University of Guam
College of Natural and Applied Sciences
Cooperative Extension and Outreach

Comprehensive Faculty Evaluation System

Work Plan
June 15, 2016 - June 14, 2017

Aubrey Moore

July 31, 2016

This document was written using LyX 2.0.8. Zotero and LyZ were used for handling references. Relevent files are stored in a GitHub repository at https://github.com/aubreymoore/CFES2016.

Contents

1 Personal Information and Roles

1.1 Basic Information

Current Rank and Step:	Entomologist / Associate Professor
Evaluation Period:	June 15, 2016 - June 14, 2017

1.2 Role Assignments

	Percent of Time
Extension and Outreach:	51% (primary focus must be at least 50%)
Creative/Research/Scholarly:	34%
Instruction:	0%
University Service:	15%
TOTAL:	100%

1.3 Consulting Activities During Performance Period

None

1.4 Signatures

As called for by the University Comprehensive Faculty Evaluation System, I hereby acknowledge that I have notified my unit Chair and unit colleagues of my preferences for role assignments.

Further, I have met with my appropriate administrative supervisor and discussed my evaluation plan for the period above cited. I understand that amendments to my plan are possible and that said amendments, if any, are to be discussed with and agreed upon by my administrator prior to initiating.

Faculty Member	Date
Associate Dean	Date
Dean/Director	Date

2 Activities

2.1 Extension and Outreach (51%)

2.1.1 Insect Diagnostic Services

As an extension entomologist, a major part of my job is providing insect identification and pest control recommendations to a diverse clientele including commercial growers, gardeners, householders, GovGuam and federal agency personnel, and University of Guam colleagues. Most client contacts are initiated by a phone call or a visit by the client to the ANR office. In many cases identification and pest control recommendations require a site visit by me and/or extension associates to collect samples to define the problem and develop recommendations. In some cases, I am sent digital images of insects and damage caused by them.

As an official USDA-APHIS cooperator, I am obligated to identify insects intercepted by Guam Customs and Quarantine and specimens submitted to the USDA-APHIS Guam Plant Inspection Facility.

Planned Activity Identify insects and make control recommendations when requested.

Planned Evidence of Accomplishment None

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.1.2 Detection and Documentation of Invasive Species

As with any other tropical island, Guam is extremely susceptible to environmental and economic damage by invasive species. Despite this fact, Guam's biosecurity is very weak and invasive species, many of them insects, are arriving at unprecedented rates. Bioinvasions are grossly under-reported for several reasons:

1. Professional capacity is lacking. Twenty years ago, there were 9 PhD level entomologists practising in Micronesia. Only 2 remain (Moore, Miller), despite an increased workload largely due to arrival of the cycad scale, coconut rhinoceros beetle and little fire ant and other invasive species of insects. UOG typically has 4 entomologists. We now have 2.

2. We suffer from the *taxonomic impediment*. The two remaining PhD level entomologists are generalists without the skills and resources for species determination of most insect groups. Timely and accurate species determination is a necessary first step in response to a new pest invasion.

3. There is no ongoing biological survey of Guam with the goal of establishing a baseline biodiversity inventory and detecting newly arrived invasive species. Unfortunately, CAPS surveys are usually focused on demonstrating absence of specific agricultural pests rather than detecting new invasions.

4. Even when invasive species are detected and properly identified, first island records are not documented and the information is not published in the scientific press.

In an attempt to improve this situation, I have set myself up as a *registrar* for new insect species arriving on Guam with the intent of properly documenting the ongoing bioinvasion of Guam. The procedure I am trying to establish is:

1. First detector sends me a digital image and/or specimen

2. Specimens are prepared and accessioned into the UOG insect collection

3. A fact sheet is prepared using a template for Guam New Invasive Species Alerts

4. The fact sheet is distributed to a list of stakeholders

5. Taxonomic assistance is obtained for an authoritative species determination.

6. A journal article is prepared and published in a refereed scientific journal. At this point the new geographical distribution data become available to the scientific community via the Global Biodiversity Facility (GBIF).

Although I have been able to generate about a dozen invasive species alerts over the past years, only one new island record has made it into a peer reviewed journal.

Planned Activity Continue adding to and maintaining the Guam Invasive Species Alerts fact sheet series.

Planned Evidence of Accomplishment None.

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.1.3 University of Guam Insect Collection

The UOG insect collection is a valuable reference collection for extension entomology, teaching and research. I am a member of the board of directors for the collection and I work with Dr. Ross Miller to curate and catalog this collection.

To increase my knowledge of collection management, I attend the annual meetings of the Entomological Collections Network, which are typically held in conjunction with annual meetings for the Entomological Society of America.

I have a professional goal of building an online website to share all available information on Micronesian insects. This will include specimen level information for the collection complete with digital images and literature references.

Here is a record of progress towards that goal:

1. I built a digital catalog for the collection is using the BioLink Biodiversity Information Management System from CSIRO, Australia. The catalog currently contains 29,200 specimen records. BioLink is currently being redeveloped as an open source project (http://code.google.com/p/biolink/). In am an active collaborator in this project. In July 2012 I published an article entitled *Hosting a Biolink Database in the Amazon Web Services Cloud (EC2)* on the project's wiki (http://code.google.com/p/biolink/wiki/BioLinkEC2).

2. I have built and evaluated two websites for serving information on Micronesian insect biodiversity, including specimen level data from the collection. One is a Drupal content management system template called LifeDesk provided the Encyclopedia of Life Project and the other is a similar template called ScratchPads provided by the Museum of Natural History in London. I am honored to have been selected as an advocate for ScratchPads as part of the project's Ambassadors program (http://scratchpads.eu/locate-scratchpad-ambassadors).

3. In March 2014 I travelled to Honolulu to attend the Biodiversity Collections Digitization in the Pacific workshop sponsored by the Integrated Digitized Biocollections (IDigBio). I made an oral presentation entitled *Evaluation of a Scratchpad Template as an Online Database for the University of Guam Insect Collection* [1] at this workshop.

4. In May 2014 I met with Dr. Bob Foottit at the Canadian National Insect Collection in Ottawa to discuss progress and future directions for the UOG collection. Dr. Foottit is a member of the board of directors for the UOG Insect collection.

Planned Activity

1. Continue curation and databasing of the UOG Insect Collection.

2. Continue evaluation of Specify as an online database for the UOG Insect Collection.

Planned Evidence of Accomplishment none

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.1.4 Guam Coconut Rhinoceros Beetle Project

This is currently my largest and most time consuming project.

The coconut rhinoceros beetle (CRB) was first detected on Guam in the Tumon Beach hotel area on September 11, 2007. CRB is a very serious pest of coconut palms. Adult beetles may kill coconuts and other palms when they bore into the crowns to feed on sap. When CRB invaded Palau during the Second World War, it killed about half of all coconuts through the islands and totally exterpated the coconut palm from some of them. A delimitation survey indicated that the Guam infestation was limited to Tumon Bay and the adjacent Faifai Beach. In consultation with the Guam Department of Agriculture (GDOA), USDA-APHIS, and USDA-Forest Survey, it was decided to launch an eradication project.

I wrote the original eradication plan and this was funded by USDA and local funds. USDA provided funds under the condition that the poject was to be run under an Incident Command System with the USDA-APHIS Guam Port Director as the federal commander, and the GDOA Director, or designee, as the local commander.

My original role was to provide scientific/technical support for the project, with the Guam Department of Agriculture (GDOA) providing project management with assistance from USDA-APHIS and USDA-Forest Service. However, it soon became apparent that GDOA had serious bureaucratic impediments which prevented hiring staff and procuring supplies and equipment within a reasonable time frame. The eradication project directors, with the consent of the Dean, agreed to run project staffing, procurement, and fiscal management through the University. As a result, my role expanded to include much of the project management.

In December 2013, an infestation of CRB was detected on Hickam Air Force Base on Oahu. Roland Quitugua and myself were recruited as subject matter experts and spent a week in Honolulu advising an incident command team set up by APHIS.

I have formed two collaborative research groups to do applied research aimed at controlling CRB damage. Dr. Sean Marshall and Dr. Trevor Jackson at AgResearch New Zealand collaborate with me on biological control using oryctes nudivirus (OrNV) and CRB population genetics. Dr. Matthew Siderhurst a chemical ecologist at the Eastern Mennonite University in Virginia collaborates with me on CRB trap improvement and CRB behavior.

In December 2013, an infestation of CRB was detected on Hickam Air Force Base on Oahu. Roland Quitugua and myself were recruited as subject matter experts and spent a week in Honolulu advising an incident command system (ICS) team set up by APHIS. Later, we were both added to a national technical working group (TWG) for CRB.

Early in 2015, the directors of the Western IPM Center at UC Davis asked me to help organize a meeting to prioritize applied research needs for development of CRB IPM. I co-authored an agenda and attendance list with Arnold Hara and Roland Quitugua. The meeting took place at the Hawaii Department of Agriculture on April 3, 2015 and was chaired by WIPM Center Director Kassim Al-Khatib.

Planned Activity Provide scientific/technical support to the Guam Coconut Rhinoceros Beetle Project. My focus will be on CRB-G biocontrol and monitoring health of coconut palms on Guam. For details, see the CRB Biocontrol section under Creative / Scholary / Research for details .

Planned Evidence of Accomplishment None.

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.1.5 National Plant Diagnostic Network (NPDN)

I am the UOG coordinator for the Western Plant Diagnostic Network (WPDN) wich is a regional branch of NPDN. This organization provides financial support for ANR's Plant Diagnostic Laboratory, offers First Detector Training workshops, and organizes identification workshops for important pest groups. As coordinator, I am required to organize First Detector Training workshops, attend monthly conference calls, and attend national meetings which are currently held on a 3 year cycle.

Planned Activity

1. Participate in monthly conference calls.
2. Train and certify First Detectors.
3. Prepare annual work plan and annual report.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.1.6 Guam Invasive Species Advisory Committee (GISAC)

I am an active, founding member of this informal group of Guam's biologists which meets irregularly about 6 times per year to discuss invasive species and what can be done to keep them out and mitigate the effects of those that do invade the island. I worked with Dr. Russell Campbell and Diane Vice to develop an emergency response plan for invasive species detected on Guam.

A wiki site which I built for for GISAC was quickly adopted by the Western Micronesia Regional Invasive Species Council.

Planned Activity

1. Participate in GISAC meetings.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.1.7 Public Outreach (Guest lectures, presentations, interviews)

Planned Activity Provide accurate scientific and technical information to the public as required.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.1.8 Public Outreach(Internet)

During the past decade I published a lot of content on various websites. I have evaluated several current technologies for building a web presence for the Agriculture and Natural Resources Unit and the Drupal content management system seems to be a good fit. This allows us to publish information for public access while keeping some documents private for internal use only. My print and online output are discussed in more detail in the Creative/Scholarly Activity section.

Previous to establishment of the CNAS-RE WordPress site, I maintained a website for the the UOG Cooperative Extension Service's Agriculture and Natural Resources Program at http://guaminsects.net/ANR. I frequently posted blog articles of public interest to this site. I also maintain a website at http://guaminsects.myspecies.info which is intended to facilitate sharing information on insects in Micronesia. I submit blog articles to this website which are more technical and are of interest to biologists. To see a list of my blog post on this site, visit http://guaminsects.myspecies.info/blogs/aubrey-moore.

Note that these blogs also contain posts containing information which is not intended for the public. These posts are shared with selected groups of clients and colleagues using a password authentication system.

I maintain a website for the Western Micronesia Regional Invasive Species Council (RISC) at http://www.guaminsects.net/gisac/. I attend RISC meetings whenever they are held on Guam and I make presentations at these meetings.

Planned Activity

1. Phase out use of the ANR Drupal site and move content to the new CNAS-RE WordPress Site.

2. Provide an online database of insect crop pests in Micronesia with links to images and fact sheets.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.2 Creative / Scholarly / Research (34%)

I am an insect ecologist with broad interests in biology and technology. In my current position of extension entomologist, I apply my knowledge and skills to finding real solutions to real problems caused by insects on Guam. In addition to providing extension services, I currently run four applied research programs:

1. Coconut rhinoceros beetle (CRB) biocontrol.
2. Cycad Aulacaspis scale (CAS) biocontrol.
3. Guam Insect Pest Survey.
4. Eight Spot Butterfly Conservation.

I spend significant time and effort keeping up-to-date with modern technology. I am currently using and learning about the following technologies:

1. Python programming; IPython Notebook; Django web framework; OpenCV digital image analysis software
2. Quantum GIS
3. Open Science Framework [2]
4. iNaturalist [3]
5. Git, GitHub [4]
6. LaTex, LyX, Zotero, OverLeaf
7. Raspberry Pi
8. Linux (Ubuntu)

2.2.1 Coconut Rhinoceros Beetle (CRB) Biocontrol

The 2002, the coconut palm was the second most abundent tree (DBH>5") in Guam's forests [5]. An uncontrolled outbreak of CRB is rapidly killing these trees.

CRB has been invading Pacific Islands for more than 100 years. If left unchecked, CRB has the potential to kill all of the coconut palms on an island. Tree mortality occurs when adult beetles destroy the growing tip of a palm when they bore into the crown to feed on sap. Immature beetles (grubs), which feed on decaying vegetation, do no damage. In a worst case scenario adult CRB become so abundant that they kill large numbers of palms. These dead palms become breeding sites which generate even more adult beetles which kill even more palms. This positive feedback loop may be initiated by an increased availability of CRB breeding sites in massive amounts of decaying vegetation left behind in the wake of a typhoon.

Prior to the CRB invasion of Guam, this pest was effectively controlled wherever it has established by introduction of oryctes nudivirus (OrNV) as a classical biocontrol

agent. OrNV is a selective insect pathogen which only kills rhinoceros beetles (Subfamily Dynastinae). The disease it causes spreads naturally through a population. OrNV is a positively density-dependent biocontrol agent, meaning that it attacks a higher proportion of individuals at higher population densities. After introduction of OrNV into a CRB population, damage to coconut palms drops by as much as 90% and population suppression is sustained.

Attempts to control CRB using OrNV have failed for the first time on Guam. Recent research by Sean Marshall at AgResearch New Zealand and myself indicates that Guam has been invaded by a new biotype, CRB-Guam, which is genetically distinct from other other populations of CRB and is resistant to all 8 isolates of OrNV available in cell culture. Thus we have lost the major biocontrol agent for controlling CRB on Pacific islands.

CRB-Guam has so far been detected in Guam, Hawaii, Palau, and the Port Moresby area of Papua New Guinea and this virus-resistant biotype is likely to spread further unless populations are suppressed. This is a regional problem for Pacific islands and trading partners. Unconstrained population outbreaks of CRB-Guam following typhoons will lead to high levels of local damage to palms and increased risk of accidental export of CRB-Guam to other other islands.

Mapping the geographical extent of CRB-Guam and searching for a strain of OrNV which is highly pathogenic for this biotype should be a priority. Although the Guam CRB Project has developed improved management tools for CRB, these are not sufficient to maintain CRB population levels at acceptable levels on an island-wide basis.

Planned Activity

1. Complete bioassays to recheck pathogenicity of previously tested OrNV samples from AgResearch New Zealand. This task is already included in the work plan for 2 of my grants.

2. As per an action item from the WIPM CRB IPM meeting in Honolulu, I will work with Sean Marshall (AgResearch NZ) and Maclean Vaqalo (SPC) on generating a white paper prioritizing applied research needs for CRB management.

3. I plan to attend the Pacific Plant Protection Conference as a technical rep for Guam and will make a presentation based on the white paper.

4. I will work to set up an international collaborative project with the goal of mapping the CRB-Guam biotype and finding a strain of OrNV wich can be used as an effective biocontrol agent. Potential collaborators are AgResearch NZ, SPC, Philippine Coconut Authority, and USDA. This project will have a foreign exploration component which will collect CRB and virus samples throughout the Asian/Pacific region. Genotyping and virus detection will done by AgResearch NZ. Bioassays in which CRB-Guam beetles will be challenged with virus candidates will be done in my laboratory at UOG.

5. I will set up an insect pathology lab and recruit Ian Iriarte as a graduate assistant to run bioassays. I have already applied to US Forest Service for $20K to fund this assistantship.

Planned Evidence of Accomplishment None

Planned Evaluation By

Actual Activity

1. We have gone through 4 cycles of the witch's brew bioassays and the mortality increases for each iteration. Gut samples from beetles are being sent to AgResearch NZ to test for OrNV.

2. White paper was written [6] and used as a source for the SPC fact sheet on CRB .

3. Made a presentation on CRB-G and participated in discussions on a coordinated response to CRB-G at the Pacific Plant Protection Meeting in Fiji, Sepember 2015. [7]

4. I continue working to set up an international collaborative project with the goal of mapping the CRB-Guam biotype and finding a strain of OrNV wich can be used as an effective biocontrol agent. Potential collaborators are AgResearch NZ, SPC, Philippine Coconut Authority, and USDA. This project will have a foreign exploration component which will collect CRB and virus samples throughout the Asian/Pacific region. Genotyping and virus detection will done by AgResearch NZ. Bioassays in which CRB-Guam beetles will be challenged with virus candidates will be done in my laboratory at UOG.

5. I recruited Ian Iriarte as a graduate assistant to run bioassays and have secured one year of support from my FY16 Farm Bill grant.

Actual Evidence of Accomplishment See references above.

Actual Evaluation By

2.2.2 Cycad Aulacaspis Scale Biocontrol

The 2002, fadang, *Cycas micronesica*, the most abundent tree (DBH>5") in Guam's forests [5]. An uncontrolled outbreak of CAS has killed about 90% of these trees. Note that this project is currently unfunded.

I include the following abstract as background to the problem:

Moore, Aubrey, Thomas Marler, Ross H. Miller, Lee S. Yudin. 2013. Biological Control of Cycad Scale, *Aulacaspis yasumatsui*, Attacking Guam's Endemic Cycad, *Cycas micronesica*. International Symposium on Biological Control, Pucon, Chile.

Despite attempted classical biological control with a predator and two parasitoids, greater than 90the island was invaded by the cycad aulacaspis scale (CAS), *Aulacaspis yasumatsui* (Hemiptera: Diaspididae) in 2003 (Marler and Lawrence, 2012). Prior to this invasion, *C. micronesica* was the most numerous plant in Guam's forests with a stem diameter greater than five inches (Donnegan et al. 2004). The CAS infestation was so severe that by 2006 *C. micronesica* was listed as endangered by the International Union for Conservation of Nature (Marler et al., 2006). This ecological disaster is still unfolding. Marler and Lawrence (2012) predict extirpation of wild cycads on Guam by 2019 if current trends persist.

CAS, described by Takagi (1977), is considered a minor pest of Cycas within its native Asian range (Anonymous 2006a), presumably as a result of natural biological control organisms. Outside of its native range, where CAS has escaped its natural enemies, it is a very serious pest of Cycas. This scale insect infests all parts of the plant including roots and reproductive structures. CAS is small enough to invade minute cracks and crevices where it is undetectable during quarantine inspections (Marler and Moore 2010). In the absence of chemical or biological control, infested plants become totally encrusted with multiple layers of CAS within a few months and die within a year (Anonymous 2006a). Accidental introduction of CAS to Florida in the 1990s (Howard et al. 1999) initiated subsequent invasions of the pest throughout several other states within the United States and other countries (Anonymous 2006b). In the Pacific, CAS was first detected in Hawaii in 1998, Taiwan in 2000, Guam in 2003, Rota in 2007, and Palau in 2008. The presumed pathway for this invasive species is movement of scales attached to cycads in the ornamental plant trade, although accidental, long-range movement of scale crawlers is an alternate invasion pathway.

CAS infestation on Guam progressed very rapidly. Initial detection in December, 2003 was on *Cycas revoluta* and *C. micronesica* growing in floral displays at the entrances to two of Guam's major hotels. Within a year the infestation had spread into a nearby population of wild *C. micronesica* and by 2006, the infestation was island-wide and plants had started dying in large numbers.

We observed no pre-existing natural enemies during frequent surveys of infested plants. A predator, *Rhyzobius lophanthae* (Coleoptera: Coccinellidae) and a parasitoid, Coccobius fulvus (Hymenoptera: Aphelinidae) were imported for CAS biocontrol during 2004 and 2005 (Moore et al. 2005). A second parasitoid, *Aphytis lignanensis* (Hymenoptera: Aphelinidae), was imported in 2012. The predator established rapidly. However, both parasitoids failed to establish in captivity and in the field.

About 100 *R. lophanthae*, were field collected on Maui, Hawaii in November 2004, flown to Guam and reared for one month in quarantine. Field releases on CAS- infested, wild *C. micronesica* at Ritidian Point were initiated in February 2005. The beetle established immediately and its initial population explosion peaked in the vicinity of the release site in June 2005, when we counted up to 57 adults per minute in visual inspections of infested wild *C. micronesica*. We also monitored adult beetles, scale crawlers, and male scales at Ritidian using a transect of yellow sticky cards. The resulting time series data clearly indicate collapse of the CAS population following introduction of the predator followed by establishment of a dynamic equilibrium with scale levels near the trapping detection threshold (Fig. 1). Following establishment at Ritidian, more than 7,450 laboratory reared and field collected *R. lophanthae* adults were introduced at 115 sites throughout Guam by collaborators.

R. lophanthae adults and grubs are voracious predators of CAS. Eggs are laid beneath female scale covers were first instar grubs consume the adult scale. Later instar grubs and adults feed on female and male scales. *R. lophanthae* are currently ubiquitous throughout Guam. They are preventing mortality of mature cycads from scale infestation, but residual scales on these trees are preventing vigorous growth and seed production. More importantly, even though *R. lophanthae* are ubiquitous within their habitat, all *C. micronesica* seedlings become infested with CAS and eventually die (Marler and Lawrence 2012). Thus, with no reproduction occurring, health of the *C. micronesica* population is still in decline. We offer two explanations for the partial failure of *R. lophanthae* as a biocontrol agent for CAS:

1. Marler et al. (2012) provide evidence that the *R. lophanthae* predation rate decreases near the ground. This at least partially explains why seedlings are more vulnerable to mortality from scale infestation than mature plants.

2. *R. lophanthae* is much larger than CAS and it is not able to prey on individuals living in small cracks and crevices on the plant. CAS living in refugia provide a steady stream of crawlers which rapidly repopulate external surfaces of the plant during periods of low predation.

We suggest that there is a urgent need to introduce one or more smaller biocontrol agents which are active near the ground and can follow CAS into its refugia.

Unfortunately, attempts to introduce CAS parasitoids to Guam have failed. A Chinese strain of *Coccobius fulvus* from Florida was imported and released several times starting in 2005. On each occasion, the parasitoids died out both in the field and the laboratory, probably out-competed by *R. lophanthae* (G.V.B. Reddy, personal communication). We are currently attempting to introduce *Aphytis lignanensis* (Hymenoptera: Aphelinidae) which coexists with *R. lophanthae* as a CAS biocontrol agent in Texas (Flores and Carlson 2009) and Hawaii (B. Kumashiro, personal communication). In 2012, we imported about 100 *A. lignanensis* adults from Honolulu, Hawaii. These wasps were reared from CAS infesting Cycas revoluta in a home garden. (There are no wild cycads in Hawaii.) We put these wasps in a cage containing CAS-infested *C. micronesica* leaves. We had carefully removed all visible *R. lophanthae* adults and grubs from these leaves, but there were

enough beetle eggs and first instar larvae hiding beneath scale covers to consume all scales before any adult wasps emerged. In our next attempt, we will present imported *A. lignanensis* with caged *C. revoluta* infested with CAS but without *R. lophanthae*.

Our immediate objective is to establish a biocontrol agent, in addition to *R. lophanthae*, which will provide adequately protect *C. micronesica* seedlings from CAS-related mortality so that this important endemic plant species can start to recover.

Since writing the above abstract, there has been a fortuitous (accidental) introduction of a cycad scale parasitoid to Guam. I discovered this parasitoid, which has recently been identified as *Arrhenophagus* sp., about a year and a half ago and thought that it would not be of much assistance in controling CAS when I discovered that it attacks only male scale insects. However, I may have been wrong because there is circumstantial evidence that CAS is being controlled by this parasitoid despite its sexual preference.

Planned Activity

- Evaluate the impact of *Arrhenophagus* sp. on the Guam cycad population
- Write and submit a peer-reviewed scientific journal article entitled something like *Fortuitous introduction of the parasitoid Arrhenophagus sp. to Guam and its impact on cycas aulacaspis scale, Aulacaspis yasumatsui, infesting endemic cycads, Cycas micronesica*.
- If Ron Cave is willing to collect *Coccobius fulvus* again and if APHIS approves, attempt a direct field release of this parasitoid.

Planned Evidence of Accomplishment None.

Planned Evaluation By

Actual Activity

1. Journal article not written due to lack of time.
2. Made direct releases of *Coccobius fulvus* at Ritidian in September and November 2015. *C. fulvus* has not been reared from recent leaf collections, so there is no proof that this parasitoid has established.

Actual Evidence of Accomplishment None.

Actual Evaluation By

2.2.3 Guam Forest Insect Survey

Planned Activity The objective of the proposed survey is to build a knowledgebase on insects associated with plants in Guam's forests. The survey will result in a reference collection of Guam's forest insects and a publicly available online database to facilitate sharing of specimen data, images and ecological associations among plants and insects. The knowledgebase will be usefull to natural resource managers responsible for maintaining the health of Guam's forests and to biologists trying to understand Guam's terrestrial ecosystems in the wake of major biological invasions.

Planned Evidence of Accomplishment None

Planned Evaluation By

Actual Activity

1. McIntire Stennis FY2015 Annual Report [8, hard copy provided]

Actual Evidence of Accomplishment Please refer to the above reference.

Actual Evaluation By

2.2.4 Eight Spot Butterfly Conservation

Larval host plants of this rare butterfly are heavily browsed by ungulates and many areas where they exist are being cleared for military buildup and associated development projects. Although there have been several recent surveys *H. o. marianensis* and its host plants, no work has been done towards establishing captive and managed populations of *H. o. marianensis* and its host plants.

This project will investigate the feasibility of rearing and breeding *H. o. marianensis* on host plants in cages and also in field sites where ungulates are excluded. The establishment of captive breeding colonies and managed populations of this rare butterfly will reduce risk of extinction.

Planned Activity

1. Propagate and maintain at least 100 plants of each of the eight-spot's known host plants, Procris pendunculata and Elatostema calcareum in a plant nursery.
2. Establish a self-sustaining, caged, breeding colony of eight-spot butterflies using 30 field-collected caterpillars reared on plants from the nursery.
3. Propagate host plants throughout two 10 x 10 meter, wooded limestone areas at the University of Guam's Agricultural Experiment Station in Yigo.
4. Release 60 cage-reared eight-spot butterflies and larvae on protected host plants.

Planned Evidence of Accomplishment None.

Planned Evaluation By

Actual Activity

1. Twelve *Procris* plants were collected and propogated by Lauren Guttierez. These plants were delivered to the Yigo Ag. Expt. Stn. and were immediately attacked by Cuban slugs. Prior to this observation, introduced slugs were not considered as serious competitors for 8-spot butterfly host plants.
2. A contract was written to support Lauren Guttierez as a collaborator on the project. Guttierez's role is to collect and propogate host plants. Due to beaurocratic delays, the contract has not yet been signed by UOG.
3. In November 2015, Hypolimnus octocula marianensis was list by the US Fish and Wildlife Service as an endangered species. A permit is now required to perform scientific work aimed at conserving this species. A permit application has been written [9].

Actual Evidence of Accomplishment Surviving *Procris* plants are growing in front of ALS105.

Actual Evaluation By

2.3 University and Community Services (15%)

2.3.1 Instruction

In addition to my job as an extension entomologist, I am required to teach a four credit course every year.

Planned Activity

1. I will teach General Entomology AG/BIO-345 during the Fall 2015 term. This is a 4 credit course consisting of 2 lectures per week plus a 3 hour lab session.
2. I plan to have Ian Iriarte as my first masters student in the EV program.

Planned Evidence of Accomplishment

None.

Planned Evaluation By

Actual Activity

1. I taught General Entomology AG/BIO-345 during the Fall 2015 term.
2. I reccruited Ian Iriarte as my first masters student in the EV program and secured support for his first year from my FY2016 Farm Bill grant (CRB-G Biocontrol).

Actual Evidence of Accomplishment

1. Syllabus for General Entomology AG/BIO-345. [10]
2. Web site for General Entomology AG/BIO-345 (static web site built using Pelican) [11].
3. Student evaluation for General Entomology AG/BIO-345.

Actual Evaluation By

2.3.2 Service as a Reviewer

Planned Activity none

Planned Evidence of Accomplishment none

Planned Evaluation By

Actual Activity

1. Acted as external examiner for master's student John Tuivavalagi, University of Queensland. I was an external examiner of his thesis entitled *Investigating the impacts of the natural enemy Trichogramma chilonis Ishii on populations of Crocidolomia pavonana in Samoa. [12]*

2. September 2015: I acted as peer reviewer for Public Library of Science (PLoS) manuscript PONE-D-15-29086R1 **Insect Biometrics: Optoacoustic signal processing and its applications to remote monitoring of McPhail type traps.** submitted by Ilyas Potamitis.

3. July 2016: I acted as peer reviewer for Journal of Medical Entomology manuscript JME-2016-0177 **2D optoacoustic sensors embedded in mosquito insectary cages report species identity through wingbeats.** submitted by Ilyas Potamis et al. [13]

Actual Evidence of Accomplishment See references above.

Actual Evaluation By

2.3.3 University Technical Advisory Committee

Planned Activity I will continue to serve on UTAC as the representative for the College of Natural and Applied Sciences.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity I continue to serve on UTAC as the representative for the College of Natural and Applied Sciences.

Actual Evidence of Accomplishment

Actual Evaluation By

2.3.4 Faculty Building Facilities Committee for the ALS

Planned Activity None. This is an unplanned activity.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

1. I became chair of this committee when Dr. Laura Biggs left during 2015.
2. Documented air conditioning problems, especially exessively high humidity (>60% RH) and met with Dr. Rachel Leon Guerrero and Jesse Rosario to discuss possible solutions
3. Procured a large screen HDTV for the teaching lab (ALS 124) (Thanks to Jim Hollyer for help with this)
4. Installed Internet cable to provide sufficient bandwidth for streaming video (Thanks to Rudy Magallanes for help with this)
5. Organized clean up of the teaching lab following the Fall 2015 semester.
6. Compiled recommendations for improving the ALS 124 as a science teaching environment.

Actual Evidence of Accomplishment

1. Recommendations for improving the ALS 124 as a science teaching environment [14] and obtained a quote for installation of audiovisual equipment.

Actual Evaluation By

3 Publications and Grants

3.1 Publications and Other Media Produced During The Review Period

3.1.1 Peer Reviewed Journal Articles

1. Moore et al. 2015. Coconut rhinoceros beetles (Coleoptera : Scarabaeidae) develop in arboreal breeding sites in Guam. Florida Entomologist 98(3) 1012-1014. [15]

2. Moore et al. 2016. Movement of packaged soil products as a dispersal pathway for coconut rhinoceros beetle, Oryctes rhinoceros (Coleoptera:Scarabaeidae) and other invasive species. Proceedings of the Hawaiian Entomological Society [In press]. [16]

3. Moore et al. 2016. Judas beetles: Discovering cryptic breeding sites by radio-tracking coconut rhinoceros beetles, *Oryctes rhinoceros* (Coleoptera: Scarabaeidae). Journal of Environmental Entomology [Submitted] [17]

3.1.2 Fact Sheets

1. Vaqalo, M., Marshall, S., Jackson, T., & Moore, A. (2015). An emerging biotype of coconut rhinoceros beetle discovered in the Pacific (Pest Alert No. 51) (p. 2). Secretariat of the Pacific Community. [18]

2. Moore, A. (2015). The new Pacific pests and pathogens app. In Pacific Pest Detector News 23. [19]

3.1.3 Presentations

3.2 Grant Proposals Submitted During the Review Period

1. USDA-Aphis Biocontrol Program: *Oryctes nudivirus for biocontrol of the Guam biotype of the coconut rhinoceros beetle.*; $20,000 requested; Not funded; Proposal[20]

2. 2015-16 USDA Farm Bill: *Oryctes nudivirus for biocontrol of the Guam biotype of the coconut rhinoceros beetle*; $120,000 requested; $100,000 awarded; Work plan [21]

3. US Forest Service: *Detector Beetles: Radio-Tracking Coconut Rhinoceros Beetles (CRB) to Discover Breeding Sites and CRB Biocontrol;* $40,000 requested; $40,000 awarded; Proposal [22]

4. McIntire-Stennis

5. Dean's 2016 High-impact Project Pool Competition: *Coconut rhino beetle as a transmission vector for Tinangaja disease.;* $39,911 requested; ???? awarded; Proposal [23]

6. US Fish and Wildlife Service FY2016 (funds passed through GDOA-DAWR via an MOU): *Establishment of Captive and Establishment of Captive and Managed Populations of Mariana Eight-spot Butterfly*;$18,000 requested; $18,000 awarded; Work Plan [24]

3.3 Grants Awarded During the Review Period

Indicated above.

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