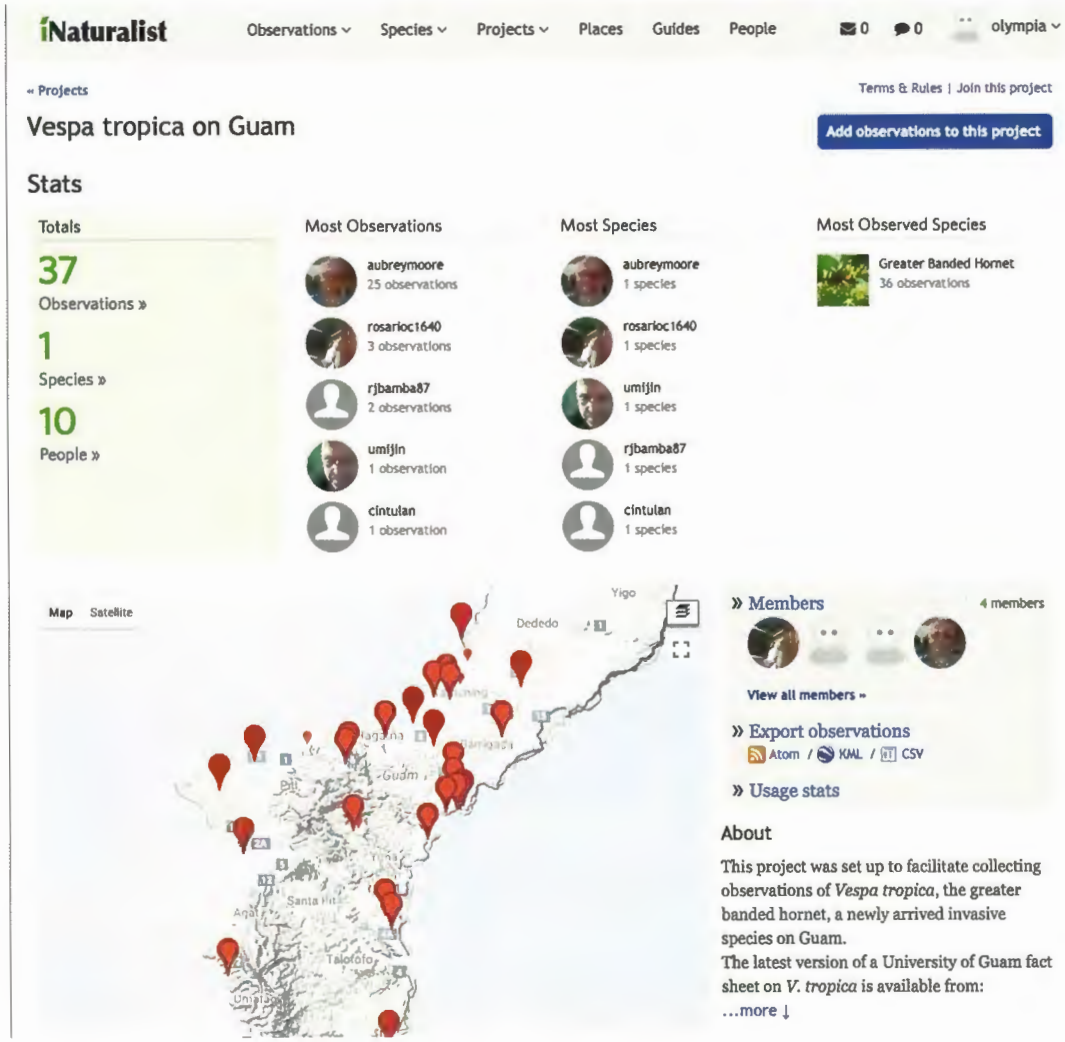
- When Moore is emailed photos of insects for identification, these are posted to an iNaturalist project called Insects of Micronesia (https://www.inaturalist.org/projects/insects-of-micronesia) and a link to the identified images is emailed back to the client. The project is publicly available and can be used as a reference to identify many of Guam's most common insects.

- The Insects of Micronesia project is used by UOG students in Moore's entomology courses to document and help identify insects they collect.

- iNaturalist projects can be used for insect surveys. For example, iNaturalist was used to map the spread of the greater banded hornet, a newly arrived invasive species.

Other UOG professors have also made use of this app with their students. Dr. Curt Feidler's environmental biology course took advantage of this technology and used an iNaturalist project to map coconut rhinoceros beetle damage.

As a citizen scientist you can make a meaningful contribution to research and share Guam's flora and fauna with the world or take part in a project across the globe.



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USDA

United States Department of Agriculture

National Institute of Food and Agriculture

WPTRC

RESEARCH FOR GUAM'S FUTURE

UNIVERSITY OF GUAM
COLLEGE OF NATURAL & APPLIED SCIENCES

Doc. No. 34GL-18-1564.

THE COCONUT RHINOCEROS BEETLE:

AN INVASIVE SPECIES ON GUAM

College of Natural & Applied Sciences

FAST FACTS:

- **Scientific name:** *Oryctes rhinoceros*
- **Discovered on Guam in 2007**
- **Rhino beetles are nocturnal and are most active about an hour after sunset.**
- **Can fly up to two miles at a time.**

FEMALE CRBs:



Smaller horn

Posterior ends usually covered in reddish hairs

MALE CRBs:



Larger horn

Little to no reddish hair on their posterior ends

HOW DID THEY GET HERE?

It is still unknown. However, it is likely that one or more beetles hitch-hiked with imported cargo.

WHAT THEY DO:

Rhino beetles' effects on our coconut trees can be seen all over the island.

They burrow into the crowns of palm trees to feed on the sap, causing the fronds to grow out with distinct v-shaped cuts.

The trees are killed when the beetles destroy the growing tip of the trees in their attempt to feed.

Only adult beetles cause harm to our trees. Juveniles feed on decaying vegetation at breeding sites.



HOW TO HELP:

PRINCIPLES OF COCONUT RHINOCEROS BEETLE (CRB) MANAGEMENT

- **Education:** Learn the facts about CRBs and the proper care of palm trees.
- **Monitoring:** Observe CRB activities and damages in the area.
- **Sanitation:** Maintain the areas' green waste and trees.
- **Trapping:** Use traps to help prevent CRBs from damaging your trees.

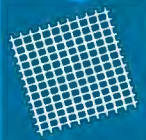
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Rhino beetles mate and lay their eggs in green waste and decaying matter- keeping your land clear of waste will prevent your yard from becoming a rhino beetle breeding ground!



TYPES OF CRB TRAPS:

1



Tekken Netting

Placing tekken netting over piles of green waste can trap beetles when they try to breed.

2



Barrel Traps

Barrel traps attract beetles with green waste, LED lights, and pheromones, then trap them in netting.

3



Tree Bow Ties

Bow tie traps, constructed of tekken net and stones, are placed directly in coconut trees to trap beetles as they try to feed.

4



DeFence Traps

DeFence traps lure beetles with pheromones and LED lights, then trap them in netting placed on a fence line.

FIND OUT MORE:



To learn more about coconut rhinoceros beetles, including information about how to prepare traps, visit UOG's coconut rhinoceros beetle page at:

www.cnas-re.uog.edu/crb

or call:

(671) 735-2080

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