

CFES Report 2020-2022

Aubrey Moore, Ph.D.
Professor / Extension Entomologist

March 26, 2022

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<https://github.com/aubreymoore/CFES2019/blob/master/CFES2019.pdf>

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, 2018 – February 17, 2020

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%
<hr/>	
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

1	Preface	5
2	Extension and Community Activities	6
2.1	Insect Diagnostic Services	6
2.2	Detection and Documentation of Invasive Species	6
2.3	University of Guam Insect Collection	9
2.4	Guam Coconut Rhinoceros Beetle Project	10
2.5	National Plant Diagnostic Network (NPDN)	10
2.6	Guam Invasive Species Advisory Committee (GISAC) and Guam Invasive Species Council (GISC)	11
2.7	Raspberry Pi Workshop	12
2.8	Insect Activities for Guam Head Start Program	13
2.9	Public Outreach: Radio and Newspaper	14
2.10	Public Outreach: Internet	15
2.11	Public Outreach: Presentations	15
3	Creative/Scholarly Activities or Research	19
3.1	Coconut Rhinoceros Beetle (CRB) Biocontrol	19
3.2	Guam Biodiversity Inventory	24
3.3	Guam Forest Insect Survey	26
3.4	Cycad Aulacaspis Scale (CAS) Biocontrol	26
3.5	Eight Spot Butterfly (ESB) Conservation	27
3.6	Development of a Camera Trap for Insects	28
4	University and Community Service	30
4.1	Instruction	30
4.2	Faculty Committees	31
5	Active Grants (n=8)	33
5.1	USDA-APHIS-2017 Biological Control of Coconut Rhinoceros Beetle Biotype-G 1Y \$200K	33
5.2	USDA-APHIS-2018 Biological Control of Coconut Rhinoceros Beetle Biotype-G 1Y \$200K	33

5.3	USDA-APHIS-2019 Biological Control of Coconut Rhinoceros Beetle Biotype-G 1Y \$200K	34
5.4	DOI-OIA Biological Control of Coconut Rhinoceros Beetle Biotype-G in Micronesia 2Y \$177K	34
5.5	McIntire-Stennis Guam Forest Insect Survey 4Y \$60K	35
5.6	McIntire-Stennis Guam Forest Biodiversity Inventory 5Y \$80K	35
5.7	GDOA-DAWR Eight Spot Butterfly Conservation \$20K	35
5.8	Western Plant Diagnostic Network 1Y \$10K	35
6	Submitted Grant Proposals (n=2)	37
6.1	USDA-APHIS-2020 Biological Control of Coconut Rhinoceros Beetle Biotype-G 1Y \$331K	37
6.2	SERDP Biological Control of Coconut Rhinoceros Beetle in the American Pacific 4Y \$3.6M	37
7	Grant Proposals in Preparation (n=3)	38
7.1	USFS Harmonic Radar	38
7.2	USFS Biological Control of Cycad Scale	38
7.3	DOI-OIA Biological Control of Coconut Rhinoceros Beetle in the American Pacific	39
8	Journal Articles in Preparation (n=7)	40

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 [1].

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 report is available as an electronic document in PDF format at <https://github.com/aubreymoore/CFES2019/blob/master/CFES2019.pdf>.

If you are reading the PDF version of the 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 three per day during the reporting period. Many of these are documented as postings to iNaturalist [1].

2.1.3 Plans

I plan to continue providing insect diagnostic services.

2.1.4 References

- [1] Aubrey Moore. *Aubrey Moore's iNaturalist Observations Entered After 2018-06-15*. Jan. 21, 2020. URL: https://www.inaturalist.org/observations?d1=2018-06-15&place_id=any&subview=grid&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

Ten new island records for insects in Micronesia were documented in iNaturalist posts during the reporting period [[3](#), [10](#), [2](#), [9](#), [4](#), [8](#), [1](#), [7](#), [11](#), [5](#), [6](#)].

I discovered a new larval host plant record: *Traminda aventiaria* (Lepidoptera: Geometridae) feeding on the critically endangered tree, *Serianthes nelsonii* (Leguminosae) [[12](#)].

2.2.3 Plans

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

- [1] iNaturalist. *First island record for Agraulis vanillae in Guam*. Nov. 6, 2018. URL: <https://www.inaturalist.org/observations/18166461>.
- [2] iNaturalist. *First island record for Agraulis vanillae in Saipan, Commonwealth of the Northern Mariana Islands*. Nov. 19, 2019. URL: <https://www.inaturalist.org/observations/35845152>.
- [3] iNaturalist. *First island record for Agraulis vanillae in Tinian, Commonwealth of the Northern Mariana Islands*. Dec. 8, 2019. URL: <https://www.inaturalist.org/observations/36470788>.

- [4] iNaturalist. *First island record for Chelonus formosanus in Guam*. Aug. 22, 2019. URL: <https://www.inaturalist.org/observations/31326484>.
- [5] iNaturalist. *First island record for Citripestis eutrapphera in Guam*. Aug. 3, 2018. URL: <https://www.inaturalist.org/observations/15067449>.
- [6] iNaturalist. *First island record for Citripestis eutrapphera in Guam*. June 15, 2018. URL: <https://www.inaturalist.org/observations/13466275>.
- [7] iNaturalist. *First island record for Dysdercus decussatus in Palau*. Sept. 21, 2018. URL: <https://www.inaturalist.org/observations/16734728>.
- [8] iNaturalist. *First island record for Hexarthrius mandibularis in Guam*. July 6, 2019. URL: <https://www.inaturalist.org/observations/29333274>.
- [9] iNaturalist. *First island record for Lepidiota squamulata in Guam*. Sept. 12, 2019. URL: <https://www.inaturalist.org/observations/32572967>.
- [10] iNaturalist. *First island record for Megymenum affine in Kosrae, Federated States of Micronesia*. Nov. 10, 2019. URL: <https://www.inaturalist.org/observations/36285968>.
- [11] iNaturalist. *First island record for Nasutitermes corniger in Palau*. June 25, 2018. URL: <https://www.inaturalist.org/observations/15747194>.
- [12] Aubrey Moore. “New Larval Host Record: Traminda Aventiaria (Lepidoptera: Geometridae) Feeds on the Critically Endangered Tree, Serianthes Nelsonii (Leguminosae), on Guam”. In: (2020). URL: <https://github.com/aubreymoore/Traminda-aventiaria>.

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.

2.3.2 Activities

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 now online [4].

I established an internship to train entomology students how to curate an institutional insect collection [3].

The Benita Laird-Hopkins collection includes more than 5,000 insect specimens reared from seeds of forest plants from Saipan and Guam as part of the Ecology of Bird Loss Project. This collection has been cataloged and accessioned into the UOG insect collection and a publication is being prepared [1].

In June 2018, I attended the Second Annual Digital Data in Biodiversity Research Conference sponsored by iDigBio (Integrated Digital Biocollections) to attend a workshop entitled Sharing and Mobilization of Massive Specimen Image Databases from Collections of Tropical Island Biodiversity as an invited participant. I made a presentation on building a biodiversity inventory for Guam [2] and discussed ongoing collaboration with Dr. Alex Vandam on writing an NSF proposal to support digitization of biological collections on American-affiliated islands [5].

2.3.3 Plans

I intend to re-established the UOG insect collection internship to train entomology students how to curate an institutional insect collection [3].

2.3.4 References

- [1] Benita C. Laird-Hopkins et al. “[IN PREPARATION] Fruit and Seed-Eating Insect Assemblages on Island Ecosystems”. 2018.
- [2] Aubrey Moore. “Building a Terrestrial Biodiversity Inventory for Guam”. oral presentation. Second Annual Digital Data in Biodiversity Research Conference (Berkeley, CA). 2018. URL: https://figshare.com/articles/Building_a_Terrestrial_Biodiversity_Inventory_for_Guam/6188315 (visited on 05/30/2018).
- [3] Aubrey Moore. *Internship: University of Guam Insect Collection Technician*. 2018. URL: <https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/internship.pdf>.
- [4] 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).
- [5] Aubrey Moore. *Trip Report: Second Annual Digital Data in Biodiversity Research Conference, Berkely, CA, June 2018*. 2018. URL: https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/Berkeley_Trip_report.pdf (visited on 08/25/2018).

2.4 Guam Coconut Rhinoceros Beetle Project

This is my largest and most important project. Please see CRB activities in the Creative/Research/Scholarly section [3.1](#).

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 [3].
Prepared annual report [1].
Served on the NPDN IT Strategic Planning Committee.
Created a digital archive for the discontinued web site, Pacific Islands Distance Diagnostics and Recommendation System [2].

2.5.3 Plans

I will continue to act as UOG coordinator for WPDN.

2.5.4 References

- [1] Aubrey Moore. *NPDN Accomplishments Survey for University of Guam, April 1, 2017 through April 1, 2018*. 2018. URL: <https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/Guam%20WPDN-Accomplishments%20Summary%20Form%202018%20final.pdf>.
- [2] Aubrey Moore. “Pacific Islands Distance Diagnostics and Recommendation System (PIDDRS) Archive”. In: *s* (Sept. 2019). URL: <https://osf.io/rz5u6>.
- [3] Aubrey Moore. *University of Guam: WPDN Funded Budget September 1, 2017 through August 1, 2018*. 2018. URL: <https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/Univ%20of%20Guam%20WPDN%20budget%202017-18-Final.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.

2.6.1 Activities

I participated in GISAC and GISC meetings.

During 2018, I served on a GISC Import Data Harmonization Committee. This committee generated recommendations [1] resulting in a bill to amend the Guam Invasive Species Act [2].

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.

2.6.3 References

- [1] Derrick Guerrero. *Guam Invasive Species Council: Import Data Harmonization Committee Report*. May 30, 2018. URL: <https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/GISC%20IDHC%20Report%20%26%20Recommendations.pdf>.
- [2] Derrick Guerrero and Joseph Santos. *Bill to Amend 5 GCA Chapter 70: Guam Invasive Species Act*. May 29, 2018. URL: <https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/5%20GCA%20Chapter%2070%20Bill%20Draft%20D.%20Guerrero%20%26%20Joseph%20Santos%20V.5%202018%20no%20password.pdf>.

2.7 Raspberry Pi Workshop

2.7.1 Description

I partnered with the University of Guam (UOG) 4H program to put on a workshop to introduce local youth to the Raspberry Pi computer and Python coding.

2.7.2 Activities

This 20 hour workshop was conducted on July 23 through July 26, 2019, 900h to 1300h each day. An Open Science Framework site was used as an online repository for course materials [1] and detailed report was submitted [2].

2.7.3 Plans

This workshop may be offered again if there is a demand and time and resources permit.

2.7.4 References

- [1] Aubrey Moore. *Open Science Framework Project: Raspberry Pi Workshop for University of Guam 4H Program*. Dec. 8, 2018. URL: <https://osf.io/ux6jn/>.
- [2] Aubrey Moore. *Report on Use of FY2018 UOG-CNAS-EO Core Funds: Development of a Raspberry Pi Workshop for 4H Students*. Oct. 18, 2019. URL: <https://github.com/aubreymoore/4HRPi/raw/master/report.pdf>.

2.8 Insect Activities for Guam Head Start Program

2.8.1 Description

As part of visits to the UOG Agriculture and Life Sciences Building by the Guam Head Start Program, I provide a section on insects.

2.8.2 Activities

On the last Friday of each month during Spring Term 2019, I put on a miniprogram for four consecutive groups of young children. Activities included:

- A short guided walk to observe insects and to collect some of them.

- Observation of pinned insects from the *Insect Road Show* display.
- Observation of live insects under a microscope connected to a large monitor.
- Hunting for coconut rhinoceros beetles in a simulated breeding site.
- Distribution of give-aways including rhino beetle stickers and hand lenses.

2.9 Public Outreach: Radio and Newspaper

- [25] 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).
- [74] 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/>.
- [95] 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).
- [116] 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).

2.10 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.

2.11 Public Outreach: Presentations

- [1] Aubrey Moore. *Presentation: Coconut Rhinoceros Beetle Update. Presented at the Regional Invasive Species Council Meeting at the Plant Inspection Facility, Tiyan, Guam. 2018-09-20.* Sept. 20, 2018.
- [2] Aubrey Moore. *Presentation: Guam Biodiversity Inventory. Presented at the Regional Invasive Species Council Meeting at the Plant Inspection Facility, Tiyan, Guam.* Sept. 21, 2018.
- [3] Andrea L. Blas, Roland Quitugua, and Aubrey Moore. *Presentation: Protecting a Cultural Icon and Food Resource: Current Research and Status of Coconut Palm in Guam and the Northern Marianas. Joint Meeting of the American Phytopathological Society (APS), Pacific Division and Conference on Soilborne Plant Pathogens (CSPP), Portland, Oregon. 2018-06-27.* June 27, 2018. URL: https://www.apsnet.org/members/community/divisions/pac/meetings/Documents/APS_PacificDivisionCSPP_2018_PROGRAM%20SCHEDULE.pdf (visited on 08/25/2018).
- [4] 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).

- [29] Sean D G Marshall et al. “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.
- [30] 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.
- [31] Aubrey Moore. “2019 Forest Service Review of University of Guam Projects” (University of Guam). Mar. 2019. URL: <https://github.com/aubreymoore/2019-Forest-Service-Review/raw/master/2019%20Forest%20Service%20Review.pdf>.
- [37] Aubrey Moore. “Biological Invasion of Forests on Guam and Other Islands in Micronesia”. Forestry Workshop on Invasive Insects (University of Guam, Mangilao, Guam). Feb. 11, 2020. URL: <https://aubreymoore.github.io/bioinvasion-of-guam-forests-2020/BioInvasionOfGuamForests2020.html>.
- [38] Aubrey Moore. “Biological Invasion of Guam”. WEDA/WAAESD Joint Summer Meeting (Guam). July 11, 2018. URL: https://github.com/aubreymoore/Guam-Bioinvasion-July-2018/raw/master/compress_biological_invasion_of_guam_July_2018.pdf (visited on 07/20/2018).
- [39] Aubrey Moore. “Biological Invasion of Guam”. 2018 Coconut Rhinoceros Beetle Training for CNMI (UOG, Guam). July 30, 2018.
- [41] Aubrey Moore. “Building a Terrestrial Biodiversity Inventory for Guam”. Guam Island Sustainability Conference (Tumon Bay, Guam). Apr. 26, 2018. URL: https://figshare.com/articles/Building_a_Terrestrial_Biodiversity_Inventory_for_Guam/6188315 (visited on 05/30/2018).

- [42] Aubrey Moore. “Building a Terrestrial Biodiversity Inventory for Guam”. oral presentation. Second Annual Digital Data in Biodiversity Research Conference (Berkeley, CA). 2018. URL: https://figshare.com/articles/Building_a_Terrestrial_Biodiversity_Inventory_for_Guam/6188315 (visited on 05/30/2018).
- [46] Aubrey Moore. “Coconut Rhinoceros Beetle Invasion of Guam”. 2018 Coconut Rhinoceros Beetle Training for CNMI (UOG, Guam). July 30, 2018.
- [54] Aubrey Moore. “Entomology Section: 17th Annual Quarantine Training Workshop, Guam 2019”. Mar. 2019. URL: <https://osf.io/ndz2h>.
- [56] Aubrey Moore. “Failed Attempts to Establish Ipm for Asian Cycad Scale and Coconut Rhinoceros Beetle on Guam”. Annual Meeting of the Entomological Society of America (Vancouver, Canada). Nov. 13, 2018. URL: <https://zenodo.org/record/2545065/files/Moore-Vancouver-2018.pdf> (visited on 01/21/2019).
- [61] Aubrey Moore. “Free Cell Phone Apps for Pest Surveys”. 2018 Coconut Rhinoceros Beetle Training for CNMI (UOG, Guam). 2018-08-09-02.
- [108] Aubrey Moore. “Predicting Invasive Species Arrivals on Guam”. Forestry Workshop on Invasive Insects (University of Guam, Mangilao, Guam). Feb. 11, 2020. URL: <https://aubreymoore.github.io/guam-ias-bolo>.
- [109] Aubrey Moore. *Presentation: The Coconut Rhinoceros Beetle Outbreak on Guam: What Can Be Done About It? Presented to Students Participating in the Guam Humanities Project: Taking Root: Growing Youth Empowerment for Island Sustainability at University of Guam, Mangilao, Guam. 2018-09-22*. Sept. 22, 2018. URL: <https://ndownloader.figshare.com/files/13141172>.
- [138] 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.

- [145] Aubrey Moore et al. “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>.

3 Creative/Scholarly Activities or Research

3.1 Coconut Rhinoceros Beetle (CRB) Biocontrol

3.1.1 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 occurred in May 2015. of a recent typhoon. Most of these breeding sites are inaccessible 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 autodissemination 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.

3.1.2 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 [5.1](#), USDA-Farm FY18 Bill [5.2](#), USDA-Plant Protection Act [5.3](#) and a grant from the Department of Interior, Office of Insular Affairs [5.4](#). 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 [5.4](#). 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 [4].

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 [9, 13, 1].

During May 2019, Moore travelled to Taiwan to collect CRB-G adults [8]. 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 [6, 11, 2].

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 [5], a Facebook site [12], an online interactive map of CRB invasion history [7] and a CRB bibliography [10].

3.1.3 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](#), 3].

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, oryctalure. 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.

3.1.4 References

- [1] Sean D G Marshall et al. “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.
- [2] 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.
- [3] 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>.
- [4] Aubrey Moore. *Coconut Rhinoceros Beetle Rearing Database*. Oct. 13, 2019. URL: <http://aubreymoore.pythonanywhere.com/rearing>.
- [5] Aubrey Moore. *CRB-G Wiki*. Oct. 13, 2019. URL: http://guaminsects.net/CRBG/index.php?title=CRB-G_Wiki.
- [6] Aubrey Moore. *India 2019 Trip Report*. Nov. 8, 2019. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/India2019_Trip_report.pdf.
- [7] 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).

- [8] 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).
- [9] 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.
- [10] Aubrey Moore and James J. Grasela. *Coconut Rhinoceros Beetle Bibliography*. 2019. URL: <https://github.com/aubreymoore/CRB-Bibliography>.
- [11] 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.
- [12] Aubrey Moore and Ian R. Iriarte. *FaceBook Site: CRB-G*. Oct. 13, 2019. URL: <https://www.facebook.com/groups/crbg07/>.
- [13] Aubrey Moore et al. "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>.

3.2 Guam Biodiversity Inventory

3.2.1 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.

3.2.2 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* [1].

3.2.3 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.

3.2.4 References

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

3.3 Guam Forest Insect Survey

3.3.1 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.

3.3.2 Activities

This grant was completed in 2018. See final report [1].

3.3.3 Plans

None. This grant project has been completed.

3.3.4 References

- [1] Aubrey Moore. *Aubreymoore/McIntire-Stennis*. Sept. 30, 2018. URL: <https://github.com/aubreymoore/McIntire-Stennis/blob/master/Final%20Report%201005269/McIntire-Stennis-2014-18-report.pdf> (visited on 02/08/2020).

3.4 Cycad Aulacaspis Scale (CAS) Biocontrol

3.4.1 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.

3.4.2 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 [1].

3.4.3 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.

3.4.4 References

- [1] 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).

3.5 Eight Spot Butterfly (ESB) Conservation

3.5.1 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_2013] which has been funded 5.7.

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

3.5.2 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.

3.5.3 Plans

Breeding experiments will commence within the next 2 months.

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

3.5.4 References

3.6 Development of a Camera Trap for Insects

3.6.1 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.

3.6.2 Activities

Initial attempts at hardware and software development are available on an Open Science Framework site [1] and in a GitHub repository [2].

3.6.3 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.

3.6.4 References

- [1] Aubrey Moore. “Development of a Camera Trap for Insects”. In: (Sept. 2019). URL: <https://osf.io/4sh2w>.
- [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 [2] 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 [1].

4.1.3 Plans

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

4.1.4 References

- [1] 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>.
- [2] 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).

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 Spears, 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 Active Grants (n=8)

5.1 USDA-APHIS-2017 Biological Control of Coconut Rhinoceros Beetle Biotype-G 1Y \$200K

Work Plan [1]; Report 1 [2]; Report 2 [3]; Report 3 [4]

- [1] Aubrey Moore. *FY17 Farm Bill Work Plan*. Jan. 1, 2018. URL: <https://github.com/aubreymoore/CFES2019/blob/master/refs/FY17%20FB%20Work%20and%20Financial%20Plan.pdf>.
- [2] Aubrey Moore. *USDA APHIS Grant AP17PPQFO000C312 Progress Report 1: Coconut Rhinoceros Beetle Biocontrol*. Feb. 23, 2018. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/FB17_report1.pdf.
- [3] Aubrey Moore. *USDA APHIS Grant AP17PPQFO000C312 Progress Report 2: Coconut Rhinoceros Beetle Biological Control*. Sept. 24, 2018. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/FB17_report2.pdf.
- [4] Aubrey Moore. *USDA APHIS Grant AP17PPQFO000C312 Progress Report 3: Coconut Rhinoceros Beetle Biological Control*. Mar. 25, 2019.

5.2 USDA-APHIS-2018 Biological Control of Coconut Rhinoceros Beetle Biotype-G 1Y \$200K

Work Plan [1]; Budget [2]; Report 2 [3]

- [1] Aubrey Moore. *Farm Bill Work Plan FY18*. Aug. 1, 2018.
- [2] Aubrey Moore. *FY18 Farm Bill Budget*. Aug. 1, 2018. URL: <https://github.com/aubreymoore/CFES2019/blob/master/refs/FY18-FB-budget%20.pdf>.

- [3] Aubrey Moore. *USDA APHIS Grant AP18PPQFO000C402 Report 2: Coconut Rhinoceros Beetle Biocontrol*. Sept. 25, 2019. URL: https://github.com/aubreymoore/CFES2019/blob/master/refs/FB18_report2.pdf.

5.3 USDA-APHIS-2019 Biological Control of Coconut Rhinoceros Beetle Biotpe-G 1Y \$200K

Proposal [1]; Proposed budget [2];

- [1] Aubrey Moore. *FY19 Farm Bill Suggestion: Biocontrol of Coconut Rhinoceros Beetle Biotpe G*. 2018. URL: <https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/MooreFB19.pdf>.
- [2] Aubrey Moore. *FY19 Farm Bill Suggestion: Budget*. 2018. URL: <https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/MooreFB19.pdf>.

5.4 DOI-OIA Biological Control of Coconut Rhinoceros Beetle Biotpe-G in Micronesia 2Y \$177K

Report 2 [1]; Report 3 [2]

- [1] Aubrey Moore. *DOI-OIA Grant D17AP00107 Progress Report 2: Coconut Rhinoceros Beetle Biological Control*. Oct. 27, 2018. URL: <https://github.com/aubreymoore/doi-CRB-biocontrol-project/blob/master/report2/report2.pdf>.
- [2] Aubrey Moore. *DOI-OIA Grant D17AP00107 Progress Report 3: Coconut Rhinoceros Beetle Biological Control*. May 16, 2019. URL: https://github.com/aubreymoore/doi-CRB-biocontrol-project/blob/master/report%203/DOI_OIA_report3_ebook.pdf.

5.5 McIntire-Stennis Guam Forest Insect Survey 4Y \$60K

Final report [1]

- [1] Aubrey Moore. *Aubreymoore/McIntire-Stennis*. Sept. 30, 2018. URL: <https://github.com/aubreymoore/McIntire-Stennis/blob/master/Final%20Report%201005269/McIntire-Stennis-2014-18-report.pdf> (visited on 02/08/2020).

5.6 McIntire-Stennis Guam Forest Biodiversity Inventory 5Y \$80K

Proposal [2]; Progress report [1]

- [1] Aubrey Moore. *Guam Forest Biodiversity Inventory Progress Report (GUA0930)*. Jan. 1, 2020.
- [2] Aubrey Moore. *McIntire-Stennis Proposal: Guam Forest Biodiversity Inventory*. June 21, 2018. URL: https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/ms_proposal_2018.pdf.

5.7 GDOA-DAWR Eight Spot Butterfly Conservation \$20K

Proposal and Permit Application [aubrey_moore_application_2016]

5.8 Western Plant Diagnostic Network 1Y \$10K

Progress report [1]

- [1] Aubrey Moore. *NPDN Accomplishments Survey for University of Guam, April 1, 2017 through April 1, 2018*. 2018. URL: <https://github.com/aubreymoore/Miscellaneous-Docs-for-CFES2018/raw/master/Guam%20WPDN-Accomplishments%20Summary%20Form%202018%20final.pdf>.

6 Submitted Grant Proposals (n=2)

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

Proposal [2]; Budget [1]

- [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>.
- [2] 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>.

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

Answers to *pitch questions* [1]; Preproposal [2]

- [1] 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).
- [2] 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 throughout Southeast 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 successfully 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)