

# Biological Invasion of Guam

Aubrey Moore

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

WEDA/WAAESD Joint Summer Meeting, Guam  
July 11, 2018



## Outline

- 1 Introduction
  - 2 Brown treesnake
  - 3 Asian Cycad Scale
  - 4 Coconut Rhinoceros Beetle
  - 5 Little Fire Ant

# Introduction

# Welcome to Guam



# HIPPO Threatens Guam's Biodiversity!



# HIPPO Threatens Guam's Biodiversity!



- H** Habitat loss
- I** Invasive Species
- P** Pollution
- P** Human Population
- O** Overharvesting

# Definition of 'Invasive Species'



**Invasive species** means an **alien** species whose introduction does or is likely to cause economic or environmental **harm** or harm to human health.

Executive Order 13112

President William Clinton

February 3, 1999

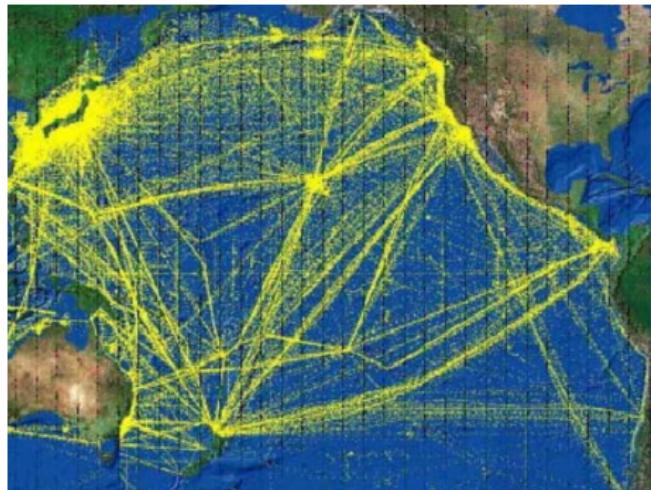
**invasive species** were previously referred to as **exotic pests**

Small tropical islands are susceptible to damage by invasive species



- no winter
- no predators, parasites, or diseases: 'escape from natural enemies'

# Invasive Species Arrival Rate



Rate of invasive species arrivals is correlated with **globalization** and **containerization**.

# Kahului Airport Pest Risk Assessment (KARA)

- comprehensive inspection of all agricultural produces was performed on 130 days between September 2000 and July 2001
- specimens were identified to species



- 125 species of pest insects and 16 plant diseases not known to occur in Hawaii were intercepted at Kahului during the 130 days of KARA inspections
- **1 new invasive species arrived every day!**

<http://www.hawaiiaag.org/PQ/KARA20Report20Final.pdf>

# Impact of invasive species on Guam

- Almost all of Guam's pests are invasive species
- One third of the "100 World's Worst Invasive Species" list published by the IUCN Invasive Species Specialist Group occur on Guam

## Impediments to Dealing with Invasive Species on Guam

- We suffer from the **Taxonomic Impediment**.
  - Professional capacity is inadequate.
  - Even when we manage to detect invasive species, our findings are rarely published in the scientific literature.
  - Arrivals of and impacts of invasive species impacts on small islands are grossly under-reported.

# Major Biological Invasions on Guam

- Brown treesnake (arrived around 1945)
  - Killed most of Guam's birds and small mammals. Caused 7 bird extinctions.
- Asian Cycad Scale (detected 2003)
  - Threatens survival of Guam's endemic cycad, listed as the most numerous tree on Guam in the 2002 Forest Service survey.
- Coconut Rhinoceros Beetle (detected 2007).
  - Threatens coconut palms, listed as the 2nd most numerous tree on Guam in the 2002 Forest Service survey.
- Little Fire Ant (detected 2011)
  - Threatens most animals remaining in Guam's forests.

# Brown treesnake

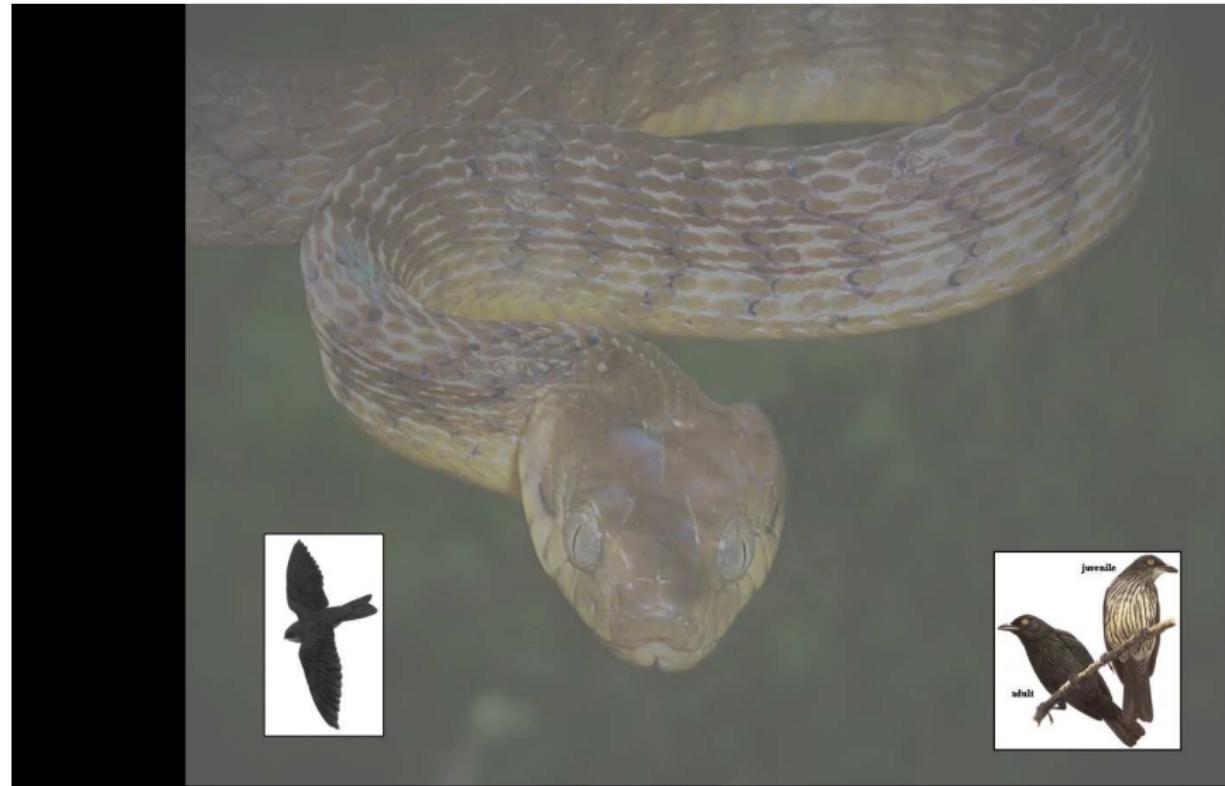
# Bird extinction by brown treesnake



# Forest Birds before BTS



# Forest Birds after BTS



# Loss of Ecosystem Services Provided by Birds



# EurekAlert!

The Global Source for Science News



AAAS

HOME

NEWS

MULTIMEDIA

MEETINGS

PORTALS

ABOUT

PUBLIC RELEASE: 9-JUL-2018

## Birds eat 400 to 500 million tonnes of insects annually

*Along with spiders, insectivorous birds play a vital role in consuming insects that would otherwise destroy forests or crops*

"Birds are an endangered class of animals ... we must fear that the vital ecosystem services that birds provide - such as the suppression of insect pests - will be lost." says Nyffeler.

- Millions of dollars per year are spent on preventing BTS from leaving Guam.
- Some funds are being used for control methods development: snake-proof barriers and "pinkies on parachutes".

# Asian Cycad Scale

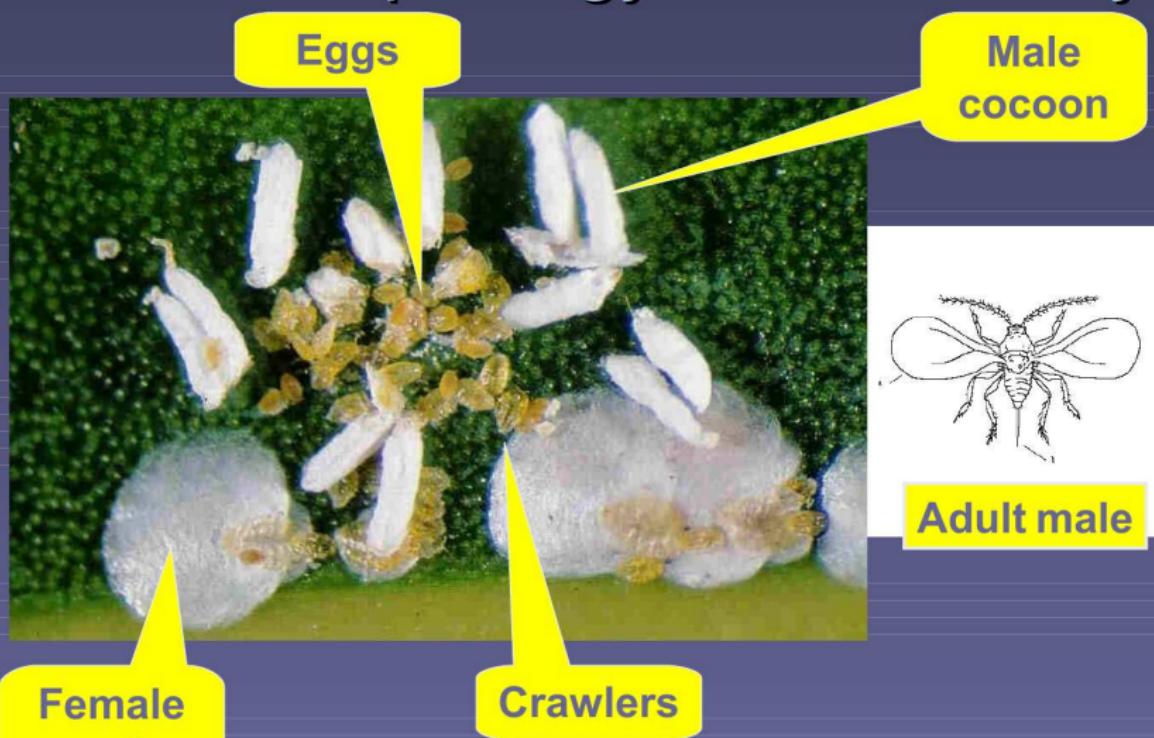


Asian cycad scale, *Aulacaspis yasumatsui* (HEMIPTERA: DIASPIDIDAE)

# Asian Cycad Scale - Origin and Pathway

- Origin: Southeast Asia
- Florida
- Hawaii 1998
- Guam 2003
- Rota 2005?
- Palau 2005?

# Scale Morphology & Life History









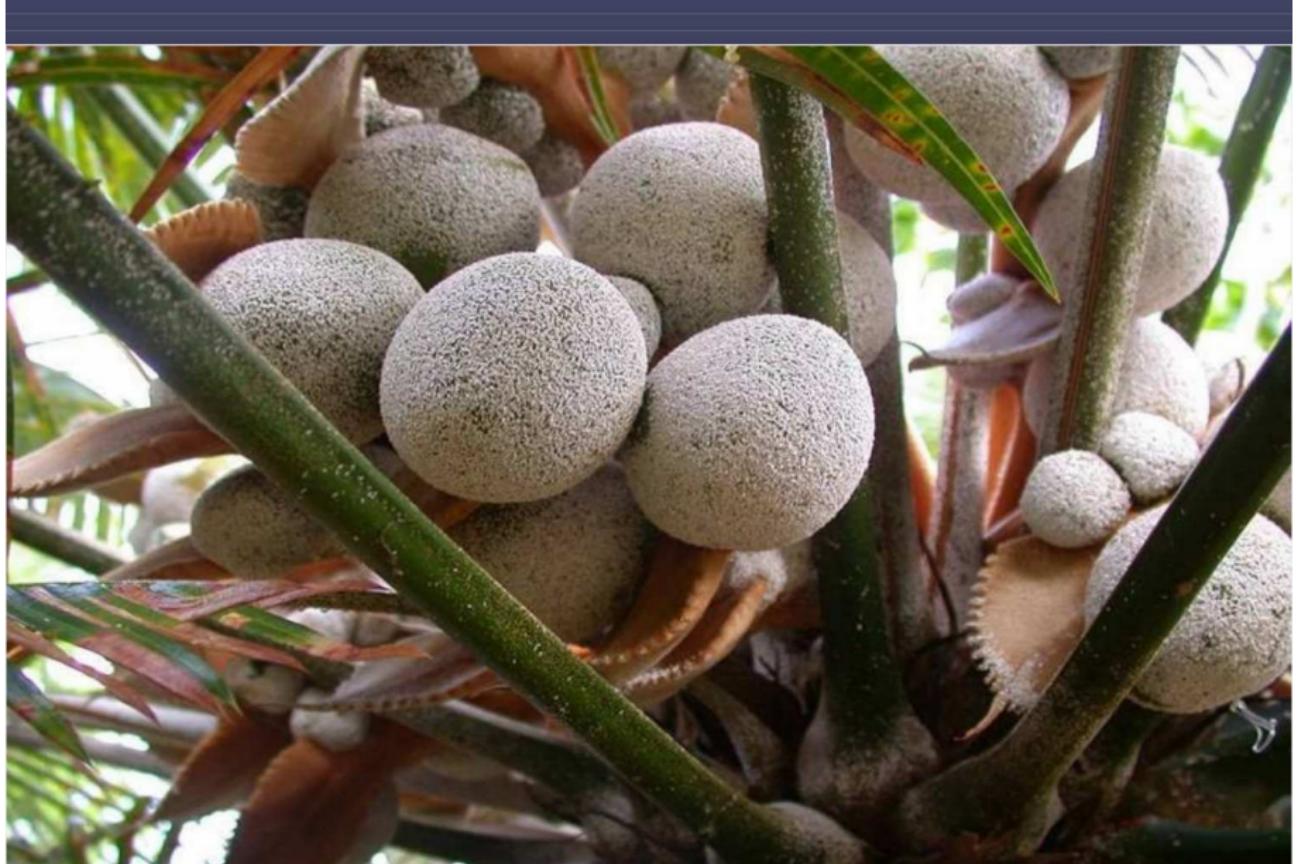


















25



2013-02-10  
ENCYRTIDAE  
*Arrhenophagus?* sp.  
parasitizing male  
*Aulacaspis ysumatsui*  
infesting *Cycas*  
*micronesica*



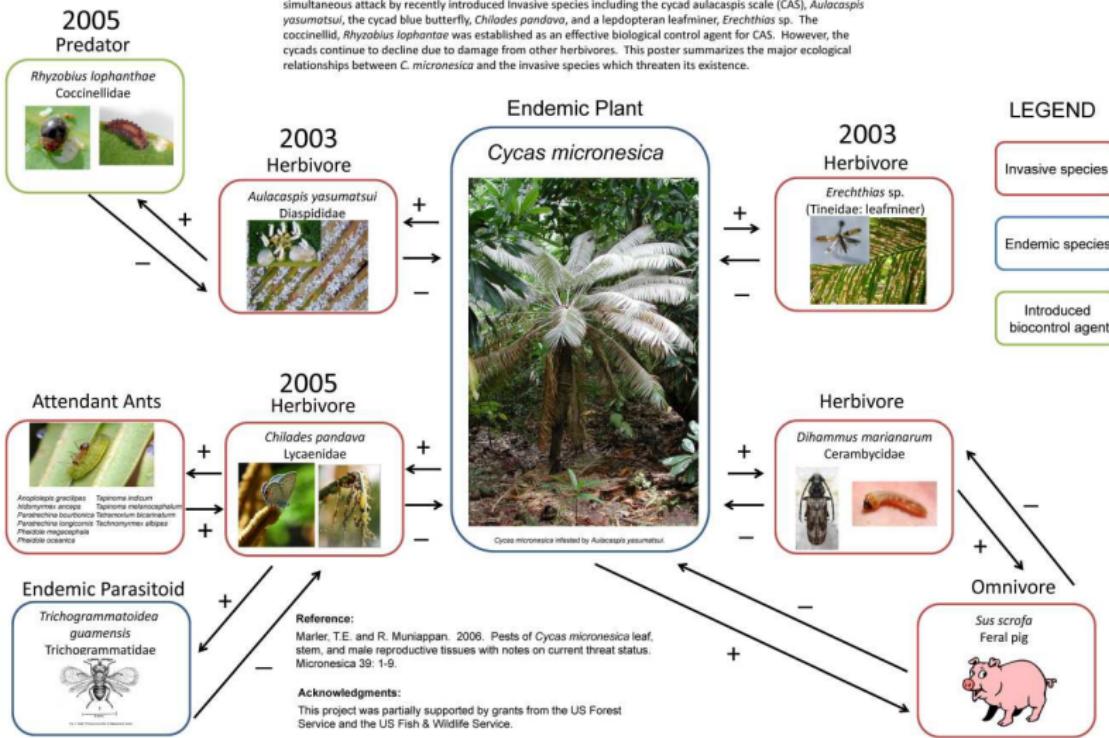
# Massive mortality of *Cycas micronesica* by invasive species

## A Coalition of Invasive Species Attacks Guam's Native Cycads

Aubrey Moore\*, Ross Miller, and Thomas Marler

Western Pacific Tropical Research Center, University of Guam, Mangilao Guam 96923

A 2002 forest survey listed *Cycas micronesica* as the most numerous tree-sized plant in Guam's forests. In 2006 *C. micronesica* was placed on the IUCN Red List of Threatened Species in response to high mortality from simultaneous attack by recently introduced invasive species including the cycad aulacaspis scale (CAS), *Aulacaspis yasumatsui*, the cycad blue butterfly, *Chilades pandava*, and a lepidopteran leafminer, *Erechthias* sp. The coccinellid, *Rhyzobius lophanthae* was established as an effective biological control agent for CAS. However, the cycads continue to decline due to damage from other herbivores. This poster summarizes the major ecological relationships between *C. micronesica* and the invasive species which threaten its existence.



## Asian Cycad Scale - Current Status on Guam

- 90% of Guam's endemic cycads have been killed by the scale and other invasive species
  - Mature plants are protected by the biocontrol beetle, but no natural reproduction is occurring
  - *Cycas micronesica* placed on the US National Endangered Species List in 2015. (Was the most abundant tree on Guam in 2002.)

# Coconut Rhinoceros Beetle

# Coconut rhincoceros beetle



*Oryctes rhinoceros* Biotype G

# Geographic Distribution of Coconut Rhinoceros Beetle

native range

first detected in the 20th century

first detected in the 21st century

open circle: population includes CRB-G biotype

filled circle: population is exclusively CRB-G biotype

© Mapbox © OpenStreetMap Improve the underlying map

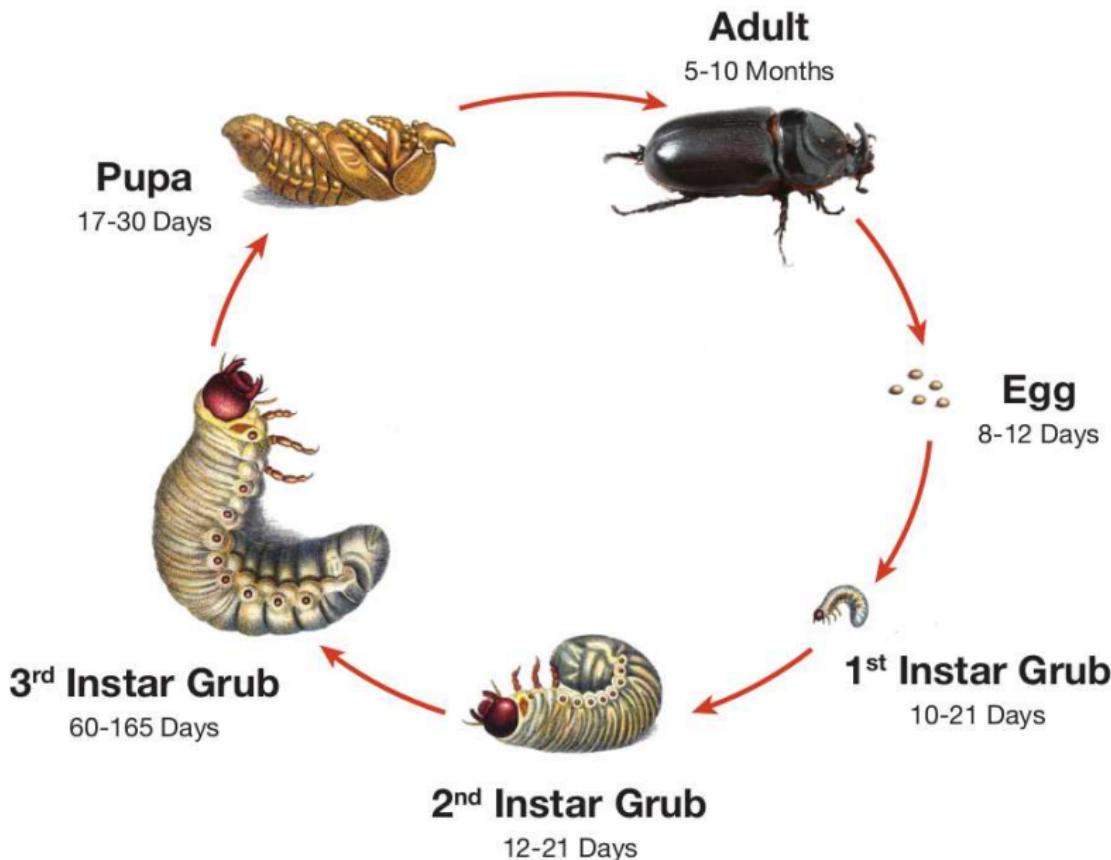


map.geojson rendered with ❤ by GitHub

<http://aubreymoore.github.io/crbdist/mymap.html>.



# Coconut Rhinoceros Beetle Life Cycle



## CRB POPULATION GROWTH ASSUMING UNLIMITED RESOURCES

- generation 0: 2
- generation 1: 100
- generation 2: 5,000
- generation 3: 250,000
- generation 4: 12,500,000
- generation 5: 625,000,000
- generation 6: 31,250,000,000

# Coconut rhincoceros beetle



# Coconut rhincoceros beetle



# Coconut rhincoceros beetle

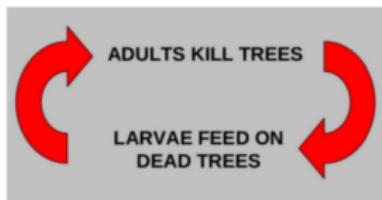


Figure : Coconut palms killed by *Oryctes rhinoceros* in Fiji (photo by Bedford)

# Coconut rhincoceros beetle



- A typhoon leaves large numbers of potential CRB breeding sites
- Large numbers of CRB adults emerge from these sites and kill many coconut palms
- Dead standing coconut palms generate even more CRB adults which kill even more palms.

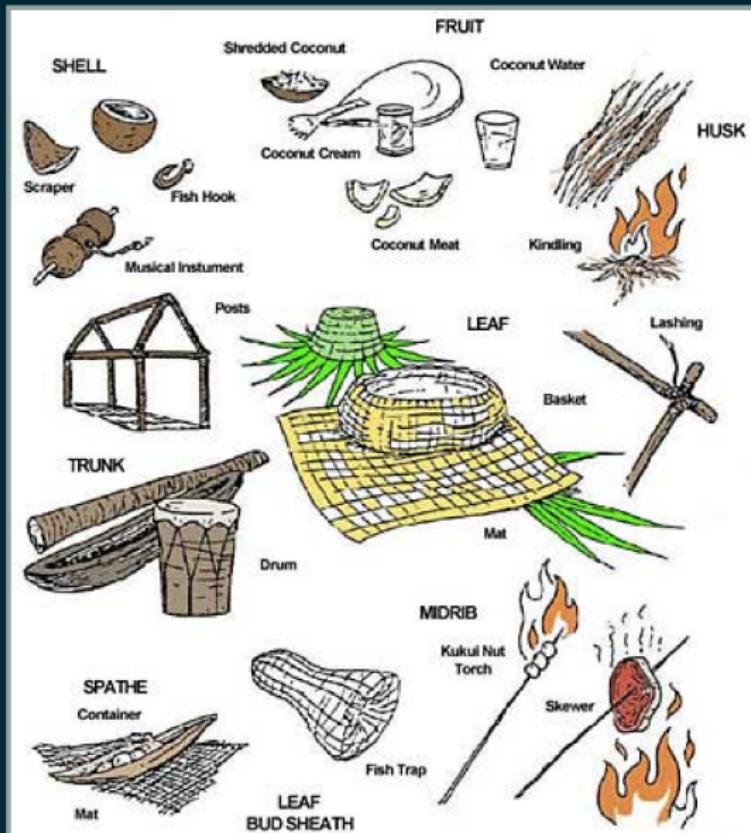
# Coconut Rhinoceros Beetle - Current Status on Guam

- Mature coconuts and other palms are rapidly being killed by an uncontrolled outbreak of CRB-G which was triggered by Typhoon Dolpine in 2016
- Damage estimates are not available. History from Palau suggests that we will lose 50% or more of our palms if the outbreak is not controlled.
- A search for an effective biological control agent, most likely a new isolate of *Oryctes nudivorus* is under way.
- If current outbreaks of CRB-G cannot be controlled, CRB-G will spread to other islands and possibly the Americas.

# LFA - Prognosis for Guam

- A search for an effective biological control agent, most likely a new isolate of *Oryctes rhinoceros* nudivirus is under way.

# Coconut rhincoceros beetle



# Coconut rhincoceros beetle



Sea level in the Solomons has risen 8 mm per year since 1993.

Source: <https://www.sprep.org/climate-change/sea-level-in-solomon-islands-predicted-to-rise-over-8mm-in-the-coming-century>



# Coconut rhincoceros beetle



# Little Fire Ant



Little fire ant, *Wasmannia auropunctata* (HYMENOPTERA: FORMICIDAE)

- Forms supercolonies with multiple queens
- Nests in trees and on ground



Little fire ants are little :)

# LFA - Biology



A reaction to little fire ant stings in Papua New Guinea (© Cas Vanderwoude)



Little fire ant stings in Papua New Guinea (© Cas Vanderwoude)

# LFA - Biology



*These domestic animals have been blinded by little fire ants (© Cas Vanderwoude)*



*Little fire ants not only sting, but support sap-sucking insects which encourage plant diseases like the fungus shown here growing on coffee  
(© Cas Vanderwoude)*

# Little Fire Ant - Origin and Pathway

- Origin: South America
  - Florida 1920s
  - Hawaii 1999
  - Guam 2011
  - Yap 2017

# LFA - Detection on Guam



LFA discovered by CRB crew at Primo Greenwaste Dump Site in Yigo in 2011.

# LFA - Current Status on Guam

- Eradication from Guam is not feasible
- LFA occurs at 20+ dispersed sites on Guam and continues to spread
- Effective ant baits and application methods are available for local control programs

# LFA - Prognosis for Guam

- There are no known biocontrol agents for island-wide control of LFA
- Will impact quality of life for humans and pets
- Possible impacts on tourism
- Impacts on natural ecosystems are unpredictable

**Invasive species aren't all bad.  
They provide job security for biologists.**

