

## How to Control Soil Insects with Beneficial Nematodes

Ed Lewis  
Department of Entomology  
Department of Nematology  
University of California, Davis

### Using Microbials in IPM

- Do not have to change everything about crop management
- Many microbial insecticides fit into current production plans with minimal effort and change
- They require specialized information about their use

### Management Options

- Whether to treat
- When to treat
- What to use
- How to use it

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

## Insect pathogens can be effective

- Naturally occur
  - Even in intensively managed systems
- Have an impact on insect populations at natural levels

---

---

---

---

---

## Necessary information: Products

- Shelf life
- Storage conditions
- Resting stage?
- Viability in field
- Host range
- Time to kill
- What does an infected insect look like?

---

---

---

---

---

## Recognized Species of Entomopathogenic Nematodes

<i>H. bacteriophora</i>	<i>H. marelatus</i>
<i>H. brevicaudis</i>	<i>H. megidis</i>
<i>H. hawaiiensis</i>	<i>H. zealandica</i>
<i>H. indica</i>	<i>H. argentinensis</i>
<i>S. kraussei</i>	<i>S. karii</i>
<i>S. arenarium</i>	<i>S. kushidai</i>
<i>S. bicornutum</i>	<i>S. longicaudum</i>
<i>S. carpocapsae</i>	<i>S. monticolum</i>
<i>S. caudatum</i>	<i>S. neocurtillae</i>
<i>S. ceratophorum</i>	<i>S. oregonense</i>
<i>S. cubanum</i>	<i>S. puertoricense</i>
<i>S. feltiae</i>	<i>S. rarum</i>
<i>S. glaseri</i>	<i>S. riobrave</i>
<i>S. intermedium</i>	<i>S. ritteri</i>
<i>S. affine</i>	<i>S. scapterisci</i>

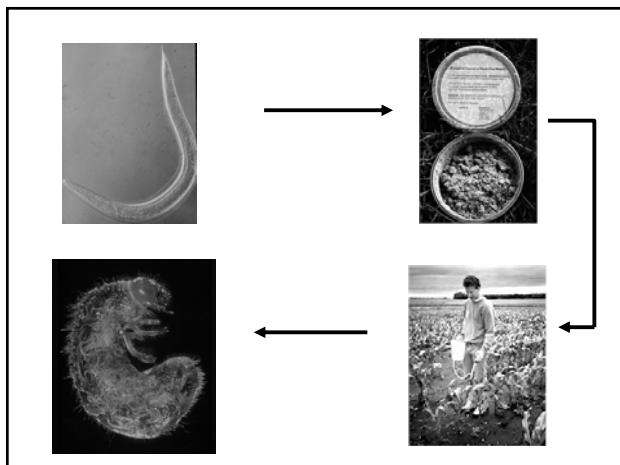
---

---

---

---

---




---



---



---



---



---



---



---

### Infective Juveniles

- Resistant to Environmental Extremes
- Only Function is to Find A New Host
- No Feeding
- No Development
- No Reproduction
- Only Life Stage Outside the Host

---



---



---



---



---

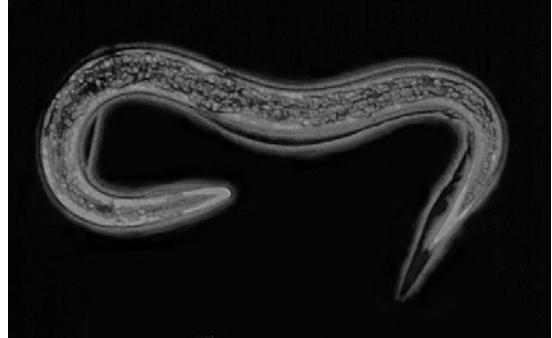


---



---

### Infective Stage Juvenile *Steinernema carpocapsae*




---



---



---



---



---

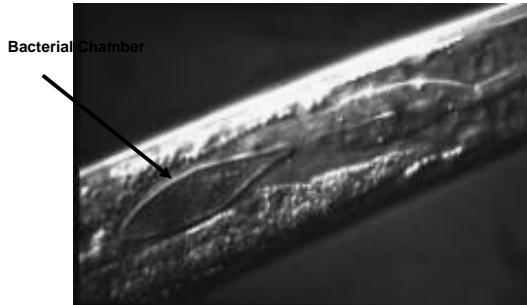


---



---

### Symbiotic Bacteria Released



### Mating for *Steinernema* spp.



Two to three generations occur in a single host.

About 6 days after the original infection, this is the appearance



---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

## New Infective Juveniles in 10 Days



---

---

---

---

---

---

## Entomopathogenic Nematodes Can Control:

- **Weevils:**  
Diaprepes root weevil, *Diaprepes abbreviatus*  
Blue green weevils, *Pachnaeus* spp.  
*Otiorrhynchus* spp.  
Bill bugs
- **Fungus gnats:** e.g., Sciaridae

---

---

---

---

---

---

## Entomopathogenic Nematodes Can Control:

- **Scarab larvae:** e.g., Japanese beetle, *Popillia japonica*, Chafer, etc.
- **Lepidoptera:**  
Black cutworm, *Agrotis ipsilon*  
Codling moth, *Cydia pomonella*  
Leafminers, *Liomyza* spp.  
Banana moth, *Opogona sacchari*  
Navel Orangeworm, *Amyelois transitella*
- **Other:** fleas, mole crickets

---

---

---

---

---

---

## **Some Things to Remember About Entomopathogenic Nematode Products**

---

---

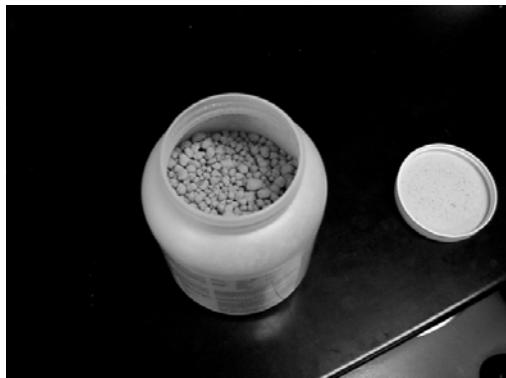
---

---

---

---

### **Products Can Be Deceiving**



---

---

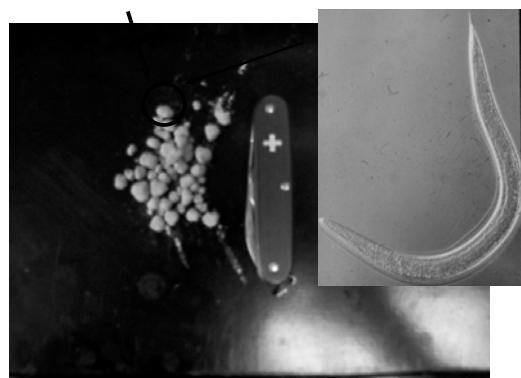
---

---

---

---

### **Live Infective Stage Nematode**



---

---

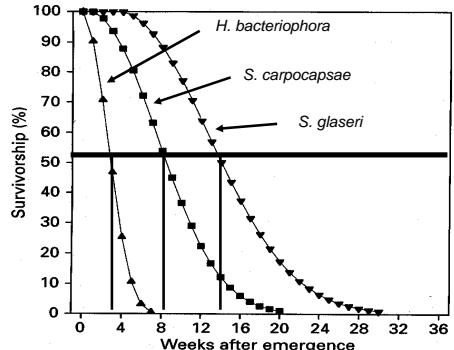
---

---

---

---

## Infective Stage Survival



## How Long Do They Last?

Formulation	Shelf-life (storage method)
Sponge	2 Months (Refrigerated)
Vermiculite	3-5 Months (Refrigerated)
Dispersable Granule	2-5 Months (Room Temperature)

## How Do We Figure Out Where and When to Use them?

- Climate
- Soil Types

## Special considerations for applying microbials

- Not chemical pesticides
  - Storage
  - Application
- Special habitat requirements
- Realistic expectations
  - Kill slower than chemicals
  - Will not (usually) completely eliminate pests

---

---

---

---

---

---

## Case Study

- Entomopathogenic nematodes to manage *Diaprepes abbreviatus* (citrus root weevil) in Florida and California



---

---

---

---

---

---

Citrus Root Weevil Adult



---

---

---

---

---

---

### *Diaprepes* Damage



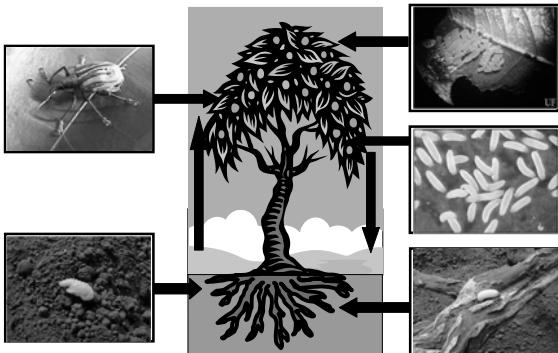
Southport Grove, Osceola County, FL

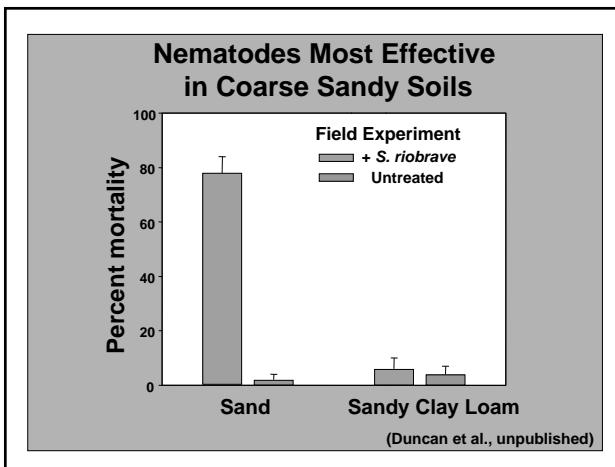


### What makes *Diaprepes* difficult to control?

- 270 known host plant species
- asynchronous, complex, variable life history
- high fecundity, protected egg masses
- many pesticides are ineffective against soil-dwelling larvae
- many natural enemies have limited, patchy distributions

### *Diaprepes abbreviatus* Life Cycle





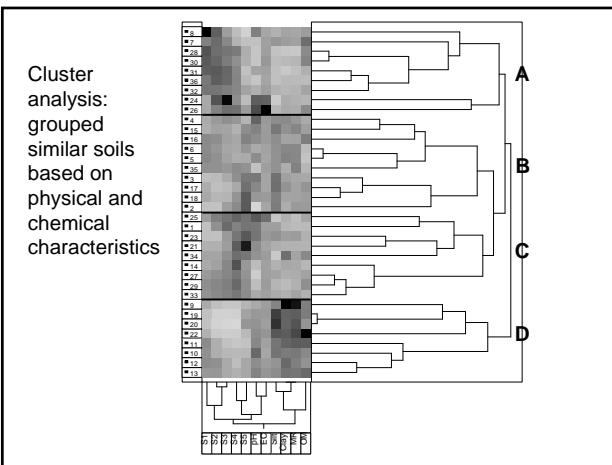
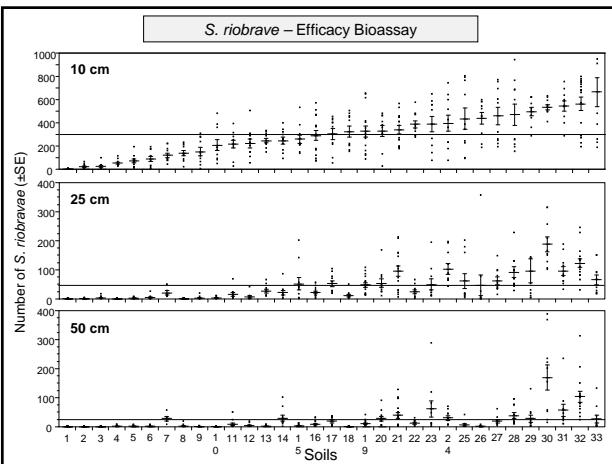
## What to do in California?

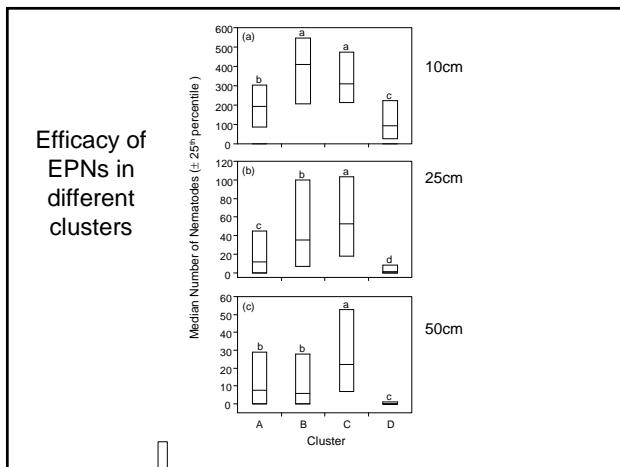
- Soil type has major impact on efficacy
- Soils in California much more diverse than in Florida

## Objective

- Develop methods to determine whether or not entomopathogenic nematodes will be effective biological control agents of citrus root weevils in CA citrus

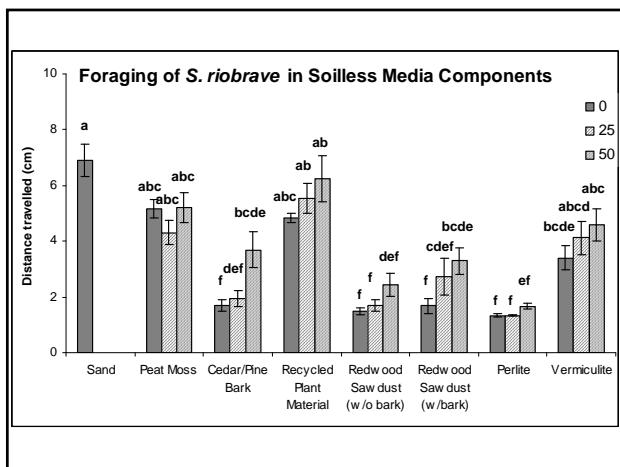
## Column Assay Units





## Using This Information

Can soilless media be constructed to enhance persistence and efficacy of microbial insecticides?



## How to Make EPNs Work?

- Product quality
- Product suitability
- Application rates
- Application timing
- Environmental conditions
- Substrate conditions

---

---

---

---

---

---

---