Item No. 1 of 1

ACCESSION NO: 1005269 **SUBFILE:** CRIS
PROJ NO: GUA0903 **AGENCY:** NIFA GUA
PROJ TYPE: MCINTIRE-STENNIS **PROJ STATUS:** NEW
START: 28 NOV 2014 **TERM:** 30 SEP 2018 **FY:** 2017

INVESTIGATOR: Moore, AU, .

PERFORMING INSTITUTION:
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GUAM FOREST INSECT SURVEY

CLASSIFICATION

KA	Subject	Science	Pct
211	0640	1130	100

CLASSIFICATION HEADINGS: R211 . Insects, Mites, and Other Arthropods Affecting Plants; **S0640** . Tropical forests; **F1130** . Entomology and acarology

Animal Health and Disease Related -- %

BASIC 50% **APPLIED** 50% **DEVELOPMENTAL** 0%

NON-TECHNICAL SUMMARY: Despite the fact that Guam's forest ecosystems are rapidly being degraded by inva-sive insect species, such as the Asian cycad scale, Aulacaspis yasumatsui, the coconutrhinoceros beetle, Oryctes rhinoceros, and the little fire ant, Wasmannia aurapunctata,little is known about Guam's forest insects and their impacts on forest health. Discoveryof three species of bark beetles not previously reported from Guam in a single trap at asingle location [Moore, unpublished] illustrates this lack of knowledge.Support is requested for a Guam forest insect survey which will fill some of the gapsin our knowledge base.

OBJECTIVES: The objective of the proposed survey is to build a knowledgebase on insects associatedwith plants in Guam's forests. The survey will result in a reference collection of Guam'sforest insects and a publicly available online database to facilitate sharing of specimendata, images and ecological associations among plants and insects.The knowledgebase will be usefull to natural resource managers responsible for main-taining the health of Guam's forests and to biologists trying to understand Guam'sterrestrial ecosystems in the wake of major biological invasions.

APPROACH: SamplingThe survey will extend beyond creating a species checklist. In addition to collectingand identifying insect specimens, associations among plants and other organisms will berecorded in a manner similar to what has been done for the pests of Cycas micronesica(Figure 1 in attached proposal).Insects associated with the 38 most abundant forest trees (Table 1) will be collectedin collaboration with the Guam Department of Agriculture's Forestry Division. Duringthe first year, insects associated with Guam's eight most predominant tree species willbe surveyed (identified in the table as group 1 in attached proposal). Ten tree species will be surveyed ineach of the following three years (groups 2, 3, and 4 in attached proposal).Insects associated with rare plants in Guam's forests will be surveyed in collaborationwith the Guam Plant Extinction Prevention Program (GPEPP) [GPE, 2014]. Recentlyarrived insect species are undoubtedly putting these plants at an increased risk of ex-tinction as illustrated by the recent discovery of a new armored scale insect attackingSerianthes nelsonii saplings [Moore et al., 2014].A workshop on sampling methods will be offered to collaborators at the start of theproject. Topics to be covered will include data requirements, photo-documentation,GPS, and rearing adults from field collected larvae. When possible, larval insects willbe reared to the adult stage to facilitate identification and to collect parasitoids.TaxonomyThe assistance of professional taxonomists will be required to accurately identify manyof the insects collected by this survey. Project funding will be used to support anexisting collaboration with Dr. Richard Zack, Director of the M. T. James EntomologicalCollection at Washington State University and also a director of the University of GuamInsect Collection. Project funds will be used for annual visits to Guam by Dr. Zackduring which he will assist with and provide expert advice on collection, identificationand curation of forest insect specimens in the UOG Insect Collection.Voucher specimens will be kept in the University of Guam Insect Collection. Theproject will support a part-time collection technician.ReportingAll project data will be stored in a modern, on-line, open-access biodiversity database.It is anticipated that several new island records, including some new invasive species,will be discovered during the survey. A Guam New Invasive Species Alert will be postedfor each new invasive species and each new island record will be documented in a peer-reviewed scientific note.

KEYWORDS: Guam, forestry, invasive species, native plants

PROGRESS: 2016/10 TO 2017/09
Target Audience:I provided information to the general public and NGOs such as the Guam Plant Extinction Prevention Project, and government agencies such as the USDA-APHIS, US Forest Service, and the United States Fish and Wildlife Service. This information includes identification of insect specimens given to me and recommendations on plant protection. Fact sheets on newly arrived invasive species were prepared and made available to the public in print and on web sites which I build and maintain. As one of only 3 practicing PhD-level entomologists in Micronesia, I provide entomological services to the Commonwealth of the Northern Mariana Islands, the Republic of Palau, the Federated States of Micronesia, and the Republic of the Marshall Islands. Many, if not most, of current insect problems in Micronesia involve damage to forests by recently arrived invasive species. Changes/Problems: Nothing Reported What opportunities for training and professional development has the project provided?At the 2017 Pacific Island Forestry Professionals Workshop, I provided training and professional development to about 50 participants from American affiliated Pacific Islands. Here's an outline of the topics I covered during the 4 hours of presentations: Concurrent Session 1B: Forest Health Protection: Entomology Tuesday afternoon, April 4, 2017 3rd Floor Unnai Ballroom 3, Westin Hotel, Tumon Bay, Guam Presentations Introduction Biological Invasion of Guam Coconut Rhinoceros Beetle Asian Cycad Scale Little Fire Ant Emerging Forest Insect Pest Issues in Micronesia Access to Information on Forest Insect Pests in Micronesia Using free Cell Phone Apps for Forest Pest Surveys Open Discussion How have the results been disseminated to communities of interest?I published presentation slides and other resources associated with the entomology section of the 2017 Pacific Island Forestry Professionals Workshop on an Open Science Framework Web Site at https://osf.io/a6t7v/. What do you plan to do during the next reporting period to accomplish the goals?During the next reporting period I will focus on building an online database of Guam's forest pest insects and the plants they attack. This is part of a larger project to assmble a biodiversity inventory for terrestrial organisms on Guam.

IMPACT: 2016/10 TO 2017/09
What was accomplished under these goals? My major accomplishment during this reporting period was organizing a forest entomology section for the 2017 Pacific Island Forestry Professionals Workshop at the request of the USDA Forest Service.

PUBLICATIONS (not previously reported): 2016/10 TO 2017/09
1. Type: Websites Status: Published Year Published: 2017 Citation: Moore, Aubrey. 2017. ?Entomology Section for Pacific Island Forestry Meeting.? Open Science Framework. Website visited December 28. httpS://osf.io/a6t7v.
2. Type: Journal Articles Status: Published Year Published: 2017 Citation: Marshall, Sean D. G., Aubrey Moore, Maclean Vaqalo, Alasdair Noble, and Trevor A. Jackson. 2017. ?A New Haplotype of the Coconut Rhinoceros Beetle, Oryctes Rhinoceros, Has Escaped Biological Control by Oryctes Rhinoceros Nudivirus and Is Invading Pacific Islands.? Journal of Invertebrate Pathology 149 (October):127?34. https://doi.org/10.1016/j.jip.2017.07.006.
3. Type: Journal Articles Status: Published Year Published: 2017 Citation: Moore, Aubrey, Diego C. Barahona, Katherine A. Lehman, Dominick A. Skabeikis, Ian R. Iriarte, Eric B. Jang, and Mattew S. Siderhurst. 2017. ?Judas Beetles: Discovering Cryptic Breeding Sites by Radio-Tracking Coconut Rhinoceros Beetles, Oryctes Rhinoceros (Coleoptera: Scarabaeidae).? Journal of Environmental Entomology 46 (1):92?99. https://doi.org/https://doi.org/10.1093/ee/nvw152.
4. Type: Conference Papers and Presentations Status: Published Year Published: 2017 Citation: Moore, Aubrey, Roland Quitugua, Trevor Jackson, Sean Marshall, and Mattew Siderhurst. 2017. ?Invasion of Guam by the Coconut Rhinoceros Beetle.? presented at the 8th Regional Island Sustainability Conference, Tumon, Guam, April 20.

PROGRESS: 2015/10/01 TO 2016/09/30
Target Audience:I provided information to the Guam Plant Extinction Prevention Project staff and the United States Fish and Wildlife Service staff at the Guam National Wildlife Refuge. This information included identification of insect specimens given to me and recommendations on plant protection. Fact sheets on newly arrived invasive species were prepared and made available to the public in print and on web site. Changes/Problems:Progress on this project was slow during the reporting period because the PD was focused on finding a solution to the an outbreak of a coconut rhinoceros beetle biotype (CRB-G) which has escaped from biological control by Oryctes nudivirus which has previously quelled CRB outbreaks on Pacific Islands. What opportunities for training and professional development has the project provided?Informal training in insect specimen collection and preservation was provided to staff of the Guam Plant Extinction Prevention Pogram (GPEPP) during several visits to the project's nursery and field sites. In some cases, pest control recommendations were provided. How have the results been disseminated to communities of interest?Fact sheets on newly arrived invasive insect species were prepared and these are available to the public in print and on-line. What do you plan to do during the next reporting period to accomplish the goals? USDA Forest Service has asked the PD to organise a forest insect workshop as part of a regional forestry meeting they are sponsering on Guam during April 2017 I plan to submit two refereed journal articles on recently arrived bark beetles species. I plan to host a visiting taxonomist to help identify a large backlog of unidentified specimens submitted to the University of Guam Insect Collection. If money is available, a student technician will be hired to coincide with the taxonomist's visit. I plan to migrate the University of Guam Insect Collection database from Biolink, a legacy biodiversity DBMS, to Specify to facilitate sharing data via GBIF. I will continue to populate the populate the Check List Plus database which will list all of Guam's forest insect pests, their host plants, and their biocontrol agents. This database will be made available on-line.

IMPACT: 2015/10/01 TO 2016/09/30
What was accomplished under these goals? A web application named CheckList Plus (CLP) was designed and developed to faciliate databasing and accessing information on Guam's forest pests. All organisms in CLP are linked to taxa in the taxonomy database maintained by the National Center for Biotechnology Information (NCBI). The NCBI taxonomy database is essentially a digitized tree of life which includes scientific names and synonyms including common names. Unlike many biodiversity databases, CLP allows definiton of trophic links between taxa. This allows queries to find all insect herbivores which feed on a particular host plant, or conversely, to find all host plants on which a particular insect feeds. The CLP is currently being populated with data from several sources: the scientific literature and specimen data from the University of Guam Insect Collection. Data from scientific literature are being mined using the Plazi Golden Gate Imagine Editor. Preparations are being made to migrated the University of Guam Insect Collection database from Biolink, a legacy biodiversity DBMS, to Specify to facilitate sharing data via GBIF. Many specimens of forest insect pests collected by the Guam Plant Extinction Prevention Program, the Guam National Wildlife Refuge, and other collaborators were accessioned into the University of Guam Insect Collection during the reporting period. Most of these specimens await identification by a taxonomist. During the 2016, taxonomic help was solicited from visiting insect taxonomists. Dr. Joshua B. Dunlap and Dr. Mary Liz Jameson, Department of Biological Sciences, Wichita State University, Kansas went through all of Scarabidae. Dr. Peter Maddison, PestNet, New Zealand, an expert on Pacific insects, spent about a week identifying unknowns.

PUBLICATIONS: 2015/10/01 TO 2016/09/30
1. Type: Journal Articles Status: Published Year Published: 2017 Citation: Moore, A., Barahona, D. C., Lehman, K. A., Skabeikis, D. A., Iriarte, I. R., Jang, E. B., & Siderhurst, M. S. (2016). Judas beetles: Discovering cryptic breeding sites by radio-tracking coconut rhinoceros beetles, Oryctes rhinoceros (Coleoptera: Scarabaeidae). Journal of Environmental Entomology 46(1) 92-99.
2. Type: Journal Articles Status: Published Year Published: 2016 Citation: Moore, A., Quitugua, R., Iriarte, I. R., Melzer, M., Watanabe, S., Cheng, Z., & Muna-Barnes, J. (2016). Movement of packaged soil Products as a dispersal pathway for coconut rhinoceros beetle, Oryctes rhinoceros (Coleoptera:Scarabaeidae) and other Invasive species. Proceedings of the Hawaiian Entomological Society, 48, 21?22.
3. Type: Journal Articles Status: Submitted Year Published: 2017 Citation: Marshall, S. D. G., Moore, A., Vaqalo, M., & Jackson, T. A. (2017). A new, virus-free haplotype of the coconut rhinoceros beetle (Oryctes rhinoceros) invades the Pacific region. Journal of Invertebrate Pathology.
4. Type: Conference Papers and Presentations Status: Other Year Published: 2016 Citation: Moore, A. (2016, March). Biological Invasion of Guam. Presented at the Micronesia Plant Pest Quarantine Workshop, Guam.
5. Type: Conference Papers and Presentations Status: Other Year Published: 2016 Citation: Moore, A. (2016, March). Update on the Guam Coconut Rhinoceros Beetle Infestation. Presented at the Micronesia Plant Pest Quarantine Workshop, Guam.
6. Type: Conference Papers and Presentations Status: Other Year Published: 2016 Citation: Moore, A. (2016, March). Update on the Guam Coconut Rhinoceros Beetle Infestation. Presented at the National Plant Diagnostics Network Conference, Washington, D.C.
7. Type: Conference Papers and Presentations Status: Other Year Published: 2016 Citation: Moore, A. (2016, April). Discovery of the Coconut Rhinoceros Beetle Guam Biotype and Implications for Global Control. Presented at the Entomological Society of America Pacific Branch Annual Meeting, Honolulu, Hawaii. Retrieved from http://guaminsects.net/GISC NOV2015/GISC NOV2015/Moore ESA PB APR2016.html
8. Type: Conference Papers and Presentations Status: Other Year Published: 2016 Citation: Aubrey Moore. (2016, June). Discovery of the Coconut Rhinoceros Beetle Guam Biotype and Implications for Global Control. Presented at the Future proofing the palm industries: Limiting damage by existing (CRB-P) and invasive (CRB-G) coconut rhinoceros beetle (Oryctes rhinoceros) in the Pacific, Suva, Fiji. Retrieved from http://guaminsects.net/GISC NOV2015/GISC NOV2015/Moore ESA PB APR2016.html
9. Type: Conference Papers and Presentations Status: Other Year Published: 2016 Citation: Moore, A., Quitugua, R., Jackson, T. A., Marshall, S. D. G., & Siderhurst, M. S. (2016, September). The rhinoceros beetle invasion of Guam: An unprecedented disaster. Presented at the XXV International Congress of Entomology, Orlando, FL. Retrieved from https://aubreymoore.github.io/CRB-G-ICE2016/Paper94967.html
10. Type: Conference Papers and Presentations Status: Other Year Published: 2016 Citation: Marshall, S. D. G., Vaqalo, M., Moore, A., Quitugua, R., & Jackson, T. A. (2016, September). Detection of an invasive biotype of Oryctes rhinoceros (L.) in the Pacific. Presented at the XXV International Congress of Entomology, Orlando, FL. Retrieved from https://aubreymoore.github.io/CRB-G-ICE2016/Paper95540.html

PROGRESS: 2014/11/28 TO 2015/09/30
Target Audience:I provided information to the Guam Plant Extinction Prevention Project staff and the United States Fish and Wildlife Service staff at the Guam National Wildlife Refuge. This information included identification of insect specimens given to me and recommendations on plant protection. Fact sheets on newly arrived invasive species were prepared and made available to the public in print and on web site. Changes/Problems:A planned visit by an insect taxonomist to assist in identification of a large backlog in the University of Guam Insect Collection did not happen during the reporting period because of schedualing problems. A visit by a taxonomist is being planned for 2016. What opportunities for training and professional development has the project provided?Informal training in insect specimen collection and preservation was provided to staff of the Guam Plant Extinction Prevention Pogram (GPEPP) during several visits to the project's nursery and field sites. In some cases, pest control recommendations were provided. How have the results been disseminated to communities of interest?Fact sheets on newly arrived invasive insect species were prepared and these are available to the public in print and on-line. What do you plan to do during the next reporting period to accomplish the goals?I plan to offer a workshop to staff of the Guam Department of Agriculture Forestry Division on survey and collection methods for forest insect pests. I plan to submit two refereed journal articles on recently arrived bark beetles species. I plan to host a visiting taxonomist to help identify a large backlog of unidentified specimens submitted to the University of Guam Insect Collection. A student technician will be hired to coincide with the taxonomist's visit.

IMPACT: 2014/11/28 TO 2015/09/30
What was accomplished under these goals? A web application named CheckList Plus (CLP) was designed and developed to faciliate databasing and accessing information on Guam's forest pests. All organisms in CLP are linked to taxa in the taxonomy database maintained by the National Center for Biotechnology Information (NCBI). The NCBI taxonomy database is essentially a digitized tree of life which includes scientific names and synonyms including common names. Unlike many biodiversity databases, CLP allows definiton of trophic links between taxa. This allows queries to find all insect herbivores which feed on a particular host plant, or conversely, to find all host plants on which a particular insect feeds. The CLP is currently being populated with data from several sources: the scientific literature and specimen data from the University of Guam Insect Collection. Many specimens of forest insect pests collected by the Guam Plant Extinction Prevention Program, the Guam National Wildlife Refuge, and other collaborators were accessioned into the University of Guam Insect Collection during the reporting period. Most of these specimens await identification by a taxonomist.

PUBLICATIONS: 2014/11/28 TO 2015/09/30
1. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Ares, M. A., N. Meneses, A. Smith, Aubrey Moore, and R. Benford. 2015. ? Molecular Identification of a Lepidopteran Herbivore on a Critically Endangered Tree.? In Northern Arizona Undergraduate Symposium.
2. Type: Journal Articles Status: Published Year Published: 2014 Citation: Fisher, Nicole, Aubrey Moore, Bradley Brown, Matthew Purcell, Gary Taylor, and John Salle. 2014. ?Two New Species of Selitrichodes (Hymenoptera: Eulophidae: Tetrastichinae) Inducing Galls on Casuarina (Casuarinaceae).? Zootaxa 3790 (4): 534{\textendash}542. http://biotaxa.org/Zootaxa/article/view/zootaxa.3790.4.2/7933.
3. Type: Journal Articles Status: Published Year Published: 2015 Citation: Moore, Aubrey, Trevor Jackson, Roland Quitugua, Paul Bassler, and Russell Campbell. 2015. ? Coconut Rhinoceros Beetles (Coleoptera : Scarabaeidae) Develop in Arboreal Breeding Sites in Guam.? Florida Entomologist 98 (3): 1012?14. http://journals.fcla.edu/flaent/article/download/84794/84044.
4. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Moore, Aubrey, and Western Pacific. 2015. ?Failure Analysis of the Guam Coconut Rhinoceros Beetle Eradication Project Aubrey Moore Western Pacific Tropical Research Center.? In Pacific Entomology Conference, 1?2. Honolulu.

5. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Moore, Aubrey, and Roland Quitugua. 2015. ?Coconut Rhinoceros Beetle Trap Improvements.? In Pacific Entomology Conference. Honolulu. http://guaminsects.net/anr/sites/default/files/pec2015-improved-traps.pdf.
6. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Moore, Aubrey. 2015. ?A Report on the Guam Coconut Rhinoceros Beetle Infestation.? In Pacific Plant Protection Organization. Nadi, Fiji.
7. Type: Conference Papers and Presentations Status: Published Year Published: 2015 Citation: Marshall, Sean David Goldie, Maclean Vaqalo, Aubrey Moore, Roland Quitugua, and Trevor A Jackson. 2015. ?A New Invasive Biotype of the Coconut Rhinoceros Beetle (Oryctes Rhinoceros) Has Escaped from Biocontrol by Oryctes Rhinoceros Nudivirus.? In International Congress on Invertebrate Pathology and Microbial Control and the 48th Annual Meeting of the Society for Invertebrate Pathology. Vancouver, BC. http://www.sipmeeting.org/van1/SIP2015-Full Program.pdf.
8. Type: Other Status: Published Year Published: 2015 Citation: Vaqalo, Maclean, Sean Marshall, Trevor Jackson, and Aubrey Moore. 2015. ?Pest Alert 51: An Emerging Biotype of Coconut Rhinoceros Beetle Discovered in the Pacific.? Suva, Fiji: Secretariat of the Pacific Community, Land Resources Division.

SUPPLEMENTARY DATA: Institution Type: SAES **Region:** 4 **Process Date:** 2014/11/28 **Progress Update:** 2018/01/04