2020
Impact Report

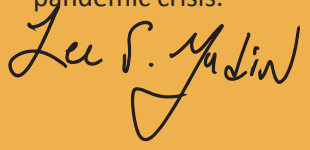
Western Pacific Tropical Research Center
College of Natural & Applied Sciences
University of Guam

Hafa adai!

2020 will be one of the most infamous years in the 21st century due to the COVID-19 pandemic. I wish to thank the WPTRC faculty, graduate students, and our community partners who have worked diligently to make this publication happen during these most difficult times. WPTRC has again demonstrated both the diversity and importance of a research institute in trying to solve issues in agricultural production/sustainability, invasive species, and new scientific discoveries on Guam and in the region.

We have selected 12 impact stories for this year's publication. One article highlights the microsurgical removal of androgenic glands of fresh water shrimp that will greatly enhance Guam's aquaculture industry. For the first time in our college's history, we were able to sign a public/private partnership in 2020, with CoreSeed Aquaculture. The interest is to raise Pacific white marine shrimp, black tilapia, and other species for commercial sale and spawn brood stock for new aqua-farmers on Guam. Another landmark for WPTRC was the production of a video that will be shown at the 15th World Forestry Conference as well as the first GIS mapping of tropical fruit trees at our research and education centers. One faculty member demonstrates the use of a cell phone and artificial intelligence to map out invasive coconut rhino beetle damage on Guam. Another article highlights a young man who came back to his birth island, received his master's degree in our college, and writes about the importance of publishing original research; which is accompanied by his faculty mentor who talks about Guam research exposure in national and international journals. Another graduate student highlights his ongoing master's project in mapping bee colonies on Guam. A related article shows how honey has helped people bring in needed revenue during our current COVID-19 times. One of our agricultural economists emphasizes the major challenges and opportunities due to food security issues during the pandemic. Lastly, a great example of a collaborative effort between UOG and the University of Georgia on over 100 different fungi within the *Corynespora* genus.

I want to personally acknowledge Dr. Adrian Ares, the associate director of WPTRC, who encourages faculty to write grants, publish their work in peer-reviewed journals, and work for the betterment of the community we serve. His efforts are shown in this year's impact with two of his own projects. To all the individuals who made this 2020 impact report possible, thank you as well. The the individual behind these reports is Ms. Olympia Terral. Her dedication to our college and her devotion in showcasing what we do is a critical component to our land-grant mission. This report involves the contribution of many faculty, students and staff who support WPTRC each day even through the 2020 pandemic crisis.



Lee S. Yudin
Dean/Director
CNAS/WPTRC

Hafa adai,

As it is said in a popular business news radio program, "First, the numbers…". Currently, 15 Hatch, five Multi-state Hatch, seven McIntire Stennis, and seven non-formula projects are being conducted at WPTRC. More than fifty people work at four experiment stations that encompass 122 acres, the Fadian hatchery, farms, wildlands, laboratories, offices, and other locales. About one million dollars is being invested to upgrade facilities for improved operability and safety, maximizing their use for research, extension and instruction activities.

Year 2020 was indeed a unique period in recent times. The most daunting challenge was the uncertainty about what the future would bring to Guam and the whole world during the COVID-19 pandemic. Several adjustments were made to pursue the WPTRC mission and minimize negative impacts on research and quality. Again, resilience came in handy in 2020. In system terminology, the COVID-19 pandemic was a stressor, definitively a formidable one. WPTRC, once again, showed resiliency and kept functioning through innovating, adapting, and redefining priorities.

I would like to thank the numerous local, regional, national, and international stakeholders that help make the work at WPTRC possible in difficult times. People within the College of Natural and Applied Sciences devoted to research continue to work hard with responsibility, hope and optimism.

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Guam Beekeepers Association, Inc.
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Cover Photo
Olympia Terral
An interesting specimen in the Cycad Walk on the UOG campus, a cycad hybrid between *Cycas thouarsii* and *Cycas platyphylla* parents.

Editor
Olympia Terral

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COLLEGE OF NATURAL & APPLIED SCIENCES

Western Pacific Tropical Research Center
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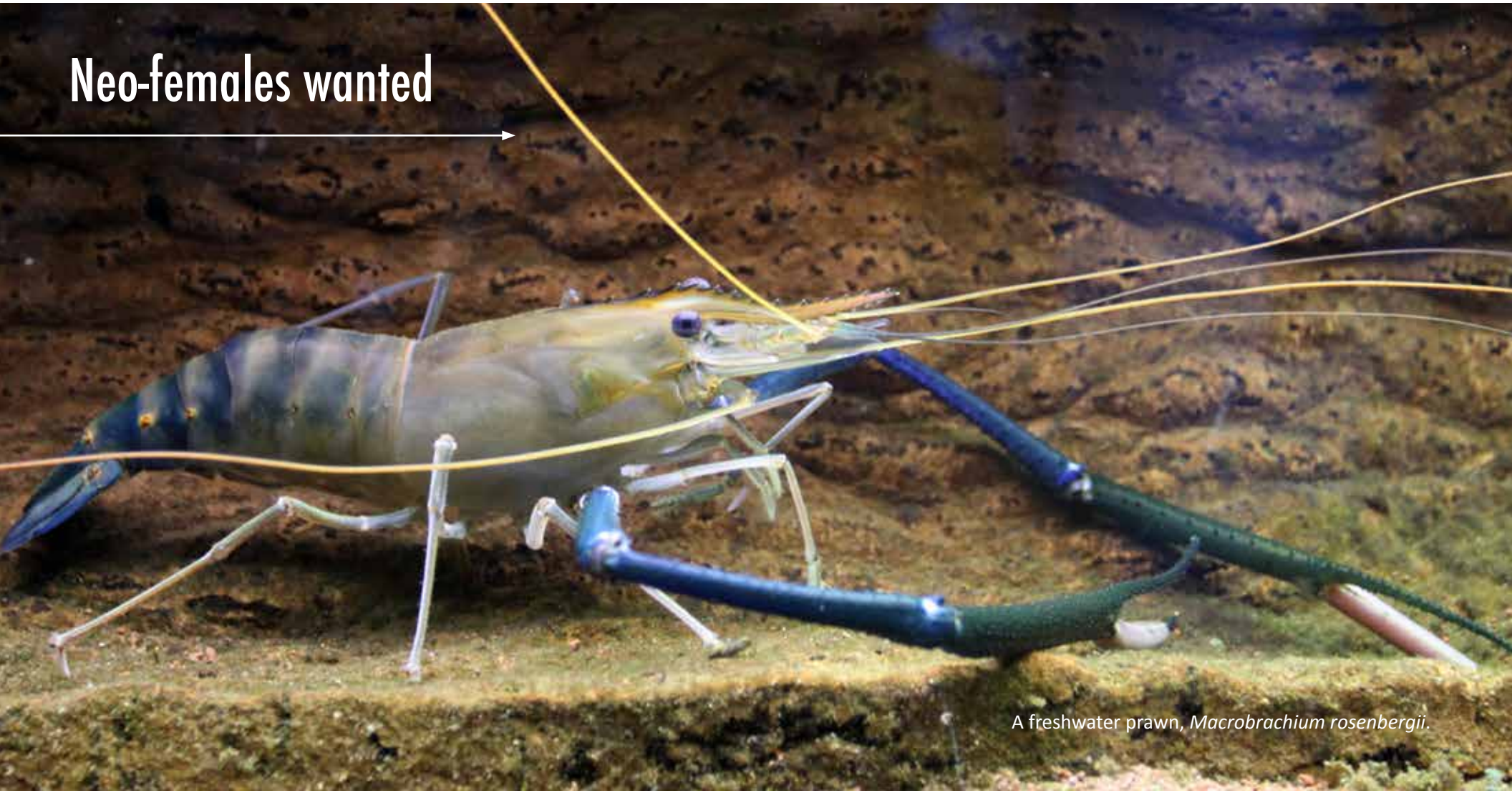
Neo-females wanted



A freshwater prawn, *Macrobrachium rosenbergii*.

Freshwater prawns, such as the native species Tahitian prawn (*Macrobrachium lar*) are a much favored food species and can be found in local streams on Guam. The giant freshwater prawn (*Macrobrachium rosenbergii*) was brought to Guam for aquaculture purposes a few decades ago and now is being further studied at WPTRC to explore its farming potential.

Aquaculture researchers at WPTRC have collaborated with their counterparts at Huazhong Agricultural University in China to study sexual differentiation in the popular giant freshwater prawn (*Macrobrachium rosenbergii*). The males of the species display a faster growth rate than the females, which is a very desirable trait for prawn farmers allowing them a means to increase yield and income.

"In giant prawns, the androgenic gland plays a crucial role in male sexual development. Surgically removing the gland triggers feminization, where the male develops female reproductive organs resulting in a neo-female. Targeting a specific gene responsible for producing that gland has also resulted in developing a neo-female prawn that only produces male offspring," said WPTRC's Hui Gong Jiang.

Using RNA *interference* (RNAi) to silence, or interfere with the expression of a gene, researchers perform microinjections in male embryos, which result in the production of neo-females. Studies carried out with *M. rosenbergii* have determined a hormone within the androgenic gland is important in determining male sexual characteristics. Targeting the expression of this gland in males using RNAi results in a neo-females.

In this collaborative study at WPTRC, Jiang and her colleagues have successfully applied these technologies to produce neo-females.

"Microsurgical removal of the androgenic gland and RNAi silencing are different methods to achieve the same goal; the production of neo-females that will produce all male offspring," said Jiang.

This will be a great boon to aquaculture farmers and eliminate the labor-intensive manual selection of male prawns for commercial production. The RNAi method entails the need for complex laboratory equipment and highly trained personnel. Using the microsurgery technique requires only skilled personnel to perform making it a more accessible choice for farmers at this time.

Funded by USDA Hatch Program

Further reading:

Tan, K., M. Zhou, H. Jiang, D. Jiang, Y. Li. 2020. siRNA-Mediated MrIAG Silencing Induces Sex Reversal in *Macrobrachium rosenbergii*. Marine Biotechnology, 22.

Tan, K., H. Jiang, D. Jiang, W. Wang. 2020. Sex reversal and the androgenic gland (AG) in *Macrobrachium rosenbergii*: A review. Aquaculture and Fisheries, 5:6.

Left to right: the male, female, neo-female sexual and morphological features of *M. rosenbergii*. Top to bottom: ventral surface, claws, second pleopod.

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Aquaculture business and research: everybody wins!

The island of Guam took a step closer to realizing food security when a public-private partnership was enacted between the University of Guam and the Research Corporation of the University of Guam. The Guam Aquaculture Training and Development Center is known for its

genetic research on shrimp families and the production of specific-pathogen-free shrimp. Currently, a visiting scholar from Thailand, Jarupan Channarong, is conducting research on genetic breeding of *Penaeus vannamei* and *Macrobranchium rosenbergii*. Additionally, the facility is now providing shrimp and fish for purchase to the community.

CoreSeed Aquaculture (Guam) hired Donghuo Jiang as the managing director to supervise operations under the new partnership. Jiang brings extensive experience in aquaculture and holds a doctorate in fisheries science from Texas A&M University.

"We are raising Pacific white marine shrimp, black tilapia, and salt-tolerant red tilapia for the commercial market and plan to make giant freshwater prawns available in the near future," said Jiang.

Local farmers have expressed a keen interest in raising tilapia. To address this interest, CoreSeed is set to provide a reliable and consistent supply of tilapia fry to support sustainable aquaculture on the island. With this solid foundation in place, the lack of reliable seed supply will no longer be a bottleneck issue for producers.

Research on salt-tolerant red tilapia is conducted at the Guam Aquaculture Training and Research Center at Fadian Point.

Since the shrimp raised at the facility are free from pathogens, including viruses that often plague commercial aquaculture farms, there is no need to use antibiotics or other chemicals. This translates into a delicious product that is available to seafood consumers on Guam. An added plus, they are fresh not frozen!

In June of 2020, Manny Duenas, president of the Guam Fisherman's Co-op, enthused that co-op customers greatly appreciate the quality products that CoreSeed delivers weekly to their store. This partnership bodes well for Guam consumers assisting in increasing food security for island residents.

CoreSeed Aquaculture Managing Director Donghuo Jiang observes post-larval shrimp that will be commercially raised for the Guam market.

"Food security is especially important now as we face the COVID-19 pandemic. We need to be able to produce food here," explained Jiang. He also believes production will be a boost for local hotels and restaurants in the tourism industry. Once tourism rebounds, CoreSeed Aquaculture Inc. will be there to provide quality local seafood that tourists appreciate and expect to find.

CoreSeed

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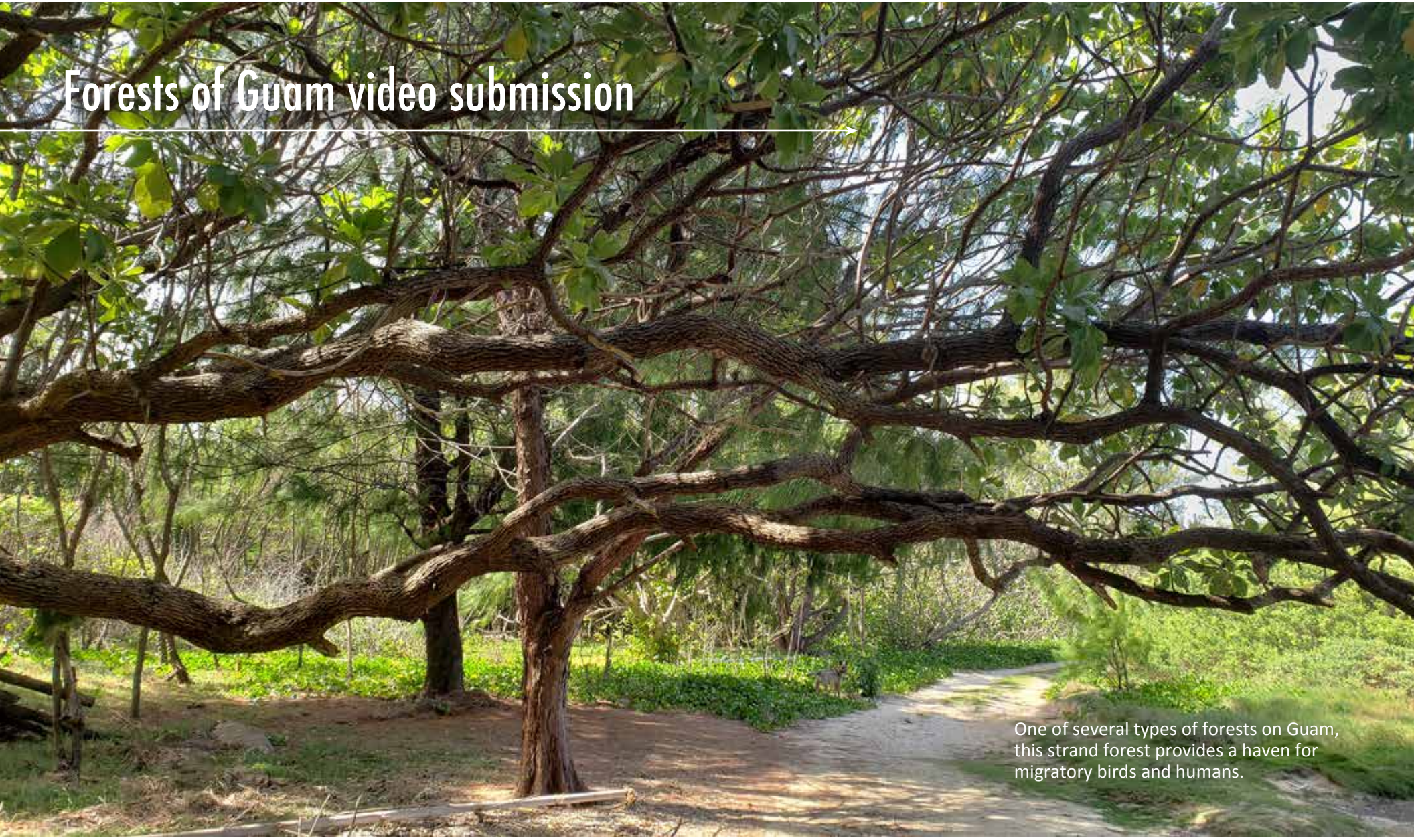
Forests of Guam video submission



One of several types of forests on Guam, this strand forest provides a haven for migratory birds and humans.

The 15th World Forestry Conference was scheduled to take place in Seoul, Korea in May 2021, but has been postponed because of the COVID-19 pandemic. The conference is held every five or six years bringing together people representing the myriad aspects of forestry from around the world. It is an important forum to continue discussions about the essential nature of the world's forests and the critical issues impacting forests, jungles, and woodlands around the globe.

The theme of the conference is "Building a Green, Healthy and Resilient Future with Forests." Organizers put out a call for video submissions and WPTRC has answered that call with a seven-minute video showcasing the forest types of Guam and the degradation of the island's forests caused by invasive species, climate change, and wildfires.

The narrative, written by Adrian Ares and Olympia Terral, features the island's distinct forest types such as limestone forests in the north, strand forests along sandy coastlines, and ravine forests in the savannas of the south. Island researchers address the dire impacts of invasive species including the Asian cycad scale, coconut rhinoceros beetle, and the infamous brown treesnake on the health of the forests and the restoration efforts under way to contend with these challenges.

The Guam Plant Extinction Prevention Program is highlighted as well as the work of the Guam Department of Agriculture, Forestry Division in replanting native trees and shrubs and spearheading public campaigns against burning in the savannas.

Drone footage from the video shows Tanguisson Beach, an area that was inhabited by CHamoru people for 3,000 years and where local healers continue to gather medicinal plants.

Beautifully filmed by Tim Rock and narrated by Bruce Lloyd, the video speaks of the history of the CHamoru people protecting and utilizing forest resources as well as the devastating effects of war, unchecked urban development, and soil erosion that impact the island and the surrounding coral reefs.

"We are proud that WPTRC was able to produce and submit a video presentation for the conference and feel strongly that it is representative of the island's beauty, immense adversities, and the dedicated individuals working to overcome these difficulties," explained Ares.

Funded by USDA NIFA, USDA APHIS

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Using a cell phone and artifical intelligence to map coconut rhinoceros beetle damage

Dead and dying coconut trees along the shoreline of Guam's west coast.

Everyone living on Guam has seen damage to coconut palms caused by coconut rhinoceros beetles (CRB). CRB has been on Guam since 2007, but until recently, the number of palms being damaged and killed on Guam was unknown. Standardized surveys of CRB damage are needed to monitor changes over time and space, especially in response to control activities and for early detection of CRB in new geographic areas.

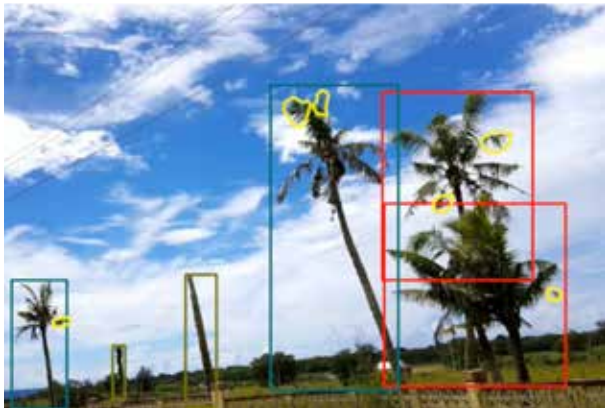
UOG entomologist Aubrey Moore has designed a highly automated method for routine island-wide monitoring of CRB damage using a cell phone and artificial intelligence (AI).

Previous methods for monitoring CRB damage relied on direct observation or image analysis by human experts and are too time-consuming and expensive for routine monitoring over large areas.

Dr. Trevor Jackson, an entomologist working for AgResearch New Zealand, has developed a survey method based on a five-level scale for classifying CRB damage to individual coconut palms. Jackson's method is being used extensively on CRB-infested islands in the South Pacific. Moore decided to create an island-wide roadside CRB damage survey for Guam based on an automated version of Jackson's method. In the automated survey, a smart phone mounted on a car or truck records continuous videos while the vehicle is driven along all major roads on Guam. The smart phone uses a couple of free apps: OpenCamera records videos and GPSLogger records GPS coordinates.

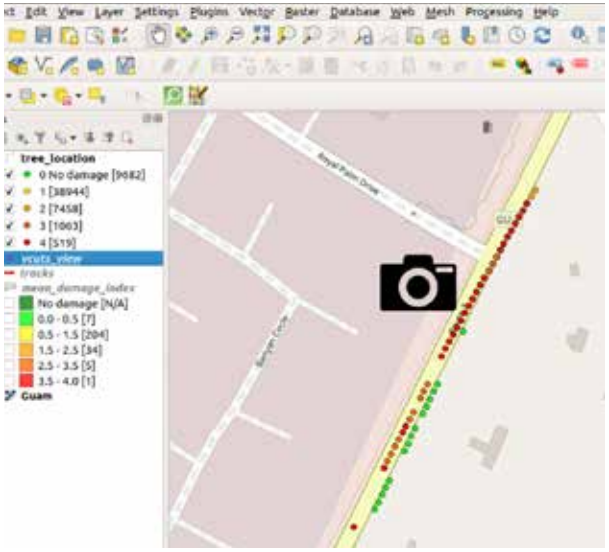
A smart phone is attached to a vehicle using a magnetic mount. As the car travels, the phone records videos that are analyzed by open-source software.

Recent technical breakthroughs in AI have made it much easier to train computers to recognize objects in digital images. Moore collaborated with OnePanel Inc., an AI tech company, to create and train a couple of object detectors using a technique called "deep learning".



Above: Medium to severe CRB damage detected in the Royal Palms area of Dededo.

Below: Each dot on the map represents a video frame in which one or more coconut palms was detected. The image at the top is a frame extract from a video with approximate coordinates indicated by the camera icon.



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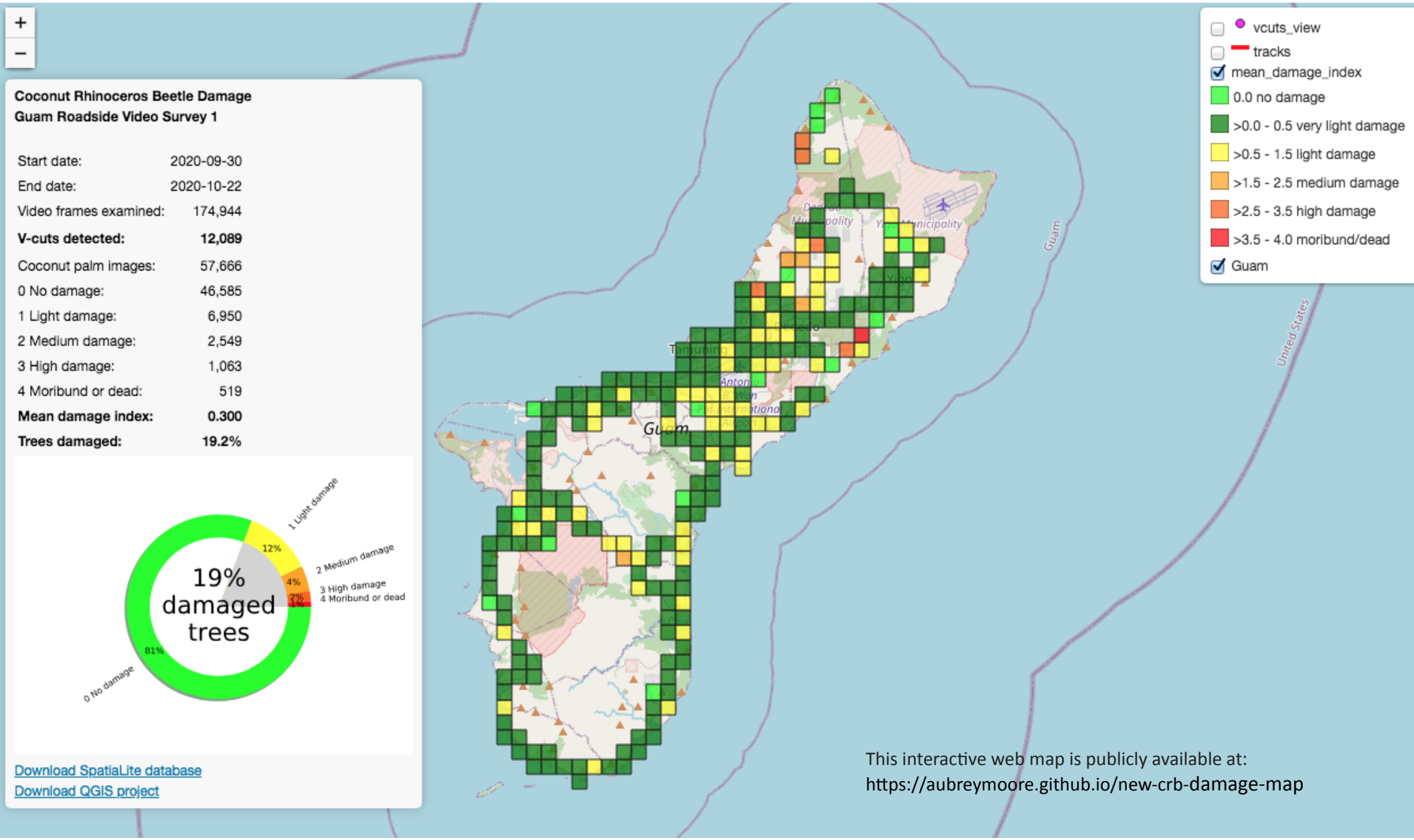

This interactive web map is publicly available at:
https://aubreymoore.github.io/new-crb-damage-map

The first object detector finds all images of coconut palms in the survey videos and classifies each one using Jackson's damage scale. The second object detector locates and counts v-shaped cuts in the fronds of each coconut palm. Data extracted from the videos are saved in a SpatialLite database.

To visualize survey results, Moore uses Quantum GIS, to make a publicly available, interactive web map. There are links on the web map to download the survey database and QGIS map project for more detailed analysis.

The first operational island-wide survey on Guam, completed during October 2020, indicated that about 19% of Guam's coconut palms show CRB damage symptoms. The Guam surveys will be conducted bimonthly. An island-wide roadside video survey is also being done on Rota for early detection of CRB damage.

There is interest in use of roadside video surveys for CRB damage elsewhere in the Pacific and Moore plans to evaluate drone imagery for use on islands without extensive roads. The Guam roadside video survey was designed to be adaptable by using only free open-source software (FOSS) components. Custom-written software for the project as well videos, databases, and GIS projects from surveys will also be made available for download from public repositories hosted on GitHub.

It is interesting to note that this is not the first time that Moore has dabbled with AI. Thirty years ago he trained an artificial neural network to identify free-flying mosquitoes.

Thanks to UOG entomology technician Christian Cayanan for doing the surveys.

Further reading:

Moore, A. 2018. The Guam Coconut Rhinoceros Beetle Problem: Past, Present and Future. Zenodo. doi.org/10.5281/zenodo.1185371}.

Moore, A. 1991. Artificial neural network trained to identify mosquitoes in flight. Journal of Insect Behavior 4, 391–396.

Funded by the US Department of the Interior-Office of Insular Affairs, US Forest Service, USDA-APHIS

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Publish and preserve

Cycad specialist Benjamin Deloso examines an old *Microcycas calocoma* plant at Nong Nooch Tropical Botanical Garden in Thailand.

Recent UOG graduate Benjamin Deloso returned to Guam to further the study of cycads, the world's most threatened plant group. Born on Guam but having left during childhood, Deloso returned to the island four years ago to immerse himself in his studies. "I first learned of the plight of Guam's native cycad *Cycas micronesica,* locally known as fadang, by reading several international publications on its island-wide decline when I was an undergraduate student in North Carolina," Deloso reminisced.

Unfortunately, this decline is not uncommon among cycads today with more than 60% of contemporary cycad species listed in a threatened category. This fueled Deloso's desire to aid in their conservation.

Thanks to his academic advisors, Deloso learned of the knowledge-action continuum which is composed of three broad elements. The first element is the sphere of knowledge production, which acts as the foundation of the continuum. This is where research institutions like the University of Guam fit into the continuum. This first element is addressed by the WPTRC's mission statement ".....research in support of the land-grant mission.....".

The second sphere is knowledge mediation, which connects new knowledge with the stakeholders that serve as the end users of this knowledge. This sphere is occupied by the Cooperative Extension & Outreach unit of land-grant institutions.

The final sphere is knowledge-informed action. Farmers, forest resource managers, conservationists, botanic gardens, departments of agriculture occupy this sphere, and other stakeholders that require new knowledge generated by the first sphere. This final sphere is the part of the continuum that university stakeholders reside. Discussing the millions of dollars of grant and contract funds being administered within the WPTRC is one example. These funds alone are not research output and therefore not knowledge production.

Of the many experiences Deloso has had over the last few years, one of the most rewarding was publishing his original research from his work as a graduate student at UOG. "Publishing original research into the international scene adds to the first sphere of new knowledge production. As a WPTRC employee, my involvement in the plant conservation knowledge-action framework required me to generate publishable data in conformity to the first sphere in the continuum," said Deloso. "Research is not completed until it is communicated," explained Dr. Mariamawit Yeshak in her 2019 keynote address to the Society for Scholarly Publishing. Within the calendar year of Deloso's graduation from UOG, he co-authored seven peer-reviewed publications.

"I learned early in my tenure at the University of Guam that the number and quality of peer-reviewed journal papers is by far the best evidence of how a professor complies with the mission of WPTRC. Dr. Marler was a role model of how to further this mission while focusing on new knowledge production," said Deloso.

Those journal papers will be a testament for the future. "During a recent literature search while writing an article about leaf movement in *Serianthes nelsonii*, I found a 19th century article written by none other than Charles Darwin on the subject," said Deloso. Research into a subject that has been scarcely studied and the inclusion of the correct key words in a manuscript revealed that a simple literature search can find a 140-year-old article as a hit.

"Having gone through the publishing process myself, I can say that submitting a manuscript to a journal is not like submitting to a black box," said Deloso. Quite the opposite, after submission, the manuscript undergoes peer review, which is the primary method by which journals evaluate the quality and importance of scientific papers. "I learned that my manuscript acts as a liaison between me and the reviewers and editors," said Deloso. This knowledge has been filtered through the peer review process, which ensures the manuscript is worthy of being published in the primary literature.

For a list of publications see page 27.

Funded by US Forest Service

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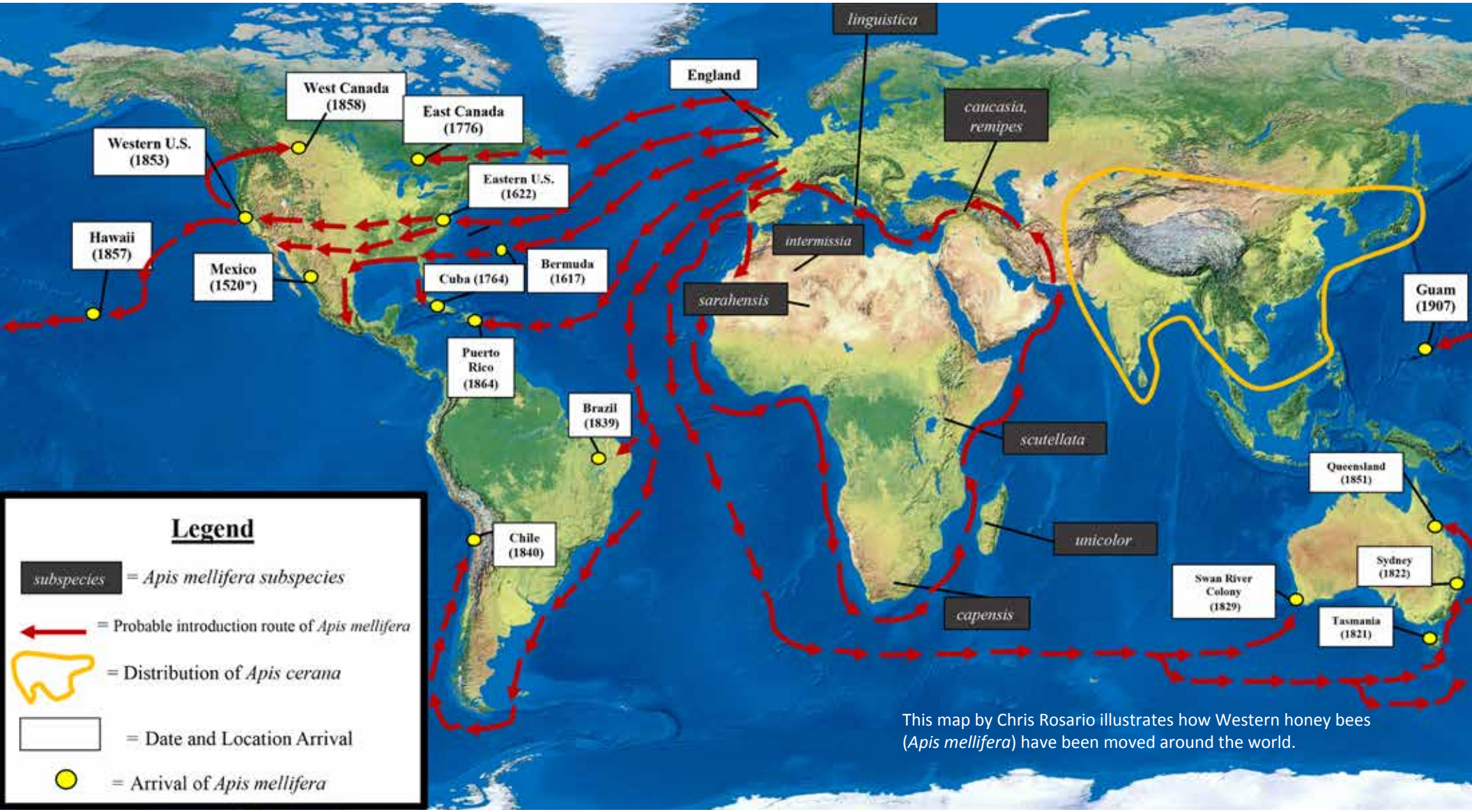
Bees and beeple on Guam



This map by Chris Rosario illustrates how Western honey bees (*Apis mellifera*) have been moved around the world.

Beeple, a term coined by bee researcher, zoologist, and author Kit Prendergast, is an apt name for the people involved in the Guam Beekeepers Association. 2020 was a landmark year for the association. After meeting informally for years and continually encouraging local interest in beekeeping, the members voted for officers and officially filed articles of incorporation and by-laws in August. The Guam Beekeepers Association, Inc. (GBA, Inc.) has been recognized as a locally incorporated entity and has applications pending with Guam Revenue and Taxation and the IRS to be recognized as a 501(c)(3) tax-exempt non-profit organization.

Chris Rosario was instrumental in the formation of the association and was unanimously voted in as the president. He became interested in honey bees (*Apis mellifera*) during his work with Dr. Ross Miller on a grant project that began in 2014 funded by USDA-APHIS. The Honey Bee Health Survey had Rosario taking samples from feral and domestic hives to send to Maryland to be tested for mites and diseases. In carrying out this work, he developed a passion for bees that he generously shares with all who are interested. "If it had not been for Dr. Miller and the Honey Bee Health Survey I may have never gotten involved in beekeeping," said Rosario.

Rosario is currently writing his thesis on honey bees for his master's in environmental science degree. His research includes mapping domestic and feral bee colonies on Guam and tracking honey bee pests including the parasitic *Varroa* mite and the greater banded hornet (*Vespa tropica*). The *Varroa* mite is the vector for several viruses that can decimate a honey bee colony including the deformed wing virus. "We have not found the *Varroa* mites in bee colonies that have been tested on Guam since 2017," said Rosario, "If this trend continues, Guam may be eligible for a varroa-free designation paving the way for a possible business supplying stateside beekeepers with queen bees."

Members of GBA, Inc. have been involved in assisting Rosario in his research as well as applying integrated pest management (IPM) strategies. Greater banded hornet colonies have been successfully eradicated by Rosario and GBA, Inc. members, most notably a large nest found near the Inarajan Elementary School. The nest was sealed at night after the hornets had returned from foraging and the entire colony was killed. GBA, Inc. members are also engaged in developing several types of hornet guards for bee hives to prevent predation by the greater banded hornet.

WPTRC researchers and students in collaboration with citizen scientists are making a difference for the honey bees and people of Guam.

Funded by USDA Hatch Program

A greater banded hornet colony located near the Inarajan Elementary School was eradicated by Chris Rosario and members of the Guam Beekeepers Association, Inc. Notice the pile of dead hornets in the foreground.

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Honey helps bring in the money in COVID-19 times

Bees gather outside their Santa Rita beehive with BEE-UTIFUL entrance cover made by local beekeeper, Rod Grino, to deter greater banded hornets from entry into the hive.

With all the difficulties the COVID-19 pandemic has inflicted on people around the world, Guam business owner Dennis Larsen has received financial and emotional relief from his bees. A member and officer of the Guam Beekeepers Association, Inc., Larsen credits his sales of honey with allowing him to continue to pay his mortgage.

COVID-19 regulations are keeping people from traveling, and his dog-boarding business, Cloud K9, has experienced an 80% drop in revenue in 2020. However, this has given Larsen more time to devote to learning about bees and taking care of his more than 20 beehives. It has also allowed him to work with other beekeepers in rescuing bee swarms and removing bees from unusual places, such as outboard boat engines.

Honey sales from his hives and rescue honey, honey that comes with removing bee colonies from unwanted places, has made a difference in offsetting COVID-19 financial hardships. "Some of the colonies we are called on to remove have gallons of honey that I am able to bottle and sell," explained Larsen. Raw 671 Honey is the label on his honey jars, which he sells in stores around the island and also periodically on Route 16 in front of the Guam National Guard building, where he usually sells out within two hours.

Larsen and other Guam beekeepers are citizen scientists conducting informal research on trapping methods for the invasive greater banded hornet, best practices for beekeeping in the tropics, and building hives using novel materials and methods. They are very willing to share their expertise and educate the public about the importance of bees as pollinators and the joys of beekeeping.

For more information about beekeeping or the Guam Beekeepers Association, Inc., please contact Chris Rosario.

A swarm of bees in a tree above Raw 671 Honey hives in Barrigada. When swarming, bees are typically docile as their only concern is their queen.

A bee colony was removed at the request of a homeowner who discovered bees living in an non-functioning outboard motor.

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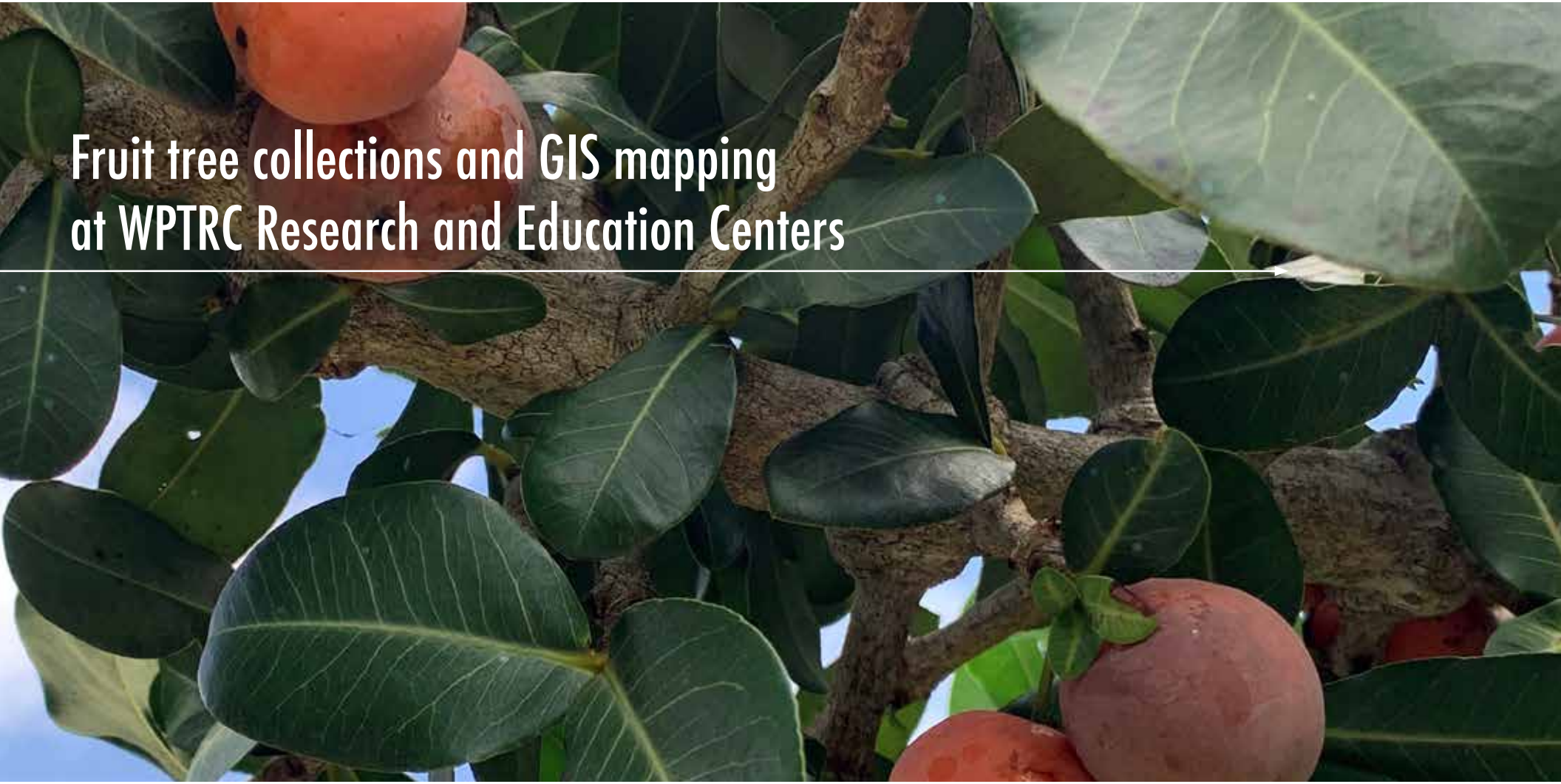
Fruit tree collections and GIS mapping at WPTRC Research and Education Centers



Humans have grown fruit trees for thousands of years across the world. In addition to their value as food, their fruits have been used for beverages, medicines, and other fresh or processed by-products. Tropical fruit trees are botanically, morphologically, and physiologically diverse. Many fruits from the tropics are known for their exotic taste and have high nutritional value and bioactive compounds that are beneficial for human health. Production and commercialization of tropical fruits have increased during this century.

WPTRC Research and Education Centers contain several fruit tree species and varieties, mostly planted under the supervision of Dr. Thomas Marler, retired pomology faculty at the College of Natural and Applied Sciences. Dr. Marler conducted valuable research on diseases, growth, physiology, salinity tolerance in atemoya, carambola, granadilla, mango, sapodilla, sapote, sugar apple, and other species. A list of the most common fruit tree species at the research centers is presented in Table 1.

Table 1. Most common fruit trees at the Ija, Inarajan, and Yigo Research and Education Centers.

Common name	Scientific name	Origin
Mango	*Mangifera indica*	South Asia
Sapodilla	*Manilkara zapota*	Mexico, Central America, and the Caribbean
Carambola	*Averrhoa carambola*	Southeast Asia
Santol	*Sandoricum koetjape*	Malaysia
Avocado	*Persea americana*	Mexico
Canistel	*Pouteria campechiana*	Mexico, Belize, Guatemala, and El Salvador
Imbe	*Garcinia livingstonei*	Africa
Seashore mangosteen	*Garcinia hombriana*	Peninsular Malaysia
Surinam cherry	*Eugenia uniflora*	South America

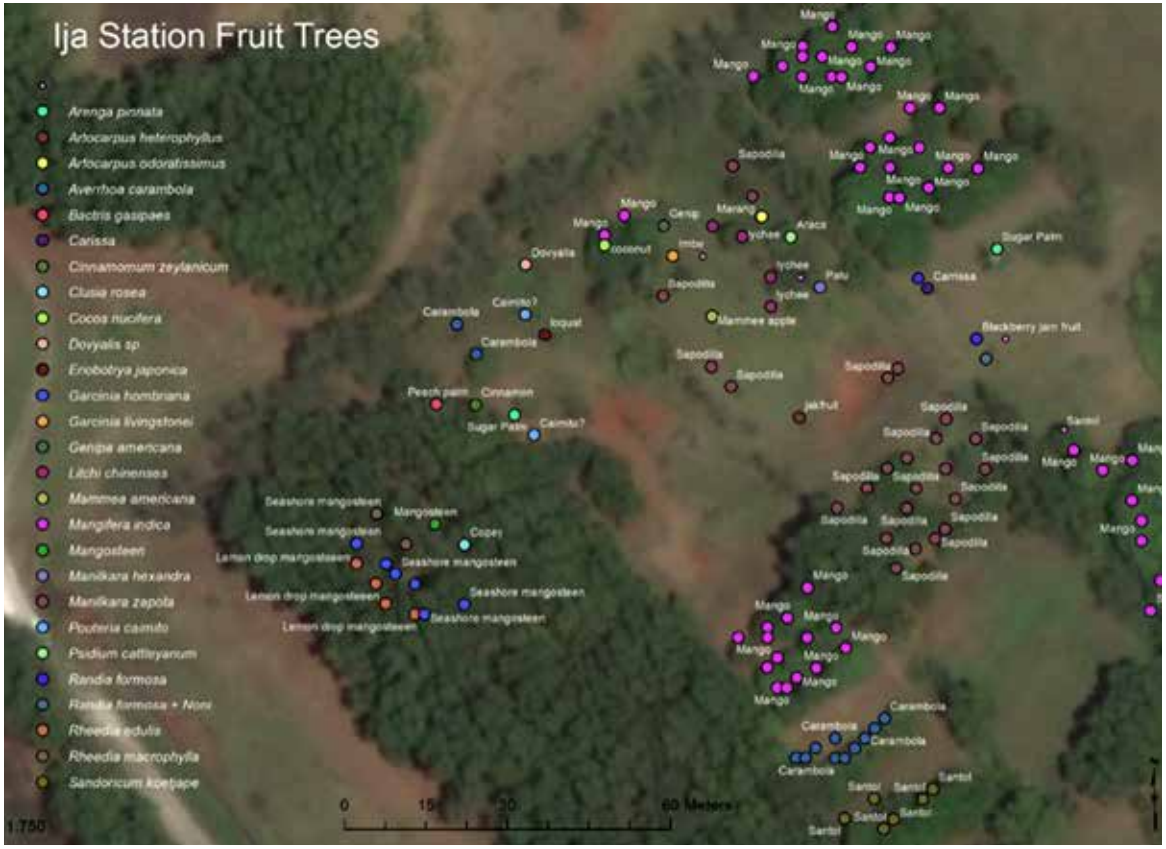


Figure 1. GIS mapping of fruit trees at Ija station in southern Guam.

Fruit trees at the research centers have been recently identified and mapped using GIS technology (Figure 1). They are also being restored to be used in research studies and outreach activities with the public.

Phenological studies to determine flowering and fruiting phases of most species are being conducted by Charles Hambley, a CNAS biology undergraduate student.

Particularly valuable is the mango variety collection at the Ija Reseach Center in southern Guam, also established by Dr. Marler. The Edward variety is deemed one of the most promising. Most trees are in good condition and have been used for technical demonstrations. Calamansi trees at the Yigo Research and Education Center are part of a study to simulate typhoon damage on plants.

Funded by USDA Hatch Program

Headway for agriculture on Guam

Guam is traditionally highly dependent on imports from the continental U.S. to meet its demand for food. This involves high transportation and storage costs that make food supply more expensive for consumers.

Local production is far from self-sufficient, owing to high fixed costs in setting up the supply chain and variable costs in hiring farm labor.

In the post-pandemic era, it is important that Guam develops its own agriculture to make our food production more self-reliant and less vulnerable to interruptions of the food supply chain.

A study conducted by Dr. Kuan-Ju Chen identifies major challenges and opportunities faced by the agricultural community in Guam. A mixed method approach is explored in this case study: individual surveys (Figure 1), and focus group discussions (Figure 2).

In November 2019, participants comprised of producers, agricultural associations, and farm managers provided information on important factors affecting their operations. They considered environmentally sustainable production and social demographics as major challenges for the local agricultural industry.

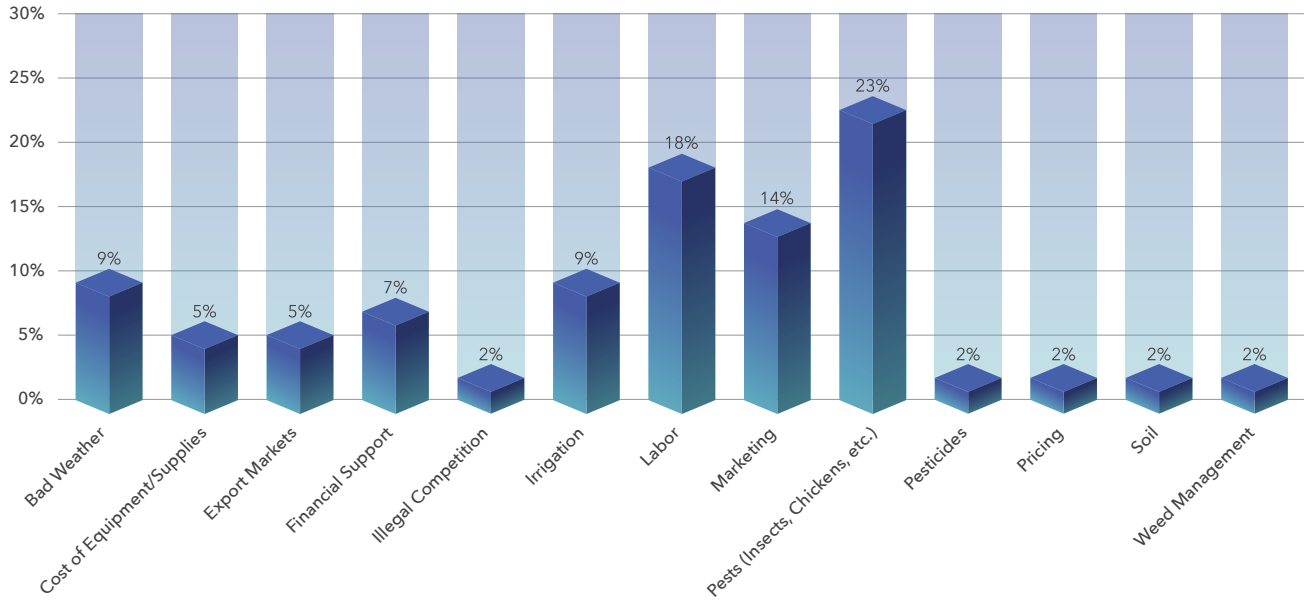


Figure 1. Major production challenges (n=15).

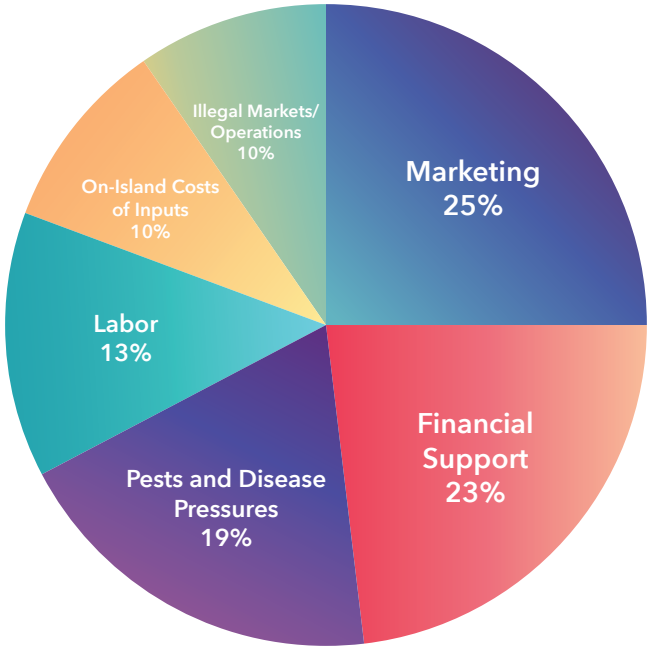


Figure 2. Focus group discussion of major challenges.

Findings indicated that marketing, pests, and labor are the top three challenges for the local agricultural industry. This research identifies farmers/producers' needs and proposes feasible solutions in facilitating the sustainable development of Guam agriculture.

Funded by USDA Hatch Program

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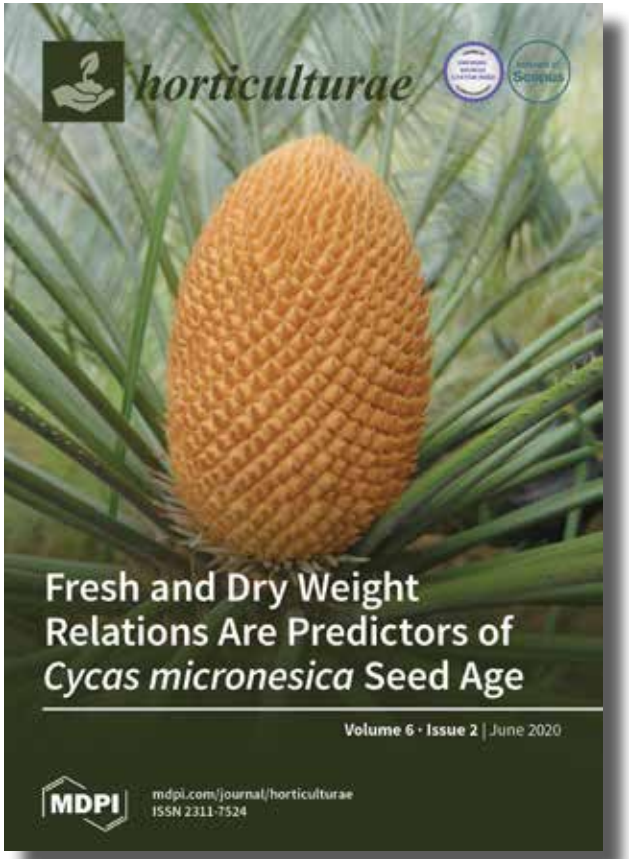
Guam research exposure

Science journal publishers are always on the lookout for interesting articles that can be supported by compelling graphics to increase interest in their journal as cover stories. Articles about Guam's cycad species continue to be selected for this purpose.

This decision by the journal publishers adds to the international interest in the research performance of the Western Pacific Tropical Research Center.



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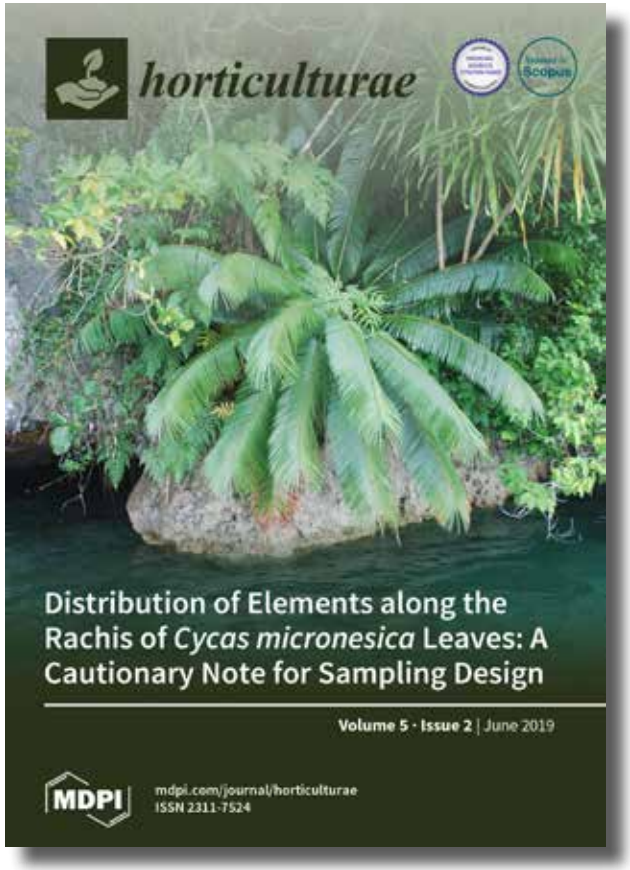

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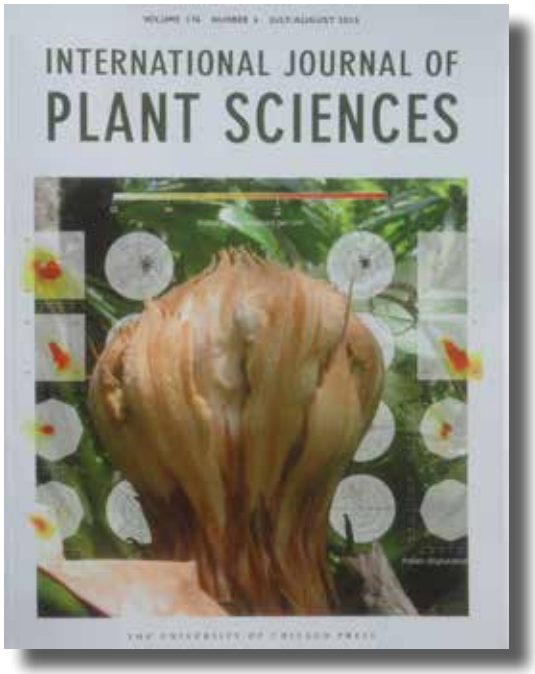

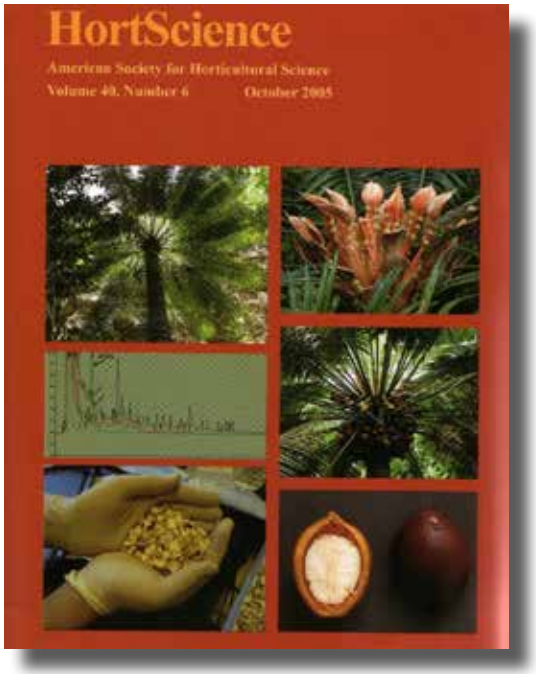

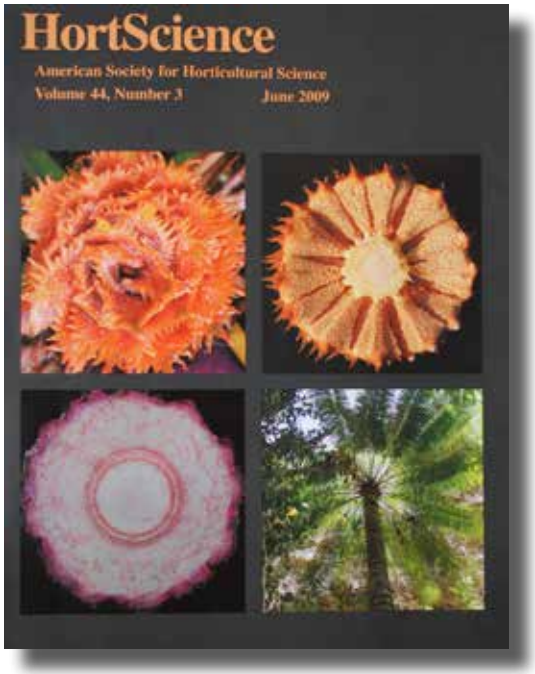

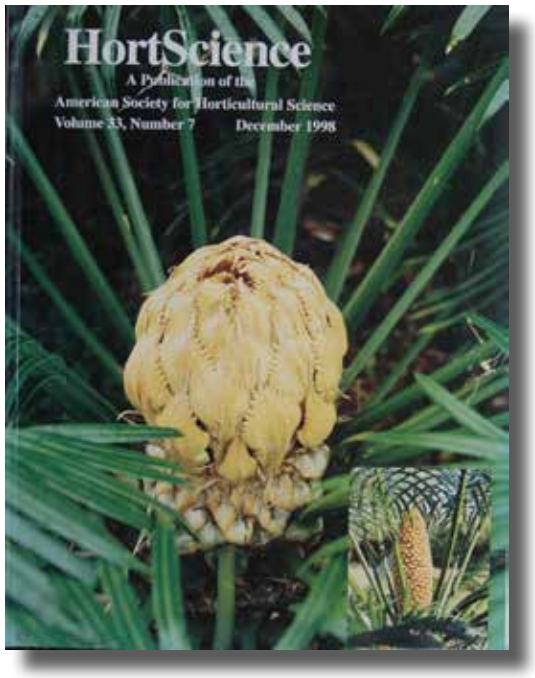

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Heirloom eggplant trials

In recent variety trials, flowers of the *Solanum melongena* were described as light violet and varying in size from 6 to 11 millimeters.

With heirloom eggplant seeds provided by the Guam Department of Agriculture (GDOA), horticulturist Dr. Mari Marutani and graduate student Chieriel Desamito conducted eggplant field trials at the Yigo Research and Education Center.

A germline for a local eggplant called 'Ideal' (*Solanum melongena* cv.) was supplied by John Borja (GDOA) for field evaluations of yield production and morphological characteristics of leaves, flowers, and fruits.

The trials were conducted during the rainy season (July to November) on Guam with seeds sown in late June.

Four-to-five-week-old seedlings were planted in rows with the Guam Crop Chart recommended distance of four feet between plants and five feet between rows. The plants were maintained with weekly fertigation using a drip irrigation system to deliver 6.50 pounds of 20-20-20 (nitrogen, phosphorus, potassium) fertilizer. In order to control for pests, a weekly spraying of 70% neem oil was applied.

Twenty plants were randomly selected for analysis of their morphological characteristics. The first flowers appeared approximately 63 days after sowing with the corolla color described as light violet and varying in size from 6 to 11 millimeters.

Seedlings were planted in the field with post harvest individual fruits being measured and weighed.

Harvesting of eggplants occurred 80 days from sowing. The calyx length ranged from 2.1 to 7.5 millimeters and the fruit breadth ranged from 8 to 9 centimeters with the length from 56 to 79 centimeters. Two to five fruits were produced per plant. Weight is an important measurement for farmers and it ranged from 37 to 208 grams with an average of 113 grams.

Field trials yield important information and knowledge that help growers understand the best varieties to plant and what to expect as a the return on their investment.

Funded by USDA Hatch program

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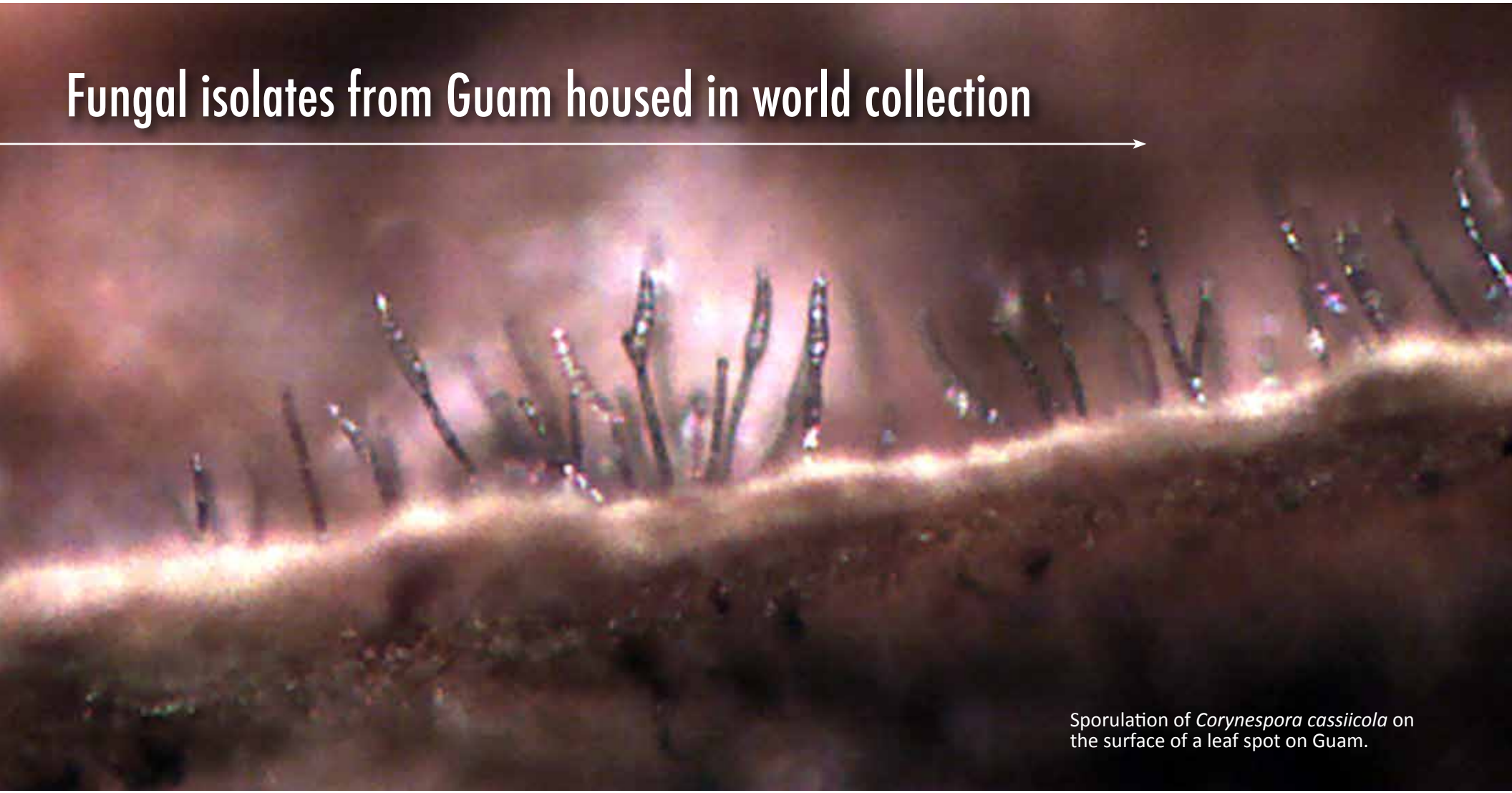
Fungal isolates from Guam housed in world collection



Sporulation of *Corynespora cassiicola* on the surface of a leaf spot on Guam.

In 2020, the process of finding a permanent home for Guam's isolates of a serious pathogen that attacks agricultural and ornamental crops began. The fungus is detrimental to a number of crops including cucumber, papaya, tomato, and researchers continue to study the pathogen to help farmers in the tropics and subtropics keep the fungus under control and avoid substantial crop losses.

As a result of a collaborative effort between University of Guam, Research and Extension Pathologist Dr. Robert Schlub and University of Georgia, Associate Professor of Mycology, Dr. Marin Talbot Brewer, isolates of the fungus *Corynespora cassiicola* collected on Guam in 2002 by Linley Dixon have found a new home. Dr. Brewer's graduate student, Manuela Samaco was able to recover 39 isolates out of 173 isolates sent by UOG Extension Associate DonaMila Taitano. Some of these isolates will eventually become part of the repository at CBS-KNAW Fungal Diversity Collection. These isolates were part of Dixon's original collection stored at the University of Florida, which were unfortunately lost.

There are over 100 different fungi within the *Corynespora* genus, of which *C. cassiicola* is the most damaging to crops. This fungus is most frequently reported in the tropical and sub tropical areas of the world. It infects over 530 species of plants in 53 families.

Though *C. cassiicola* is known to infect and produce symptoms on various plant parts and has several disease names, it is most commonly referred to as target leaf spot. Losses from target leaf spot in major production areas of the world are in the millions of dollars. In the past 10 years, target leaf spot has become a major pathogen in cotton and soybean production areas of Georgia and other states in the US. In August of 2014, it was reported for the first time in North America in highbush blueberry. What started out in 2002 as part of a 3-year $163,150 Tropical/Subtropical Agriculture

Dr. Linley Dixon working on her certified organic fruit and vegetable farm in Colorado.

University of Georgia graduate student Manuela Samaco infiltrates fungal extracts of *C. cassiicola* tomato isolates onto their host plant tomato and other hosts such as cotton and soybean to test for host specificity.

Research Grant to determine the impact of invasive weeds on the occurrence of *C. cassiicola* on Guam, would lead to another 3-year grant in 2005 for $241,815 to characterize species of *C. cassiicola*. This grant

Damage to tomato leaves caused by the fungus *Corynespora cassiicola.*

paved the way for Linley Dixon to receive her Doctorate of Philosophy in Plant Pathology from the University of Florida in 2008 and to author with Dr. Schlub and others a paper in the journal Phytopathology in 2009.

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Funded by USDA NIFA Hatch

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