



2012

IMPACT REPORT

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

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College of Natural and Applied Sciences
University of Guam

Greetings from the College of Natural and Applied Sciences,

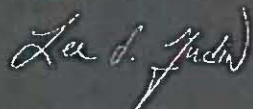
The diversity of the Western Pacific Tropical Research Center is exemplified in our 2012 Impact Report. As a small tropical research institute in the Western Pacific, we are known regionally, nationally and internationally and our current work is highlighted in this year's report.

Many tropical island eco-systems are under constant threat from invasive pests that can have a tremendous influence on both plant and animal habitats. The island of Guam, with a total land area of 212 square miles (549 km²), is no exception to harmful pests and this year's front cover portrays four invasive pests (brown tree snake, coconut rhinoceros beetle, little fire ant and Asian cycad scale) that continue to influence the lives of all the inhabitants on Guam. As you read through our impact report, you will note that our scientists have provided current updates on projects they are engaged in and what they are trying to do to minimize the threat of these unwanted organisms.

The 2012 impact stories include an article on the blueprint for bio-security, some of Guam's conservation efforts, and a unique article on snakes, birds and teachers. We included some new research on endangered bats, predatory mites, aphids, tomatoes, and coral groupers. And have highlighted updates on the rhino beetle project and Guam's cycad population.

Lastly, I personally want to thank all the gifted individuals that have contributed to this report, and I hope you will find this year's impact report a true example of the excellence we strive for at the Western Pacific Tropical Research Center.

Hafa Adai,



Lee S. Yudin
Dean and Director
CNAS/WPTRC

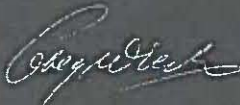
Dear Readers,

This year's Impact Report contains several research related stories chosen to highlight activities conducted at the Western Pacific Tropical Research Center. We hope that by reading them you will become more familiar with our activities and have a better understanding of our regional importance.

As an integral part of a land-grant university, we work to fulfill our mission to provide solutions to the broadly understood agricultural needs and challenges in the Western Pacific region. As you will learn from the feature stories, in spite of many economic challenges on Guam and across the nation as well as our geographical isolation, our faculty and staff continue to be competitive. Our scientists conduct groundbreaking research studying new plants, fish and invasive species.

As University of Guam professors, we also strive to combine discoveries, innovations and research applications in the education of our students. Our students are an essential part of research teams that keep asking important questions and attempting to find answers. We hope to expand existing programs, develop new programs and keep contributing to the well being of our tropical island home.

Sincerely,



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Associate Director
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Blueprint for Biosecurity



Funded by Department of Navy

WPTRC scientists in collaboration with University of Guam researchers, regional invasive species professionals, and the Department of Navy (DON) are poised to make history. UOG entered into a cooperative agreement with the DON to review risk assessments and develop a regional biosecurity plan. The Micronesia Biosecurity Plan (MBP) is the first of its kind to confront biosecurity issues on behalf of a region encompassing multiple sovereign states or parts thereof. This regional approach to biosecurity for Micronesia is anticipated to be the most appropriate method to keep the region safe from the accidental introduction of invasive species and reducing the potential for spreading those already established in some but not all parts of the region. Jurisdictions covered in the MBP include the unincorporated U.S. territory of Guam, the U.S. Commonwealth of Northern Mariana Islands, the Federated States of Micronesia, the Republic of the Marshall Islands, the Republic of Palau, and the U.S. State of Hawaii.

DON has provided a substantial amount of funding to proactively address the potential risk from invasive species within the marine, freshwater and terrestrial systems of the region. A risk that, if not addressed by all entities in the region, could be expected to change with any increase in shipments. The military is taking the first steps in considering potential impacts that may result from the proposed expansion of military activities within the entire region. This is an example of the approach that all stakeholders in the region should follow in the future when contemplating current activities or changes in the way they do business.

James Stanford, MBP project director is an invasive species biologist who has been working in the Pacific region for the past eight years. "The UOG team feels this is a very meaningful endeavor and is working with experts throughout the region to review the draft documents provided by DON and make recommendations that will ensure regional needs and concerns are taken into consideration," says Stanford.

UOG will work with its partners at the Secretariat of the Pacific Community (SPC) and Landcare New Zealand as well as other regional experts to conduct a review of the draft MBP documents and assist with the development of the final MBP. UOG will also be working on a strategic implementation plan (SIP) for the MBP. The anticipated SIP will

be a framework that will provide direct assistance to the jurisdictions covered in the MBP in implementing the MBP recommendations to ensure the best harmonization of biosecurity efforts for the region.

Roland Quitoqua, MBP project co-director says, "Risk analyses were prepared by federal experts who visited Guam in 2010 to gather information used in Phase I of the MBP. We are beginning Phase II, which will allow for regional input into the finalization of these baseline documents."

Researchers at WPTRC are very familiar with the negative impacts of invasive species on Guam and in the region. They have been actively involved for many years with assessing damage to ecosystems from invasive species already established on some islands within the region. Examples include the Brown Treesnake, Asian Cycad Scale, Coconut Rhinoceros Beetle, and Little Fire Ant.

WPTRC scientists are involved in the review process, which will involve examining thousands of pages of draft documents on terrestrial, marine and fresh water ecosystems. Their recommendations, as well as input from experts from throughout the region, will be incorporated into a peer-reviewed document slated to be completed in January 2013. The peer review is the first step of Phase II and it will be used

to guide the development of an updated version of the MBP.

The second part of Phase II will be the development of the SIP. The SIP will be developed as a document to demonstrate effective and realistic ways in which to actualize the recommendations found in the MBP. For example, the SIP could potentially lead to the establishment of both local and regional invasive species response guidelines allowing diverse entities to react swiftly and effectively with a common goal in mind.

A key aspect of the SIP is the active consultation with regional leaders and experts. "To orchestrate a coordinated response with such diverse participants is a monumental task that we feel is quite possible if we work collaboratively and with insight as to what assets and difficulties are faced by the jurisdictions involved," says Stanford.

Good science will inform this unprecedented undertaking of a program that has conservation of biodiversity and island sustainability at its core. Harmonizing the region's biosecurity efforts through the MBP and SIP should also have direct and positive implications on the preservation of culture, economics, human health, and the environment within the region.



Invasive Insects Cause Staggering Impact on Native Tree

Funded by USDA CSREES, U.S. Forest Service

The endemic and endangered cycad *Cycas micronesica* was once a dominant forest tree on the island of Guam, but recent rates of plant mortality predict it will be lost from Guam habitats by 2019. This dire prediction by scientists at the Western Pacific Tropical Research Center is validated by the research of Thomas E. Marler and John H. Lawrence, a forester with the U.S. Department of Agriculture's Natural Resources Conservation Service. *Cycas micronesica* is the only native host for the invasive scale insect *Aulacaspis yasumatsui* which recently invaded Guam, Rota, and Palau. "The potential cascading ecosystem responses are yet to be completely understood," says WPTRC research scientist Marler.

The armored scale insect *A. yasumatsui* attacks several cycad genera, but only members of the *Cycas* genus are killed by the pest. Around twenty years ago the insect was unintentionally introduced to an area in southern Florida where extensive production and exportation of *Cycas revoluta* occurred. The scale was documented in Hawaii in 1998 and in Guam in 2003, and by 2005 it was found in native limestone forest habitat close to the initial outbreak site.

"We looked for native habitats that would be representative of the general cycad populations where we could study population-level responses to the devastating scale pest. Seedlings were killed first, then the juvenile plants," says Marler. The number of months for juvenile plants to reach 100% mortality was dependent on plant size and other demographic features.

Just like the human body, plants exposed to constant stress eventually become weakened and unable to withstand additional stresses that by themselves would not be fatal. After the scale invasion, the compromised *C. micronesica* trees began to succumb to other pressures. These other factors included two other invasive insects that enjoy eating cycad salads for dinner: the cycad blue butterfly (*Chilades pandava*) and a tiny moth (*Erechthias sp.*).

"During the time frame of our study, this pest has been found in Rota in 2007 and in Palau in 2008," says Marler. "The spread of *A. yasumatsui* in the region underscores the importance of empirical studies to inform conservation efforts on Guam and the rest of Micronesia."

Further Reading:

Journal of Tropical Ecology (2012)
28:233–242.

Memoirs New York Botanical Garden
(2012) 106:20–35.

Plant Signaling & Behavior (2012)
7:1484–1487.

"The potential cascading ecosystem responses are yet to be completely understood."



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Guam Conservation Efforts Progress



Funded by U.S. Department of Defense

The U.S. Department of the Navy has initiated a project designed to help conserve one of Guam's important tree species. The tree is called *fadang* locally, and it belongs to a group of plants known as cycads. Cycads are represented by about 300 species, and collectively they comprise the most threatened group of plants worldwide. "This will be the first cycad transplantation project of this magnitude, so we are excited," said Jennifer Farley, Environmental Program Manager with Naval Facilities Engineering Command Marianas Guam Build-Up Office.

The local tree is known by botanists as "*Cycas micronesica*" and its seeds were once processed into the main source of starch for human consumption. Written accounts from the early European ships that visited Guam mention the prominence of the unique tree throughout Guam's terrain. Historical documents also indicate that reliance on the tree for food was crucial following typhoons when other crop plants had been damaged.

Recent forestry surveys revealed that *fadang* was sustained as Guam's most abundant tree until about 10 years ago. Several alien insects that feed

exclusively on cycad trees have invaded Guam in recent years. Research in WPTRC has validated that more than 90% of Guam's *fadang* trees have been killed by the insects since 2004.

The Department of the Navy project is pushing conservation work into new territory. The salvage and transplantation of cycads from the Andersen Air Force Base project in northern Guam will provide valuable insight to conservationists around the globe on the relationship between the health status of cycad trees and potential for transplant success.

"If this project can identify how to select a tree that has a high chance of transplant success, then we can use that information in future conservation efforts," said Farley. Alternatively, if the

project reveals factors that indicate a *fadang* tree is too unhealthy to transplant, then valuable resources can be used more intelligently in future conservation projects.

The project was managed by WPTRC Professor Thomas Marler. Investing the resources to transplant these important trees demonstrates a commitment to the National Environmental Policy Act, the National Historic Preservation Act, and the Coastal Zone Management Act. *Cycas micronesica* has been described as endangered on lists compiled by the International Union for Conservation of Nature and the Government of Guam. The lessons learned and trees saved by this project will advance much-needed conservation of the species.



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Rhino Beetle Update: Five Years on Guam



Funded by USDA-APHIS, US Forest Service, Government of Guam

The number of coconut rhinoceros beetles (CRB) caught in Tumon traps is currently low to minimal, five years since *Oryctes rhinoceros* was first discovered there. Roland Quituqua, director of the Guam Coconut Eradication Project attributes this decrease to heightened attention to sanitation of organic debris, the preferred breeding grounds for CRB, and to more careful pruning and management of palm trees in the area.

Although the number of beetles trapped in Tumon is low, the rhino beetle has spread to central and southern parts of the island. "The beetles are moving out of the original quarantine areas because they are good flyers and because people have moved them to other parts of the island in infested green waste," says Quituqua. The fact that there is such a bountiful food source and so many potential breeding places around the island makes control very difficult. Adult beetles have been caught in traps as far south as Merizo, but no breeding sites have been found in that village.

Progress has been made in better understanding this beautiful but destructive beetle. Dr. Aubrey Moore, in collaboration with New Zealand

scientists Dr. Sean Marshall and Dr. Trevor Jackson, have used DNA barcoding to find out more about Guam's CRB population. Preliminary results show that Guam beetles are genetically different from rhino beetle populations in Fiji and Samoa. "This may be a clue as to why the virus that was so effective in curtailing CRB in Fiji and Samoa did not have the desired effect on beetles here," says Moore. "We are now working on barcoding DNA for rhino beetles in Philippines, Palau and elsewhere to see if we can find a genetic match with the beetles we have on Guam. We may be able to determine where our beetles came from."

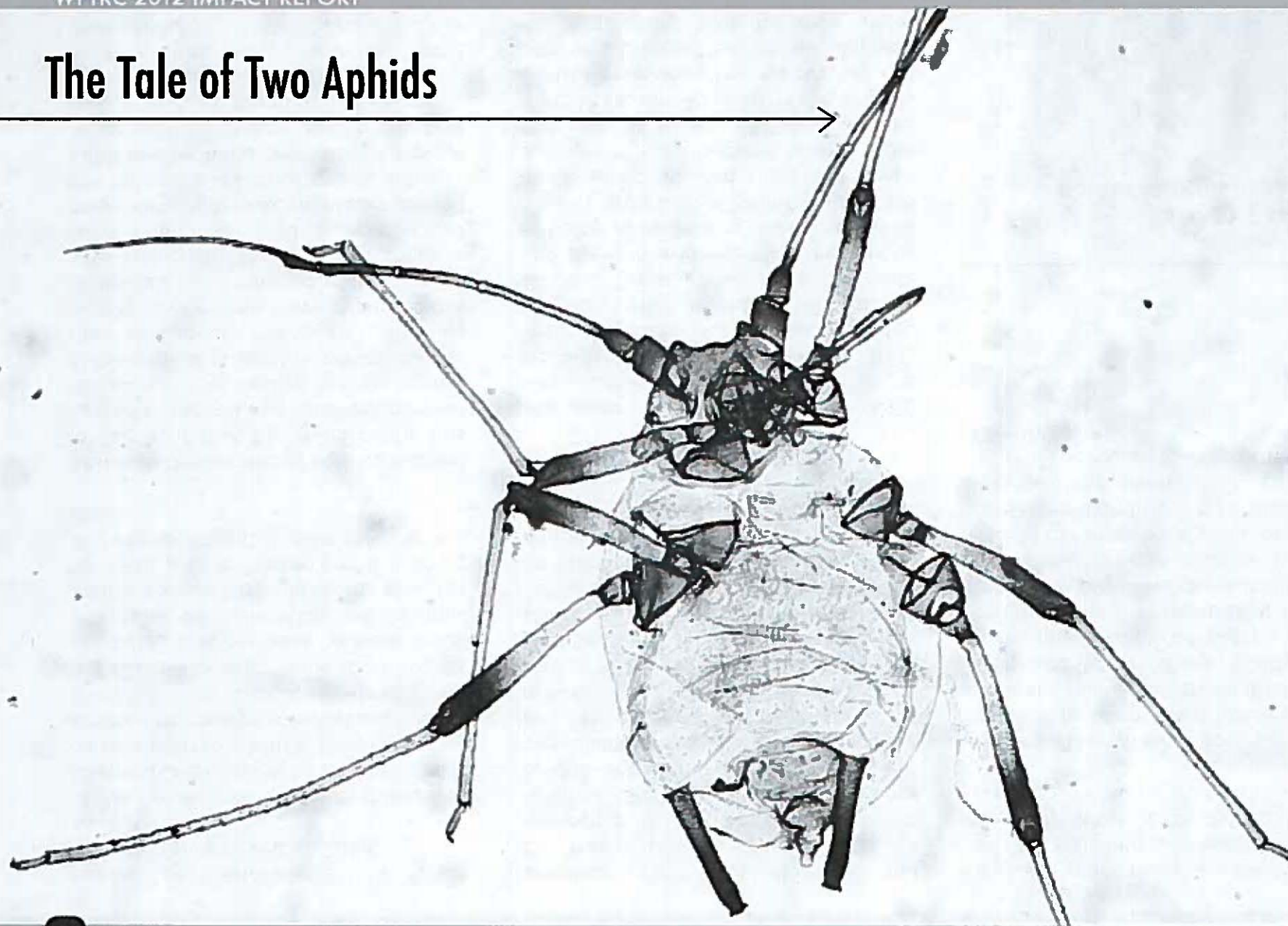
The green muscardine fungus (GMF) was successfully introduced as a biocontrol agent in September 2011. Whenever rhino beetle breeding sites are found, they are inoculated with the fungus. Results have been favorable and there is evidence that the fungus is being auto-disseminated (beetle to beetle) around the island. Once CRB adults and grubs come in contact with the spores they become sick and die within a few weeks. GMF only attacks rhino beetles. As with all biological control measures, the fungus will not eradicate the beetles but will suppress the population, keeping them under control. Something the CRB personnel have noticed is that, in areas where feral

pigs are active there is a low incidence of CRB breeding and evidence of pigs foraging after CRB infected green waste.

Islands like Guam are particularly vulnerable to invasive species as the flora and fauna have developed without the need for defenses against these accidentally introduced plants, animals or organisms that make their way into the ecosystem. The coconut rhinoceros beetle has yet to escape Guam to invade our neighboring islands. WPTRC researchers and UOG extension agents are working with their colleagues around the region to keep other islands CRB free.

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The Tale of Two Aphids



Funded by USDA T-STAR

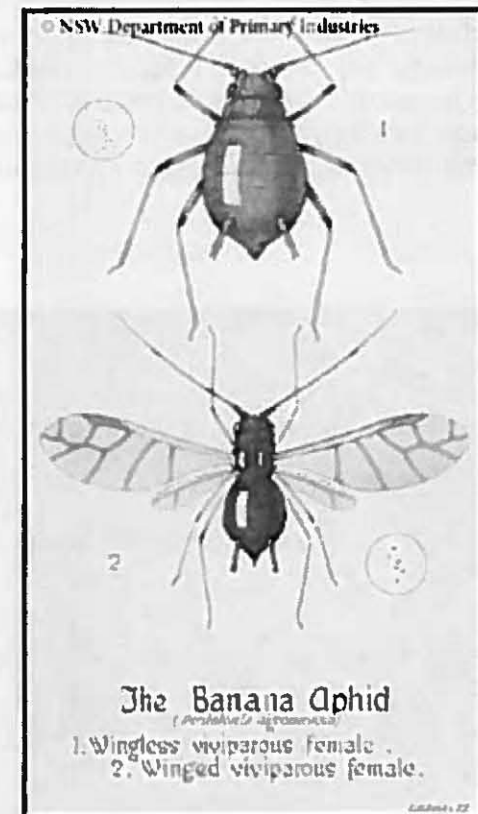
In 2010 WPTRC entomologist Ross Miller and his aphid-focused colleagues, aphid systemetist Robert Foottit, DNA expert Eric Maw and aphid authority Keith Pike published an important paper on the genetic differences between aphids that make their home on banana plants and aphids that live on ginger and heliconia plants. This was important news as their findings resulted in the reclassification of *Pentalonia caladii* as a separate species from *Pentalonia nigronervosa*. *P. nigronervosa* carries the banana bunchy top virus (BBTV), but the aphids living predominately on heliconia and ginger plants, *P. caladii*, may not carry the virus. As a result of these findings, Dr. Miller received a \$135,000 grant from USDA to identify the Micronesian islands that currently have BBTV and *Pentalonia* aphids and determine the ability of these aphids to transmit the virus and switch host plants.

Julie Duay, a master's candidate in UOG's Environmental Science program has been working on this aphid project for two years. In fact, her thesis will be on this very topic. She and Drs. Miller, Pike and Foottit have spent the last few years collecting samples of aphids and plant tissue from banana and non-banana plants throughout Micronesia. Their survey of Micronesian islands

confirmed that BBTV is currently present only on Guam, Saipan and Rota.

Duay began rearing *P. caladii* and *P. nigronervosa* on their respective host plants and then tried to get them to switch hosts. "While sometimes the aphids would switch from one plant species to another, often they would not survive very long on the new host," says Duay. "This suggests that *P. caladii* is not a major vector of BBTV, if indeed it transmits it at all under natural conditions in the field."

The best part of working on this project for Duay, beside spending time in the field, is the connection she has made with local farmers. "Our research is very valuable for them. Whether or not non-banana plants host the virus or other aphids than banana aphid transmit it is important for them to know," says Duay.



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Endangered Naked Bats



Funded by National Geographic Society Young Explorers Grant

Dr. Ross Miller and his Entomology Laboratory are fortunate to have several bright, young University of Guam master's candidates working there. Maia Raymundo's passion is terrestrial biology and she is currently in the graduate biology program. She has worked on several interesting grant projects through Dr. Miller's lab, which gave her the field experience needed to submit a proposal for a National Geographic Society Young Explorers Grant (YEG). YEG funds innovative hypothesis-based scientific research for individuals between the ages of 18-25 that are not usually covered by other sources of funding. Raymundo's proposal, to study endangered bats, was deemed significant enough to be funded at the maximum level YEG provides to applicants.

The bats she is researching, *Dobsonia chapmani*, are found on only two islands in the Philippines archipelago. They were declared extinct by the IUCN in 1996 but were sighted on the island of Negros Occidental in 2003 by Leonardo Averia and Dr. Alcala of Silliman University. These bats are also known as the Philippine naked-backed fruit bat as their wings connect to the vertebra on their back giving them the appearance of being naked.

Raymundo recently spent time in Negros applying for permits and doing some reconnaissance work before her research begins in earnest. That trip turned out to be more like a Sherlock Holmes adventure than she could have imagined, as few things were "elementary". In her favor, Raymundo speaks fluent Tagalog and Cebuano, which was of immense help as she started her bat detective work.

Field research always presents interesting challenges and logistical problems. Raymundo had the additional difficulty of needing to venture into a politically sensitive area due to rebel NPA (New People's Party) presence. But a series of fortuitous encounters allowed her to reach the Calatong Forest where the bats had last been seen. Most importantly, Leonardo Averia agreed to accompany her, as he was concerned that the local people would not give her their trust due to

the political situation. Mayor Montilla of Sipalay City, the municipality with jurisdiction over the forest, generously gave the group permission to enter the target area and suggested that two local CENRO (City Environment and Natural Resources Office) employees accompany them.

Once in the forest they met a sprightly older woman who lives there and tends her coffee trees and other plants under the canopy. "It was incredible to be in such a beautiful, wild place. There are monkeys, small cats, hornbills, owls, and bats that are still part of the ecosystem, but they are living under increasing threats from mining and clearing of the forest for agriculture," says Raymundo.

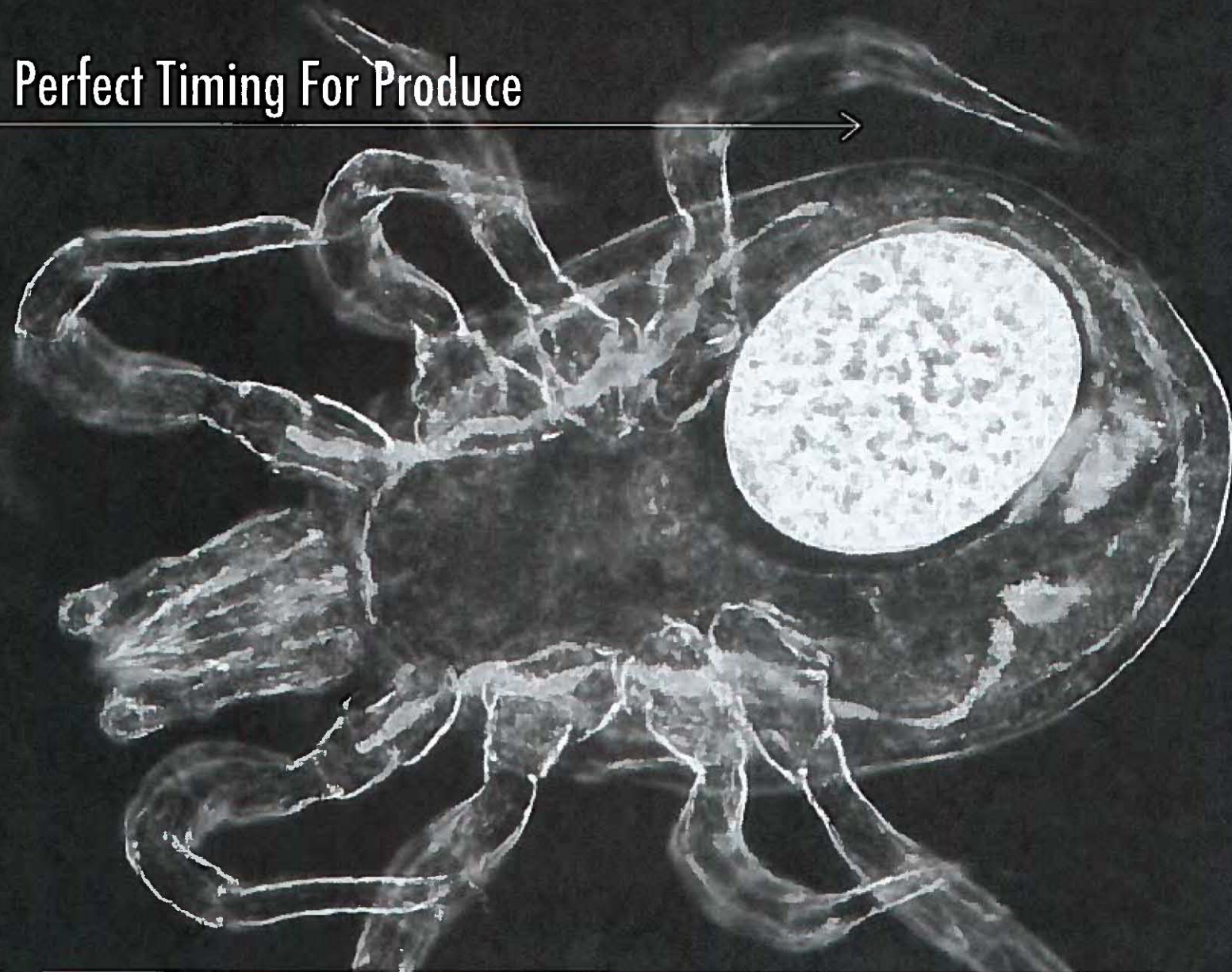
In their two nights of camping in the Calatong forest Raymundo was elated at the sighting of an adolescent *Dobsonia chapmani*, her research subject in the flesh. It was a good sign against incredible odds and she is looking forward to a prolonged stay to study the bare-backed bat. Originally she had thought to compare the two bat populations on Cebu and Negros, but she may broaden her thesis and compare *D. chapmani* to other bats in Indonesia, to understand whether they are the same species or if the Philippine bat is a completely separate species. She hopes to find the answer through DNA genome sequencing. There is no

time to spare; at the moment there are no measures in place to actively study or monitor the last remaining *D. chapmani* on Negros. Perhaps Raymundo's research will ignite an interest in protecting this bat so that extinction will not be its fate.



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Perfect Timing For Produce



Funded by USDA-NIFA PMAP

Western Pacific Tropical Research Center scientist Dr. Gadi V.P. Reddy is concerned about the effect of toxic agricultural chemicals on the health of island residents and ecosystems. Through the years, he has been educating farmers on the alternatives to pesticide use and was awarded an \$188,000 grant from USDA-National Institute of Food and Agriculture (USDA-NIFA) Pest Management Alternatives Program (PMAP).

This project focused on developing an ecologically sound and cost effective Integrated Pest Management (IPM) program for tomato farmers in the region. "The majority of growers in this region use dicofol, carbaryl, malathion, and other insecticides for the control of spider and broad mites and caterpillar pests on tomato. It is not unusual for as many as 10 insecticidal applications to be applied each cropping period, which is not only expensive in terms of financial outlay but is also associated with ecological and toxicological hazards," says Dr. Reddy. This funding has allowed Dr. Reddy to conduct studies that implemented the use of predatory insects, petroleum spray oils, neem oil, microbial pest control agents, and modern miticides, thereby reducing the reliance on toxic pesticides to control insect pests.

"There have not been any no-damage threshold levels developed for the red spider mite *Tetranychus marianae*, and some growers in the Mariana Islands are applying 10 to 12 chemical sprays per cropping period, often leading to extensive foliar damage and resulting in lower yield levels because the mites develop a resistance to the chemicals," says Reddy. Many growers in the Mariana Islands are unaware of the benefits of utilizing threshold levels or the adverse effects of chemical sprays on beneficial organisms. The use of pesticides in the Pacific region has increased dramatically in the recent past due to a greater number of pests on tomato crops. There has been no record of any predatory mites or any other biological control being used in the region. Although both economic injury level (EIL) and an economic threshold level (ETL) or action threshold (AT) are important and help in reducing the judicious use of chemical applications, extensive field studies for several consecutive years are necessary.

As if contending with spider mites was not enough, another insect pest, the fruit borer *Helicoverpa armigera* has been causing serious damage to tomatoes during the latter stage of the crop. A threshold-based approach for determining when to use an insecticide application for fruit borer control in fresh-market tomato in the Mariana

Islands was effective and resulted in fewer insecticide applications. Tomato growers should be encouraged to follow this research-based approach for managing insect pests and to abandon the current practice of a calendar-based insecticide application program.

USDA funding for WPTRC projects gives Guam residents more opportunities to have healthier, locally grown produce at reasonable prices.



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Spray Oils and Predatory Mites Make a Killer Combo

Funded by USDA/APHIS, USEPA/USDA-NRCS

Eggplant farmers in the Mariana Islands may get some relief in their struggle with spider mites damaging their crops. Dr. G.V.P. Reddy and his team have been active in rectifying the lack of research on the control of spider mites in the Pacific Islands. Their studies over the past few years have focused on the control of the spider mite *Tetranychus marianae* with biological pesticides and a biocontrol agent, which will give farmers an alternative to using toxic chemical pesticides such as carbaryl and dicofol.

"Petroleum spray oil (PSOs or horticultural mineral oils) are an effective and safe alternative to commonly used insecticides and miticides in controlling mite populations. Using them in combination with a predatory mite is an integrated control approach to pest management that is effective, economical and environmental friendly," says Reddy.

Dr. Reddy imported the predatory mite *Neoseiulus californicus* to Guam and this spider-mite-loving predator has been successful in establishing itself on the island, in part due to its preference for tropical temperatures. Experiments were carried out during both wet and dry seasons at the Western Pacific Biocontrol Laboratory, University of Guam in a nursery shade house with

walls and roof constructed using shade cloth.

Dr. Reddy's team looked at whether *N. californicus* would be able to flourish in the region and whether the PSOs would have any adverse effects on the predatory mite. His team evaluated the data from numerous experiments in order to develop an optimum Integrated Pest Management (IPM) treatment for controlling spider mites in the tropics.

"We found the best combination for reducing the *T. marianae* population was a treatment that included both the predatory mite and spraying with PSOs," says Reddy. This is good news for farmers, the environment and the predatory mites. "In the trials where we sprayed with the synthetic chemicals carbaryl or dicofol the population of the predatory mite was significantly reduced." In addition, the PSOs cause no harm to humans and pose a minimal

threat to predatory mites.

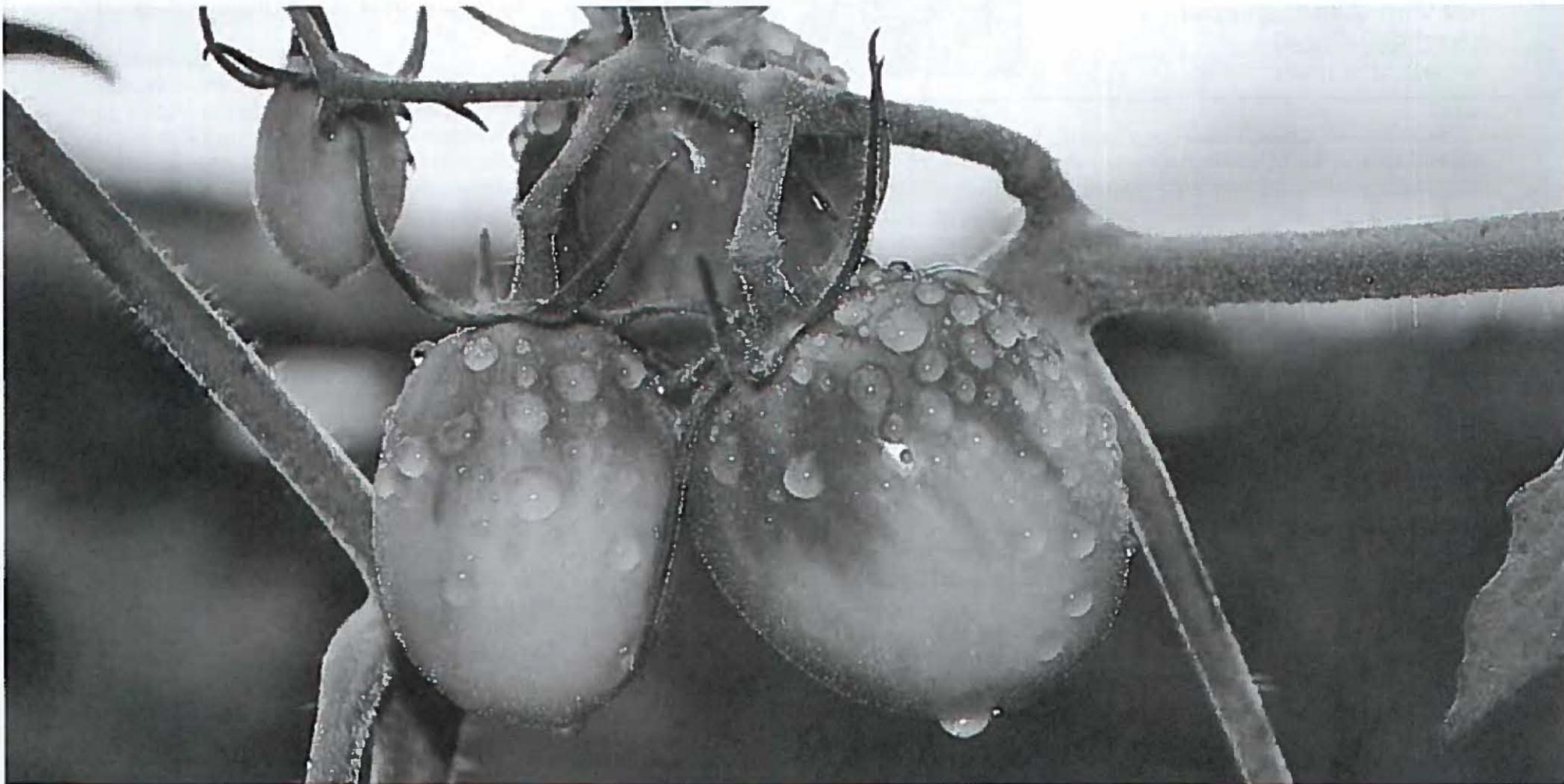
The results of team Reddy's trials concluded that using *N. californicus* alone was not as effective in controlling spider mite populations as the spray oil and mite combination. Using PSOs also had the added benefit of simultaneously controlling other incidental pests that may be present during the crop-growing period. "Even though our experiments were conducted indoors, we fully expect that this winning combination will prove to be effective in larger eggplant plantations," says Reddy. Moreover, this integrated control approach might work well for controlling mites on other vegetable crops. The results of this study have just been published in *Biocontrol Science and Technology* 22: 1211-1220 (2012).

Working to increase yields for regional farmers continues to be a high priority for WPTRC researchers.



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The Good, the Bad and the Best Tomato Plants



Funded by USDA Western IPM, UOG Cooperative Extension

The plot could be right out of a spaghetti western: bad elements come to town, plants are killed, big showdown, local farmer saves crops with help of the good guys.

The teamwork of University of Guam researchers, extension agents and local farmers averted a tomato tragedy on the island. The saga began during the 2011 spring planting, Bernard Watson and neighboring farmers John Mesa and Mark Pieper began noticing severe leaf curling and stunted growth of young plants of the cherry tomato variety Season Red. By October, Watson's tomato crop was a total loss and the disease had spread to Vicente Valasquez's farm. Jesse Bamba collected samples for analysis by Extension Plant Pathologist Dr. Bob Schlub.

The culprit is a Begomovirus that attacks tomatoes and other plants which is spread by a small insect, *Bemisia tabaci* or white fly. Schlub says, "As a result of several conversations with Dr. George Wall, we concluded that Dr. Wall may have discovered the virus years earlier at Mr. Watson's farm. This was partially confirmed when Agdia Diagnostics compared results from tissue samples collected by Mr. Bamba in 2011 to those from Dr. Wall in 2007."

Several control strategies were recommended to the farmers by extension agents Bob Schlub, Jesse Bamba and Roger Brown including the growing of seedlings under netting to exclude vectors, not transporting plants from infected areas, allowing infected fields to be rotated out of tomatoes for 120 days with plants that do not promote buildup of white fly populations, and growing Begomovirus resistant tomatoes.

Following recommendations from extension personnel, Mr. Watson decided to switch varieties and grow TYLCV resistant varieties from Lefroy Valley vegetable seed company. Mr. Watson discovered that the varieties Carmine, Felicity and Martyni did well on Guam. Five weeks after transplanting, all three varieties set fruit and were asymptomatic. During this period, Valasquez replanted his virus-infected field with Season Red plants and

experienced a total crop failure.

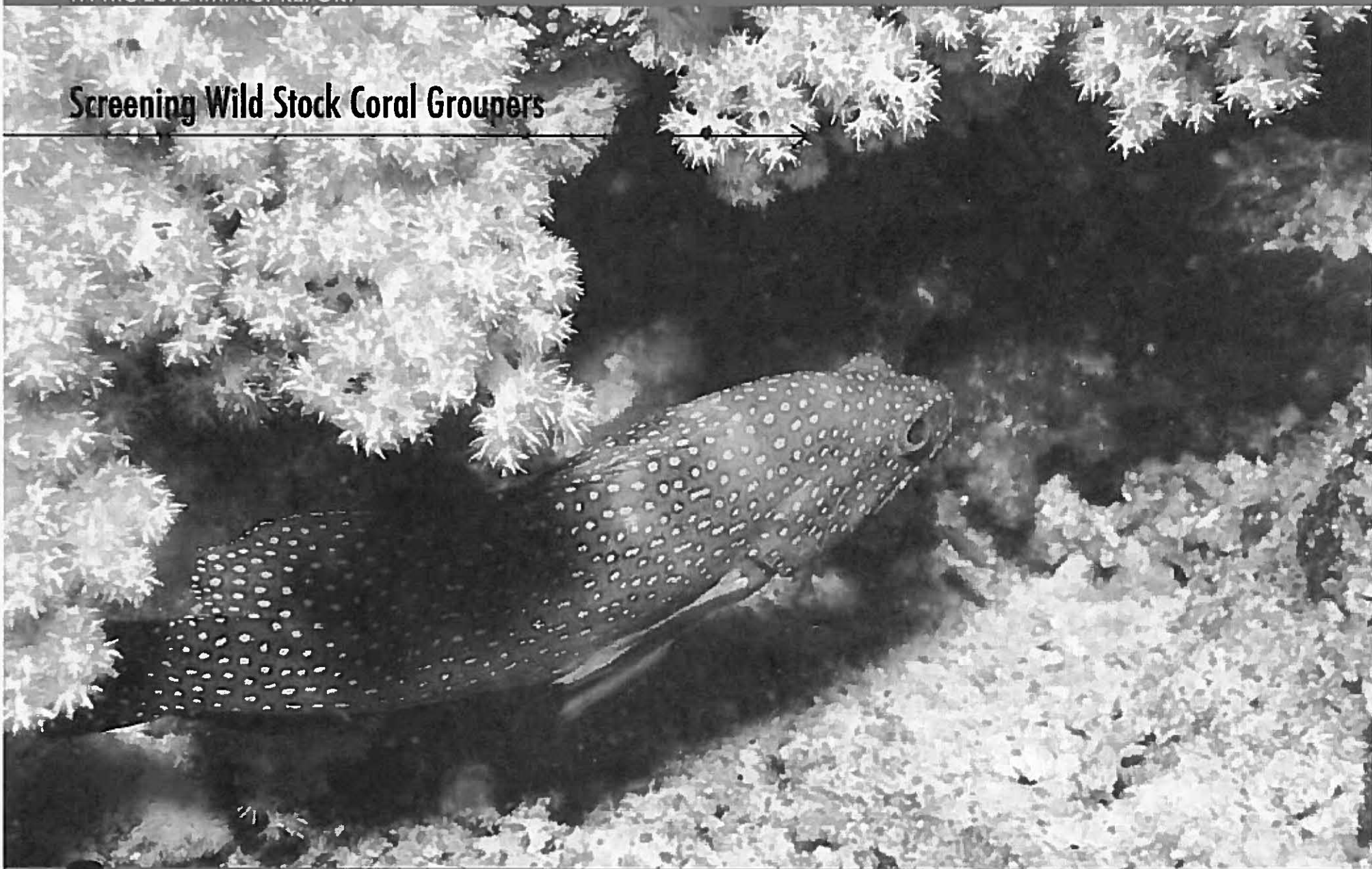
"It is always rewarding to work with Bernard. He is a passionate farmer who wants to take advantage of research and modern diagnostic tools to make informed decisions about his crops and he allows us complete access to his fields to monitor and assist," says Bamba.

Researchers, extension agents and farmers working together make a real difference for the island of Guam.



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Screening Wild Stock Coral Groupers



Funded by USDA Center for Tropical and Subtropical Aquaculture

Coral groupers are among the most sought after and valuable food fish of the coral reef habitat worldwide. They are some of the highest priced fish in the Live Food Fish markets in Hong Kong, where they are imported from across vast regions of Asia and Oceania. However, their populations are suffering from over fishing on Guam to the point where their natural recruitment may be threatened. Many grouper species are listed as vulnerable on the IUCN Red list, and Guam's *Plectropomus areolatus* status is currently listed as threatened.

The aquaculture industry of Guam has a strong desire to develop a local, high-end product that can be marketed as a live, in-restaurant product for the tourist trade. Coral grouper might be a potential candidate for meeting this need. The truncated tail with a narrow white posterior margin, and relatively large dark-edged circular blue spots of the *P. areolatus* coral grouper make them ideal for a premium live fish dish for a prestigious dinner in any white table cloth Asian cuisine restaurant.

Viral infections plague the grouper industry in Asia. Chief among the culprits are two viral diseases, viral nervous necrosis (VER/VNN) and the grouper iridovirus diseases. The lack

of wild coral grouper broodstock, its questionable health status and the widespread presence of viral infections in commercial grouper hatcheries indicate that there may be a ready market for SPF coral grouper fry or broodstock in Asia.

Drs. Hui Gong, John Brown and researchers at the Guam Aquaculture Development and Training Center (GADTC) are studying whether or not sufficient numbers of healthy local coral groupers can be obtained and maintained in order to establish a broodstock base for import of the existing technology.

This ongoing project has three main objectives: 1) collect live *P. areolatus* from the wild; 2) test for presence of VER/VNN and iridoviral disease; 3) maintain the stock in quarantine and monitor for any other diseases for several months.

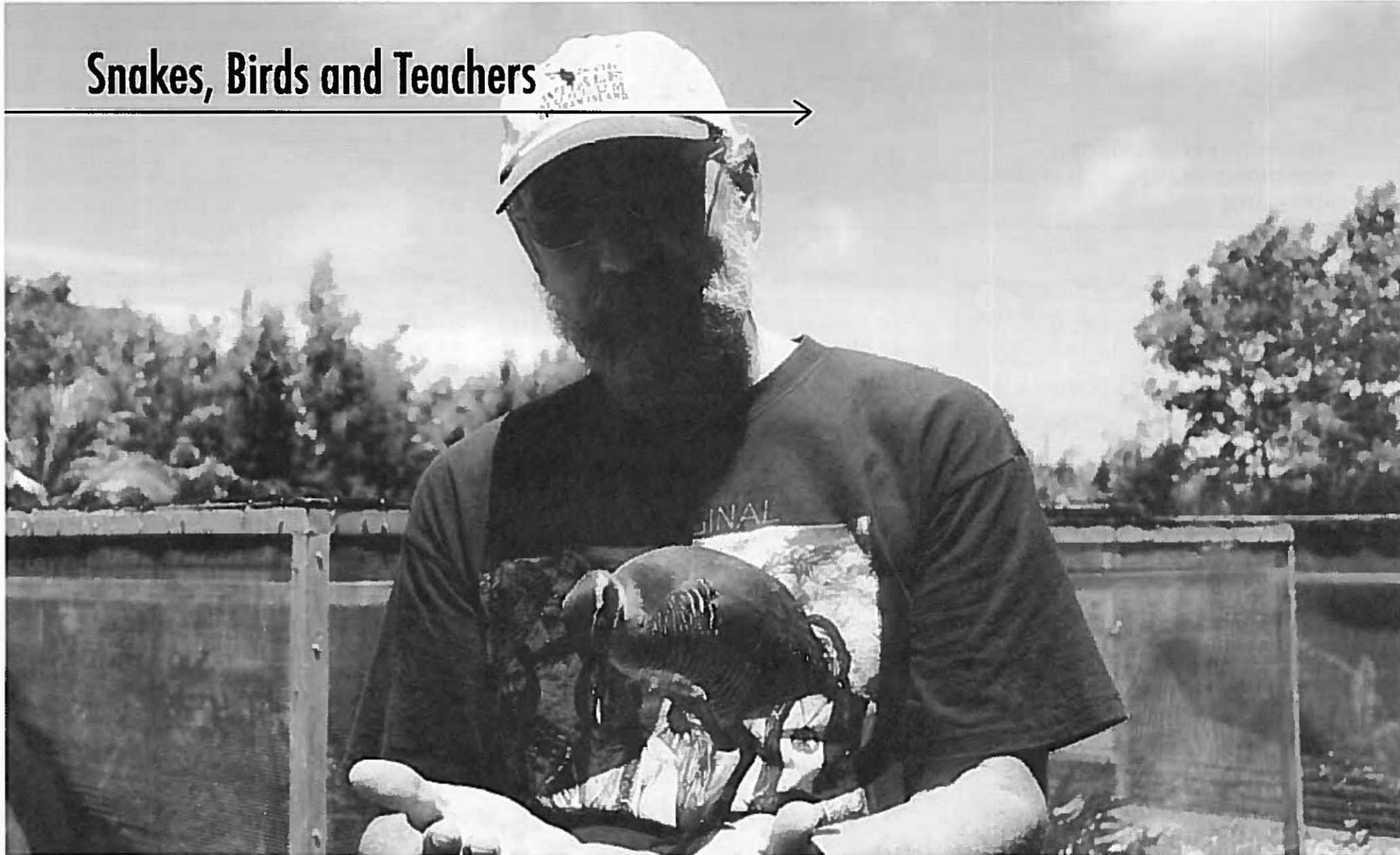


The study of coral groupers serves three possible goals: providing fish for the restoration of natural reef populations, providing fry for local farmers and providing SPF fry or broodstock to the Asian industry. Results of this research will increase our understanding of whether the coral grouper is a good candidate for aquaculture, and will provide useful information to both academia and the aquaculture industry.

Coral groupers are among the most sought after and valuable food fish of the coral reef habitat worldwide.

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Snakes, Birds and Teachers



Funded by the National Science Foundation

Science teachers on Guam, Saipan, Rota and Tinian now have a new resource to help teach about the local island ecology, thanks to the National Science Foundation-sponsored Ecology of Bird Loss Project. Sixty-five copies of the curriculum booklet, titled "*Mariana Islands Forest Ecology Teaching Guide*", were distributed in October 2012 to area high schools this month, free of charge.

The booklet is the result of three years of work by four high school teachers along with Ecology of Bird Loss Project staff. The teachers participated in the Research Experience for Teachers program through the National Science Foundation during the summers of 2010 and 2011. Through this program, they spent 7 weeks assisting scientists from the EBL project with research in the limestone forests on Guam, Saipan, Tinian and Rota, and then using their experience to develop lesson plans for use during the school year. Each teacher received a weekly stipend and funds to purchase classroom supplies needed for teaching the lessons they developed.

The teacher participants in 2010 were Sabina Perez from Simon Sanchez High School on Guam and Michael Subbert from Guam High School. In 2011,

Annette Pladavega from Kagman High School on Saipan and Mary Garvilles from John F. Kennedy High School on Guam were the participants. Dr. Haldre Rogers from Rice University is the director of the Ecology of Bird Loss project, and oversaw the RET program, while Kaitlin Mattos supervised and collaborated with the teachers throughout the process.

"Being able to do hands-on research outside of my classroom, and then to build a curriculum and lesson plan that deals with science that is happening on our island is what excited me," said Garvilles, a Biology and Physical Science at Simon Sanchez High School.

All of the lesson plans aim to use local examples and experiences to address concepts included in the Guam Learning Standards and CNMI Benchmarks. Some of the lesson plans are novel creations of the teachers, inspired by field techniques learned while doing research with the EBL project. Other lesson plans are based on lessons created for use in the mainland US, but have been adapted to make them relevant in the Marianas.

Perez emphasizes the importance of using local examples to teach scientific concepts. "The textbooks we use for science are mainland-based textbooks that use concepts from the environment there, they teach about things like

maple leaves and snow. This teaching guide is a great resource for teachers to use to make the life sciences come alive in the classroom and also to bring them out of the classroom as well."

The Ecology of Bird Loss project is a collaborative effort between Dr. Ross Miller from the Western Pacific Tropical Research Center at the University of Guam, Dr. Joshua Tewksbury and Dr. Janneke Hille Ris Lambers from the University of Washington and Dr. Rogers from Rice University. The project investigates the impact of the loss of native forest birds from Guam, with a focus on the role of birds in seed dispersal and as top predators in the food web.

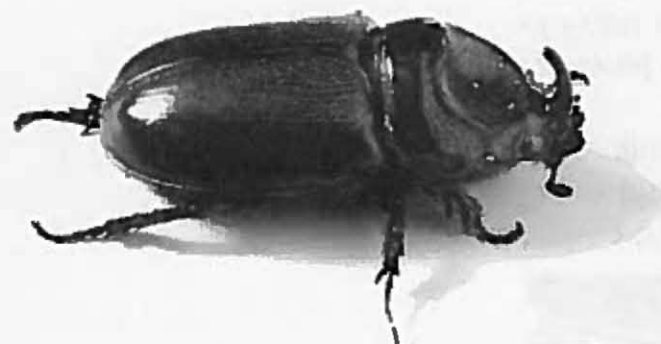
The *Mariana Islands Forest Ecology Teaching Guide* can be found online at:
hsr3.web.rice.edu/education.html

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WPTRC RESEARCH FOR GUAM'S FUTURE



United States
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Agriculture

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