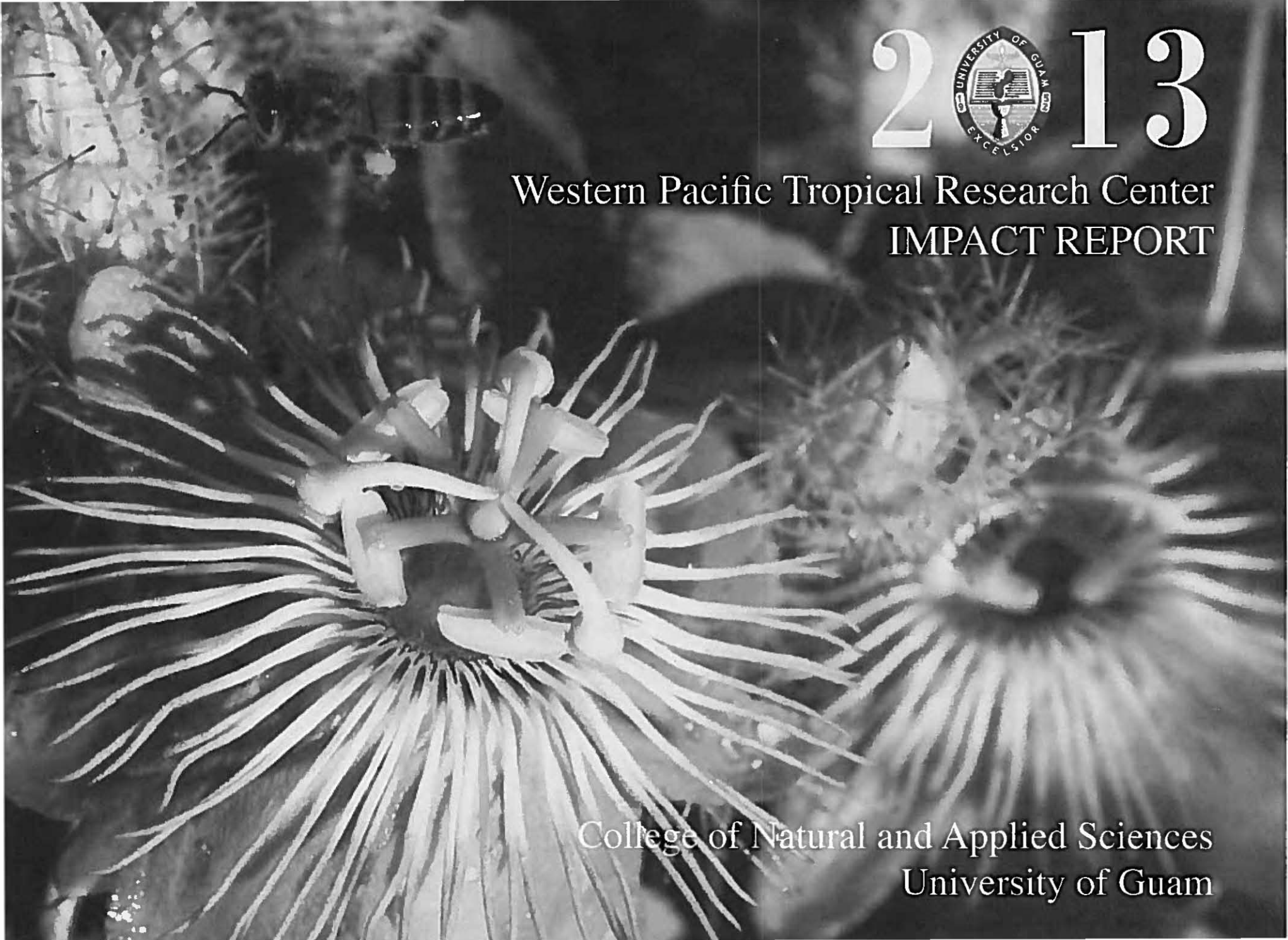

2013

Western Pacific Tropical Research Center
IMPACT REPORT

College of Natural and Applied Sciences
University of Guam

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

"Our research centers feed our passion, strengthen our mission, protect our resources, and empower our people."

Dr. Robert A. Underwood, UOG President

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Hafa adai and Welcome to the Western Pacific Tropical Research Center,

The Western Pacific Tropical Research Center (WPTRC) is once again proud to showcase some of our 2013 research outcomes and the relevance of our center plays in the advancement of "UOG Statement of Greatness." The University of Guam's statement of greatness consists of "leadership in learning, teaching, discovery, and service that preserve the essential strengths of the Region's cultures and natural resources." WPTRC combines each facet of greatness into a dynamic interface that units all these goals.

The nine research works that are highlighted in the 2013 Impact Report include: (1) the potential varroa mite free zone, where beekeepers on Guam may be able to provide certified queen bees, free of the damaging mite, to beekeepers in the mainland, (2) newly developed barrel traps that are catching 10 times as many coconut rhinoceros beetles than the standard adult beetle trap catches, (3) a study showing for the first time that gymnosperms posses kin recognition capabilities, (4) a report that highlights the interaction of alien insect pests and typhoon damage, (5) use of vetiver grass in reducing soil erosion and sedimentation, (6)update on the role of birds in moving seeds to forest gaps, (7) the development of a panel of useful internal markers, to improve the genetic diversity of shrimp stocks, (8) a collaborative effort assessing the local reefs which respect to coral bleaching, and (9) one of our graduate student's research on manta feeding behavior. I believe each of these nine articles will allow each reader a brief glance into the research we conduct at WPTRC and our collaborators at UOG's Marine Laboratory.

Lastly, I personally want to thank all the scientists, staff and students that have contributed to the 2013 WPTRC impact report. I believe you will find this year's publication a true example of what UOG is collectively calling "Good to Great." WPTRC is a great investment and is an internationally recognized research center that preserves the essential strengths of Guam's natural resources.

Lee S. Yudin

Lee S. Yudin
Dean and Director
CNAS/WPTRC

COLLEGE OF NATURAL AND APPLIED SCIENCES
UNIVERSITY OF GUAM

UNIVERSITY OF GUAM

WPTRC is committed to greatness.

The Western Pacific Tropical Research Center has been the venue where the research outcomes of UOG's Land Grant obligations are fulfilled. We embrace our tropical location and the facets of agriculture and ecology that are unique to small islands in a manner that defines our international niche.

In 2013, as in previous years, we made every effort to extend our current capabilities beyond the boundaries of UOG's campus and the Territory of Guam to become an internationally recognized tropical island research center. At WPTRC we recognize that as a small research unit with very limited financial, logistical, and human resource support, greatness for WPTRC can be achieved if we stay focused on our distinctive opportunities: clean ocean water for aquaculture research, proximity to Asia, partnerships with other Micronesian islands and other regional entities that understand the daily needs of life in the tropics.

We continue to increase ways for University students to become directly involved in our research projects. We employ many graduate and undergraduate students and these students not only enjoy receiving a paid salary to support their educational endeavors, they gain practical experiences that ideally position them to represent the University as they enter the workforce. We will keep pursuing opportunities that advance WPTRC research output and benefit our students because we believe that student engagement in WPTRC should motivate and inspire.

Sincerely,

Greg Wiecko
Associate Director
WPTRC

National Honey Bee Health Survey

Funded by USDA-APHIS

Dr. Ross Miller's Entomology Lab at the University of Guam, Western Pacific Tropical Research Center has its antennae in a lot of hives with a first ever survey of the island's honey bees. Honeybee health in the US mainland has been in decline for many years: Mites, diseases and environmental toxins have taken their toll on honeybee populations throughout the states. Funded by USDA-APHIS, this national survey will look to understand what viruses, mites, pests or other factors may be influencing honeybee health. With a clearer understanding of what is negatively impacting bee colonies, scientists are hoping to find efficient methods to mitigate this decline.

"The varroa mite has infected bees throughout the country. If Guam can be declared a varroa free zone, beekeepers on island may be able to provide queen bees certified to be free of the damaging mite to stateside beekeepers. This could be a potential new apiary opportunity for the island," says Miller.

Bees pollinate many of our favorite foods including cherries, oranges, lemons, cucumbers, blueberries, carrots, almonds, avocados and more. Bees are also important pollinators of forest plants and trees. Pesticide use, habitat loss, GMO crops, and global warming have been cited by researchers as playing a role in the declining health of honeybees.

Conducting a survey of this magnitude takes a considerable amount of behind the scenes activity and coordination. Research assistant and UOG graduate Chris Rosario has been charged with contacting beekeepers on Guam to inform them of the survey and schedule times to take samples of their bees and hives. "I will need to get samples from a total of 24 domestic and feral (wild) colonies from around Guam. My task is to collect 1/2 cup of bees from each hive," says Rosario. Dressed in his bee suit and armed with a bee smoker Rosario will also be checking the hives for mites and collecting them if he finds any.

WPTRC scientists continue to serve the needs of Guam's people, plants and animals through their efforts to secure grant monies and carry out valuable research.

"If Guam can be declared a varroa free zone, beekeepers on island may be able to provide queen bees certified to be free of the damaging mite to stateside beekeepers."

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Rhino Research: Scent of a Coconut Tree

Funded By USDA-ARS-PBARC Hawai'i, USDA-APHIS, the US Forest Service, the Government of Guam, and UOG

As the coconut rhinoceros beetle (CRB) invasion threatens Guam's coconut trees, it has inspired regional collaboration by researchers determined to understand what attracts a rhino. Decoding chemical cues that attract rhino beetles may unlock the secret to saving the island's palm trees.

Dr. Matthew Siderhurst, a chemical ecologist from Eastern Mennonite University and technician Dominick Skabeikis of USDA-ARS-PBARC (Pacific Basin Agricultural Research Center) were recently on island working with the Coconut Rhinoceros Eradication team and University of Guam entomologist Dr. Aubrey Moore. "One outcome of our collaboration with Dr. Siderhurst is the important improvement of adding lights to our CRB bucket traps which has resulted in a three-fold increase in the number of beetles found in these traps," says Dr. Moore. Many CRB reports indicate beetles being attracted at night to lit areas. "On this trip Mat and Dom are is collecting chemical compounds from local coconut trees and compost material for analysis at his lab in Hilo."

Dr. Siderhurst held a postdoctoral research associate position with Dr. Eric Jang at the USDA-ARS-PBARC in Hilo, Hawaii, working to identify attractants for several economically important invasive insects. Hawaii is very concerned about the possibility of rhino beetles showing up in their coconut trees, so they are funding Jang and Sidehurst's studies on CRB. The concern in Hawaii was heightened last week when a live rhino beetle was caught in the baggage area at the Honolulu International Airport. It is not known if the beetle was a hitch-hiker from Guam.

Sidehurst has been conducting electrophysiology tests to find out which chemicals excite the beetle. "We attach electrodes to their antennae and our equipment records the beetles' reaction to the plant volatiles we pass over them," says Siderhurst. "Our hope is to isolate the chemical in coconut trees that attracts the adult beetles to feed or aggregate, and use it as a improved lure to attract them to traps in order to suppress the population."

The experiment to isolate chemicals from coconut trees involves wrapping the crown of a coconut tree in a huge plastic bag, and then inserting glass tubes into the bag in order to pump air through the tree and extract the plant volatiles. The volatiles are then put through a gas analyzer to identify individual compounds.

University of Guam extension agent and Coconut Rhinoceros Eradication team leader Roland Quitugua is curious as to why the CRB is attracted to coconut palms and not areca (betel nut) palms. "I find coconut palms with rhino damage growing right next to betel nut trees that haven't been disturbed by the beetles at all. What is it that draws them to feed on the coconut trees and not touch the betel palms?"

Continued on next page→

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Rhino Research: Scent of a Coconut Tree

Since Sidehurst's visit to Guam, a rhino beetle infestation has been found on the island of Oahu next the runway on the Hickham Air Force Base Golf Course. Moore and Quitugua were invited to Hawaii as Subject Matter Experts (SME) and were able to offer valuable information on how to identify and eradicate CRB breeding sites. Hawaii is benefiting from technology developed on Guam by UOG and PBARC researchers.

These collaborative efforts have resulted in two new rhino beetle trap designs. Panel traps equipped with a solar powered ultraviolet light emitting diodes catch more than three times as many beetles as standard pheromone traps. In addition, newly developed barrel traps, which simulate rhino beetle breeding sites catch more than ten times as many beetles as standard pheromone traps.

Moore and Quitugua trained Hawaii Dept of Agriculture, USDA personnel and 30 stakeholders from public & private sectors on how to identify CRB damage on palms trees and identification of CRB breeding sites. They also helped to develop protocol procedures for CRB eradication.

It is interesting to note that Hawaii Department of Agriculture, Plant Industry, Quarantine Branch officer Wilfred Leon Guerrero, whose father is a past president of UOG, discovered the first CRB breeding site found in Hawaii. He learned about CRB on a recent visit to Guam and knew exactly what to look for.

The Japanese proverb, "None of us is as smart as all of us," certainly applies to the difficulties of controlling invasive species introduced to island ecosystems that have developed in isolation.

To report invasive species sightings on Guam, please call 475-PEST(7378).

Newly developed barrel traps catch more than ten times as many beetles as standard pheromone traps.

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Do Guam Mantas Plan Moon Parties?

Guam mantas will be forever mentioned in the scientific literature because of UOG Master of Biology candidate Julie Hartup's passion for her research subject. She has been studying Guam's *Manta alfredi* for eight years and is the first to document a very interesting behavior, mantas eating fish spawn.

Several of Hartup's paddler and free diving friends told her about seeing mantas congregating purposefully in an area where surgeonfish were spawning. Since they were able to give her an exact date, Julie was able to calculate the moon phase, which is important as many fish synchronize their spawning with the moon. Using this information she predicted when the spawning events would occur that upcoming year and was there to witness a shoal of spawning surgeonfish accompanied by a fever of mantas.

Hartup's research findings not only highlight important information about mantas, but also reveal predictable spawning aggregations (SPAGs) for three important reef dwellers: *Acanthurus triostegus, Acanthurus gutattus, Acanthurus lineatus*. These surgeonfish react to the presence of mantas by trying to evade them.

As is often the case with basic research, many more questions evolve out of finding a few answers. "The mantas come in patterns. Are they herding the spawning fish? Is there cooperative behavior? How do the mantas know to come? Mantas are thought to be singular except for feeding or visiting cleaning stations. Are they really singular or more social than we know? These are some of the questions I really want to investigate," says Hartup.

What science does know about mantas is that they live 40 to 50 years and are late to mature. They usually have only 1 pup every 2 to 5 years, which takes 13 months to develop and comes out rolled up like a burrito. There is no parental care, so the pups navigate life without motherly guidance. No one knows where mantas have their young.

"I believe mantas must have a remarkable sensory system. Their cerebellum and frontal lobes are quite large so they are naturally curious and will check out humans in their vicinity," explains Hartup. Through direct observation, photographs and videos she has documented 41 individuals on Guam, but there is a massive lack of information about the lives of mantas in Micronesia.

In 2008 the Yap state government passed Law No. 7-36 which designates " . . . all the internal and territorial waters of the State of Yap are hereby established as an official sanctuary for manta rays." Hartup's research has been tapped by the Yap government to develop an effective management plan for the protection of the mantas in Yap. She has been collecting data on Yap's mantas for several years: "By understanding the lives of Micronesia's mantas, we'll know where to start protecting them." Hartup wants to document them before they are lost to the threats of human encroachment or habitat degradation.

Julie Hartup is the Mariana Islands Program Leader for the Manta Trust, a not-for-profit organization dedicated to research and conservation of mantas and their ocean home. She is making a difference in the region one manta at a time.

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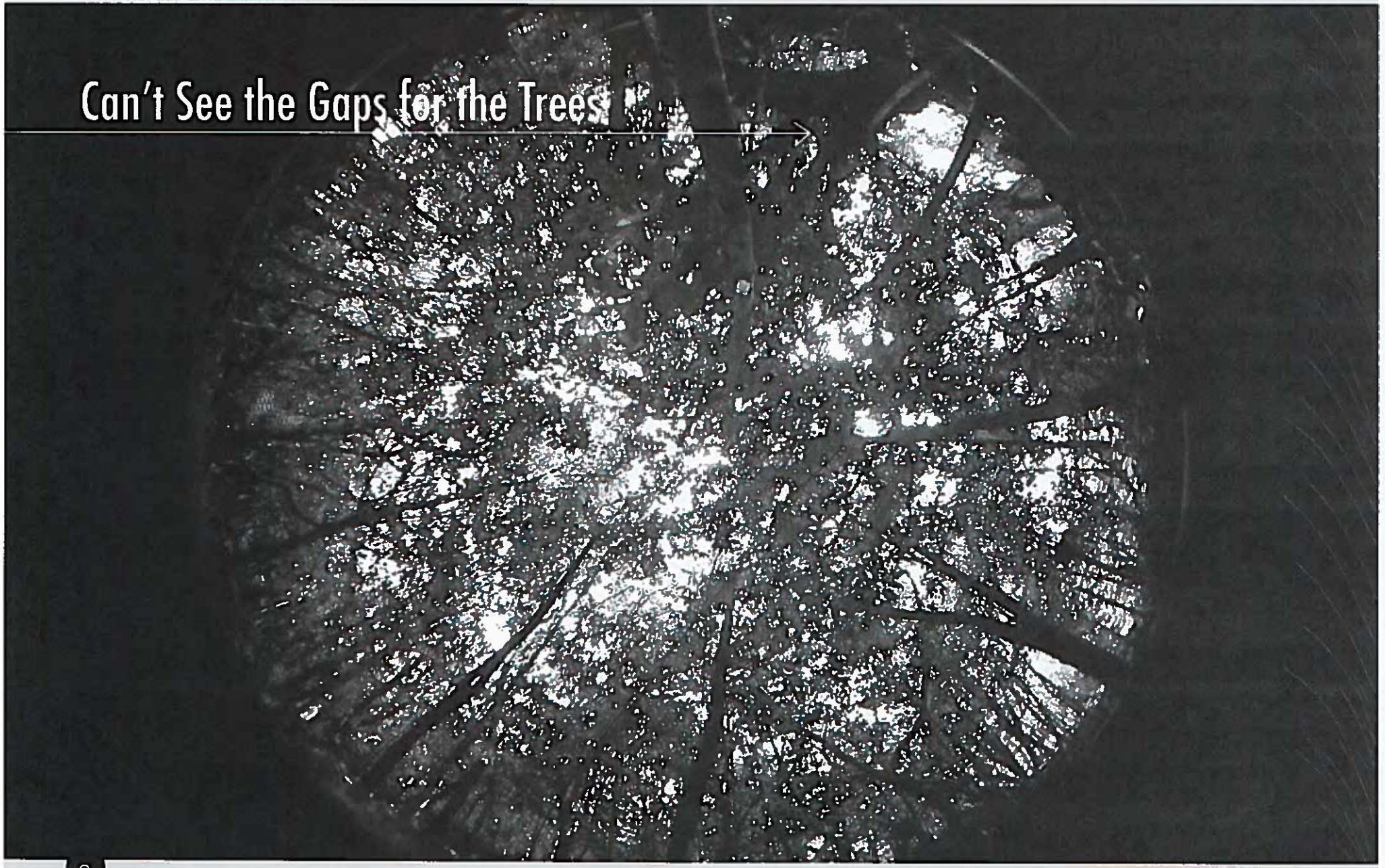
Please visit, www.mantatrust.org for more information about manta research around the globe.

Can't See the Gaps for the Trees



Funded by National Science Foundation

The Ecology of Bird Loss project (EBL) continues its sixth year of studying the effects of bird loss to brown tree snake predation on the health of Guam's limestone forests. This collaborative effort between WPTRC entomologist Dr. Ross Miller and Rice University ecologists Dr. Haldre Rogers and Dr. Amy Dunham has helped bring to light the cascading effects of invasive species on small island ecosystems like Guam.

"This new grant looks at the role of birds in moving seeds to forest gaps. We are creating small gaps in forests on Guam, Saipan and Rota in order to compare the regeneration rate within these gaps between islands that still have healthy bird populations (Saipan and Rota) and on Guam," said Rogers, "We have noticed that Guam has twice as many gaps in its forests when compared to Rota and Saipan and hypothesize that the lack of birds may be the explanation for this phenomenon."

Rogers and her team will be monitoring the seedlings in these gaps over the next three years to see how bird presence affects gap regeneration. They have enclosed the recently created gaps with fencing to eliminate the impact of pigs and deer on gap regeneration. If birds are important for moving seeds to the gaps, especially those of quick-growing pioneer species, then the islands with an abundant avian presence should have many seedlings from pioneer species spread by birds regenerating in the gaps, whereas Guam's gaps would be limited to regrowth from trees and plants immediately surrounding the area. Since birds disperse the seeds of most trees and vines in the Marianas, the hypothesis for this experiment is that forest gaps in Guam will have the slowest rate of regeneration.

Two Guam teachers are working with scientists on the forest gap project to develop localized lesson plans for their classrooms. Val Atalig is incorporating her fieldwork with EBL into language arts and science lessons for her students. Dan Ho, a math teacher at Southern High School is using his experience in the field with EBL methods to design math lessons including having students calculate the volume of the forest gaps. "I want to make lesson plans that are relevant to our island environment and to our students' understanding of the interrelatedness and fragility of the web of life that surrounds us," said Ho.

Forest ecologist and invasive species specialist, Dr. Lizzie Wandrag is the boots on the ground for Rogers. She will be running the research and doing the science for the next 2 years. "Prior to coming to Guam I was working on invasive species issues in New Zealand. I thought things were bad there, but the invasive species problems on Guam are much worse," said Wandrag.

The environmental issues faced by Guam and other Micronesian islands need the spotlight of serious scientific research like the Ecology of Bird Loss to prevent future invasive species debacles.

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Strong Kinship Ties in Cycad Seedlings

Funded by WPTRC

The social life of plants is surprisingly complex. When confronted with a competing plant, some species have been shown that they can recognize if the competitor is a relative. Many plants use that recognition skill to be selfish and compete more strongly for soil resources when confronted by a non-relative, but to exhibit altruism and reduce acquisition of soil resources when confronted by a relative.

The growing body of research on this subject was restricted to recently-evolved flowering plants. Underrepresented in this literature are the cycads, an ancient lineage of gymnosperms. Cycad aficionado Dr. Thomas Marler decided to rectify this lack of information by investigating kin-recognition phenomenon in one species, *Cycas edentata*.

"*Cycas edentata* is widespread in the Philippines and is closely related to Guam's cycad, *Cycas micronesica*," said Marler. "I selected *C. edentata* for this study because it grows in close proximity to several other Cycas species." To discover the reaction of cycad seedlings grown with seedlings from their neighborhood and from afar, Marler used *Cycas edentata* seeds from the islands of Mindoro and Marinduque and *Cycas nitida* seeds from the island of Samar.

Marler designed his experiment using four groups of seeds: 1) the test group seeds from one mother tree in the Mindoro habitat; 2) seeds from another mother tree in the same habitat; 3) seeds from a mother tree in Marinduque located 130 km away and representing competitors of the same species but a different habitat; 4) *Cycas nitida* seeds from a mother tree in Samar representing competitors from a different species. The test group of seedlings had their taproot split and were planted in conjoined pots with half of the root on one side planted with one seedling and half on the other side planted with a different seedling.

Plants compete for nutrients by maximizing root length. Within the context of the study, plants minimized root growth if grown with a close relative, but maximized root growth if grown with a non-relative of the same species. Most interesting was the treatment of planting *Cycas edentata* seedlings with a different species, *Cycas nitida*, which showed an 82% increase in root growth.

This study unequivocally demonstrates that this cycad species possesses the ability to recognize kin. These results can inform cycad conservation decisions including which genotypes to conserve and how to design the planting layout to take advantage of the non-kin incentive to encourage more vigorous root growth.

"This is the first time that a gymnosperm has been shown to possess kin recognition capabilities," said Marler. "The results indicate that kin recognition by roots may be an ancient phenomenon."

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The Intersection of Al n Typhoons

Funded by National Science Foundation, USDA TSTAR, USDA Hatch, US Forest Service

The United Nations Intergovernmental Panel on Climate Change reports that the average maximum wind speed of typhoons will likely increase throughout the coming century. Reporting the details of damage to and recovery following typhoons may improve our collective ability to predict how these changes may influence ecosystem processes.

Guam is ideally positioned to contribute to this international need for information on case studies, due to the frequency of typhoons that damage our island's forests. The WPTRC's plant physiology laboratory has been involved in these efforts over the years, and this year two articles were published that highlight the interaction of alien insect pests and typhoon damage.

Ecologist Thomas Marler teamed up with USDA Forester John Lawrence to determine why damage to Guam's *Cycas micronesica* population was more severe in the 2004 Typhoon Chaba than in the 1997 Supertyphoon Paka. Their findings indicated that the recent invasions of the armored scale *Aulacaspis yasumatsui* and the specialist butterfly *Chilades pandava* to Guam have eliminated the ability of the native trees to recover from typhoon damage.

Marler also used standard biomechanics research protocols to quantify *Cycas micronesica* stem strength following chronic infestations of *Aulacaspis yasumatsui*. "Many studies have shown that damage to stems often leads to stem rot, which then reduces stem strength," said Marler. "What was unique in our work this year was that direct insect herbivory alone caused a reduction in stem strength without the intermediating stem rot."

Results from the WPTRC work this year indicate that documenting the interactive aspects of the broad disciplines of invasion biology and climate change may inform future predictions and management decisions. Ecologists throughout the globe will benefit from the ongoing work on typhoons at the WPTRC.

Further Reading:

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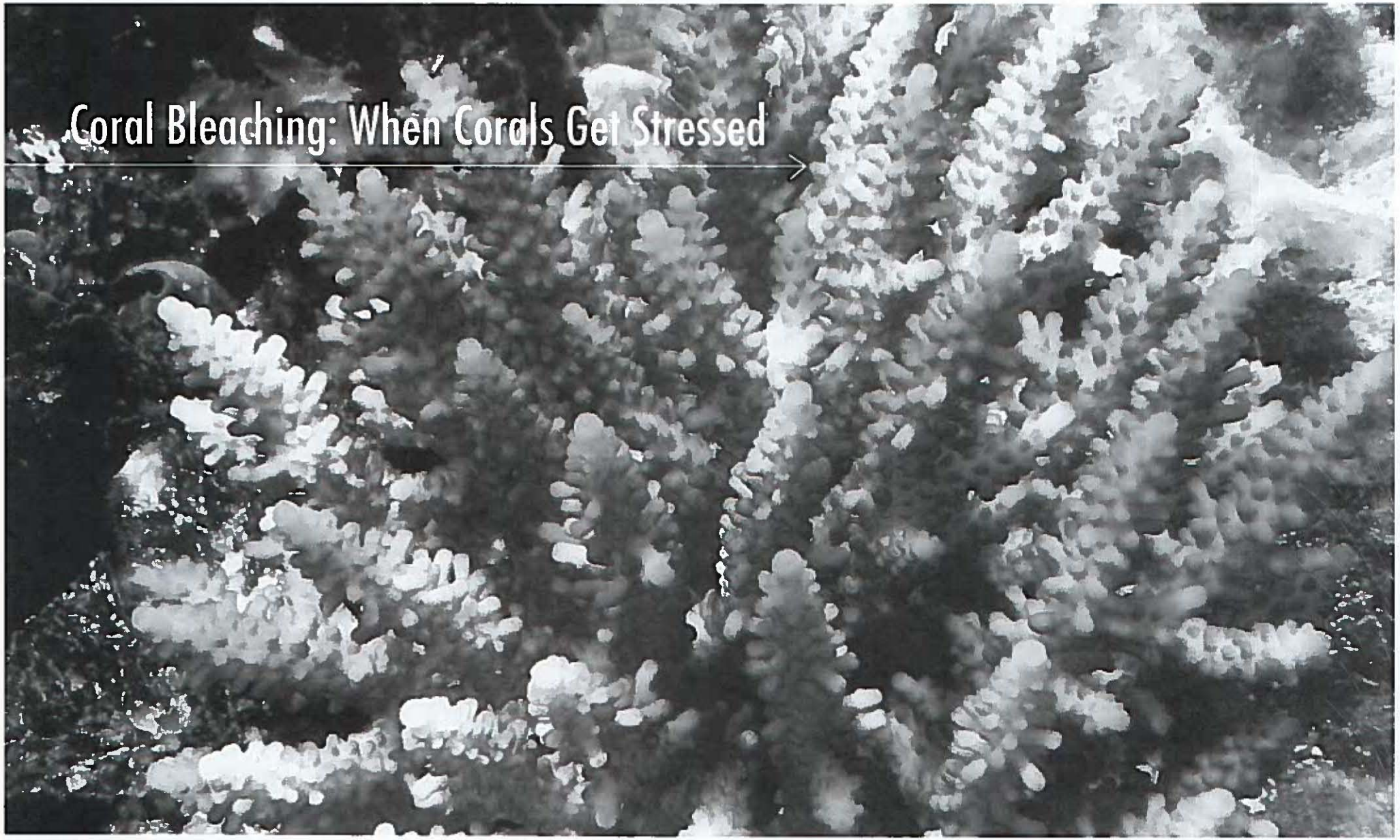

Coral Bleaching: When Corals Get Stressed

Funded by NOAA, National Parks Service, National Science Foundation RAPID Grant

Modern medicine understands that stress often causes a chain reaction within the human body resulting in a breakdown of bodily resources that can lead to illness. Coral reefs under stress are not much different than you and I, and prolonged stress can trigger a collapse of resources that can be fatal.

Coral bleaching is one of the symptoms reefs exhibit when under stress and is often precipitated by higher than normal water temperatures. UOG Marine Lab coral scientist Dr. Laurie Raymundo and graduate student Travis Reynolds have been noticing disturbing symptoms of coral bleaching in the waters around Guam. They are members of the local Bleaching Response team that includes Val Brown from National Oceanic Administration Agency (NOAA); Dave Burdick, Coastal Management, Government of Guam; and other individuals from UOG Marine Lab; Guam EPA; National Parks Service.

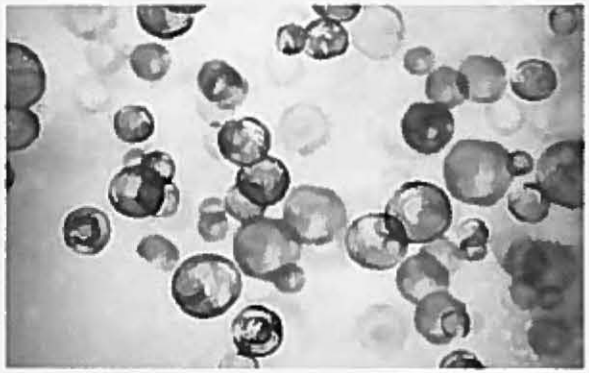
This collaborative team recently conducted assessments of local reefs surrounding Guam and documented an island-wide bleaching episode, which was not limited to shallow waters. "We are finding bleaching even at depths of 50-60ft. The hardest hit in this recent event were several species of Acropora and Pocillopora. These are important habitat species for fish and invertebrates," says Raymundo.

Corals get their vibrant colors from photosynthetic algae, genus Symbiodinium that live in their tissues. Up to 90% of the organic material produced during photosynthesis is used by the coral polyps to build tissue. It is a mutualistic relationship that reef-forming corals cannot live without.

Dr. Rob Rowan, UOG Marine Lab researcher, has found that different types of Symbiodinium have varying degrees of susceptibility to thermal and UV stresses. This is an interesting finding that has broadened the perspective of how corals may recover from bleaching. Research since this time has shown that some coral colonies can survive bleaching episodes better than others, even within the same species. If these more resilient colonies can be identified and cultured, it may be possible to repopulate reef areas that have suffered mortality of certain susceptible species.

Starting an ocean coral nursery to begin this process is exactly what Raymundo would like to make happen. A project initiated by SECORE Foundation began such a nursery summer 2013, culturing larvae from corals spawned during its first Guam workshop. She is working to secure funding to expand this initial effort. "Wherever a coral nursery is established the waters must be free from contamination by sewage and protected from destructive human activities. Increased nitrogen input from sewage is detrimental to coral health and corals are particularly vulnerable to this," says Raymundo.

The importance of coral reefs to Guam's economic and ecological health cannot be overstated. Coral research by Marine Lab scientists plays an important role in keeping the island's waters healthy and full of life.



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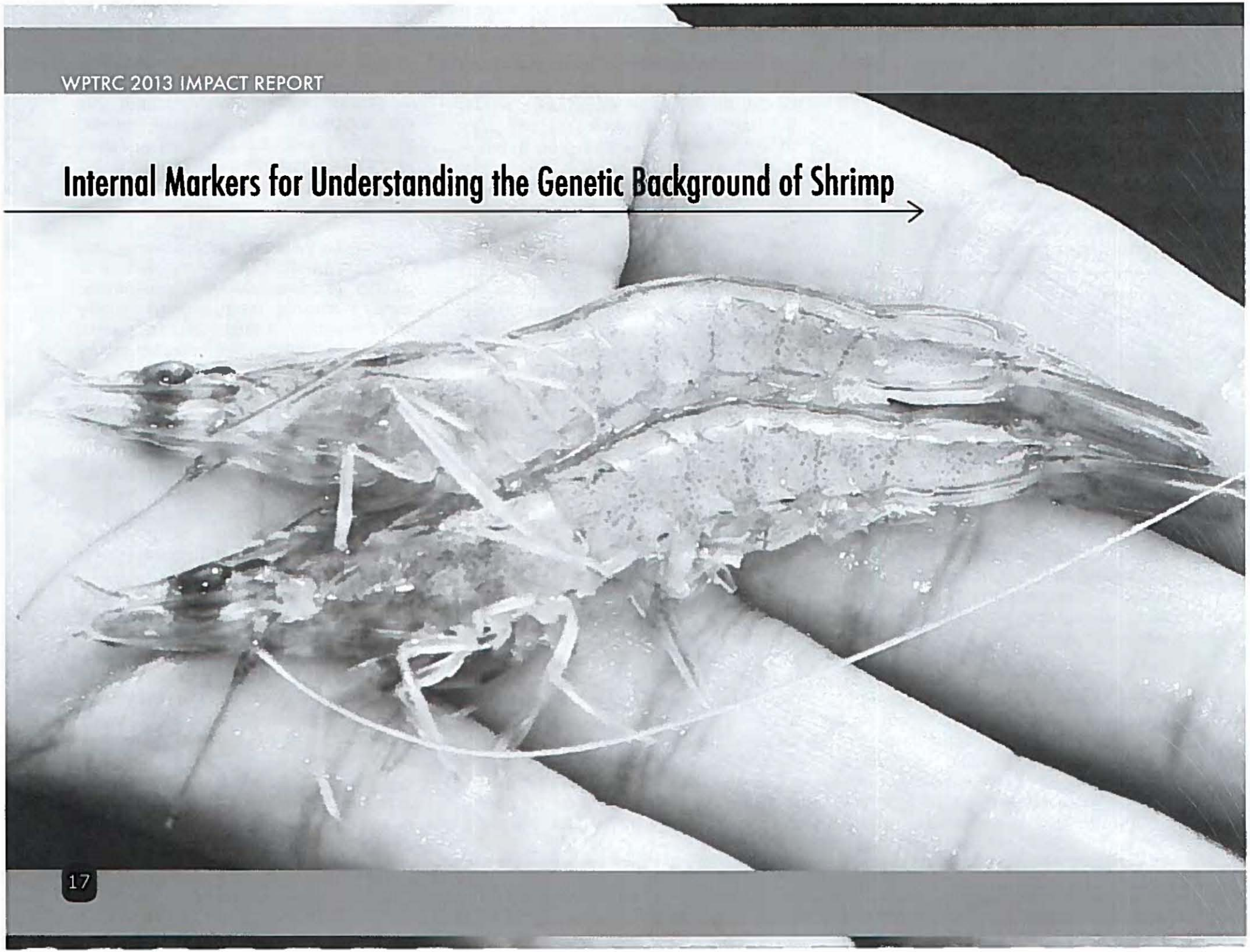
Internal Markers for Understanding the Genetic Background of Shrimp



Funded by USDA T-STAR & USDA HATCH

In 2007, Dr. Hui Gong and her research team initiated a shrimp (*Penaeus vannamei*) breeding program at the University of Guam Hatchery. It is crucial to maintain clear pedigree lines and minimize inbreeding in the program for sustainability purposes. This could be done by physically tagging (see shrimp tails at left), which is a monumental task, as the researchers would need to physically tag each individual animal. There is also the strong possibility of losing the tag during the molting process of the shrimp or of misreading the tag, which would pose great difficulties and confusion for processing and interpreting data.

Therefore, Dr. Gong's team aimed to develop a panel of useful internal markers, in order to maintain the shrimp breeding program, and ultimately improve the genetic diversity of shrimp stocks for the aquaculture industry on Guam and the region.

Gong's team used a panel of 16 polymorphic markers selected from 128 microsatellite loci (positions of genes in chromosones) that were screened using pooled DNA samples from Guam Aquaculture Development Training Center (GADTC) stock. This work has been carried out in multiple generations of the program. The parents of 36 shrimp families and 30 progeny per family were sampled and genotyped. Their work allows them to identify pedigrees and facilitates marker-assisted selection, which may link genetic markers to desirable phenotypic traits.

To determine the minimum number of microsatellite markers required for accurate pedigrees, parentage assignment using various numbers of markers was compared with the known pedigree. Two computer programs, CERVUS and COLONY, were used to analyze the data and both programs concurred that 12 or more loci yielded 100% accuracy in assigning the correct parents at the genotyping error level of 1%.

The panel of these informative microsatellite markers developed in this study will be optimized and effectively employed in shrimp breeding programs at the hatchery for monitoring genetic diversity and managing the program.

Dr. Gong's team aimed to develop a panel of useful internal markers and ultimately improve the genetic diversity of shrimp stocks.

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Talakhaya Watershed Soil Loss Project

Funded by National Oceanic & Atmospheric Association (NOAA) Managed by National Fish & Wildlife Foundation (NFWF)

Controlling soil erosion is imperative for the health of coral reefs surrounding tropical islands like Guam and her northern neighbor Rota. Soil erosion and run-off result in sedimentation and suffocation of the complex organisms that make up a reef system.

Soil scientist Dr. Mohammad Golabi has been monitoring the water quality of Rota's Talakhaya Watershed since the planting vetiver grass in eroding areas. "This watershed is located in an area containing steep slopes and experiences frequent wildfires in the dry season. Vetiver's ability to tolerate high stress situations, adapt to a variety of conditions, develop a dense vertical root system, and powerful soil binding characteristics make it an ideal candidate for controlling soil erosion," said Golabi.

The scientific name for vetiver is *Chrysopogon zizaniodes* and the thick, stiff-stemmed cultivars are used for controlling soil erosion. Researchers around the world have evaluated the application of vetiver grass and found it to be very effective when bioengineering technology is needed to stabilize soil on steep slopes like those in the Talakhaya. The plant's spongy root system binds the soil beneath the plant to a depth of up to 3 meters forming a dense underground curtain that prevents gullying and tunneling. Once the hedge has been established, it can live up to 50 years and does not require further maintenance other than periodic trimming. Under certain circumstances thick hedges can be formed in one year, it generally takes two to three growing seasons to establish a hedge dense enough to withstand torrential rains and/or heavy storm events, and protect the shoreline from sedimentation.

Golabi's team has analyzed 8 months of data and are expecting to find reduced run-off in areas of the watershed that have been planted with vetiver grass. "Streams with a higher rate of turbidity during heavy rainfall are in areas that have not yet been planted," said Sydonia Manibusan research associate on the project. "We are using hydrological data collection techniques and collecting data from streams including water levels, stream discharge and water quality. Specific to water quality, we are using a probe to measure pH, total dissolved solids (TDS) and dissolved oxygen."

The analysis of the soil and water sampling from the areas of the watershed planted with vetiver grass will be compared with areas of watershed without any vetiver plantation to evaluate the environmental impact of the vetiver plantings on the watershed. It is expected that the results of planting the new vegetation, particularly vetiver grass, will show a positive impact on the environment, especially the health of coral reefs in areas fed by the Talakhaya Watershed as well as other marine life.

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2013 Publications

Duay, J.A.M., R.H. Miller, G.C. Wall, K.S. Pike, and R.G. Foottit. 2013. *Pentalonia nigronervosa Coquerel* and *Pentaloniacaladii van der Goot* (Hemiptera: Aphididae) and their relationship to banana bunchy top virus in Micronesia. *Pacific Science* 68(3), in press.

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Cyathea lunulata, a tree fern indigenous to Micronesia is one of Guam's rare plants deserving protection.