CFES Report 2020-2022

Aubrey Moore, Ph.D.
Professor / Extension Entomologist

May 14, 2022

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

Comprehensive Faculty Evaluation System (CFES)

Your name: Aubrey Moore

Your current Rank and Step: Professor

This CFES/POW evaluation period: June 15, 2020 – June 15, 2022

Role Assignments	**Percent of Time**
Extension & Outreach	51% (primary focus must be a minimum of 50%)
Creative/Research/Scholarly	34%
Instruction	0%
University Service	15%
TOTAL	100%

Please list any outside consulting or paid board activities for this performance period:
None.

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.

Signature of Faculty Date:

_____
Signature of Associate Dean Date:

_____
Signature of Dean/Director Date:

Contents

add Guam beekeeper presentation

1 Preface

I was hired by the University of Guam on October 1, 2003 under a limited-term, split appointment (50% extension and 50% research). On June 26, 2008, I started a tenure-track appointment as extension entomologist (100% extension) with the academic rank of assistant professor. At the end of the 2012 fall term I applied for tenure and promotion to associate professor and received both in 2013. At the end of 2018 fall term I applied for promotion to full professor and was promoted on July 11, 2019.

I work within the Agriculture and Natural Resources Unit of the University of Guam Cooperative Extension Service. I am a faculty member of the Environmental Science Graduate Program and a member of the Western Pacific Tropical Research Center.

This report documents my activities during the period spanning June 15, 2020 to the present date.

My current faculty role allocation is as follows:

- 51% Extension and Community Activities
- 34% Creative/Scholarly Activity or Research
- 15% University and Community Service

Note to Reader:

This most recent version of this report is available as a PDF format which can be downloaded from https://github.com/aubreymoore/CFES2020-22/raw/main/CFES2020-22.pdf.

If you are reading the PDF version of this report on a device connected to the internet, you will be able to follow hypertext links to documents I have referenced.

2 Extension and Community Activities

2.1 Insect Diagnostic Services

2.1.1 Description

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 agencies, federal agencies, and UOG 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 and define the problem.

2.1.2 Activities

The number of extension calls requiring my assistance averaged approximately one per day during the reporting period. Many of these are documented as postings to iNaturalist **moore_inat_since_2020-06-15**.

2.1.3 Plans

I plan to continue providing insect diagnostic services.

2.1.4 References

moore_inat_since_2020-06-15 Aubrey Moore. *Observations posted on iNaturalist by Aubrey Moore between June 15 2020 and June 15 2022*. 2022. URL: https://www.inaturalist.org/observations?d1=2020-06-15&place_id=any&user_id=aubreymoore&verifiable=any.

2.2 Detection and Documentation of Invasive Species

2.2.1 Description

Invasive insects are arriving on Guam at a very high rate (estimates range as high as one new species per day). Very few of these are detected and even fewer are identified because Guam suffers from the taxonomic impediment. Even when reliable species determinations are made, new island records are only rarely documented in the scientific press. Thus, impacts of invasive insects on Guam and elsewhere in Micronesia are grossly underestimated. One of my professional goals is to work towards solving this problem by increasing the detection rate, getting specimens identified by qualified taxonomists, and publishing new island records in the scientific literature.

2.2.2 Activities

iNaturalist was used to document new records for insects detected in Guam and other Micronesian Islands **inatSearch20220327**. Four new island records for insects in Micronesia were documented in iNaturalist posts during the reporting period **inat108690775**; **inat103065598**; **inat57656025**; **inat48501627**.

2.2.3 Plans

I will continue to document new island records of insects detected in Micronesia.

The International Union for Conservation of Nature (IUCN-ISSG) is building a Global Register of Introduced and Invasive Species. I have volunteered to coordinate building a check list for species on Guam.

The Guam Invasive Species Council is required to maintain a list on invasive species on Guam. I have volunteered to be "registrar" for this list.

2.2.4 References

inatSearch20220327 Aubrey Moore. *Search for new island records documented in iNaturalist since June 1, 2020 by Aubrey Moore*. 2022. URL: https://www.inaturalist.org/observations?created_d1=2020-06-01&place_id=any&q=new&user_id=aubreymoore&verifiable=any.

inat108690775 Aubrey Moore. *Suspected first island record for a whitefly infesting Euphorbia cyathophora on Guam*. Mar. 16, 2022. URL: https://www.inaturalist.org/observations/108690775.

inat103065598 Aubrey Moore. *First island record for a Icerya imperatae infesting napier grass on Guam*. Dec. 14, 2021. URL: https://www.inaturalist.org/observations/103065598.

inat57656025 Aubrey Moore. *First island record for Pericyma cruegeri attacking flame trees on Tinian*. Aug. 26, 2020. URL: https://www.inaturalist.org/observations/57656025.

inat48501627 Aubrey Moore. *First record for Xanthodes transversa attacking okra in Palau and Micronesia*. June 3, 2020. URL: https://www.inaturalist.org/observations/48501627.

2.3 University of Guam Insect Collection

2.3.1 Description

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.

In 2018 I ported the digital catalog for the UOG Insect Collection from a CSIRO BioLink database to a more modern web-based Symbiota database which is publicly available online **moore_scan_2018**. I also established an internship to train entomology students how to curate an institutional insect collection and how to add specimen images to the digital

catalog**moore_internship_2018**. However, this work came to a halt because of space limitations.

Facilities provided for the UOG insect collection are very poor. It is literally *moth balled* in a small storage room which is too small for essential equipment such as microscopes and cameras. Curation and digitization necessitates removing specimens from the collection and transporting them outdoors to a lab where there is working space and equipment.

2.3.2 Activities

No significant progress on curation and digitization of the collection has taken place recently because of space limitations.

2.3.3 Plans

In 2019 I submitted a proposal for support of the UOG Insect collection as part of the Biorepository Component of the EPSCOR grant **moore_university_2019**. EPSCOR has recently offered up to $10k in support of the collection. I intend to use this money to temporarily solve the space limitation issue by installing a door to allow access to bench space in the adjoining ANR lab. We already have a quote for this work.

When the space problem has been solved, I intend to re-established the UOG insect collection internship to train entomology students how to curate an institutional insect collection.

2.3.4 References

moore_scan_2018 Aubrey Moore. *SCAN University of Guam Insect Collection Collection Profiles*. 2018. URL: http://scan-bugs.org/portal/collections/misc/collprofiles.php?collid=180 (visited on 08/23/2018).

moore_internship_2018 Aubrey Moore. *Internship: University of Guam Insect Collection Technician*. 2018. URL: https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/internship.pdf.

moore_university_2019 Aubrey Moore and Christian Cayanan. "University of guam insect collection / UoG insect collection internship summer 2019". In: (July 2019). tex.publisher: OSF. URL: osf.io/qymrt.

2.4 Mitigation of Damage to Guam's Ecosystems by Invasive Species

Guam's ecosystems are rapidly being degraded by invasive species. These include:

- **Brown treesnake** which has extirpated Guam's forest birds, causing the loss of ecosystem services they provided, such as seed dispersal, insect control and pollination.
- **Cycad aulacaspis scale insect**, ACS, which has killed more than 90% of Guam's endemic cycads, known locally as *fadang*. Fadang went from being the most abundant plant in Guam's forests in 2002 to being listed as an endangered species in 2015.
- **Coconut rhinoceros beetle**, CRB, which is killing coconut palms and palma brava throughout the island. These two palm species where the second and third most abundant trees in Guam's forest in 2002.

Clearly, an ecological disaster is happening on Guam, especially in forest ecosystems. As an extension entomologist, I am tasked with providing solutions to problems caused by insect pests. Unfortunately, there are no known methods for effectively controlling CAS and CRB on Guam. Therefor, I spend much of my time and effort performing applied research in an attempt to adequately control CAS and CRB so that restoration of Guam's forests can be attempted.

2.4.1 Activities

Applied research is reported in the Creative/Research/Scholarly: section 3.2 for CRB and section 3.5 for CAS.

2.4.2 Plans

I plan to continue providing control recommendations for invasive insect species when control methods are available.

I will continue with applied research on CAS and CRB in an effort to mitigate the major damage being done by these pests.

2.5 National Plant Diagnostic Network (NPDN)

2.5.1 Description

I serve as the UOG Coordinator for the National Plant Diagnostic Network.

2.5.2 Activities

Participated in monthly conference calls.

Prepared an annual work plan and budget **moore_western_2021**.

2.5.3 Plans

I will continue to act as UOG coordinator for WPDN.

2.5.4 References

moore_western_2021 Aubrey Moore. *Western Plant Diagnostics Network: FY2022 Work Plan and Budget*. May 12, 2021. URL: https://github.com/aubreymoore/WPDN/raw/main/WPDN%202021-2022%20workplan%20and%20budget.pdf.

2.6 Guam Invasive Species Advisory Committee (GISAC) and Guam Invasive Species Council (GISC)

I am a founding member and regular participant in GISAC. President Underwood delegated me to represent UOG as a voting member of GISC

and President Krise has reconfirmed my delegation.

2.6.1 Activities

I participated in GISAC and GISC meetings.

2.6.2 Plans

I plan to continue as an active member of GISAC and GISC.

I plan to participate in a review of the Guam Invasive Species Management Plan.

2.7 Public Outreach: Radio and Newspaper

moore_guam_2019-1 Aubrey Moore. *Guam NewsTalk Radio K57: Man, Land and Sea Program: Invasive Species on Guam*. June 27, 2019. URL: https://www.facebook.com/guam.biosec/posts/thanks-to-dave-duenas-of-man-land-and-sea-for-hosting-us-on-k57-tonight-90-minut/420937051832311/.

moore_letter_2019 Aubrey Moore. "Letter: Invasive species causing ecological disaster". In: *Pacific Daily News* (Feb. 24, 2019). URL: https://www.guampdn.com/story/opinion/2019/02/24/invasive-species-causing-ecological-disaster-letter/2957267002/ (visited on 02/26/2019).

moore_radio_2018 Koro Vaka'uta. *Radio New Zealand Interview: Viral control wanted for Coconut Rhinoceros Beetle*. In collab. with Aubrey Moore. Aug. 8, 2018. URL: https://www.radionz.co.nz/international/programmes/datelinepacific/audio/2018657196/viral-control-wanted-for-coconut-rhinoceros-beetle (visited on 08/22/2018).

moore_special_2018 Aubrey Moore. "Special Report for Guam Invasive Species Awareness Week: Invasive Species are a Crisis for Guam and the Pacific, Right Now". In: *Pacific Island Times* (Feb. 25, 2018). URL: https://www.pacificislandtimes.com/single-post/2018/02/25/Special-Report-Invasive-species-are-a-crisis-for-Guam-and-the-Pacific-right-now (visited on 08/25/2018).

2.8 Public Outreach: Internet

Since the 1990s, I have built and maintained web sites to facilitate sharing information about insects in Micronesia. I created a wiki site to serve as an index to web resources I have developed (Available at https://guaminsects.net/aubwiki2020). I will continue to use web sites to facilitate sharing information on Guam's insects.

2.9 Public Outreach: Presentations

moore_biological_2021; **moore_how_2021**; **moore_presentation_2021** **grasela_preliminary_2022** **moore_invasive_2022**

2.9.1 References

moore_biological_2021 Aubrey Moore. "Biological Invasion of Guam's Forests". Guam Soil and Water Conservation Districts 2021 Educator's Symposium: Healthy Forests, Healthy Communities. Guam, July 30, 2021. URL: https://aubreymoore.github.io/albi345-slides/SWCD-2021-07-30/.

moore_how_2021 Aubrey Moore. "How Bad is Guam's Invasive Species Problem?: A Global Perspective". Marianas Terrestrial Conservation Conference. Guam, 2021. URL: https://aubreymoore.github.io/top-10-most-costly-ias-mtcc/.

moore_presentation_2021 Aubrey Moore. "Presentation: Using harmonic radar to track the greater banded hornets to their nests so that they can be destroyed". Guam Beekeepers Association Meeting. Jeff;s Pirates Cove, Ipan,Guam, Dec. 2021.

grasela_preliminary_2022 James J. Grasela and Aubrey Moore. "Preliminary efforts to establish a continuous coconut rhinoceros beetle (CRB) cell line (*Oryctes rhiniceros*) (Coleoptera: Scarabaeidae)". 2022.

moore_invasive_2022 Aubrey Moore. "The Invasive Species Problem on Guam". Western Plant Diagnostics Network Annual Meeting. Davis, California, Apr. 2022. URL: https://aubreymoore.github.io/WPDN2022/.

2.10 Public Outreach: Miscelleaneous

moore_what_2022

2.10.1 References

moore_what_2022 Aubrey Moore. "What are the five worst invasive species on Guam that are likely to spread to other Micronesian islands? Submitted to the Micronesian Forester Newsletter." Apr. 2, 2022. URL: https://github.com/aubreymoore/guam-ias-bolo/raw/master/newsletter-submission.pdf.

2.11 Public Outreach: Public GitHub Repositories

I attempt to provide access to as much of my work as possible using public GitHub repositories. GitHub is a free service for backing up and sharing documents on the web. Repositories which I have updated during the reporting period are listed in Table 1. Somewhere near the top of this list you will find a link to a repo called **CFES2020-22**. This repo contains the this document and all previous versions of the document.

I also use GitHub pages for serving static websites. A couple of good example sites are one which I created for my ALBI345 General Entomology course and one which is a List of Insects and Mites Attacking Crops in Micronesia.

Table 1: List of GitHub repositories updated after 2020-06-15.

updated	repo
2022-03-29	data-mining-insects-of-guam
2022-03-28	CFES2020-22
2022-03-27	Tinian-CAS
2022-03-24	Tinian-cycad-images
2022-03-23	CAS
2022-03-16	Cave-micrographs-2022-03-16
2022-03-13	treevibes
2022-03-13	CAS-biocontrol-seminar
2022-02-27	IAS-BOLOs-based-on-Hawaii-NPAs
2022-02-27	sticky-trap-image-analysis
2022-02-16	Harmonic-Radar
2022-02-13	guam-ias-bolo
2021-12-17	McIntire-Stennis
2021-12-11	inat_labels
2021-12-09	CRB-PPA19-Final
2021-12-07	crb-diet-experiment-2021
2021-12-07	Guam-CRB-Damage-Map-2021-08
2021-12-06	ALBI-345
2021-12-04	FY19-PPA-Report-1
2021-12-03	bug-soup
2021-11-28	CRB-Action-Group-Webinar-2021-11-23
2021-11-27	aubreymoore
2021-11-26	Guam05
2021-11-21	MCC-trap
2021-11-14	albi345-slides
2021-10-24	github-repos-bibtex
2021-10-21	SWDC-2021-07-30
2021-10-19	aubrey_nikola_test
2021-10-13	pyzotero

Continued on next page

Table 1: List of GitHub repositories updated after 2020-06-15.

updated	repo
2021-10-12	GGI-Linux
2021-09-28	SUMMA21
2021-09-22	lecture-mimicry
2021-09-20	lecture-insect-chemical-ecology
2021-09-16	open_pos
2021-09-08	groupImg
2021-09-06	mydemo
2021-08-29	InsectWingbeat
2021-08-21	Guam-CRB-damage-map
2021-08-16	InsectWingbeatWaveforms
2021-08-08	wingbeat
2021-08-06	USFS-Suggestions-2021
2021-07-28	CRB-Import-Permit
2021-07-22	Pachodynerus
2021-07-22	WPDN
2021-07-13	cas-biocontrol
2021-06-17	cycad-scale
2021-06-16	wiki
2021-06-14	2020-FS-CRB-biocontrol-project
2021-06-09	top-10-most-costly-ias-mtcc
2021-05-24	Guam-CRB-Damage-Map-2021-05
2021-05-24	worlds-most-costly-ias-on-guam
2021-05-18	roadside
2021-04-24	Guam-CRB-Damage-Map-2021-03
2021-04-14	CRB-Project-Update-2021
2021-03-29	crb-roadside-slides
2021-03-22	online-learning-course
2021-03-22	CRB-PPA19-Report3
2021-03-18	CRB-Action-Group-Webinar-2021-03-17

Continued on next page

Table 1: List of GitHub repositories updated after 2020-06-15.

updated	repo
2021-03-13	University-of-Guam-Insect-Collection
2021-02-21	CRB-CNMI
2021-02-16	2020-DOI-CRB-Biocontrol
2021-02-02	bts-mosquitoes
2021-01-27	Guam-CRB-damage-map-2020-12
2021-01-13	crb-roadside-impact-report
2021-01-12	GGI-odonata
2020-12-19	testhtml
2020-12-10	CRBG-action-group-webinar-20201209
2020-12-01	py4web-crb-app
2020-11-24	CRB-Damage-Survey-Validation
2020-11-23	new-crb-damage-map
2020-11-13	Guam-CRB-damage-map-2020-10
2020-11-02	USAPI-Mosquito-ID
2020-10-15	Guam01
2020-09-17	roadside-article
2020-09-12	roadside-spatialite
2020-09-04	PDF_to_Reveal
2020-08-23	CRB-Damage-Detection
2020-07-10	Leo-Palace-Traps
2020-07-06	qgiswebmap
2020-07-01	Guam-Corona-Virus-Data
2020-06-25	CRB-trap-improvement
2020-06-21	temp

3 Creative/Scholarly Activities or Research

3.1 Peer Reviewed Publications

siderhurst_effects_2021; **barrera_electron_2021**; **marshall_production_2021** **cave_biological_2022** **moore_detecting_2022**

siderhurst_effects_2021 Matthew S. Siderhurst, Aubrey Moore, Roland Quitugua, and Eric B. Chang. "Effects of Ultraviolet Light and Pheromone Release Rate in Trapping Coconut Rhinoceros Beetles, Oryctes rhinoceros (Coleoptera: Scarabaeidae), on Guam". In: (Dec. 31, 2021). Accepted: 2022-01-01T23:27:07Z Publisher: Hawaii Entomological Society. ISSN: 0073-134X. URL: http://scholarspace.manoa.hawaii.edu/handle/10125/81413 (visited on 01/02/2022).

barrera_electron_2021 Gloria Barrera, Sean Marshall, Aubrey Moore, and Trevor Jackson. *Electron microscopy study confirms infection of coconut rhinoceros beetle (CRB-G) gut cells by OrNV -V23B. (Poster) Abstracts - 2021 International Congress on Invertebrate Pathology and Microbial Control & 53rd Annual Meeting of the Society for Invertebrate Pathology. Le Studium Conference (Virtual), Tours France. p 137.* July 21, 2021. URL: https://www.researchgate.net/publication/353356673_Electron_microscopy_study_confirms_infection_of_coconut_rhinoceros_beetle_CRB-G_gut_cells_by_OrNV_-_V23B_Poster_Abstracts_-_2021_International_Congress_on_Invertebrate_Pathology_and_Microbial_Control_5.

marshall_production_2021 Sean D. G. Marshall, G. Barrera, Laura F. Villamizar, Gideon Suda, Aubrey Moore, James J. Grasela, P. D. Scotti, and Trevor A. Jackson. "Production of Oryctes nudivirus (OrNV) through the DSIR-Ha-1179 Heteronychus arator cell line. (Poster) Abstracts - 2021 International Congress on Invertebrate Pathology and Microbial Control & 53rd Annual Meeting of the Society for Invertebrate Pathology. Le Studium Conference (Virtual), Tours France." In: (June 21, 2021). DOI: 10.13140/RG.2.2.30278.80963.

cave_biological_2022 Ronald D. Cave, Aubrey Moore, and Mark G. Wright. "Biological Control of the Cycad Aulacaspis Scale, *Aulacaspis yasumatsui*". In: *Contributions of Classical Biological Control to U.S. Food Security, Forestry, and Biodiversity*. 2022.

moore_detecting_2022 Aubrey Moore and Matthew Siderhurst. "Detecting Coconut Rhinoceros Beetle Breeding Sites Using Harmonic Radar". In: *ARPHA Preprints* 3 (2022). Publisher: Pensoft Publishers _eprint: https://doi.org/10.3897/arphapreprints.e86423, ARPHA Preprints. DOI: 10.3897/arphapreprints.e86423. URL: https://doi.org/10.3897/arphapreprints.e86423.

3.2 Coconut Rhinoceros Beetle (CRB) Biocontrol

3.2.1 Description

A newly discovered biotype of coconut rhinoceros beetle (CRB-G) is rapidly killing coconuts and other palms on Guam and on other Pacific islands. Following a failed eradication attempt on Guam, CRB-G proved hard to control because it is resistant to *Oryctes rhinoceros* nudivirus (OrNV), which was previously used as the preferred biological control agent for control of CRB outbreaks on Pacific Islands and elsewhere. Previous to the discovery of CRB-G, all OrNV releases on Pacific Islands resulted in immediate and sustained suppression of CRB damage to low levels and prevented tree mortality.

Guam is currently experiencing an uncontrolled and unmonitored island-wide CRB-G outbreak which was triggered by abundant CRB-G breeding sites in the form of dead and dying vegetation left in the wake of Typhoon Dolphin which occured in May 2015. of a recent typhoon. Most of these breeding sites are inaccessable to sanitation efforts, being either in the jungle or on military land (which covers one third of Guam). A positive feedback cycle has begun whereby large numbers of adult beetles are killing large numbers of palms which become breeding sites which generate even higher numbers of adults. Severe damage to Guam's palms prompted the Governor of Guam to declared a state of emergency in July 2017.

The main objective of this project is to stop the uncontrolled outbreak

on Guam. Entomologists working on the CRB-G problem on several Pacific islands agree that the most feasible tactic to halt tree mortality and suppress damage to tolerable levels is establishment of biological control using an isolate of OrNV which is highly effective as a biological control agent for CRB-G. We are working with collaborators to identify populations of CRB-G throughout the Asia-Pacific region. We will sample these populations for biological control agent candidates which will be evaluated in laboratory bioassays performed at UOG. Promising candidates will be field released using autodissemmination as per a USDA-APHIS import and release permit.

Concurrent with establishment of CRB-G biocontrol, success of the project will be monitored in a quarterly, island-wide tree health survey and incidence of OrNV infection will be monitored in a subsample of all field collected CRB-G.

If the Guam CRB-G infestation cannot be controlled, it is expected that most palms on the island will be killed and CRB-G will continue to spread to other islands and beyond. If CRB-G invades smaller islands and atolls where coconut is the tree of life, a human tragedy will ensue. On larger islands, coconut and oil palm industries will be severely impacted. Attempts to organize a regional project in response to CRB-G are underway.

3.2.2 Activities

Funding This is my largest and most important project, requiring a lot of time and effort for project management including preparation of grant proposals and reports. Funding is currently provided by four grants: USDA-APHIS FY17 Farm Bill **??**, USDA-Farm FY18 Bill **??**, USDA-Plant Protection Act 5.1 and a grant from the Department of Interior, Office of Insular Affairs 5.2. Links to progress reports for these grants are in the appendices.

I submitted a proposal for FY20 USDA-Plant Protection Act Funds 6.1 and a preproposal for SERDP FY21 funding 6.2.

Staffing I am assisted by Dr. James Grasela, and insect pathologist funded by my Department of the Interior Office of Insular Affairs grant 5.2.

Roland Quitugua collaborates on the project with separate funding. During the reporting period my technician and graduate student, Ian Iriarte, left the University. I have recently hired an entomology student, Christian Cayanan, as a technician.

Current focus is on finding an isolate of *Oryctes* rhinoceros nudivirus which can be used as a biological control agent for CRB-G. Laboratory bioassays have identified one OrNV isolate which is potential candidate and further tests are under way.

I have developed an online database to facilitate record keeping and report generation for CRB rearing and bioassays **moore_coconut_2019-1**.

Dr. Grasela has worked in coordination with Dr. Hui Jiang to build DNA diagnostics capacity. We can now test for OrNV in individual beetles.

International collaboration will be essential for finding a way to halt massive ecological and economic damage to Pacific islands invaded by CRB-G. A CRB-G Action Group has been formed to facilitate collaboration and cooperation.

In August 2018, Moore, Grasela, Quitugua and Iriarte participated in the Congress on Invertebrate Pathology and Microbial Control and the 51st Annual Meeting of the Society for Invertebrate Pathology **moore_trip_2018-1**; **moore_attempted_2018**; **marshall_progress_2018**.

During May 2019, Moore travelled to Taiwan to collect CRB-G adults **moore_taipei_2019**. Based on previous research, it seems likely that these beetles will contain OrNV which can be used as a biocontrol agent.

During November 2019, Moore and Grasela participated in the XIX International Plant Protection Congress **moore_india_2019**; **moore_status_2019**; **marshall_challenge_2019**.

Outreach In an effort to facilitate technical and scientific information among people working on CRB, we have developed and maintain several online resources including a wiki **moore_crb-g_2019**, a Facebook site **moore_facebook_2019**, an online interactive map of CRB invasion history **moore_online_2019** and a CRB bibliography **moore_coconut_**

2019.

3.2.3 Plans

Plans for this project are contingent on applied research results, availability of funding and availability of resources.

Funding I have submitted a proposal for FY20 USDA-Plant Protection Act Funds 6.1. A preproposal for SERDP resulted in a request for a full proposal due March 4, 2020. I intend to apply for two more grant proposals to support this project. One to the Department of the Interior Office of Insular Affairs for further support of the insect pathologist postdoctoral position (due April 1, 2020) 7.3 and one to the US Forest Service for a feasibility test of harmonic radar for locating cryptic CRB breeding sites (no deadline) 7.1.

CRB-G biocontrol We will continue performing bioassays until a potential OrNV biocontrol candidate is found. Once we have one, we will begin propagation *in vivo* and field releases via autodissemination. I already have a USDA-APHIS permit for field release of OrNV.

Establishment of CRB laboratory colonies We plan to establish a colony of CRB-G from Guam and also a colony of CRB-S from American Samoa. We have 3 computer controlled environmental chambers for this purpose and have obtained an permit from USDA-APHIS which allows us to import CRB from American Samoa **usda-aphis_crb_2019**; **moore_additional_2019**.

We will use beetles reared in these colonies to perform laboratory bioassays will be performed to quantify the toxic (LD50, LT50, etc.) and nontoxic effects (fecundity, flight capability, etc.) of OrNV on CRB-G.

Beetles from these colonies will also be used to test two hypotheses:

- **Hypothesis 1:** CRB-G has a higher tolerance than CRB-S to OrNV isolates previously used for effective biocontrol. Although CRB-G

virus resistance has been presumed, this has not been confirmed by comparative bioassays.

- **Hypothesis 2:** CRB-G is less attracted than CRB-S to the synthetic aggregation pheromone, oryc- talure. Although CRB pheromone traps baited with oryctalure are widely used, these traps are not very attractive to CRB-G on Guam. When marked beetles were released within grids of pheromone traps, only 8% of these were recaptured (Moore, unpublished). We will compare responses of CRB-G and CRB-S to oryctalure using a custom-designed y-tube olfactometer and an electroantennogram. Dr. Michael Orr and his graduate student, Leilani Sablan are planning to do this work.

Once our lab rearing program is established we will provide CRB-S to collaborators, Dr. Madoka Nakai and Dr. Ross Miller, who are independently investigating the mechanism of virus resistance in CRB-G.

Harmonic radar I intend to request a small grant from the US Forest Service to test the feasibility of using harmonic radar for locating cryptic CRB breeding sites. This work will be done in collaboration with Dr. Matt Siderhurst, a chemical ecologist at Eastern Mennonite University and it builds on a previous study in which we investigated radio tracking of CRB.

3.2.4 References

moore_coconut_2019-1 Aubrey Moore. *Coconut Rhinoceros Beetle Rearing Database*. Oct. 13, 2019. URL: http://aubreymoore.pythonanywhere.com/rearing.

moore_trip_2018-1 Aubrey Moore. *Trip report for the International Congress on Invertebrate Pathology and Microbial Control and the 51st Annual Meeting of the Society for Invertebrate Pathology, Gold Coast, Australia, August 2018*. Aug. 8, 2018. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/SIP_Trip_report.pdf.

moore_attempted_2018 Aubrey Moore, Sean D G Marshall, Roland Quitugua, and Ian R. Iriarte. "Attempted microbial control of coconut rhinoceros beetle, *Oryctes rhinoceros*, biotype G on Guam using *Oryctes rhinoceros* nudivirus and *Metarhizium majus*". 51st Annual Meeting of the Society for Invertebrate Pathology and International Congress on Invertebrate Pathology and Microbial Control. Gold Coast, Australia, Sept. 13, 2018. URL: https://www.zotero.org/aubreymoore/items/7VDF7QFR/file.

marshall_progress_2018 Sean D G Marshall, Aubrey Moore, Mark Ero, Crispus Fanai, Maclean Vaqalo, and Trevor A. Jackson. "Progress with control of a virus resistant coconut rhinoceros beetle". 51st Annual Meeting of the Society for Invertebrate Pathology and International Congress on Invertebrate Pathology and Microbial Control. Gold Coast, Australia, Sept. 13, 2018.

moore_taipei_2019 Aubrey Moore. *Taipei 2019 trip report*. May 6, 2019. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/Taipei_2019_trip_report.pdf (visited on 02/07/2020).

moore_india_2019 Aubrey Moore. *India 2019 trip report*. Nov. 8, 2019. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/India2019_Trip_report.pdf.

moore_status_2019 Aubrey Moore, James J. Grasela, and Sean D. G. Marshall. *Presentation: Status of a Major Outbreak of Coconut Rhinoceros Beetle,. Oryctes rhinoceros biotype G, on Guam and Attempts at Establishing Biological Control. XIX International Plant Protection Congress, Hyderabad, India. Nov. 11, 2019.* Nov. 11, 2019. URL: https://github.com/aubreymoore/IAPPS-2019-Presentation/raw/master/Moore_IAPPS-2019.odp.

marshall_challenge_2019 Sean David Goldie Marshall. "The challenge of coconut rhinoceros beetle (Oryctes rhinoceros) to palm production and prospects for control in a changing world". XIX International Plant Protection Congress. Hyderabad, India, Nov. 11, 2019.

moore_crb-g_2019 Aubrey Moore. *CRB-G Wiki*. Oct. 13, 2019. URL: http://guaminsects.net/CRBG/index.php?title=CRB-G_Wiki.

moore_facebook_2019 Aubrey Moore and Ian R. Iriarte. *FaceBook Site: CRB-G*. Oct. 13, 2019. URL: https://www.facebook.com/groups/crbg07/.

moore_online_2019 Aubrey Moore. *Online interactive map of coconut rhinoceros beetle invasion history*. 2019. URL: http://aubreymoore.github.io/crbdist/mymap.html (visited on 05/28/2019).

moore_coconut_2019 Aubrey Moore and James J. Grasela. *Coconut Rhinoceros Beetle Bibliography*. 2019. URL: https://github.com/aubreymoore/CRB-Bibliography.

moore_additional_2019 Aubrey Moore. *Additional Documentation in Support of a Permit Application for Importation of Live Coconut Rhinoceros Beetles to Guam*. June 2, 2019. URL: https://github.com/aubreymoore/CRB-Import-Permit/blob/master/CRB-import-permit-request-additional.pdf.

3.3 Guam Biodiversity Inventory

3.3.1 Description

I consider this to be my second most important project.

A biodiversity inventory is essentially a database containing a comprehensive check list of all taxa known occur within a defined area.

A terrestrial biodiversity inventory for Guam is needed to document rapid changes to Guam's ecosystems, to provide free and open access to information on Guam's flora and fauna, and to share Guam biodiversity information with the global scientific community, policy makers and the public.

The Guam Biodiversity Inventory will facilitate automatic generation and updates to lists such as: a list of all invasive species on Guam with year first recorded, a list of new species described from specimens collected on Guam, a list of observations for Guam's endangered species, a list of Guam's native plants with associated herbivores and pathogens, and a list of crops grown on Guam and pests and pathogens which attack them.

3.3.2 Activities

Students in my AL/BI 345 class assisted in a project to liberate data from the scientific literature. In this datamining project occurrence records and ecological associates (hosts etc.) for 370 species of insects recorded in Insects of Guam I, Bishop Museum Bulletin 172 were extracted. Data extraction was done by 15 entomology student volunteers using free crowdsourcing software called Turkle **moore_github_2019-1**.

3.3.3 Plans

I plan to publish the dataset from the above mentioned datamining project as a Darwin core archive, in the Global Biodiversity Information Facility.

I intend to participate in the 4th Annual Digital Data in Biodiversity Research Conference, Bloomington, Indiana, June 1-3, 2020.

3.3.4 References

moore_github_2019-1 Aubrey Moore. *GitHub Repository: Insects of Guam Datamining*. 2019. URL: https://github.com/aubreymoore/insects-of-guam-datamining.

3.4 Guam Forest Insect Survey

3.4.1 Description

The objective of this project is to compile a comprehensive check list of insects impacting Guam's forests. While it is notable that Guam's two most numerous forest trees, namely fadang, *Cycas micronesica*, and coconut palm, *Cocos nucifera*, are under simultaneous attack by invasive insects, there are many other forest plants under attack from invasive insects. This project is funded by McIntire-Stennis.

3.4.2 Activities

This grant was completed in 2018. See final report **moore_aubreymoore/mcintire-stennis_2018**.

3.4.3 Plans

None. This grant project has been completed.

3.4.4 References

moore_aubreymoore/mcintire-stennis_2018 Aubrey Moore. *aubreymoore/McIntire-Stennis*. Sept. 30, 2018. URL: https://github.com/aubreymoore/McIntire-Stennis/blob/master/Final%20Report%201005269/McIntire-Stenis-2014-18-report.pdf (visited on 02/08/2020).

3.5 Cycad Aulacaspis Scale (CAS) Biocontrol

3.5.1 Description

A US Forest Service survey published in 2002 reported that the most abundant tree in Guam's forests (DBH $>$ 5 inches) was Guam's endemic cycad, *Cycas micronesica*. In 2003, an invasive scale insect, *Aulacaspis yasumatsui,* was detected on ornamental cycads but it soon infested wild cycads and started killing them. Within a decade, 90% of Guam's endemic cycads have been killed by the scale and other invasive species. *Cycas micronesica* was placed on the US National Endangered Species List in 2015.

Mature plants are protected by a lady beetle I introduced, but no natural reproduction is occurring because seeds and seedlings are still being killed by the scale insect. A likely solution to this problem is establishment of a small biocontrol agent, such as a miniature parasitic wasp which will control scale insects infesting seeds and seedlings.

3.5.2 Activities

Worked with Ben DeLoso, Tom Marler's grad student, to perform a CAS parasitoid survey. Results were presented at the Annual Conference of the American Society for Horticulture Science **deloso_parasitoid_2018**.

3.5.3 Plans

I plan to write a grant proposal to bring Dr. Ron Cave, an expert on cycad scale biocontrol, as a consultant to provide a plan for dealing with this problem 7.2.

3.5.4 References

deloso_parasitoid_2018 Benjamin E. Deloso, Aubrey Moore, and Thomas E. Marler. "Parasitoid Surveys in Cycad Habitats on Guam". American Society for Horticulture Science 2018 Annual Conference. Washington, D.C., Aug. 3, 2018. URL: https://ashs.confex.com/ashs/2018/meetingapp.cgi/Paper/28523 (visited on 08/25/2018).

3.6 Eight Spot Butterfly (ESB) Conservation

3.6.1 Description

The Guam Department of Agriculture Division of Aquatic and Wildlife Resources (GDOA-DAWR) requested assistance with conservation of the rare Mariana eight-spot butterfly, *Hypolimnas octocula marianensis.* . I prepared a grant proposal and permit application to do this work **aubrey_moore_application_20** which has been funded 5.4.

The objective of this project is to investigate the feasibility of captive rearing.

3.6.2 Activities

I have partnered with Dr. Curt (George) Fiedler, Biology Department, and the Center for Island Sustainability to colaborate on this project.

A large field cage (20x20X10 feet) is being built in the CIS compound in Dean's Circle.

3.6.3 Plans

Breeding experiments will commence within the next 2 months.

I intend to publish a review article on *Hypolimnas octocula* **moore_mariana_2013**

3.6.4 References

moore_mariana_2013 Aubrey Moore. *The Mariana Eight Spot Butterfly, Hypolimnas Octocula Marianensis.*

3.7 Development of a Camera Trap for Insects

3.7.1 Description

The objective of this project is to build a camera trap which uses motion detection to automatically capture short videos of active insects.

The initial target application is a surveillance system for insects visiting flowers.

3.7.2 Activities

Initial attempts at hardware and software development are available on an Open Science Framework site **moore_development_2019** and in a GitHub repository **moore_github_2019-2**.

3.7.3 Plans

For the first target application of this technology, I am partnering with Dr. Jim McConnel and staff of the Guam Plant Extinction Prevention Project to discover insect pollinators of an endangered endemic plant.

I plan to test the camera trap for monitoring bee hive activity, including detecting arrival of hornets (*Vespa tropica*).

USDA-APHIS herpetologist, Dr. Shane Sears, has asked me to collaborate with him on developing digital image analysis of brown tree snake videos.

3.7.4 References

moore_development_2019 Aubrey Moore. "Development of a camera trap for insects". In: (Sept. 2019). tex.publisher: OSF. URL: https://osf.io/4sh2w.

moore_github_2019-2 Aubrey Moore. *GitHub Repository: Macro-Cam-Trap: Development of a Camera Trap for Insects*. 2019. URL: https://github.com/aubreymoore/Macro-Cam-Trap.

4 University and Community Service

4.1 Instruction

4.1.1 Description

In addition to fulfilling my primary role as an extension entomologist, I am required to teach undergraduate courses.

4.1.2 Activities

During Fall term 2019, I taught the lecture and laboratory sections of AL/BI 345 General Entomology.

I prepared a syllabus for this course REF. I also built and maintained a web site **moore_web_2019-1** and populated this with lecture notes and other resources.

My scores in the student evaluations of both sections were higher than the university and college averages **moore_student_2019**.

4.1.3 Plans

I plan to teach the lecture and laboratory sections on AL/BI 345 in Fall, 2021.

4.1.4 References

moore_web_2019-1 Aubrey Moore. *Web Site for General Entomology AL/BI345 Fall 2019*. 2019. URL: https://aubreymoore.github.io/ALBI-345/output/ (visited on 08/10/2018).

moore_student_2019 Aubrey Moore. *Student evaluations for lecture and laboratory sections of AL/BI 345, General Entomology, Fall 2019*. 2019. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/ALBI345-2019-student-evals.pdf.

4.2 Faculty Committees

4.2.1 Faculty Building Facilities Committee for the ALS

This committee was formed by the Agriculture and Life Sciences Division to provide advice to the Dean on facilities problems within the Agriculture and Life Sciences Building. During the reporting period, I was re-elected as chair of this committee, joined by Dr. Jim McConnell.

Activity
Plans for improvements to the ALS124 teaching lab have been only partially achieved. For the past four years, faculty have asked for a dedicated computer and modern audiovisual equipment to facilitate science teaching. This equipment would also be used for the many workshops conducted in that room.
We continue to struggle with finding solutions to chronic lack of support for maintenance and infrastructure improvement.

4.2.2 Search Committee: Extension Animal Scientist

I chaired this committee, joined by Mari Marutani, LaJoy Spears, Bob Schlub, and Tom Poole, Guam's Territorial Veterinarian. This committee concluded with submission of our recommendation to the Dean on November 20, 2018.

4.2.3 Search Committee: Extension Agricultural Economist

I was a member of this committee and I am joined by Bob Barber (chair), LaJoy Speers, and John Brown. This committee concluded with submission of our recommendation to the Dean during December 2018.

4.2.4 Search Committee: Research Associate II (CRB Project)

I chaired this committee and was joined by Jim Grasela, Roland Quitugua, and Jesse Bamba.

4.2.5 Continuing Employment Committee: Austin Shelton

I chaired this committee, joined by Ross Miller and Hui Gong. This committee concluded with submission of our recommendation to the Dean during October 2018.

5 Grants which were active during the reporting period (n=8)

Five grants to be completed before the end of 2022.

Table 2: List of grants active during the reporting period (2020-06-15 through 2022-06-15).

code	title	funding
OIA-CRB	Establishment of Self-sustaining Biological Control of Coconut Rhinoceros Beetle Biotype G in Micronesia	$239,994
APHIS-CRB	Biological Control of Coconut Rhinoceros Beetle Biotype G on Guam	$200,000
FS-CRB	Establishment of Self-sustaining Biological Control of Coconut Rhinoceros Beetle Biotype G in Micronesia	$98,240
BIODIVERSITY	Guam Forest Biodiversity Inventory	$80,000
WPDN1	Western Plant Diagnostic Network	$63,366
8SPOT	Captive Breeding of Eight-spot Butterfly	$23,212
FS-CRB-HR	Improving Coconut Rhinoceros Beetle Breeding Site Detection Using Harmonic Radar	$23,000
WPDN2	Western Plant Diagnostic Network FY2022	$15,000

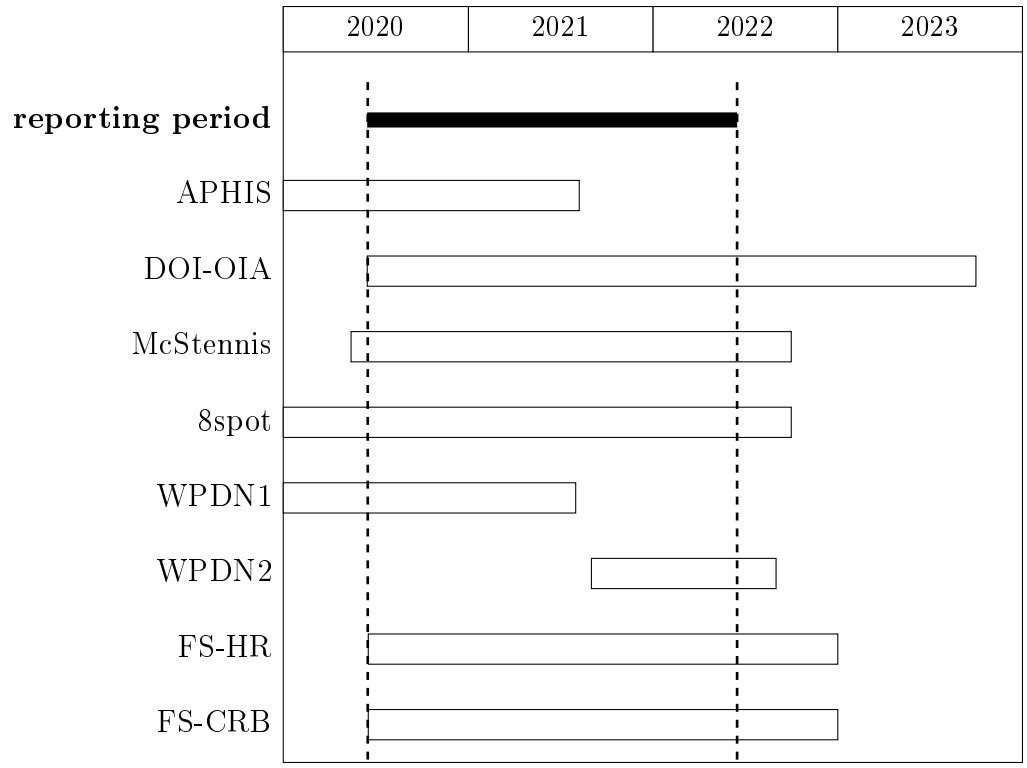

Figure 1: Performance periods for grants which were active during the reporting perion (2020-06-15 through 2022-06-15).

5.1 APHIS-CRB Biological Control of Coconut Rhinoceros Beetle Biotype-G $200K

5.1.1 Key data

- **Code:** APHIS-CRB
- **Long title:** Biological Control of Coconut Rhinoceros Beetle Biotype G on Guam
- **Start date:** 2019-08-08
- **End date:** 2021-08-07
- **Total budget:** $200,000
- **Federal ID:** AP19PPQS&T00C168
- **UOG ID:** USDA Biocontrol 2019
- **UOG Account:** 30-2F-311117
- GitHub repository

5.1.2 Documents

- Proposal
- Award letter
- Ammended work plan
- Report 1
- Report 2
- Report 3
- Final Report

5.2 OIA-CRB Biological Control of Coconut Rhinoceros Beetle Biotype-G in Micronesia $177K

5.2.1 Key data

- **Code:** OIA-CRB
- **Title:** Establishment of Self-sustaining Biological Control of Coconut Rhinoceros Beetle Biotype G in Micronesia
- **Start date:** 2020-05-14
- **End date:** 2023-09-30
- **Total budget:** $239,994
- **Federal ID:** D20AP00060
- **UOG ID:** DOI Biocontrol CRB
- **UOG Account:** 30-2F-311150
- GitHub repository

5.2.2 Documents

- Proposal
- Award letter
- Reporting requirements
- Report 1

5.3 BIODIVERSITY Guam Forest Biodiversity Inventory $80K

5.3.1 Key data

- **Code:** BIODIVERSITY
- **Title:** Guam Forest Biodiversity Inventory
- **Funding source:** McIntire-Stennis (administered by CNAS)
- **Reporting system:** REEport
- **Start date:** 2018-10-15
- **End date:** 2022-09-30
- **Total budget:** $16,000 per year for each of 4 years
- **Federal ID:** GUA0930
- **UOG ID:**
- **UOG Account:**
- GitHub repository

5.3.2 Documents

- 2018-06-21 Proposal
- 2018-10-08 Project initiation
- 2020-01-02 2019 Annual report
- 2020-12-28 2020 Annual report
- Annual report due 2021-12-31
- Final report due 2022-12-31

5.4 8SPOT Eight Spot Butterfly Conservation $20K

5.4.1 Key data

- **Code:** 8SPOT
- **Title:** Captive Breeding of Eight-spot Butterfly
- **Start date:** 2013-10-01
- **End date:** 2022-09-30
- **Total budget:** $23,212
- **Funding Agency:** DOI-FWS (via GDOA-DAWR)
- **Federal ID (FAIN):** F13AF01300
- **UOG ID:**
- **UOG Account:** 30-1F-315058-R
- GitHub repository

5.4.2 Documents

- Award letter (includes scope of work and budget)
- Updated Award Letter
- Report 1; performance period; due on

5.5 WPDN1 Western Plant Diagnostic Network 2016 $63K

5.5.1 Key data

- **Code:** WPDN1
- **Long title:** Western Plant Diagnostic Network
- **Start date:** 2016-09-01
- **End date:** 2021-07-31
- **Total budget:** $63,366
- **Federal ID(FAIN):** 20163762025851
- **UOG ID:**
- **UOG Account:** 2F-243432R5
- GitHub repository

5.5.2 Documents

- Proposal and Award Letter
- Report 1; performance period; due on YYYY-MM-DD

5.6 WPDN2 Western Plant Diagnostic Network FY2022 $15K

5.6.1 Key data

- **Code:** WPDN2
- **Title:** Western Plant Diagnostic Network FY2022
- **Start date:** 2021-09-01
- **End date:** 2022-08-31
- **Total budget:** $15,000
- **UOG ID:** WPTRC-UCDAVIS/USDA WPLANTDI
- **UOG Account:** 61-1F-243432
- GitHub repository

5.6.2 Documents

- Work plan and budget
- Award letter
- UOG account setup

5.7 FS-CRB-HR Harmonic Radar $23K

5.7.1 Key data

- **Code:** FS-CRB-HR
- **Long title:** Improving Coconut Rhinoceros Beetle Breeding Site Detection Using Harmonic Radar
- **Start date:** 2020-06-17
- **End date:** 2022-12-31
- **Total budget:** $23,000
- **Federal ID:** 20-DG-11052021-227
- **UOG ID:** CNAS-USDA-CRB Harmonic Radar
- **UG Account:** 30-2F-311144-R
- GitHub repository

5.7.2 Documents

- Proposal
- Award letter
- Extension until 2022-12-31
- Report 1 (2021-01-31)
- Report 2 (2021-07-31)
- Final report (90 days after expiration date)

5.8 Forest Service CRB $98K

5.8.1 Key data

- **Code:** FS-CRB
- **Long title:** Establishment of Self-sustaining Biological Control of Coconut Rhinoceros Beetle Biotype G in Micronesia
- **Start date:** 2020-06-17
- **End date:** 2022-12-31
- **Total budget:** $98,240
- **Federal ID:** 20-DG-11052021-229
- **UOG ID:** CNAS-USDA Control of CRB
- **UG Account:** 30-2F-311143-R
- GitHub repository

5.8.2 Documents

- Proposal
- Award letter
- Extension until 2022-12-31
- Report 1 (2021-01-31)
- Report 2 (2021-07-31)
- Final report
- 2021-06-15 Amended agreement

6 Submitted Grant Proposals (n=2)

6.1 USDA-APHIS-2020 Biological Control of Coconut Rhinoceros Beetle Biotype-G 1Y $331K

Proposal **moore_fy20_2019**; Budget **moore_fy20_2019-1**

moore_fy20_2019 Aubrey Moore. *FY20 PPA Suggestion: Coconut Rhinoceros Beetle Biological Control*. July 31, 2019. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/Moore%20FY20%20PPA%20Suggestion.pdf.

moore_fy20_2019-1 Aubrey Moore. *FY20 PPA Budget: Biological Control of Coconut Rhinoceros Beetle*. Aug. 31, 2019. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/Moore%20FY20%20PPA%20budget.pdf.

6.2 SERDP Biological Control of Coconut Rhinoceros Beetle in the American Pacific 4Y $3.6M

Answers to *pitch questions*
moore_aubreymoore/answers--pitch-questions_2019; Preproposal **moore_serdp_2020**

moore_aubreymoore/answers–pitch-questions_2019 Aubrey Moore. *aubreymoore/answers-to-pitch-questions*. June 12, 2019. URL: https://github.com/aubreymoore/answers-to-pitch-questions/raw/master/pitch.pdf (visited on 10/09/2019).

moore_serdp_2020 Aubrey Moore. *SERDP FY21 Preproposal: Biological Control of Coconut Rhinoceros Beetle in the American Pacific*. Jan. 1, 2020. URL: https://github.com/aubreymoore/answers-to-pitch-questions/blob/master/SERDP_Proposal/preproposal.pdf.

7 Grant Proposals in Preparation (n=3)

7.1 USFS Harmonic Radar

We plan to submit this proposal to the US Forest Service and to publish it in Research Ideas and Outcomes Journal **moore_improving_nodate**. Here is the lead paragraph:
The coconut rhinoceros beetle, Oryctes rhinoceros L., is a serious pest of coconut and other palms throughoutSoutheast Asia and on several Pacific Islands including Hawaii and Guam. One of the major hurdles for eradication and control of CRB is the location of cryptic breeding sites. While searching for cryptic breeding sites can be conducted by both humans and dogs, each of these search methods have drawbacks. Supported by a previous US Forest Service grant, we successful developed a third detection method for cryptic CRB breeding sites using radio-tagged CRB (a so-called "Judas beetle" method). However, there are both financial (radio tags are expensive) and logistic (radio tags have both limited field- and shelf-life) issues with radio-tracking. A cheaper and longer lasting alternative to radio-tracking is harmonic radar, which uses cheaper tags that have a near infinite operational lifetime but have a shorter range and more limited available tracking frequencies. We have recently been successful in using harmonic radar to track the spotted lanternfly, Lycorma delicatula, and are eager to employ this technology to locate cryptic CRB breeding sites. We propose to develop a harmonic radar tag based CRB tracking system to provide a more cost-effective method for finding cryptic breeding sites, therefore providing a needed tool for CRB eradication and control.

7.2 USFS Biological Control of Cycad Scale

I intend to write a small grant proposal to request funding from the US Forest Service to bring Dr. Ron Cage, an expert on biological control of Asian cycad scale, to Guam as a consultant to provide recommendations.

7.3 DOI-OIA Biological Control of Coconut Rhinoceros Beetle in the American Pacific

I intend to write a grant to the Department of Interior Office of Insular Affairs requesting continued support for Biological Control of Coconut Rhinoceros Beetle in the American Pacific.

8 Journal Articles in Preparation (n=7)

moore_first_nodate-1; **moore_mariana_2013**;
moore_three_nodate-1; **moore_change_nodate**;
moore_aubrey_crb_nodate; **marshall_recent_nodate**;
moore_coconut_nodate-1

moore_first_nodate-1 Aubrey Moore, N-Y Su, and Leonard Sigrah. "First Record of the Coconut Termite, *Neotermes Rainbowi* (Isoptera: Kalotermes) from Micronesia". In: (In Preparation).

moore_mariana_2013 Aubrey Moore. *The Mariana Eight Spot Butterfly, Hypolimnas Octocula Marianensis.*

moore_three_nodate-1 Aubrey Moore. "Three New Island Records for Bark Beetles (Curculionidae: Scolitinae) on Guam from a Single Coffee Berry Borer Trap". In: (In Preparation).

moore_change_nodate Aubrey Moore. *Change Analysis of Guam Forest Inventory Data.*

moore_aubrey_crb_nodate Aubrey Moore. *CRB Trap Improvement.* in preparation.

marshall_recent_nodate Sean D G Marshall, Aubrey Moore, Mark Ero, Crispus Fanai, Maclean Vaqalo, Trevor A. Jackson, Roland Quitugua, Ian R Iriarte, Christopher Kitalong, Justin Omak Ramarui, Jason Ngiramengior, Balang Skey, Nelson Masang, Shizu Watanabe, Michael Melzer, Madoka Nakai, Joel Miles, Nur Ain F R S Khudri, Norman Kamarudin, Ramle Moslim, Francis Tsatsia, Helen Tsatsia, Hilda Wratten, Bob Macfarlane, Visoni Timote, and Fereti Atu. *Recent Challenges from Coconut Rhinoceros Beetle to Palm Production in the Pacific and Prospects for Microbial Control.* IN PREPARATION.

moore_coconut_nodate-1 Aubrey Moore. *Coconut Rhinoceros Beetle Invasion History.* IN PREPARATION.

9 Uncited References

This section should be commented out when the report is completed.

moore_fitting_2020 Aubrey Moore. *Fitting Curves to COVID-19 Data from Guam and Hawaii*. Apr. 1, 2020. URL: https://medium.com/@aubreymoore2013/fitting-curves-to-covid-19-data-from-guam-and-hawaii-4c6c116645c4 (visited on 05/07/2020).

grasela_technical_2020-2 James J. Grasela and Aubrey Moore. *Technical Report: Polymerase Chain Reaction (PCR) Analysis of the Coconut Rhinoceros Beetle (CRB), Oryctes rhinoceros. Part 3.* 2020. URL: https://github.com/aubreymoore/FY19-PPA-Report-1/blob/master/pcrdata/PCR-Summary-Part-3.pdf.

grasela_technical_2020-1 James J. Grasela and Aubrey Moore. *Technical Report: Polymerase Chain Reaction (PCR) Analysis of the Coconut Rhinoceros Beetle (CRB), Oryctes rhinoceros. Part 2.* 2020. URL: https://github.com/aubreymoore/FY19-PPA-Report-1/blob/master/pcrdata/PCR-Summary-Part-2.pdf.

grasela_technical_2020 James J. Grasela and Aubrey Moore. *Technical Report: Polymerase Chain Reaction (PCR) Analysis of the Coconut Rhinoceros Beetle (CRB), Oryctes rhinoceros. Part 1.* 2020. URL: https://github.com/aubreymoore/FY19-PPA-Report-1/blob/master/pcrdata/PCR-Summary-Part-1.pdf.

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