Natural Enemies of Lebbeck Mealybug

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Invasive invertebrates are a huge problem

- Responsible for ~$120 billion in damages to the U.S. economy every year (Pimentel et al. 2005)
- Threaten Florida's agriculture, natural resources, and food industries, which contribute over $160 billion in revenue to the state's economy (Hodges et al. 2017)
- Ecologically: can upend essential ecosystem services and have unpredictable, cascading impacts

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What is biological control?

Essentially, using **“top-down” pressure** to our advantage

“The use of living organisms to suppress the population of a specific pest organism, making it less abundant or less damaging than it would otherwise be” (Eilenberg et al. 2001)

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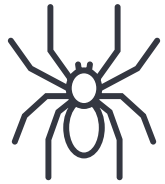
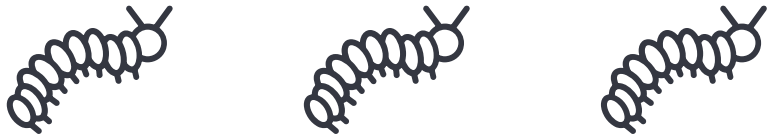
“Normal” or “Balanced” system (<u>with</u> top-down pressure)



- Predator eats pest
- Enough pests survive to reproduce, but not overwhelm
- Plants are eaten, but it’s manageable
- Populations cycle up and down, but are within historic limits



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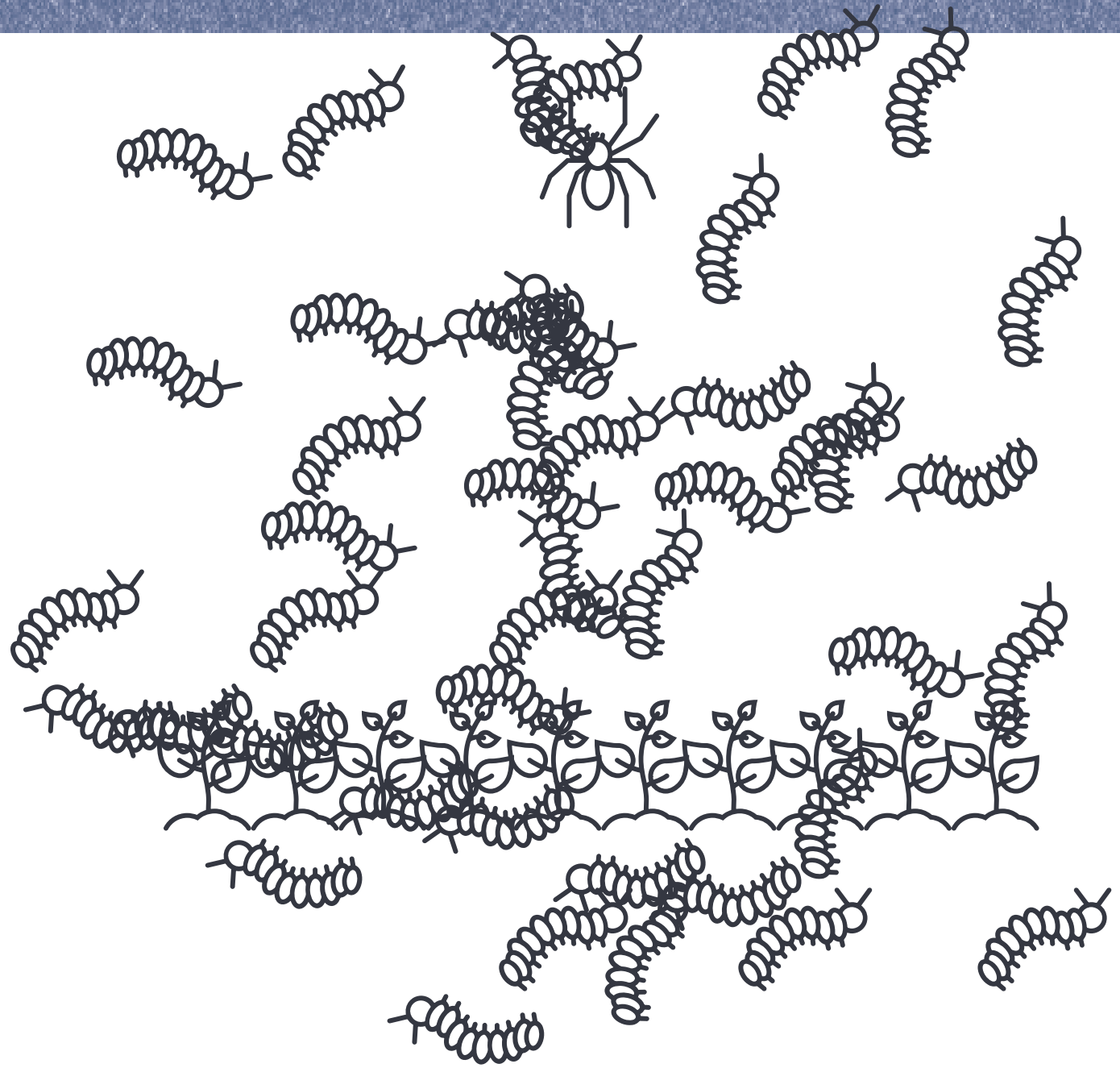
Predator is <u>not</u> present (Top-down pressure removed)

- Predator is not present to eat pest
- Pest population grows unchecked
- Too many plants eaten
- Ecological meltdown



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Classical biological control

- Introduction of a specialized natural enemy of an invasive species to reduce that species' population or impact
- Highly regulated
  - Permits and quarantine facilities
  - Risk analysis, efficacy, and host specificity testing
  - Typically takes 5-10 years to get approval for release (if ever)

JW Lotz, FDACS

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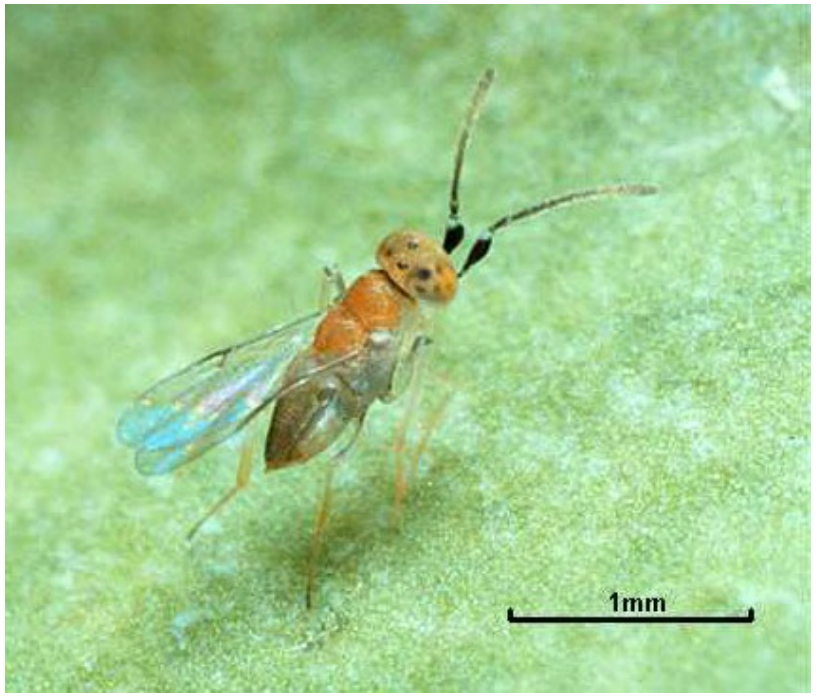
Classical biological control of mealybugs

- Many success stories!
  - Papaya mealybug (*Paracoccus marginatus*) in Palau (Muniappan et al. 2006)
    - Released three parasitoid species
    - Reduction of *P. marginatus* to below detectable levels
    - Note that one parasitoid species was not recovered after release
  - Mango mealybug (*Rastrococcus invadens*) in Benin (Murphy and Laing 1995)
    - Released *Gyranusoidea tebygi* Noyes (Hymenoptera: Encyrtidae)
    - ~50% reduction in infestation
  - And more!



Gyranusoidea tebygi Noyes (Hymenoptera: Encyrtidae)
Photo & © Georg Goergen

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Why are mealybugs so difficult to manage?

- Cryptic
- Difficult to identify
- Protected by wax
- Insecticide resistance
- Fast reproduction
- **Natural enemies are key in regulating their populations**

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ENTOMOPHAGA 40 (1), 1995, 105-117

EFFECT OF NATIVE NATURAL ENEMIES ON THE POPULATION DYNAMICS OF THE GRAPE MEALYBUG, *PSEUDOCOCCUS MARITIMUS (HOM.: PSEUDOCOCCIDAE)*, IN APPLE AND PEAR ORCHARDS

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Washington State University, Tree Fruit Research and Extension Center, 1100 N. Western Ave., Wenatchee, WA. 98801, USA

The impact of native natural enemies on populations of the grape mealybug, *Pseudococcus maritimus* (Ehrhorn) in apple and pear orchards was assessed using a combination of techniques, including exclusion cages, limb-banding, and visual inspection of shoots and fruits. The complex of native natural enemies (which included two encyrtid parasitoids, (*Pseudaphycus websteri* Timberlake and *Mayridia* species), a coccinellid beetle (*Hyperaspis lateralis* Mulsant), and a chamaemyiid fly (*Leucopis verticalis* Malloch), provided reasonably good control in orchards that had not been treated with insecticides for one to two years. However, surveys indicated that most of these species were absent from orchards regularly sprayed with pesticides.

KEY-WORDS: biological control, *Pseudaphycus*, Encyrtidae, *Hyperaspis*, Coccinellidae, *Leucopis*, Chamaemyiidae, orchard.

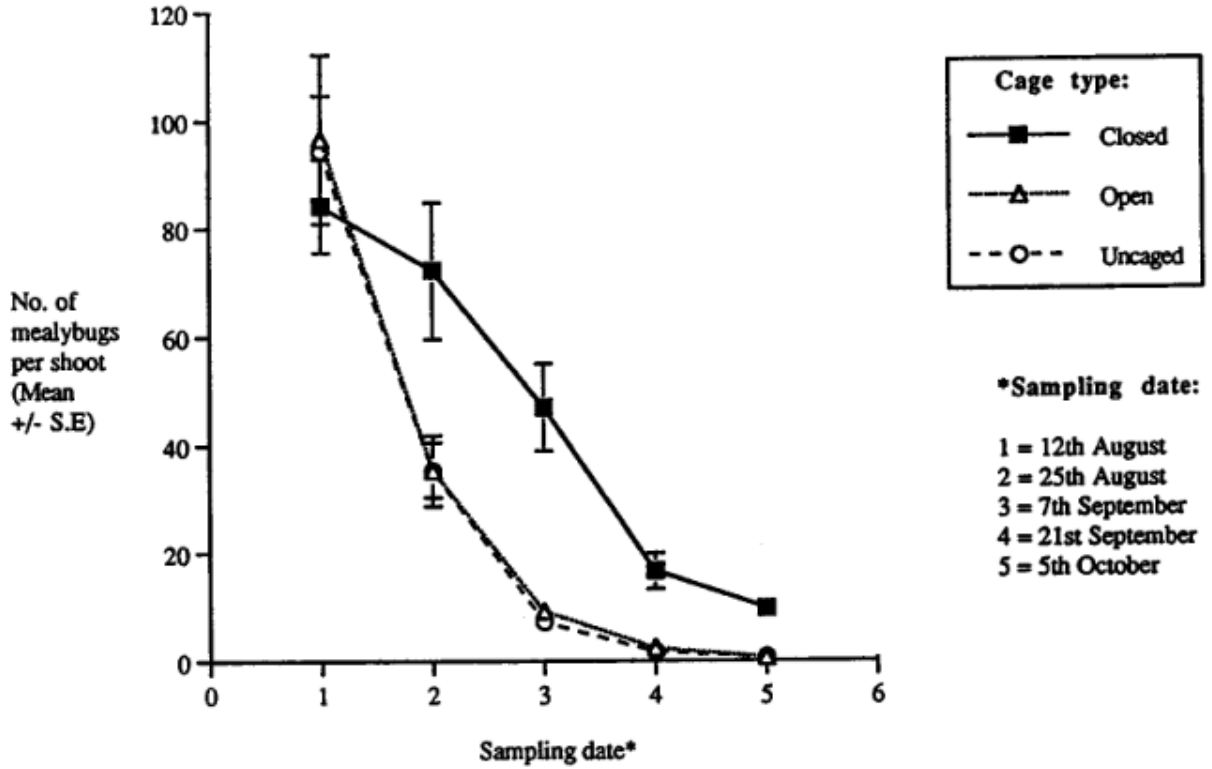

Fig. 2. Survival of *P. maritimus* in natural enemy exclusion cages, second generation (unsprayed apple site).

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Nipaecoccus viridis in Florida

- Invaded Florida in 2009 (Stocks and Hodges 2010)
- Did not begin causing widespread economic losses until 2019 (Ahmed et al. 2019).
- Feeding reduces yield and can kill trees (Diepenbrock and Ahmed 2021)
- Many other crops impacted

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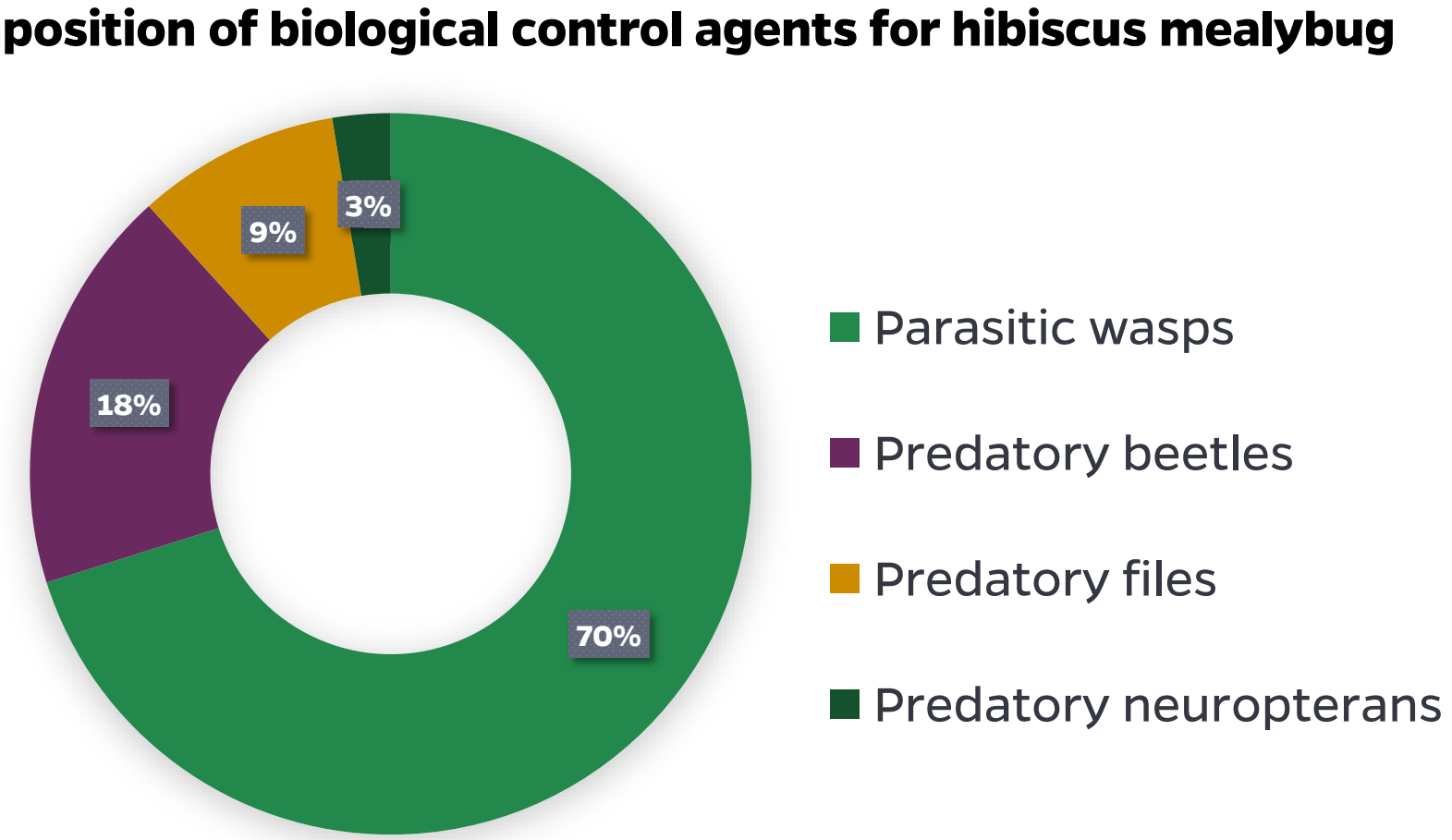
Composition of biological control agents for Lebbeck mealybug (outside of Florida)



Sharaf and Meyerdirk, 1987

Generalist predators known to attack hibiscus mealybug

1) Predators

- *Cryptolaemus montrouzieri* (Coleoptera: Coccinellidae)

  → Mealybug destroyer

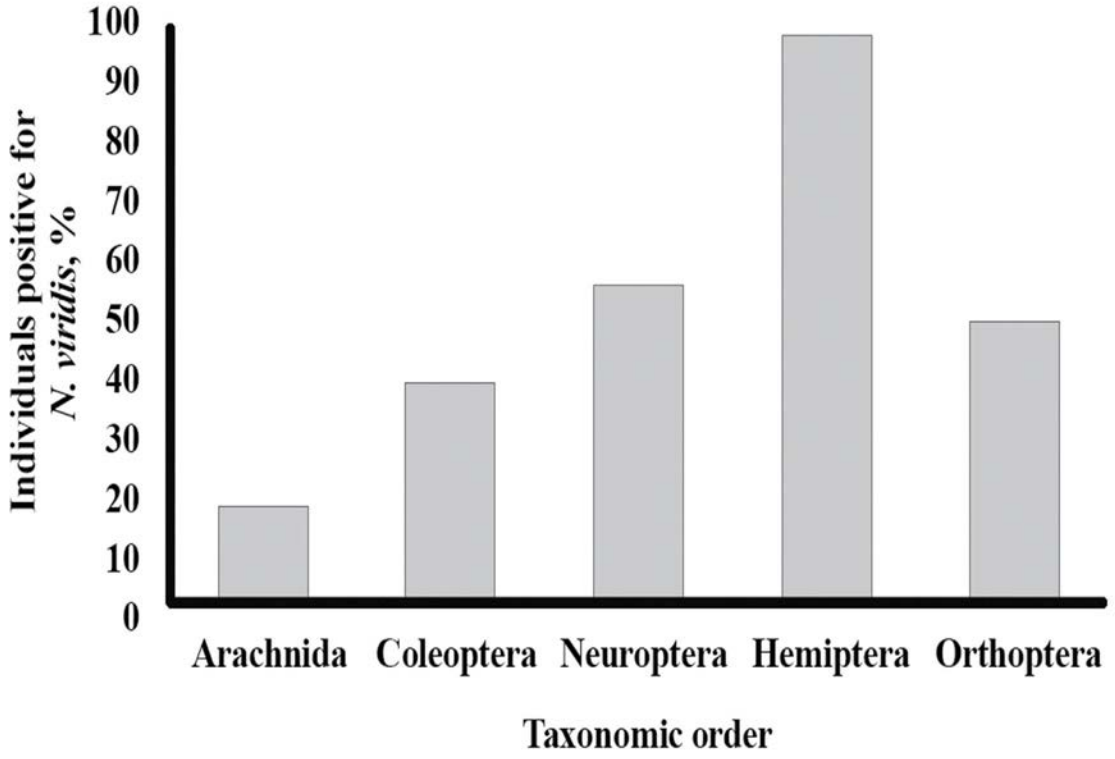
  → Killed 82% of population in Pomelo (Mani and Krishnamoorthy, 2008)

- *Nephus arcuatus* (Coleoptera: Coccinellidae)

  → Promising agent for eggs (Löbl and Smetana, 2007; Zarghami et al., 2016)

Cryptolaemus montrouzieri
Photo: Koppert

Predators of *N. viridis* in Florida



Predator	Abundance	Positive for *N. viridis* (%)
C. montrouzieri	23	43.48
Adult	15	46.67
Juvenile	8	37.5
Ceraeochrysa	8	50
Adult	5	40
Juvenile	3	66.67
Chrysoperla	5	40
Adult	3	33.33
Juvenile	2	50

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Gaines et al., 2022

Parasitoids known to attack hibiscus mealybug

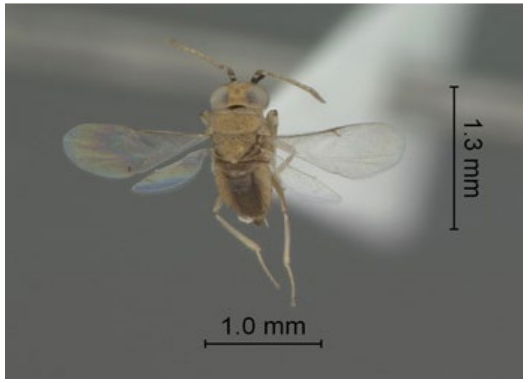
2) Parasitoids

Anagyrus indicus
Photo: Olabiyi et al., 2023

Not present in FL (yet)

Anagyrus dactylopii
Photo: Hyojin Jeong

Present in FL



Anagyrus mirzai
Photo: BA Bhuiya

Unknown

Leptomastix dactylopii
Photo: Salman AL Shami

Present in FL

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Anagyrus indicus:
A promising candidate classical biological control agent

- Common in the native range
- Relatively host specific (based on field observations)
- Has spread and established in other countries and territories
  - Guam:
    - Adventive
    - Became dominant parasitoid of *N. viridis.*
    - 42-88 % of *N. viridis* were parasitized by *A. indicus*! (Nechols 2003)
  - Jordan:
    - Intentional release
    - One year after release became dominant parasitoid of *N. viridis* and greatly reduced infestation (Meyerdirk et al. 1988)

Current biological control of hibiscus mealybug in FL

1) Not fully understood
   - Lack of information on its parasitoids and effectiveness on hibiscus mealybug and their interaction.

2) Preparing classical biological control program
   - Early stage

Important to gather baseline information for biological control of hibiscus mealybug

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Survey of mealybug parasitoids

Yellow pan trap

Sentinel host

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Preliminary Results: Yellow pan traps

- Among 272 specimens, 56 Chalcidoidea and 6 Encyrtidae were collected

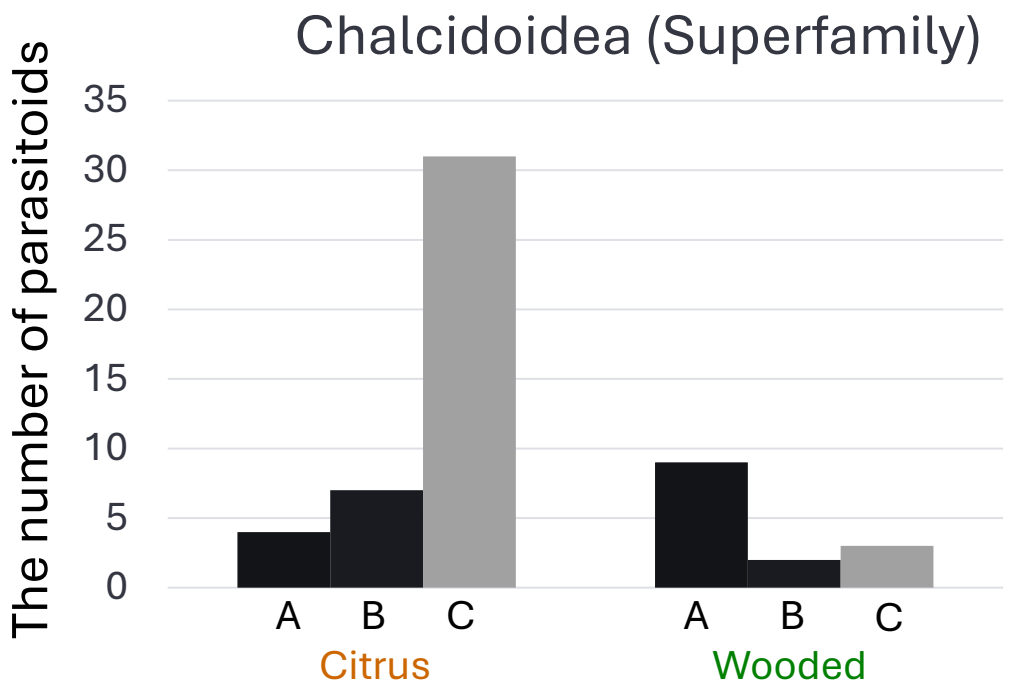

Figure 1. Total Chalcidoidea by site and habitat

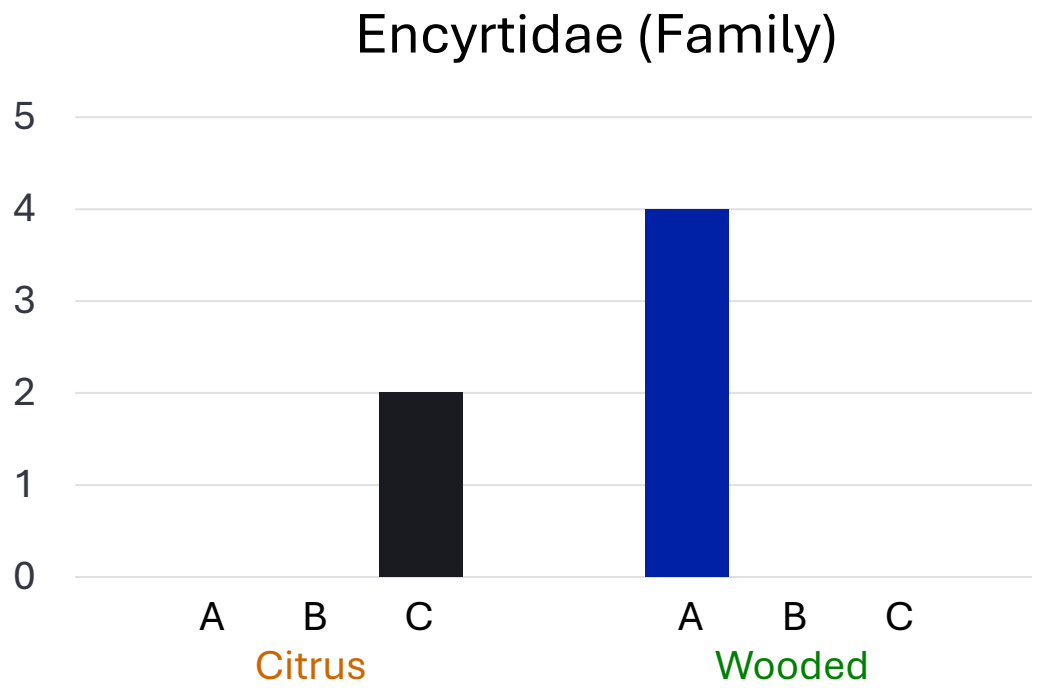

Figure 2. Total Encyrtidae by site and habitat

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Anagyrus sp1.

Anagyrus sp2.

Gyranusoidea sp.

Cerchysiella sp.

Photos credit: Robert Kresslein

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Ongoing parasitoid work

- Field: expand survey
- Laboratory:
  - Optimize rearing
    - Augmentative releases?
  - Improve understanding of lebbeck/parasitoid interactions
    - Improve performance
  - Prepare for candidate classical biological control agent

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Questions?

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Thank You

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