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

Comprehensive Faculty Evaluation System

Annual Report
June 15, 2015 - June 14, 2016

Aubrey Moore

July 29, 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 2015 - May 2016

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 The number of extension calls requiring my assistance during the reporting year averaged approximately three per day.

During this reporting year, my USDA-APHIS cooperator workload was very high because the Guam Territorial Entomologist retired and there was a campaign to intercept pests arriving with the Pacific Festival of the Arts.

Actual Evidence of Accomplishment

- Insect diagnostic cases documented as iNat observations: [1]
- Press stories on flies discovered in nipa leaves imported from the Philippines for FestPac: [2, 3, 4, 5, 6]
- On May 26, 2016 I wrote a press release +=with Olympia Terral, intended to highlight cooperation among GCQA, Guam Agriculture, USDA-APHIS, and UOG: [7]
- Press stories triggerred by the above press release: [8][9]

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

1. Added a page to the CNAS-RE web site which links to the Guam Invasive Species Alerts fact sheets. [10]

2. Prepared a fact sheet for Vespa tropica. [10]

Actual Evidence of Accomplishment References provided above.

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* [11] 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 Continue curation and databasing of the UOG Insect Collection.

Planned Evidence of Accomplishment none

Planned Evaluation By

Actual Activity

1. I have begun evaluating Specify as an online database for the UOG Insect Collection. iDigBio recommends Specify as the online collection database of choice for small biological collections.

2. Whenever, taxonomists visit Guam, I recruit their expert help to improve the collection. Dr. Mary-Liz Jamison and Dr. Josh Dunlap visited during January 14-16, 2016 and worked on the scarab beetles. Dr. Peter Maddison visited Guam June 23-29, 2016 and put together a synoptic collection of common insects using specimens collected by students.

Actual Evidence of Accomplishment none

Actual Evaluation By

2.1.4 Guam Coconut Rhinoceros Beetle Project

Planned Activity 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 recruitedlthough I have amm 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. I built and maintain an online, full-text bibliographic for use by the TWG at \url{http://guaminsects.myspecies.info/CRB_biblio}.

Frequent requests for scientific/technical information from the ICS, TWG and Hawaii Department of Agriculture (several queries per week) has significantly increased my workload over the past several months.

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 Evidence of Accomplishment None.

Planned Evaluation By

Actual Activity

1. Discovery of arboreal breeding of CRB on Guam
   a) Refereed journal article published [12, HARD COPY PROVIDED]
   b) Prepared press release and web post with Olympia Terral [13]
   c) Press articles : [14, 15, 13]
2. Radio-tracking CRB to find cryptic breeding sites:
   a) Referred journal article submitted [16]
   b) Press release
3. Discovery of the CRB-Guam biotype
   a) Whitepaper prepared as requested by the Western IPM Center [17]
   b) Discovery of the CRB-Guam biotype announced at a Society for Invertebrate Pathology meeting [18]
   c) Fact sheet on CRB-G prepared for SPC [19]
4. Movement of packaged soil as a dispersal pathway for coconut rhinoceros beetles.
   a) Refereed journal article submitted and accepted [20]
   b) Press release and web article prepared with Olympia Terral [21]
   c) Press articles generated: [22, 23, 24]

Actual Evidence of Accomplishment References provided above.

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. WPDN publishes newsletters for First Detectors, including the Pacific Pest Detector to which I occasionally contribute .

Planned Activity

1. Participate in monthly conference calls.
2. Train and certify First Detectors.
3. Attend the NPDN National Conference in Washington, D.C., March 8-12, 2016.

Planned Evidence of Accomplishment None.

Planned Evaluation By

Actual Activity

1. Participated in monthly conference calls.
2. Submitted an article to the Pacific Pest Detector Newsletter [25].
3. Trained and certified students as First Detectors via a module in my Fall 2015 AG/BI 345 course.
4. Attended the NPDN National Conference in Washington, D.C., March 8-12, 2016.

Actual Evidence of Accomplishment References provided above.

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 None.

Planned Evaluation By

Actual Activity

1. Participated in GISAC meetings.

Actual Evidence of Accomplishment None.

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 None.

Planned Evaluation By

Actual Activity During the reporting period I was interviewed numerous times by newspaper reporters, radio talk show hosts, and television news reporters. Most, but not all involved questions about the Guam coconut rhinoceros beetle and other invasive species issues. I helped to produce several fact sheets and articles for public print media.

Actual Evidence of Accomplishment

1. A Google news archive search for pages containing "Aubrey Moore" and "Guam" posted between June 15, 2015 and June 14, 2016 returned 23 results. [26]

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.

I maintain a website for the the UOG Cooperative Extension Service's Agriculture and Natural Resources Program at \url{http://guaminsects.net/ANR}. I frequently post blog articles of public interest to this site (Table \ref{blog-table}). I also maintain a website at \url{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 \url{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.

\input{blog-table}

\section{Regional Collaboration }

\subsection{Regional Invasive Species Council Website}

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

Planned Activity

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.2 Creative / Scholarly / Research (34%)

In addition to meeting the objectives of my current grants (Section 3.2), I plan to work towards finding solutions to two severe pest invasions impacting Guam: coconut rhinoceros which threatens to kill most of Guam's coconut palms and cycad aulacaspis scale which has already killed 90% of Guam's endemic fadang plants. Given that a 2003 US Forest Service survey listed fadang as the most abundant tree (DBH $>$ 5 inches) in Guam's forests and coconut as the second most abundant plant, loss of these trees should be considered as an ecological disaster.

2.2.1 Coconut Rhinoceros Beetle Biocontrol

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

- 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.
- 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.
- 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.
- 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.
- 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

Actual Evidence of Accomplishment

Actual Evaluation By

2.2.2 Cycad Aulacaspis Scale Biocontrol

I include the following abstract as background:

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

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.2.3 Guam Forest Insect Survey

Planned Activity

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

1. McIntire Stennis FY2015 Annual Report [27, hard copy provided]

Actual Evidence of Accomplishment

Actual Evaluation By

2.2.4 Eight Spot Butterfly Conservation

Planned Activity

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.2.5 Presentations at Professional Meetings

Planned Activity

- I plan to participate in the NPDN national meeting in Washington DC in March 2016. My grant requires attendance at this meeting.
- I have been invited to make a presentation on CRB in a symposium at the International Congress of Entomology to be held in Florida, September 2016.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.2.6 Technical Reports Documenting Applied Research in Support of of the Guam Coconut Rhinoceros Beetle Project

Planned Activity

- I will continue to add to the collection of tech reports.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.2.7 Guam New Invasive Species Alerts

Planned Activity

- I will continue to add to the collection of Guam New Invasive Species Alerts.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

Actual Evaluation By

2.2.8 Referreed Scientific Journal Articles

Planned Activies Priority topics for journal article preparation include:

- Discovery of coconut termite on Kosraie
  - Fish gill netting for controling CRB
  - CRB trap improvement: solar-powered LEDs, mark-release-recapture, etc.
  - *Fortuitous introduction of the parasitoid Arrhenophagus sp. to Guam and its impact on cycad aulacaspis scale, Aulacaspis yasumatsui, infesting endemic cycads, Cycas micronesica*
  - Scientific notes documenting new island records.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

- My heavy workload does not leave much time for writing journal articles, especially during terms in which I am required to teach.

Actual Evidence of Accomplishment

Actual Evaluation By

Web Sites Designed and Maintained by Me For the past several years, I have been searching for the "right" technology for providing on-line extension information. The features I want include:

- Ease of use, including immediate, on-line editing, so that colleagues and collaborators can create content
- Ability to display digital images at several resolutions
- Full text search
- Methods for handling on-line and offline references
- Fine grained security which protects client confidentiality and allows for both protected, internal and public information sharing

My current technology of choice is Drupal, a free, open source contents management system.

ANR Web Site Home page: http://guaminsects.net/anr
This Drupal site is intended to facilitate sharing both internal and external information generated by the Agriculture and Natural Resources Unit of the University of Guam Cooperative Extension Service. This site is currently being used heavily by the Guam CRB Eradication Project. I also use this site for documenting ny diagnostics work. I provide a recent example web page documenting discovery of thrips in anthurium flowers.

Insects of Guam Web Site Home page: http://guaminsects.myspecies.info
This Drupal site is being evaluated for sharing information on Micronesian insects. Information will include include specimen level information from the UOG insect collection complete with digital images and literature references. It was built using a template developed by the Scratchpad project http://scratchpads.eu/ is sponsored by the European Institute of Distributed Taxonomy (EDIT) and the Natural History Museum in London . The ScratchPad project is celebrating the International Year of Biodiversity by highlighting a different Scratchpad taxon every week. I was honored to have one of my pages, describing the indigenous bug, *Leptocoris vicinus*, highlighted during the week of April 18 to 24, 2010.

Micronesia Biosecurity Plan Review Web Site Home page: MBP.GuamInsects.net
This is a secure, private Drupal site developed to facilitate sharing information among those reviewing the Micronesia Biosecurity Plan.

Moodle Site for my AG 109 Insect World Course Home page: http://campus.uogdistance.com/course/view.php?id=286
This site was my first experence with Moodle, a content management system designed for teachers. I originally built it to provide on-line resources for my students, but later

decided to open a few wikis to promote collaboration on laboratory exercises. I also kept track of grades using Moodle. Examples from this site include the course resource page (Evidence 2.5.3a; available on-line at http://campus.uogdistance.com/mod/resource/view.php?id=7349) and a small PHP program I wrote to facilitate printing pinned insect specimen labels (Evidence 2.5.3b; available on-line at http://tinyurl.com/insect-labels).

Knowledgebase Wiki for the UOG Cooperative Extension Home page: http://www.guaminsects.net/uogces/kbwiki/index.php
This was my first attempt at building an extension website to facilitate collaborative content creation. Digital copies of all of ANR's pest fact sheets can be found on this site. There is also a list of insect pests found on all major crops grown in Micronesia. I stopped maintaining this site in May, 2009 because the ANR site built with Drupal has more of the features I need.

Western Micronesia Regional Invasive Species Council Wiki Home page: http://www.guaminsects.net/gisac/index.php
Originally built for the Guam Invasive Species Advisory Council, this site was quickly adopted fo sharing regional information on invasive species by the Western Micronesia Regional Invasive Species Council.

Guam Insects Blog Site Home page:http://blog.guaminsects.net/
I ran into recurring technical problems with this site which uses the WordPress content management system and have more or less abandonded development and maintenance.

Life Desk Site for Micronesian Insects Home page: http://micronesianinsects.lifedesks.org/
This site uses a Drupal template being developed by the Encyclopedia of Life Project. I evaluate it for sharing information on Micronesian insects, but decided that the Scratchpad template (number 2, above) had a better feature set for what I wanted to do.

Planned Activity

- Some of my web sites are down following a recent malicious hack attack. I will fix these.
- When I am given adequate access to the the official UOG Extension web site I will start using it and I will start migrating content from my older sites.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

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

- 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.
- I plan to have Ian Iriarte as my first masters student in the EV program.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity website

Actual Evidence of Accomplishment

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. [28]*

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. [29]

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

Actual Evidence of Accomplishment

Actual Evaluation By

2.3.4 Faculty Facilities Committee for the Agriculture and Life Sciences Building

Planned Activity None. This is an unplanned activity.

Planned Evidence of Accomplishment

Planned Evaluation By

Actual Activity

Actual Evidence of Accomplishment

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. [12]

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]. [20]

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] [16]

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. [19]

2. Moore, A. (2015). The new Pacific pests and pathogens app. In Pacific Pest Detector News 23. [25]

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[30]

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 [31]

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 [32]

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 [33]

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 [34]

3.3 Grants Awarded During the Review Period

Indicated above.

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