

# Recent Advances in BioControl of Brazilian Peppertree, *Schinus terebinthifolia*

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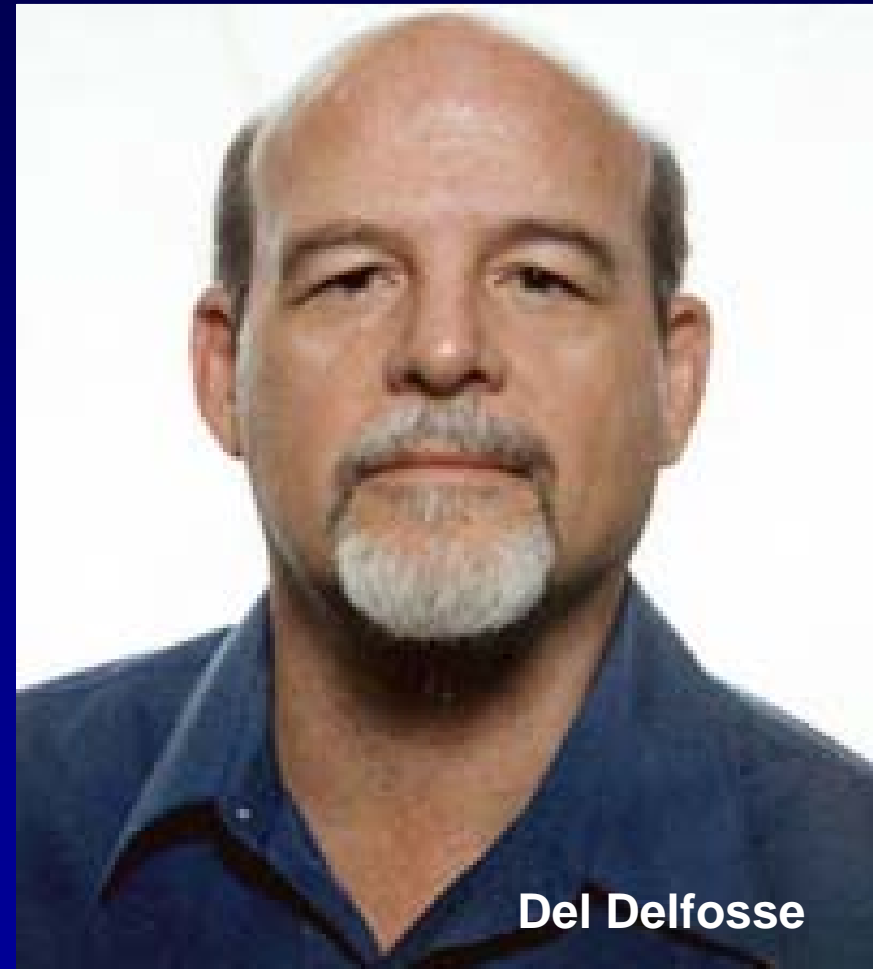
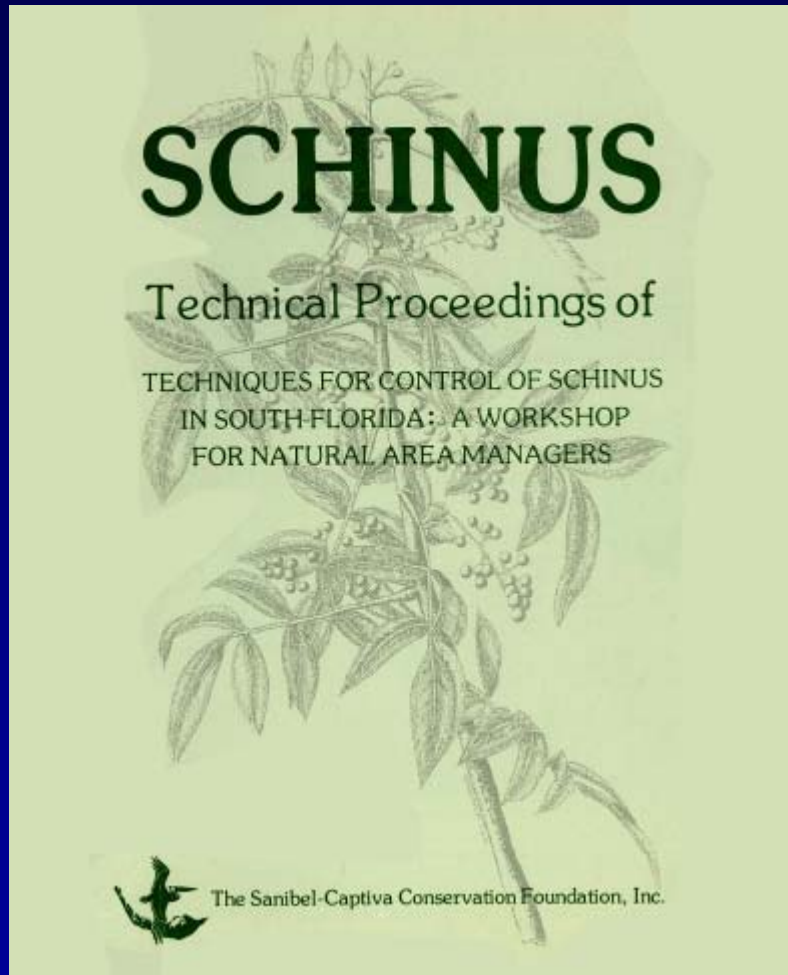
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- Florida Department of Environmental Protection
- South Florida Water Management District
- Florida Industrial & Phosphate Research Institute



(Photo credit: Bryan Harry, NPS)

# Late 1970s



# Early 1980s



**John Cassani**

184

*Florida Entomologist* 69(1)

March, 1986

STATE OF FLORIDA DEPARTMENT OF AGRICULTURE  
***SCHINUS TEREBINTHIFOLIUS***  
**(ANACARDIACEAE), IN SOUTH FLORIDA**

J. R. CASSANI  
Lee County Hyacinth Control District  
Post Office Box 06006  
Fort Myers, Florida 33906

**ABSTRACT**

Arthropods on *Schinus terebinthifolius* Raddi were collected by hand and with a sweep net every other week between 8 May 1979 and 29 July 1980 at three sites in Lee County, Florida. Of the 115 arthropod species identified, 46 (40.0%) were phytophagous, 59 (51.3%) predatory, and 10 (8.7%) miscellaneous. The six most frequently occurring species belonged to either the Formicidae or Araneae. The most frequently (65.5%) occurring phytophagous sp. was a bush cricket (*Cyrtozypka* sp.). The phytophagous

- **First Domestic Survey of Arthropods on BP**

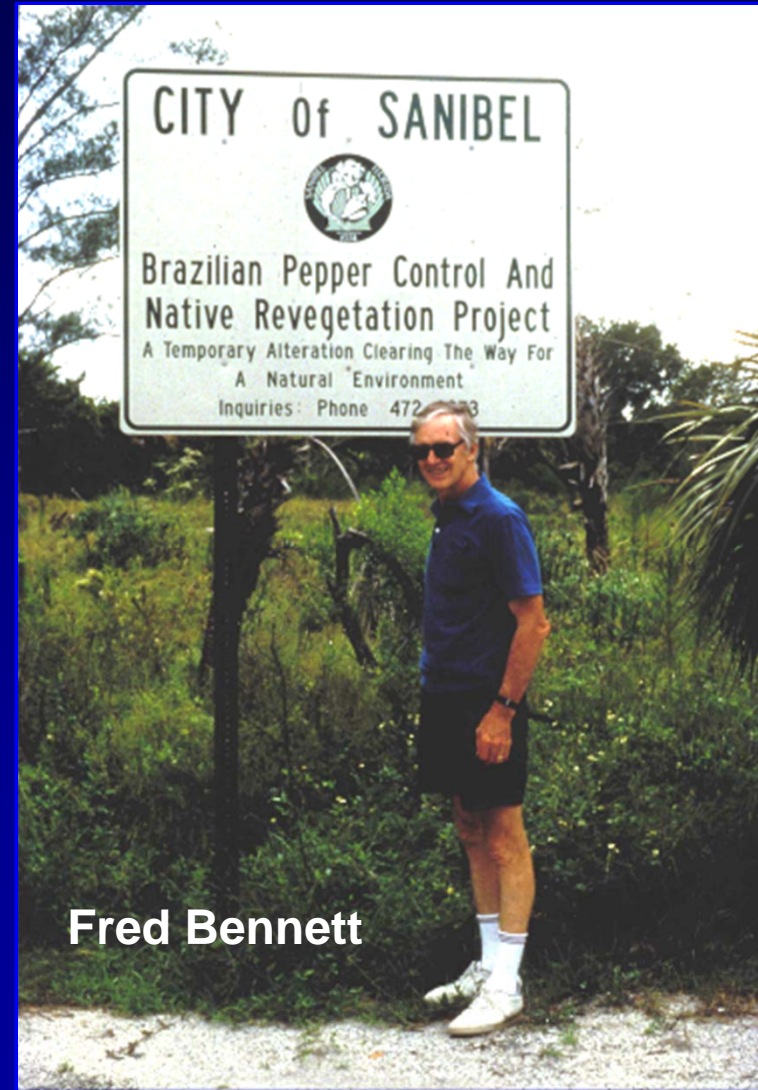
# Late 1980s

- Extensive Faunal Surveys Conducted in Brazil by UF/IFAS
- Collaboration with Local Scientists Established

Bennett et al. (1990)



Dale Habeck



Fred Bennett

# Outline

- Rationale for the Project
- Progress to Date
  - Thrips
  - Weevil
  - Psyllid
- Questions & Comments



# Brazilian Peppertree

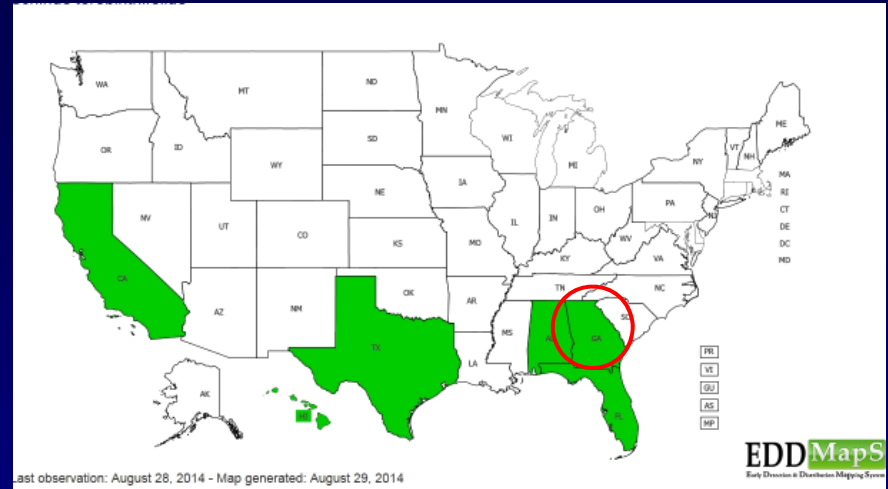
## *Schinus terebinthifolia* Raddi



Brazilian pepper-tree  
*Schinus terebinthifolius*  
Photo by Ann Murray  
© 2000 University of Florida

# Distribution of BP

- **ORIGIN-** Brazil, Argentina, Paraguay
- **US DISTRIBUTION-**
  - California, Florida, Georgia, Hawaii
  - Texas, Alabama, Caribbean Islands
- **DESCRIPTION-**
  - Evergreen Shrub
  - Compound Leaves
  - Red Berries
  - Several 'Varieties'
  - Dioecious



Mukherjee et al. (2011)



# History of BP in Florida

- **Date of First Introduction Uncertain**
  - As Early as 1884, More Likely ca. 1900
- **Popularized as Ornamental by George Stone, Punta Gorda, ca. 1926**
- **Recognized as Invasive Weed**
  - During 1950s - 1960s
- **Currently Estimated to Occupy > 700,000 acres**

# BP Not Invasive in Brazil

- “Nowhere in Brazil is [BP] invasive like it is in Florida . . . .”
- “[BP] does not form pure dense stands in its native habitat . . . . In most areas you really have to look for it . . . .”

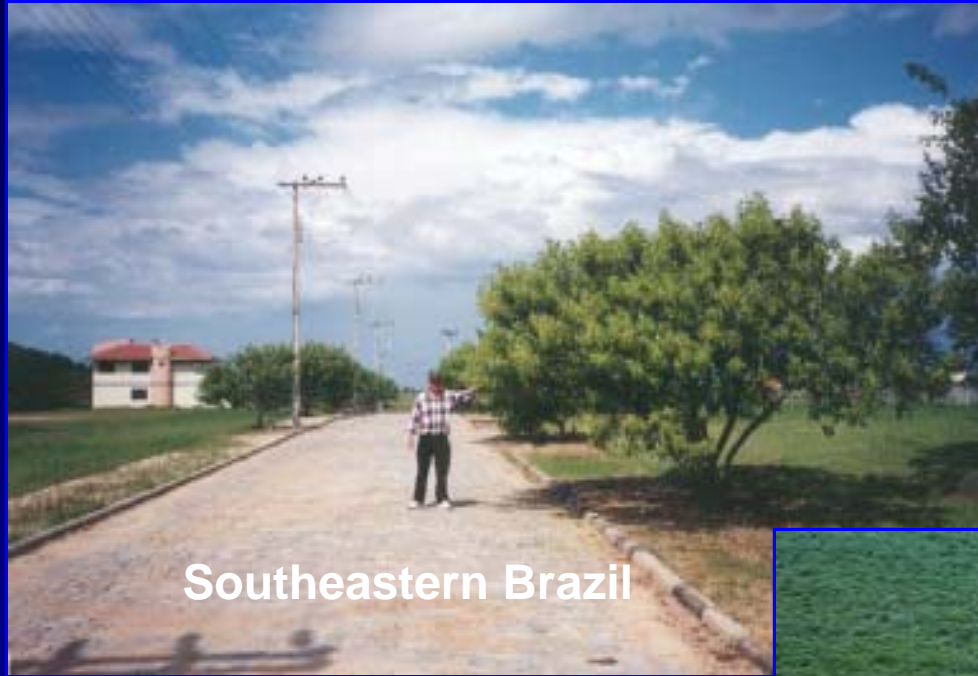
Campbell et al. 1980. Brazil Expedition: Search for BioControl Agent(s). Interim Rpt., July. First Fund for Animals, Sanibel, FL.

# Aroeira = Brazilian Peppertree

- Popular Ornamental in Brazil
  - Street Names
  - Neighborhoods



# Growth Habit of BP



Southeastern Brazil



Everglades National Park

# BP Supports Other Invasive Species

Simpson et al. (1996), McCoy et al. (2003)

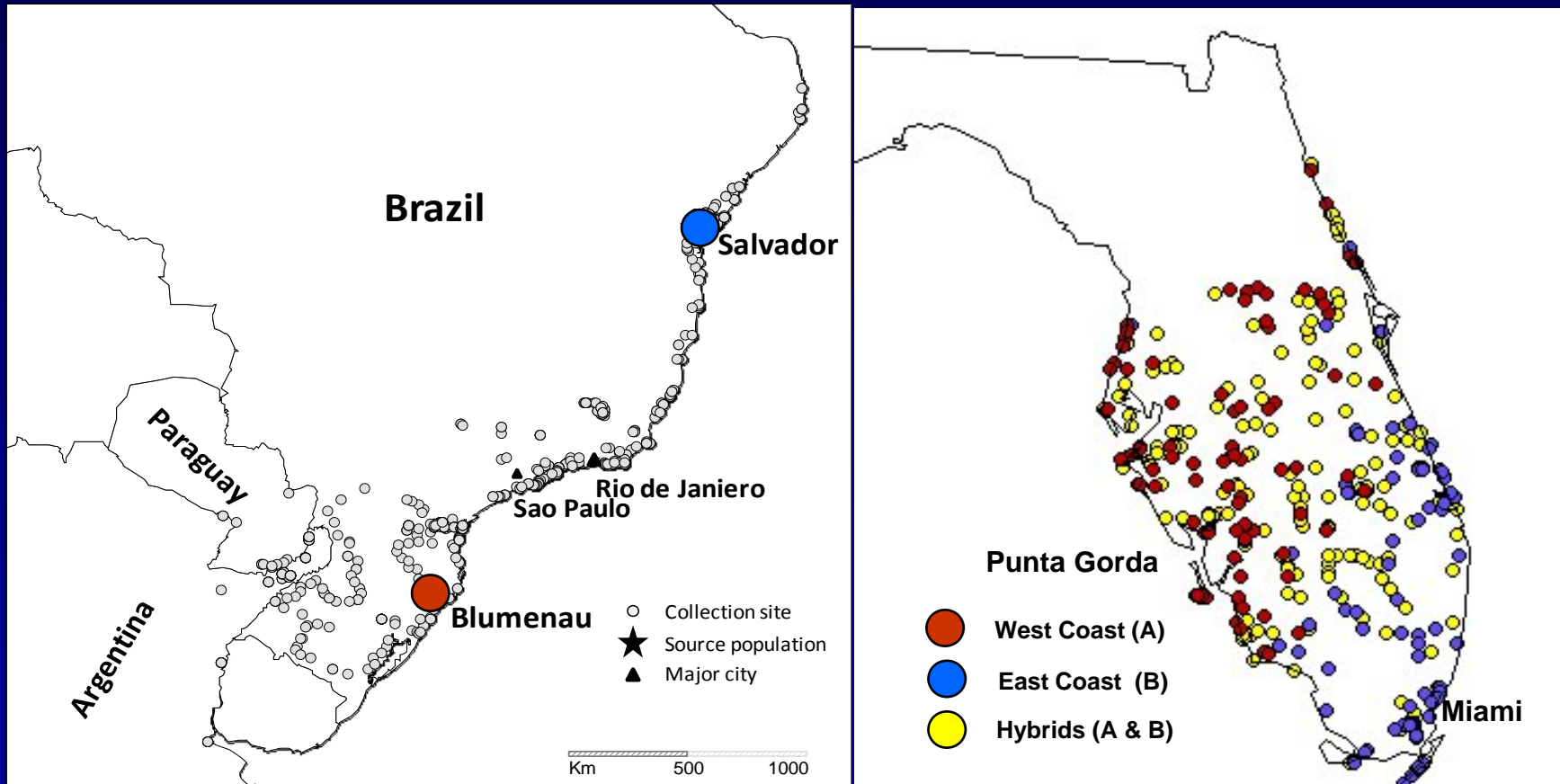


**Diaprepes Weevil**

[http://creatures.ifas.ufl.edu/citrus/S\\_R\\_B\\_W\\_TW4.htm](http://creatures.ifas.ufl.edu/citrus/S_R_B_W_TW4.htm)

# Why is BP Invasive in Florida?

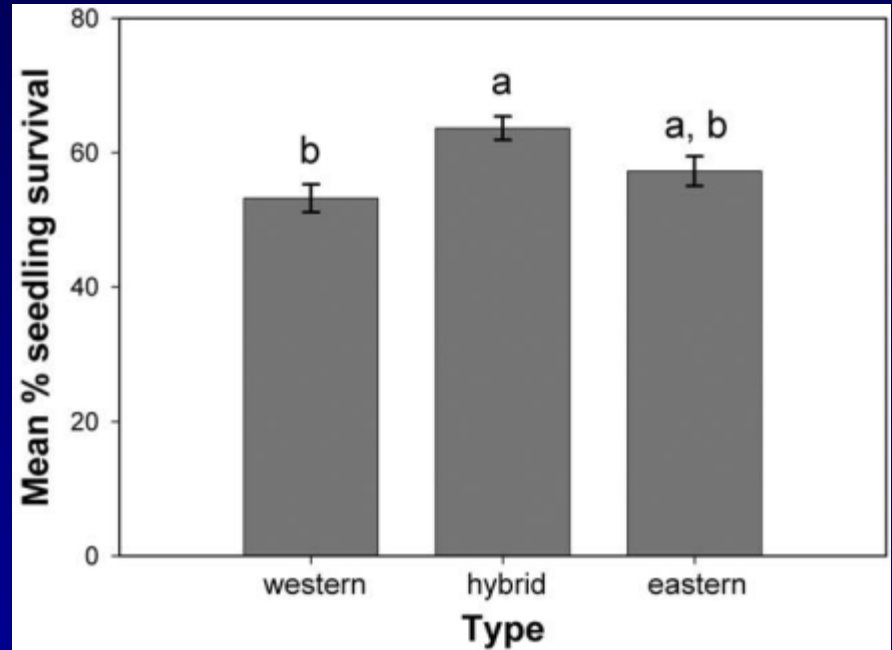
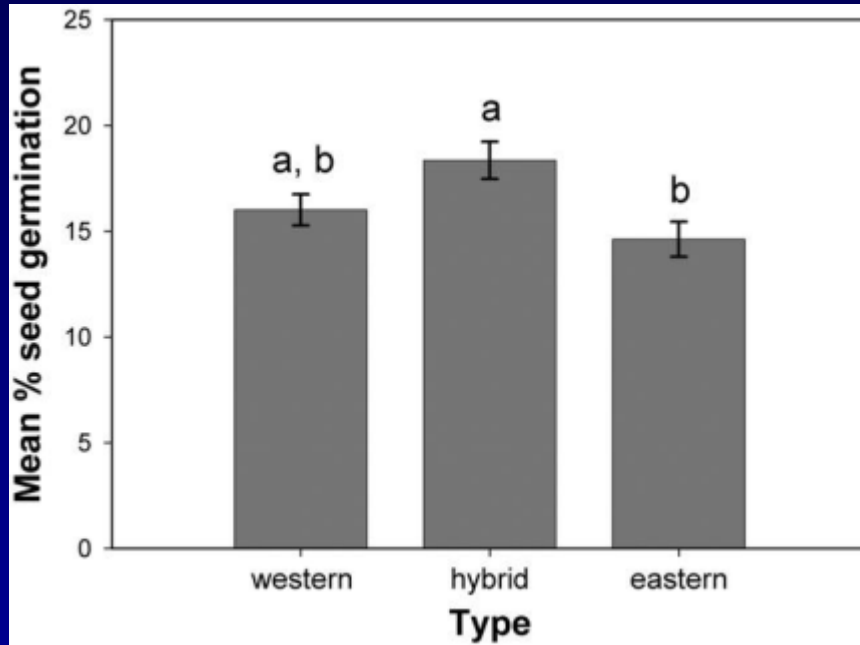
- Multiple Genotypes in South America



Williams et al. (2005,2007)

# Why is BP Invasive in FL?

- Hybrid Vigor



Geiger et al. (2011)

# Why is BP Invasive in Florida?

- **Enemy Release Hypothesis** (Williams 1954)  
(or Escape from Natural Enemies)
  - Native Specialist Enemies Strongly Control the Abundance and/or Distribution of Native Plants
  - Escape from Specialist Enemies Key Contributor to Exotic Plant Success
  - Enemy Escape Benefits Exotics
    - Gain Competitive Advantage Over Native Plants That Have Natural Enemies

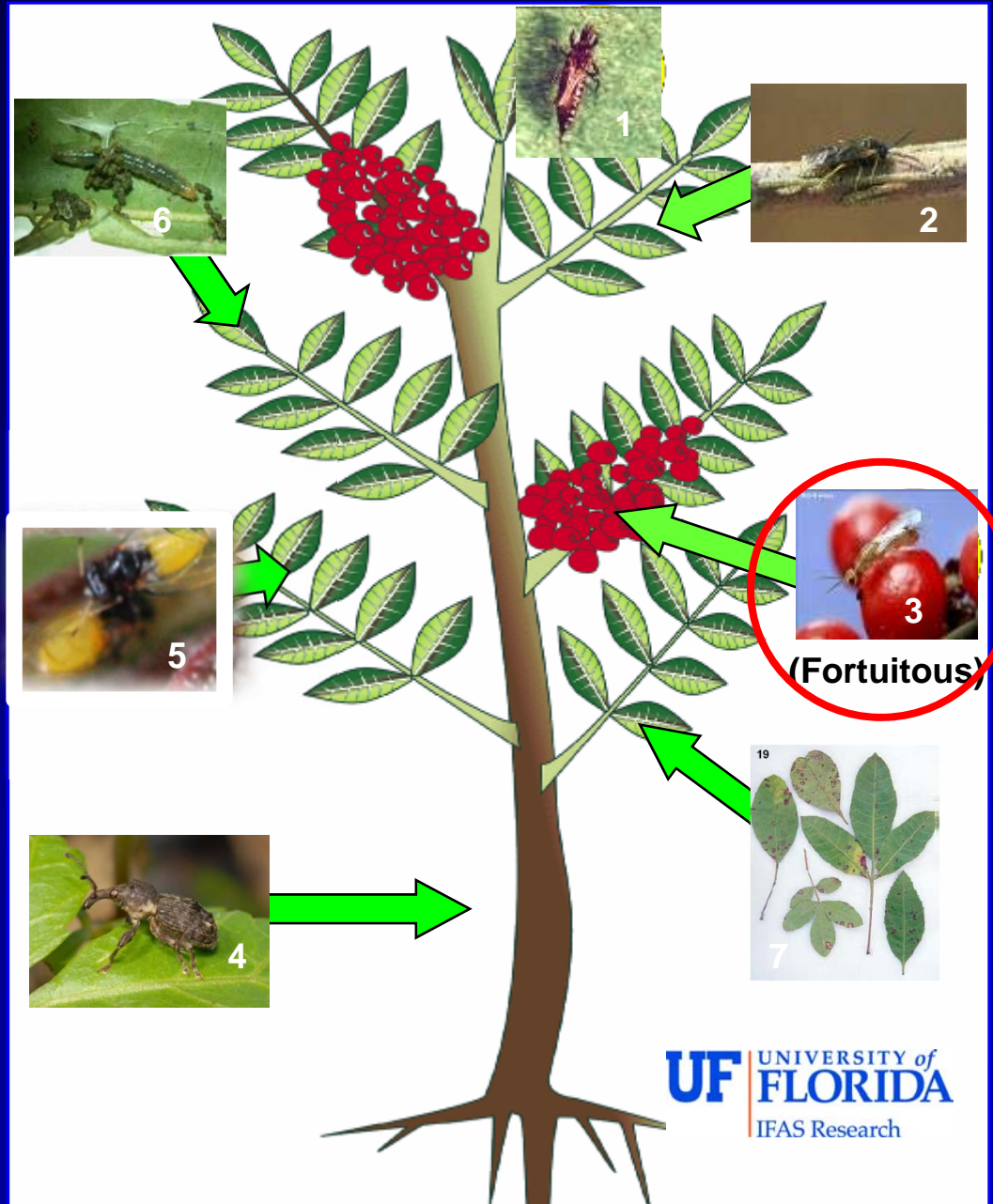


# BP Targeted for BioControl

- Non-native Invasive Species
- Causes Severe Ecological Damage
- Toxic and Allergenic (Poison Ivy Family, Anacardiaceae)
- Low Beneficial Value (Beekeepers?)
- Conventional Controls Temporary, Costly
- **No Native *Schinus* spp. in US !!!**

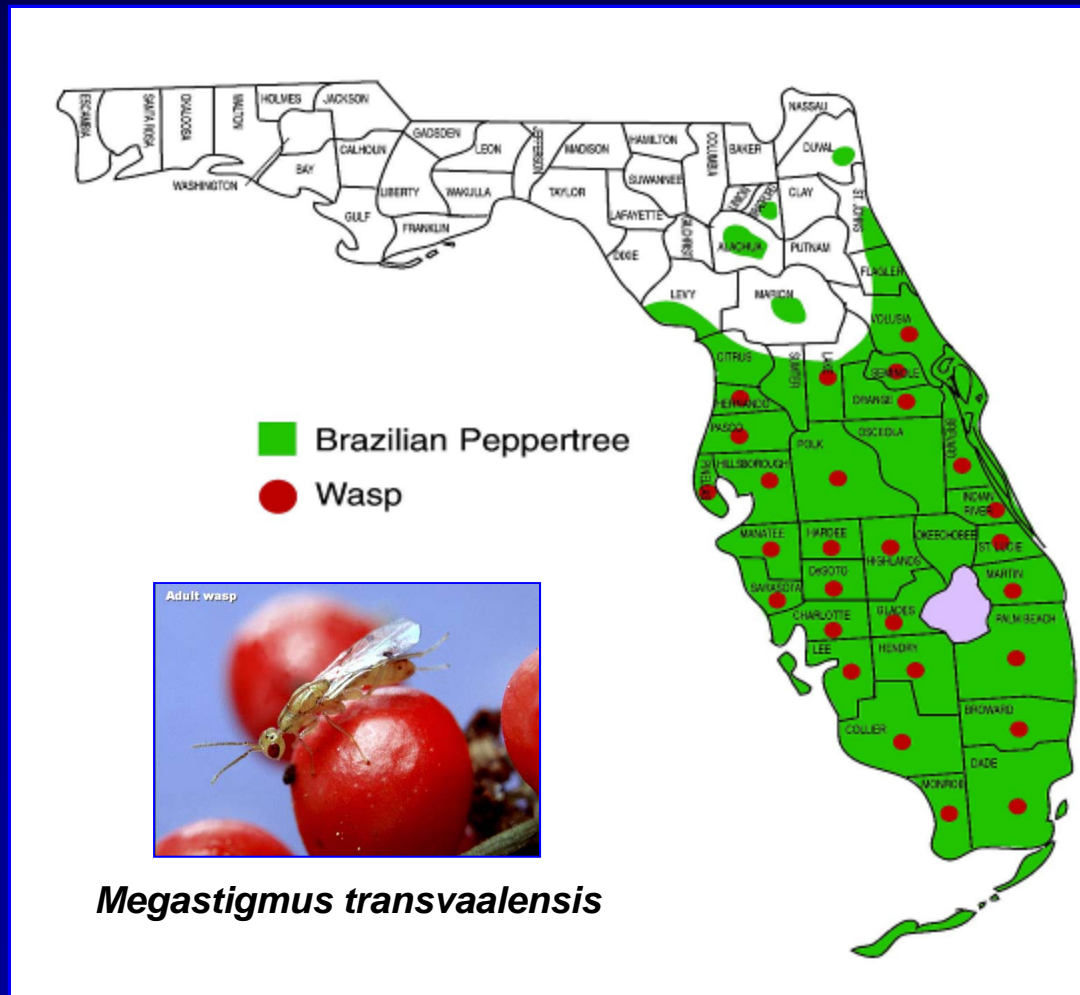
# BP Natural Enemies

1. Thrips
  - Damages Shoots
2. Sawfly
  - Defoliator
3. Seed Wasp
  - Attacks Fruits
4. Weevil
  - Stem Feeder
5. Psyllid
  - Galls Leaves
6. Leafroller
  - Defoliator
7. Fungus
  - Leaf Spot



# Late 1980s

- Discovery of Adventive Torymid Seed Wasp



(Habeck et al. 1989, Wheeler et al. 2001)

# BP Natural Enemies

## 1. Thrips

- Damages Shoots

## 2. Sawfly

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## 3. Seed Wasp

- Attacks Fruits

## 4. Weevil

- Stem Feeder

## 5. Psyllid

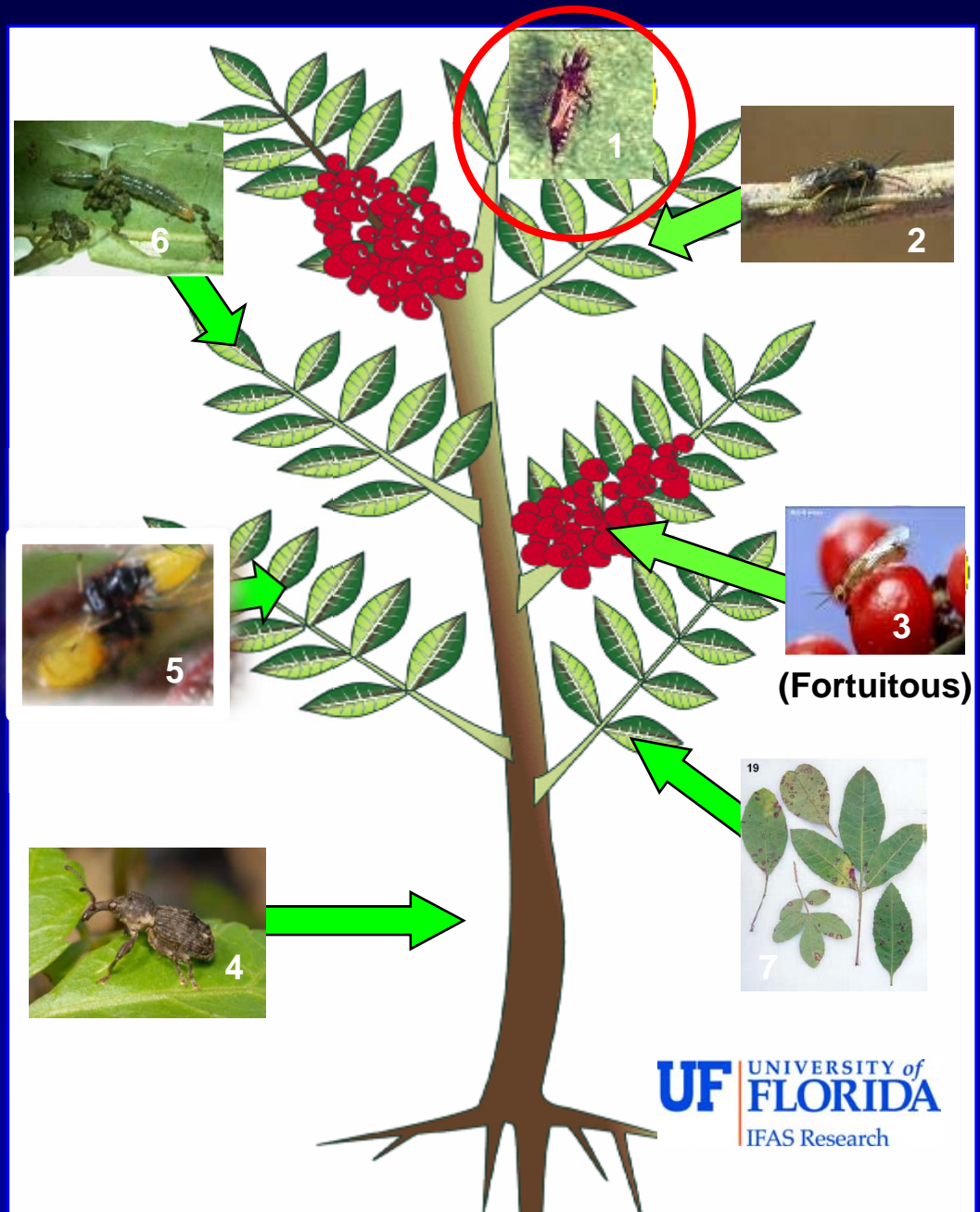
- Galls Leaves

## 6. Leafroller

- Defoliator

## 7. Fungus

- Leaf Spot



# *Pseudophilothrips ichini* (Thysanoptera: Phlaeothripidae)

- Adults- Black, Winged
- Females Live ca. 50 days & Deposit 220 Eggs
- Oviposit on New BP Growth
- Four Generations in Brazil

(Garcia 1977)



# *Pseudophilothrips ichini* s.l. (Hood) (Thysanoptera: Phlaeothripidae)

- Larvae- Red or Orange;  
Feed on Tender Growth
- Damage / Kill New  
Shoots & Young Plants
- Host Specific?
  - Only Collected only on  
Brazilian Peppertree in  
South America (Garcia 1977)



# No-Choice Oviposition Tests

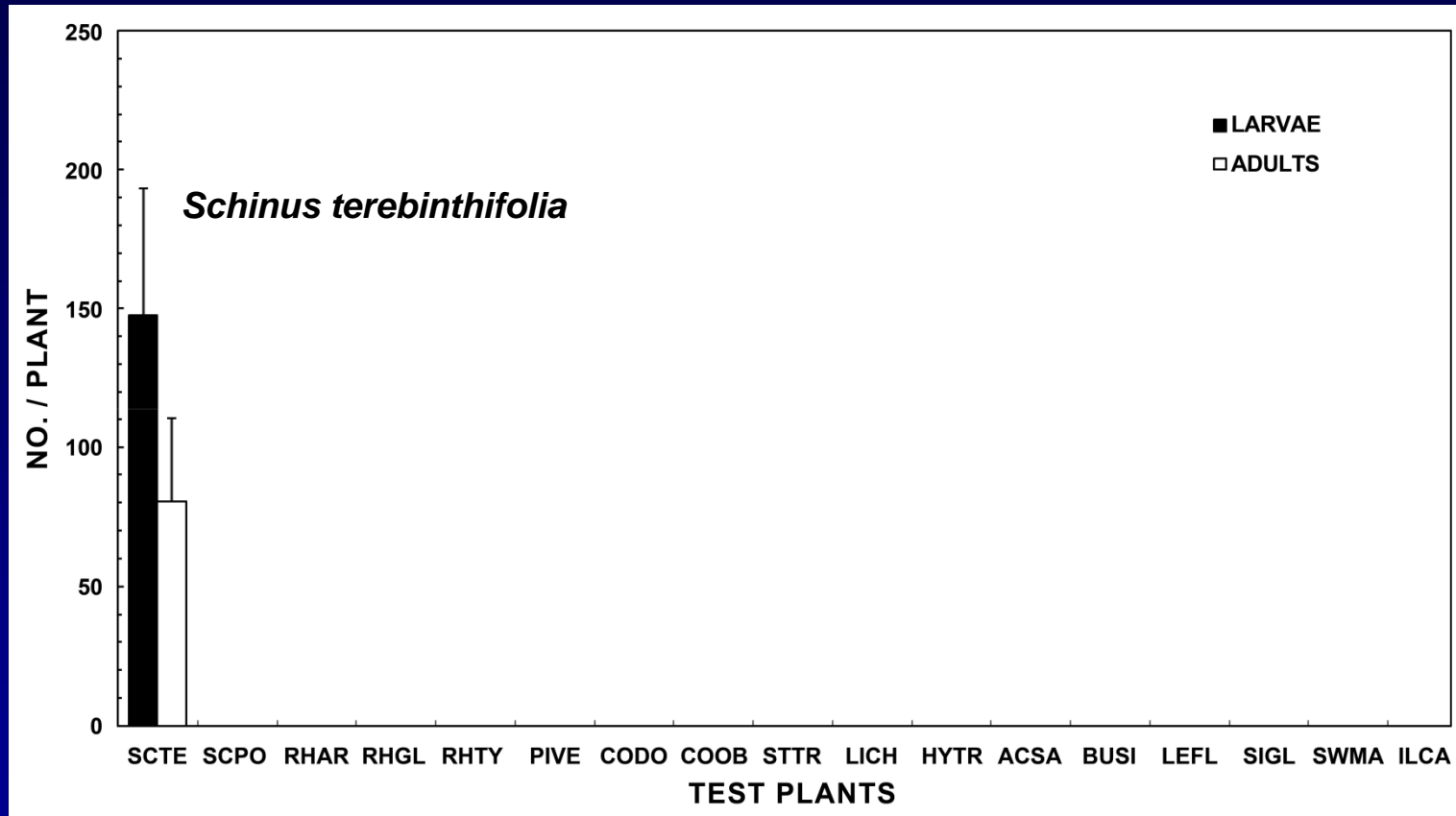
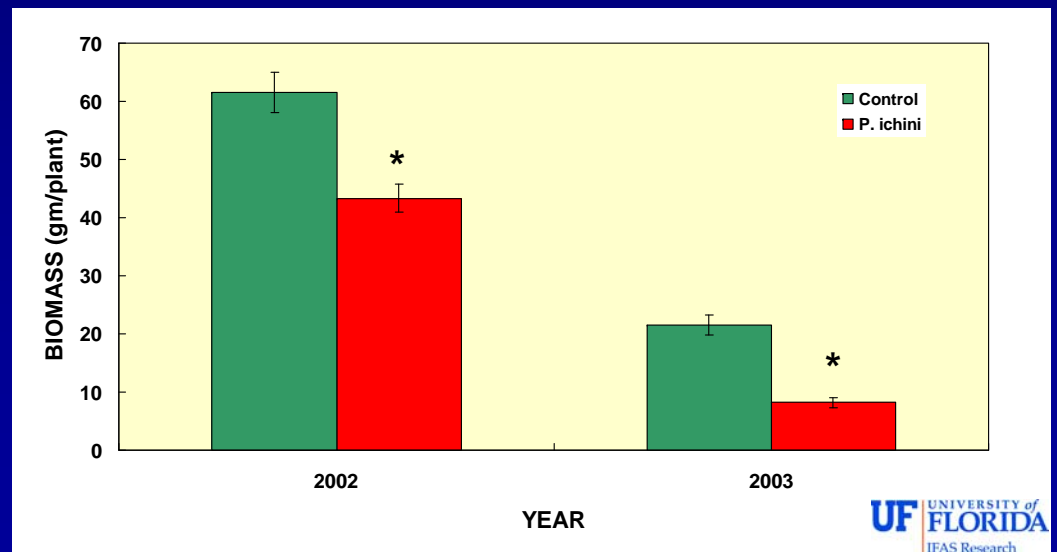
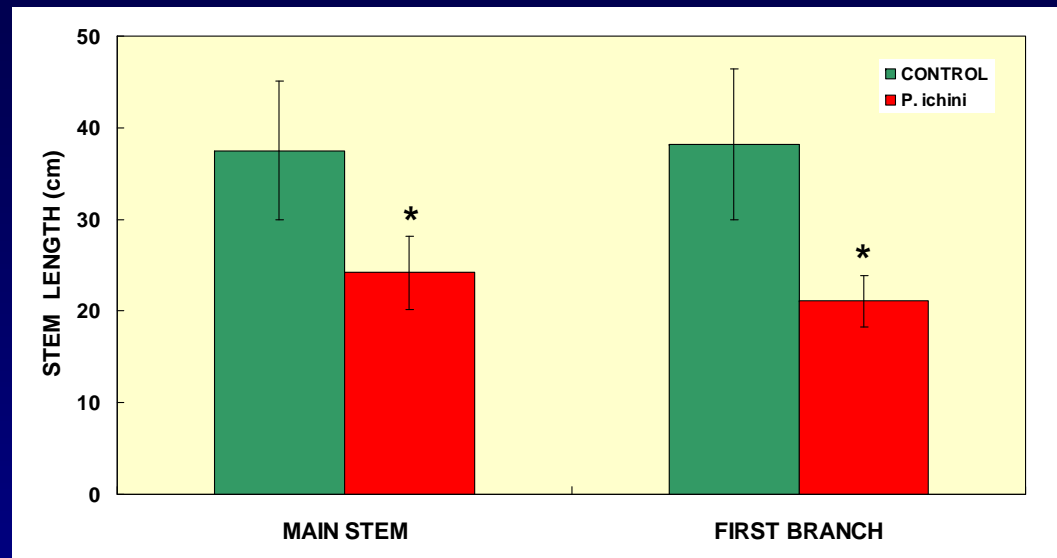


Figure 2. Performance of *P. ichini* s.l. on Caribbean and other native plants in supplemental no-choice oviposition tests conducted in Florida, June 2003-November 2005.

# BP Thrips Field Impact Study

## Curitiba, Parana, Brazil

- Growth Reduction
  - Stem Length, 40%
  - Biomass, 46%





# *P. ichini* Haplotypes



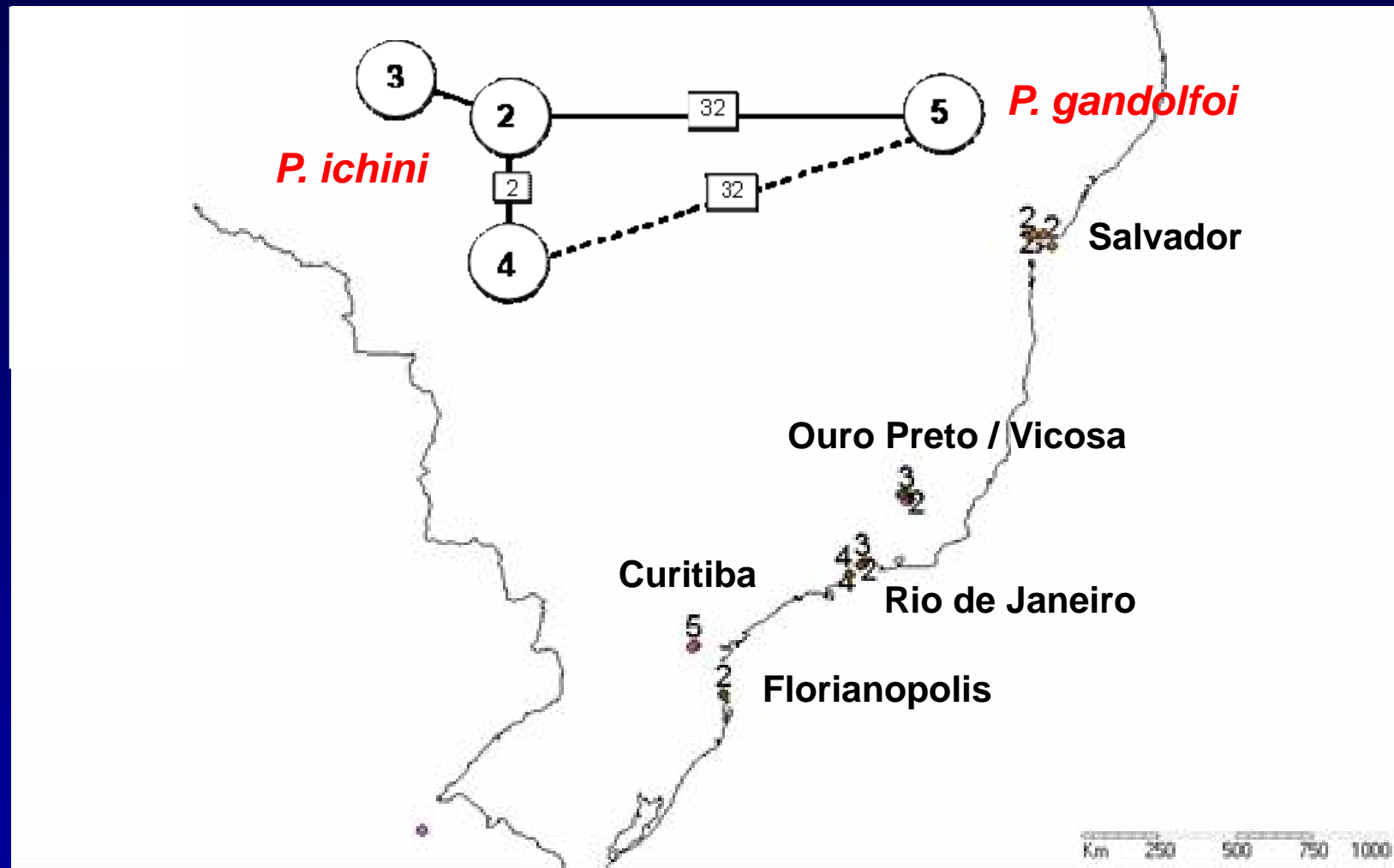
Hap 5- Curitiba,  
Brazil



Hap 2 or 3- Ouro Preto,  
Brazil

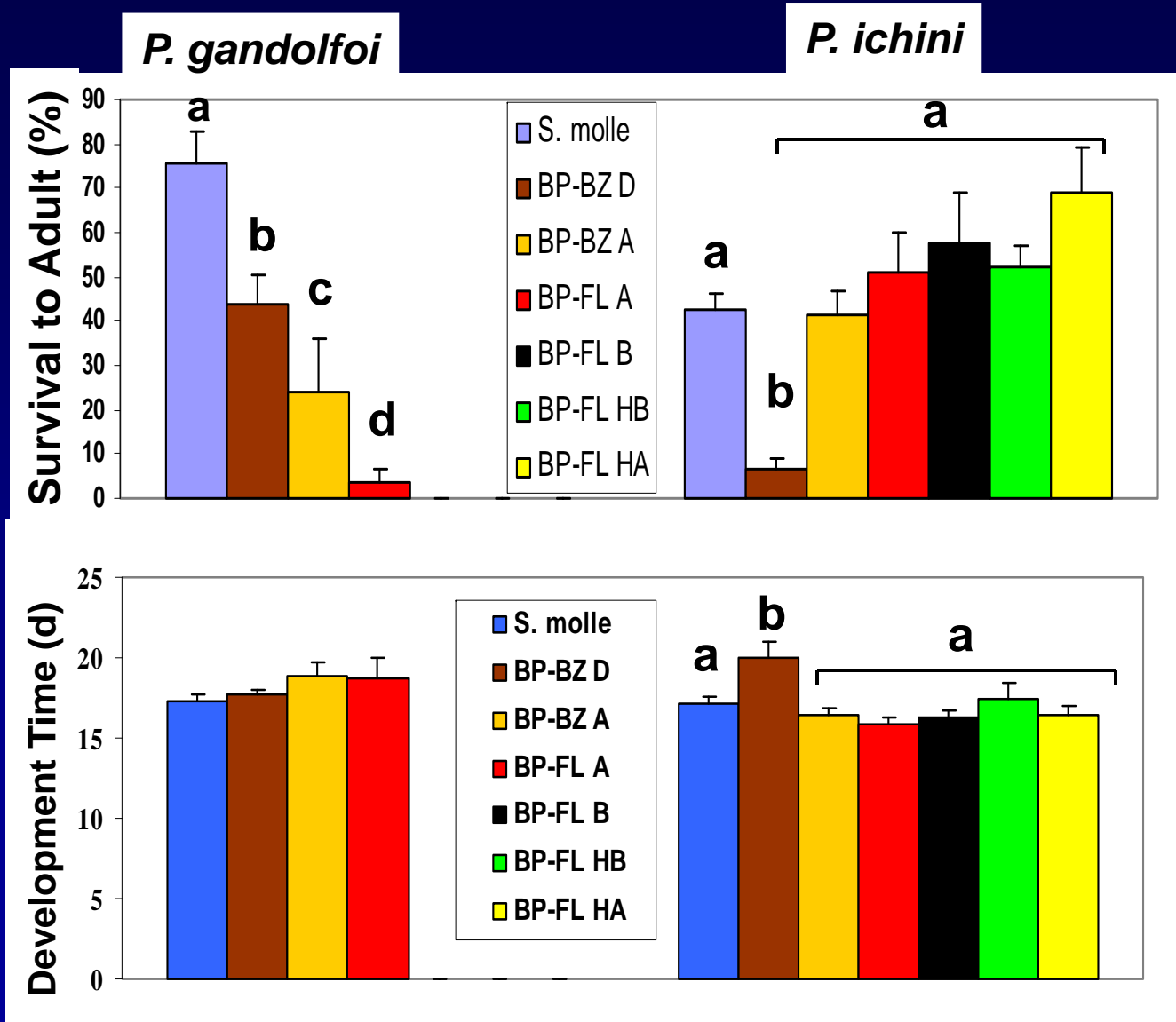
Manrique et al. (2008)

# Distribution of *P. ichini* “Haplotypes”



Manrique et al. (2008), Mound et al. (2010)

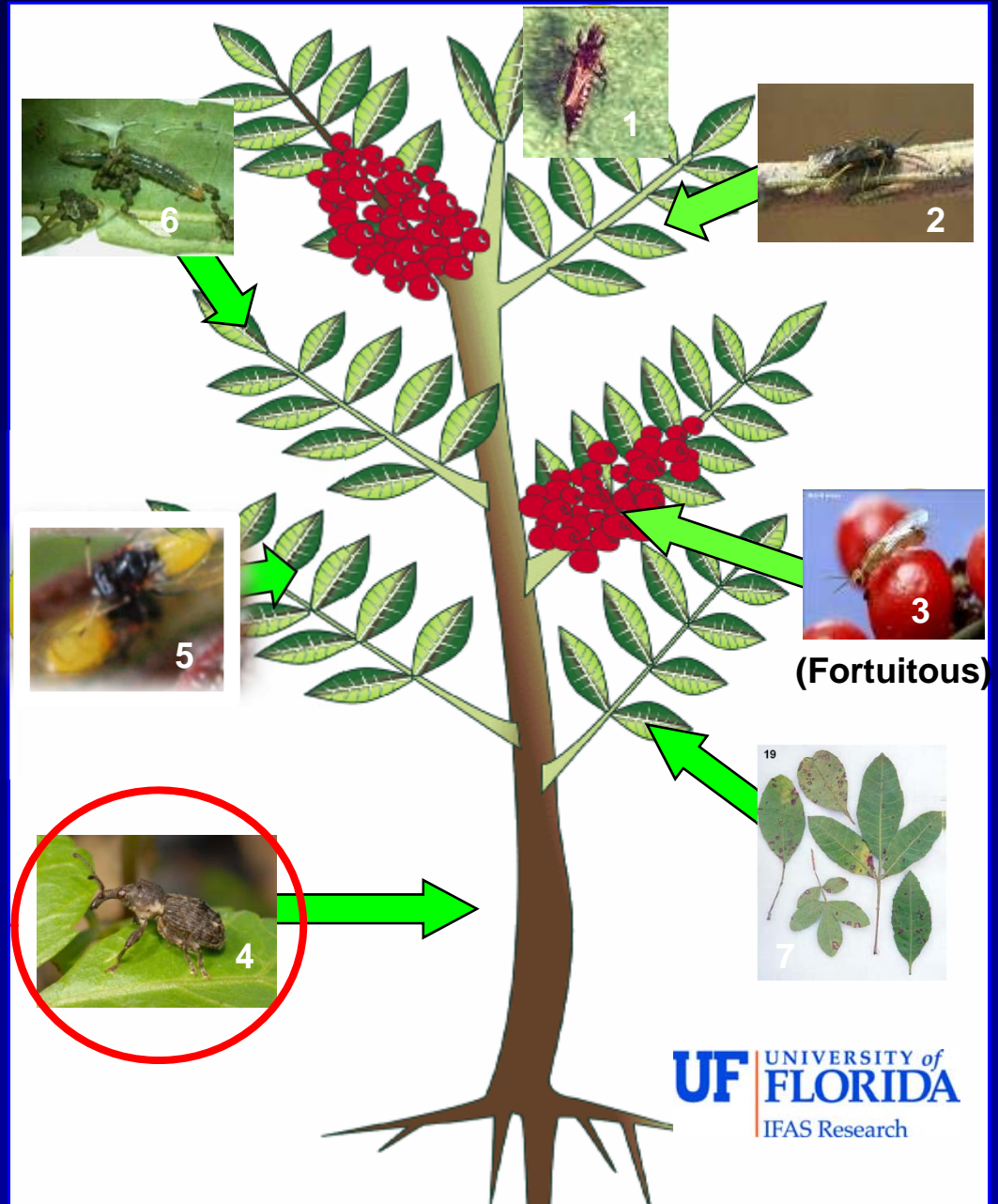
# 'Fine Scale' Adaptation to BP



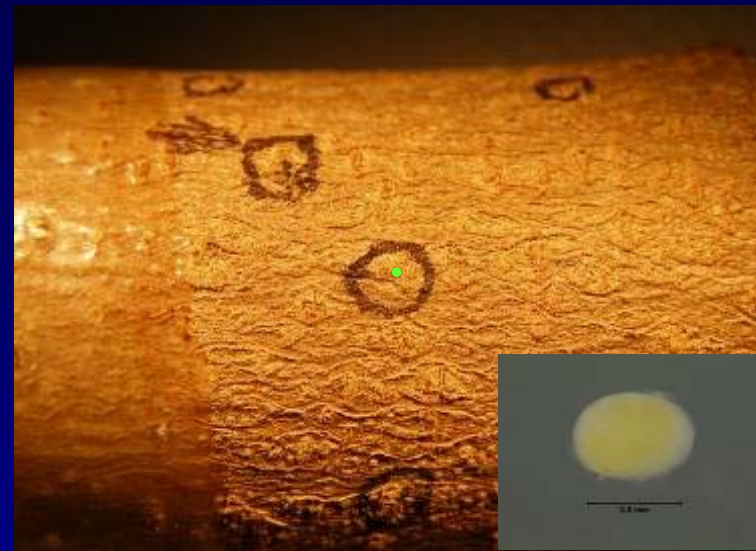
Manrique et al. (2008), Cuda et al. (2012)

# BP Natural Enemies

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  - Leaf Spot



# *Apocnemidophorus pipitzi* (Coleoptera: Curculionidae)



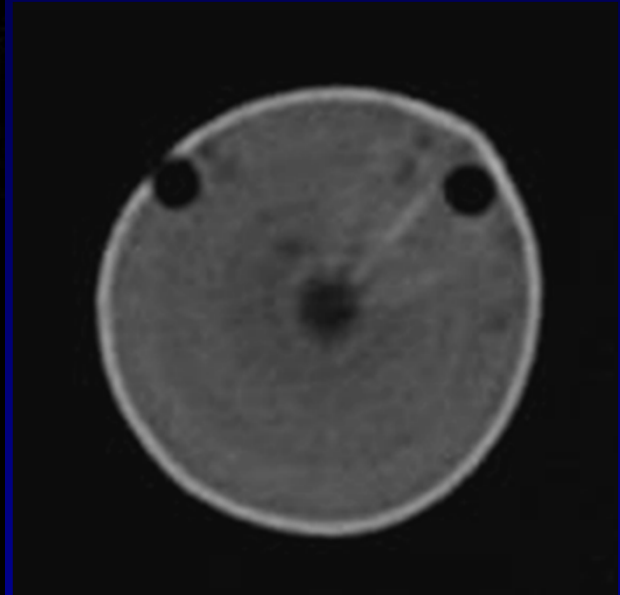
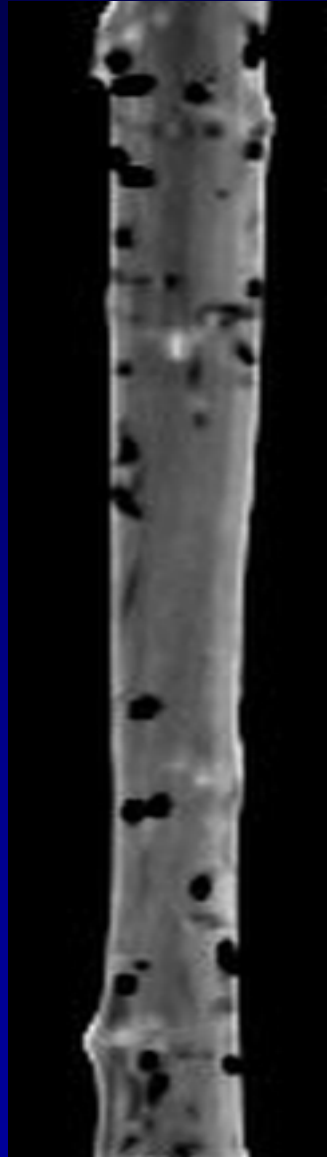
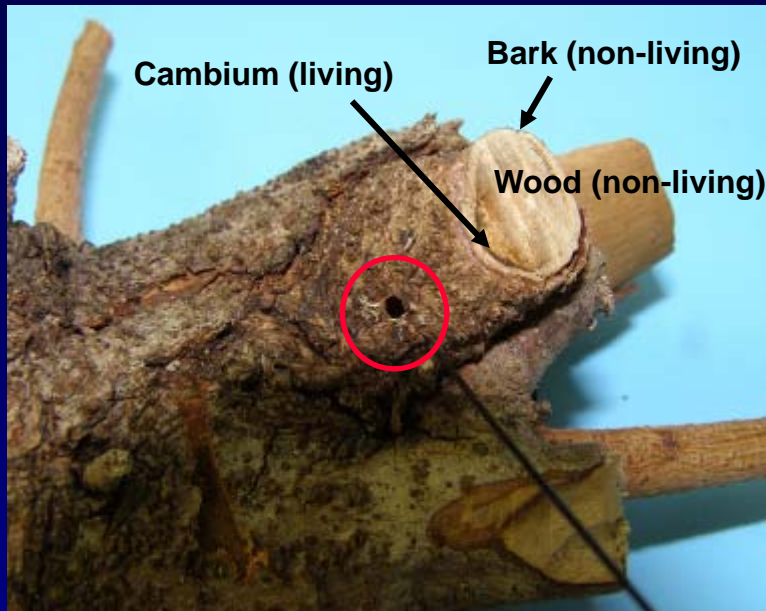
# Field Host Range of *A. pipitzi*

- **Argentina**
  - *Schinus terebinthifolia* Raddi
  - *S. molle* L.
  - *Lithrea molleoides* (Vell.) Engl.
- **Brazil**
  - *Schinus terebinthifolia* Raddi \*
  - *S. longifolius* (Lindl.) Speg.

\* Adults Reared from *S. terebinthifolia*

(Sources: F. D. Bennett, unpubl.; C.W. O'Brien, unpubl.; McKay et al. 2009)

# Weevil Exit Hole & Larval Tunnels



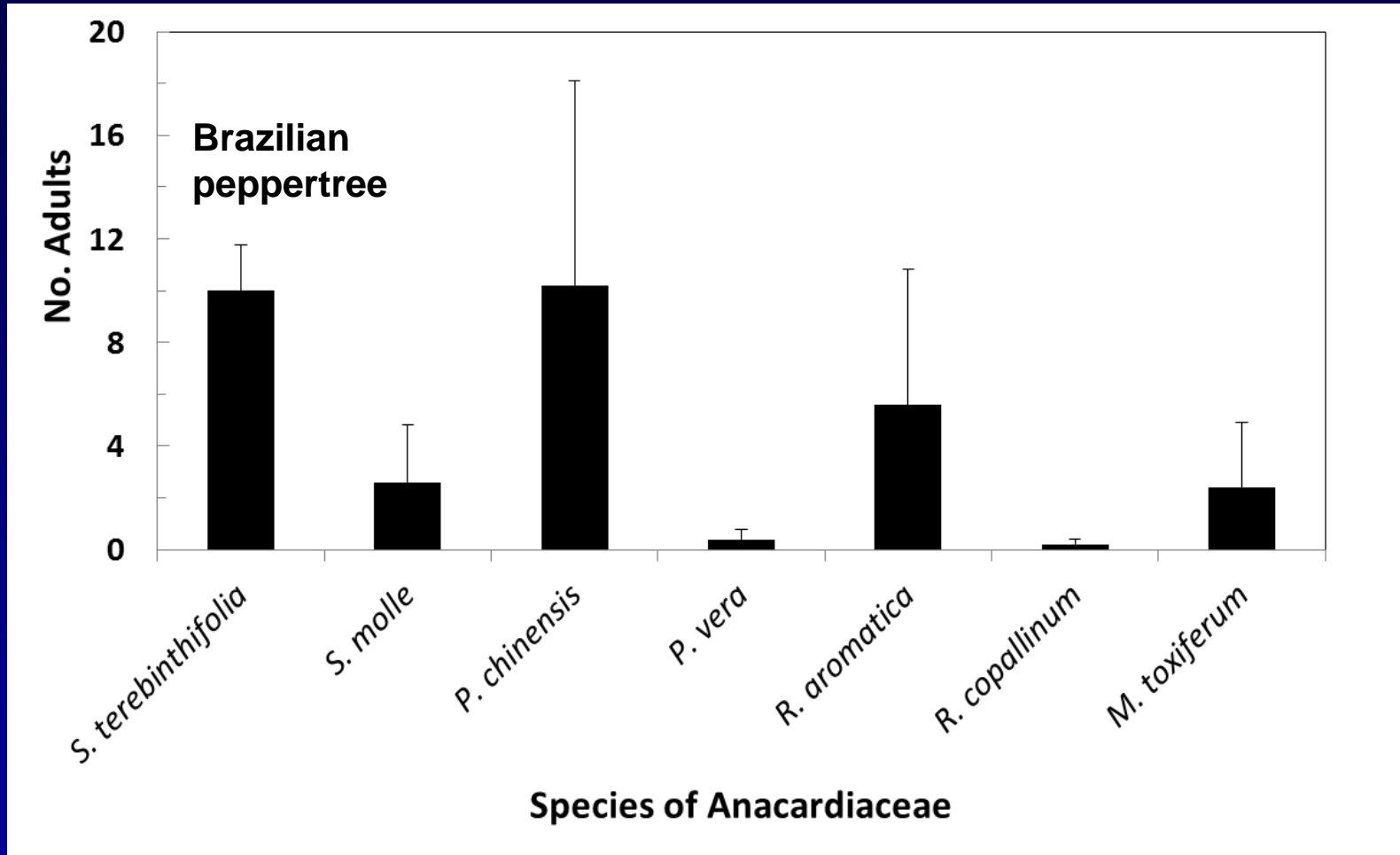
# Host Range Test: No-Choice





# Weevil Emergence

## No-Choice Host Range Tests

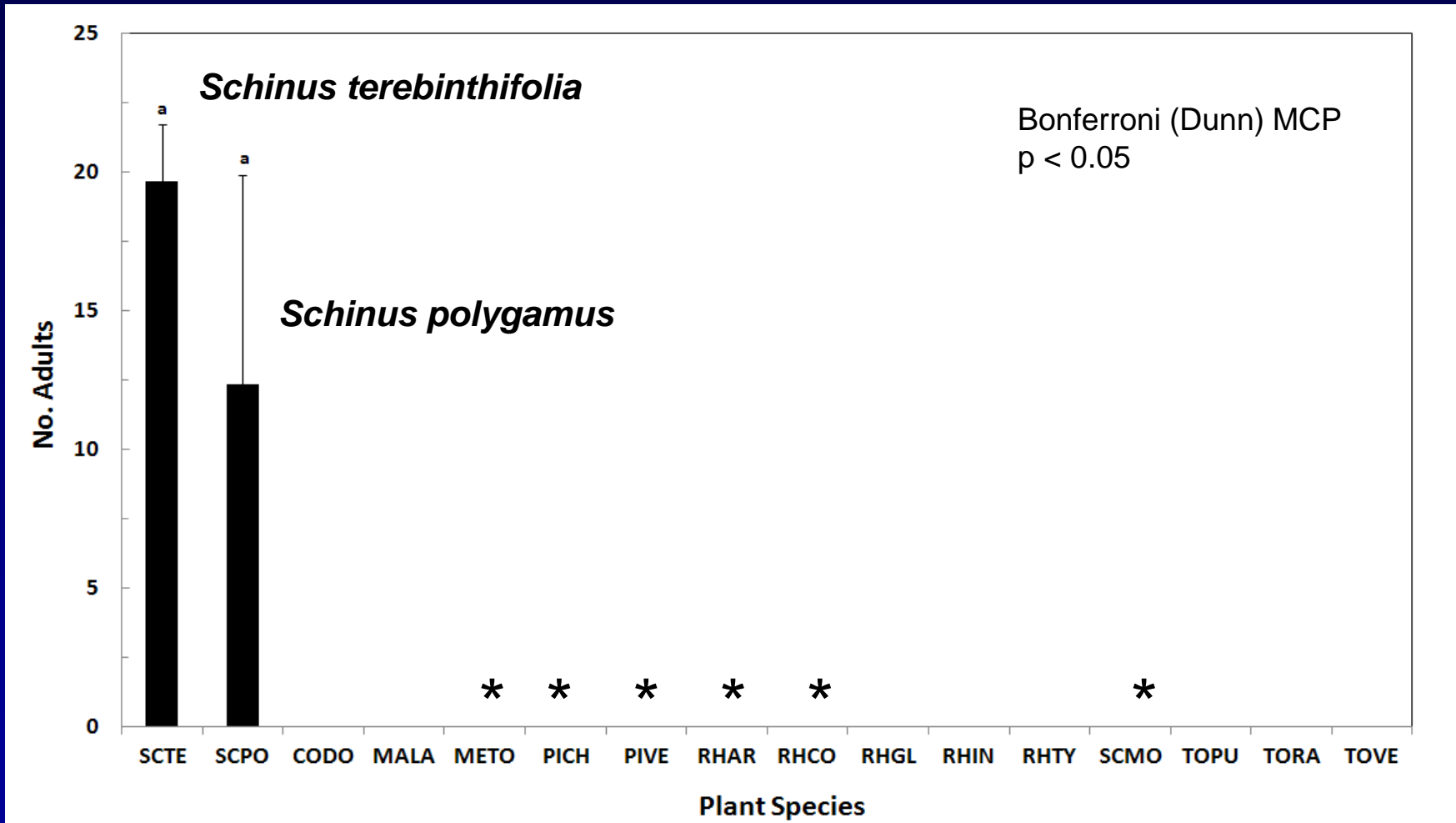


# Host Range Testing- Multiple Choice



# Weevil Emergence

## Multiple Choice Minus Target Host Range Tests \*



\* Brazilian peppertree (SCTE) tested separately.

# *A. pipitzi* Impact Study

## EDCL, 2015



**Experimental Design-  
Complete Randomized**



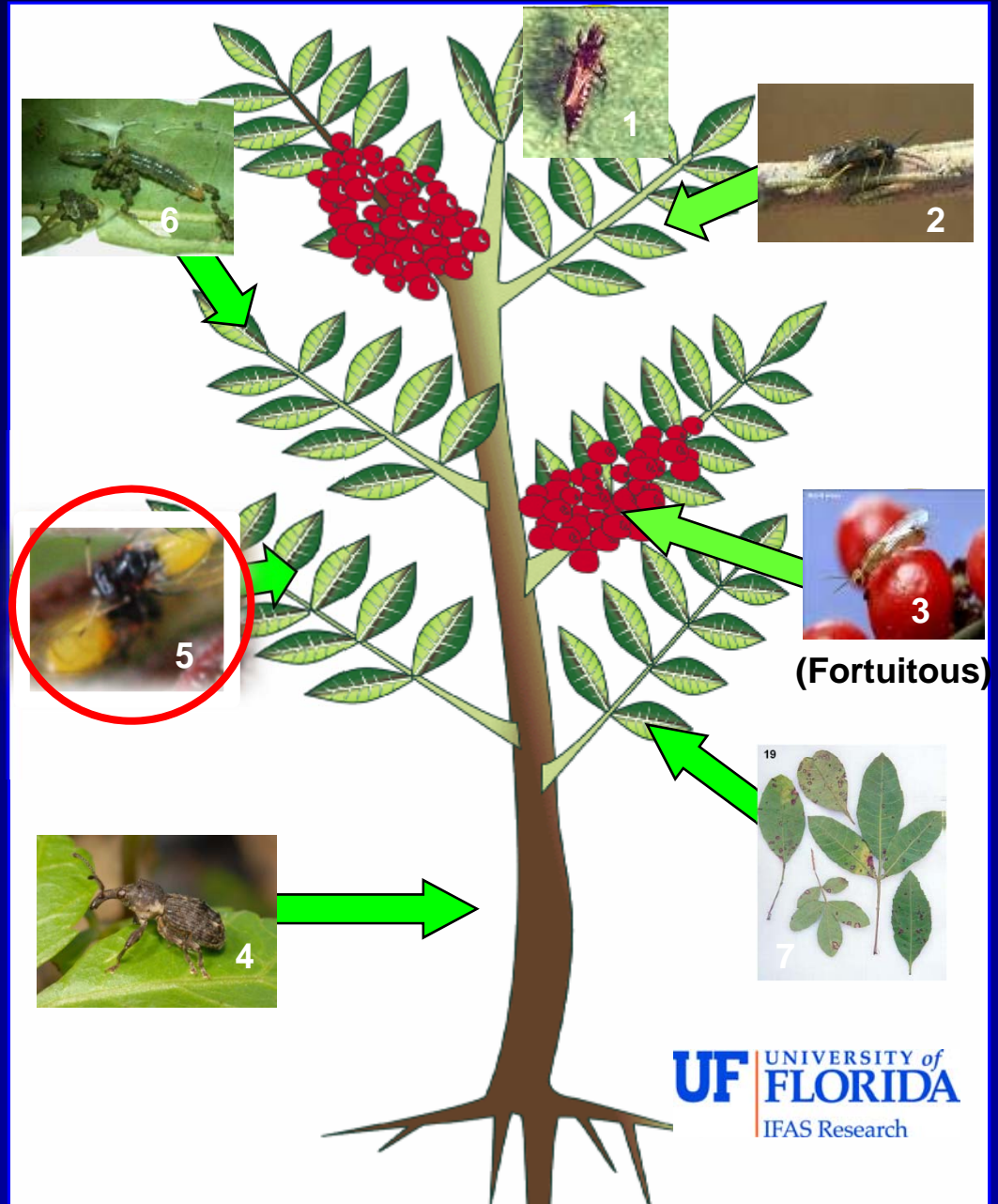
**Controls, n=3  
(No Weevils)**



**Treatment, n=3  
(5 Males, 5 Females)**

# BP Natural Enemies

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  - Leaf Spot



# Peruvian Peppertree Model

- *Calophya schini* Discovered in CA, 1980s
- Attacked Ornamental *Schinus molle* L.
  - Spread from San Diego to San Francisco
  - Caused Severe & Widespread Damage
  - Did NOT Attack Brazilian Peppertree

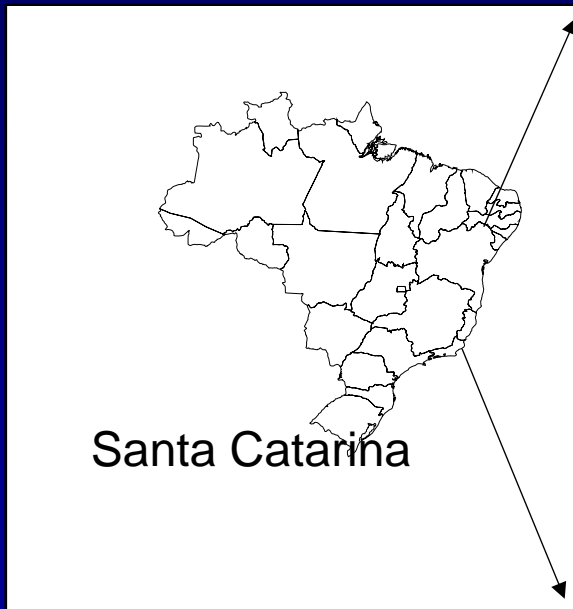


Downer et al. (1988)

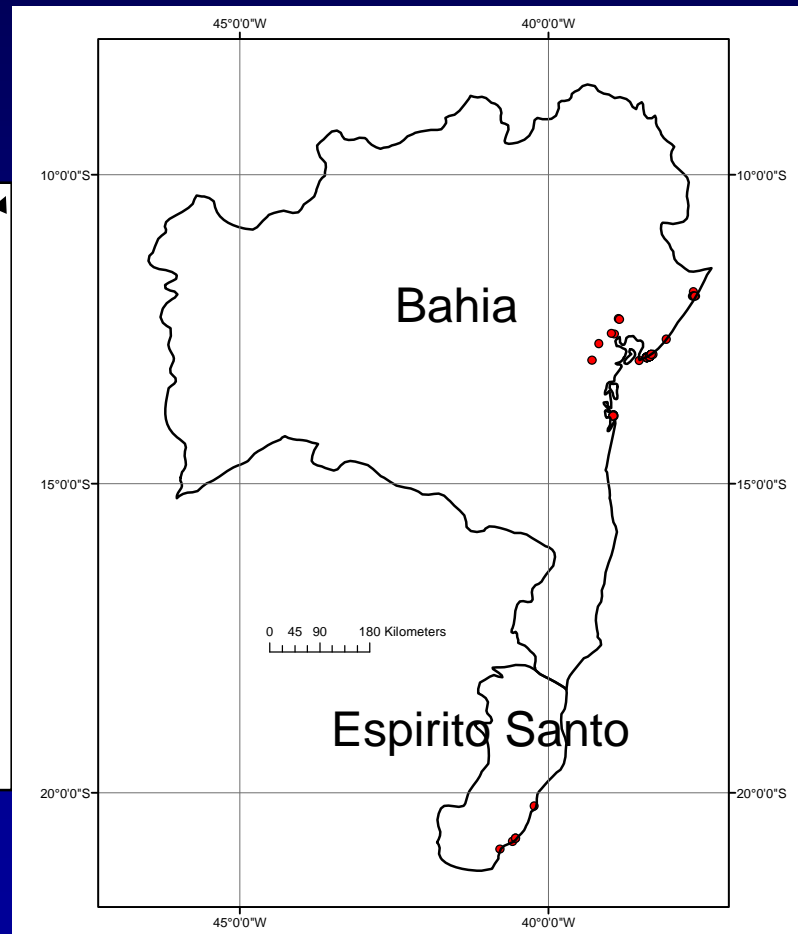


# Surveys in Brazil

- Conducted near Salvador, Bahia; Ubu, Espirito Santo; Itajai, Santa Catarina
  - August 2012
  - March 2014



Santa Catarina



# *Calophya terebinthifolii*

(Hemiptera: Calophyidae)

- Native to Brazil, Paraguay & Argentina
- Adults
  - Black & Yellow
- Nymphs
  - Form Circular Pit Galls
  - Dorsal Surface Sclerotized



Photo Credit: L. Christ

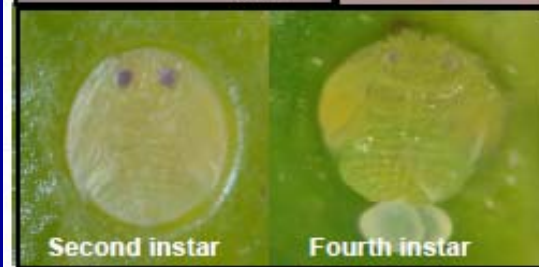
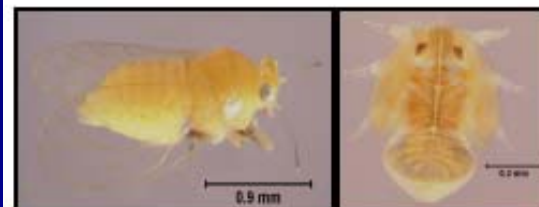
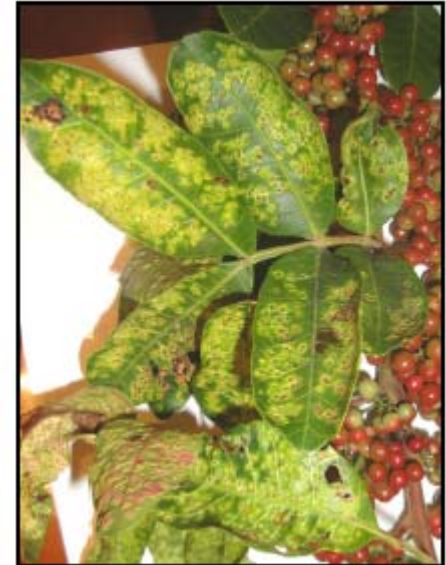
Cuda et al. (2006), Mc Kay et al. 2009



# *Calophya latiforceps*

(Hemiptera: Calophyidae)

- Native to Brazil, Adults
  - Green & Yellow
- Nymphs
  - Form Circular Pit Galls
    - Dorsal Surface Sclerotized
- Discovered in 2010 Burckhardt et al. (2011)

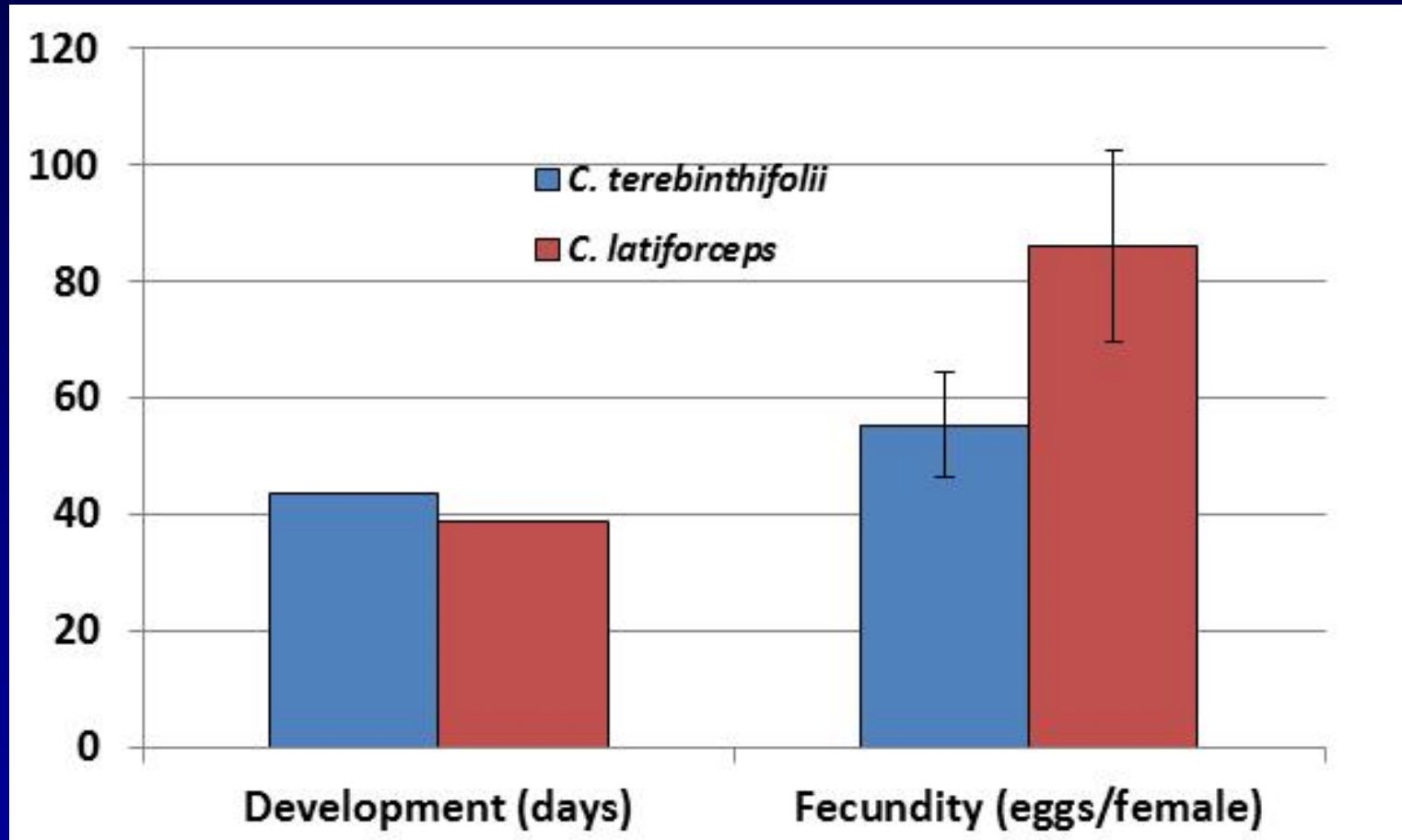


# Psyllid Rearing Cages

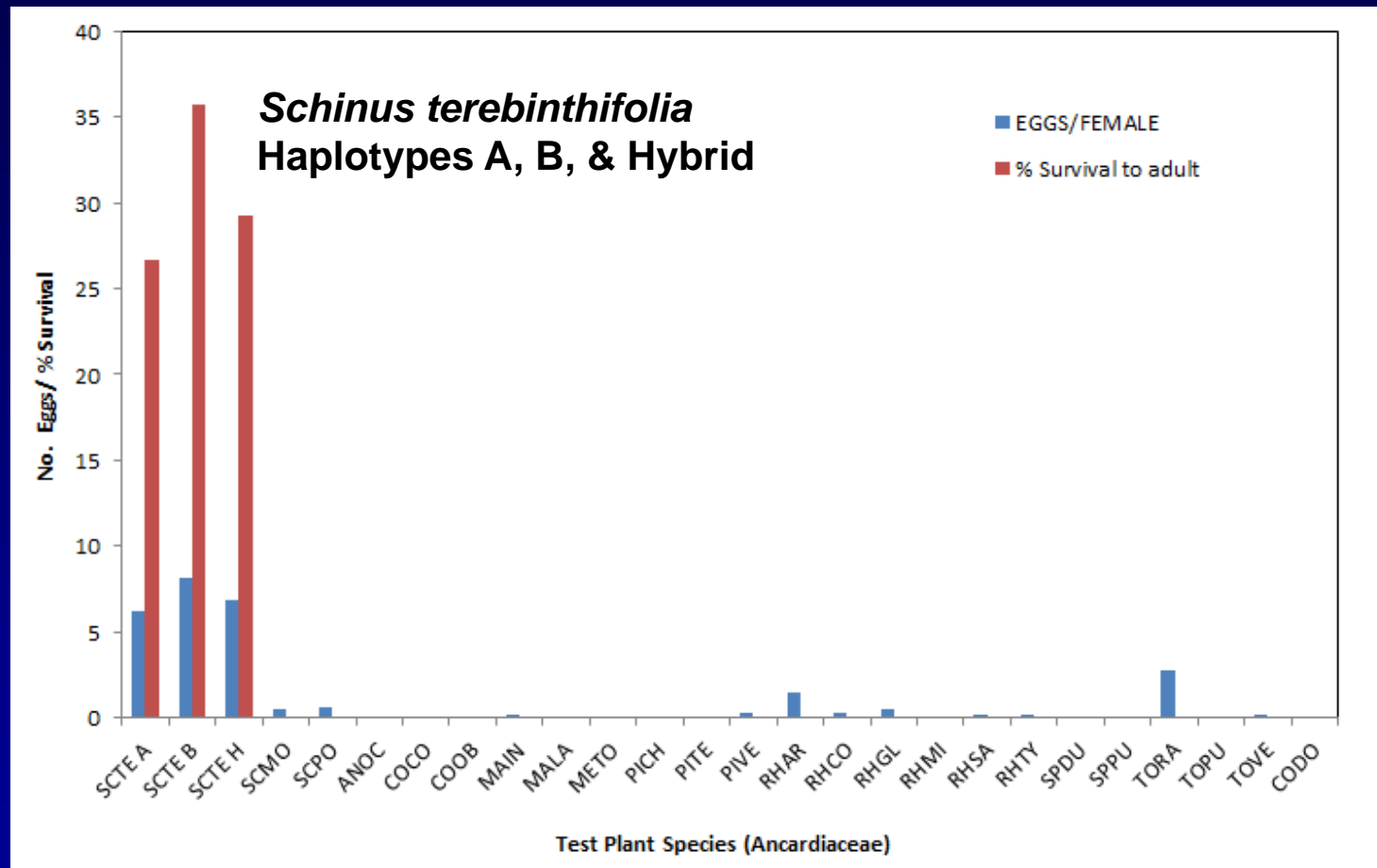


Cages used for experiments in quarantine, Indian River REC, Ft. Pierce, FL, Photo Credit: R. Diaz

# Development & Fecundity Comparison



# Oviposition and Survival *C. latiforceps*



- Test plants included 90 species in 48 families
- Gall initiation and complete development only on Brazilian peppertree!!

# Impact on Plant Height *C. latiforceps*



Plants after 4 months of exposure, without (L) & with (R) psyllid galls, Photo Credit: R. Diaz.

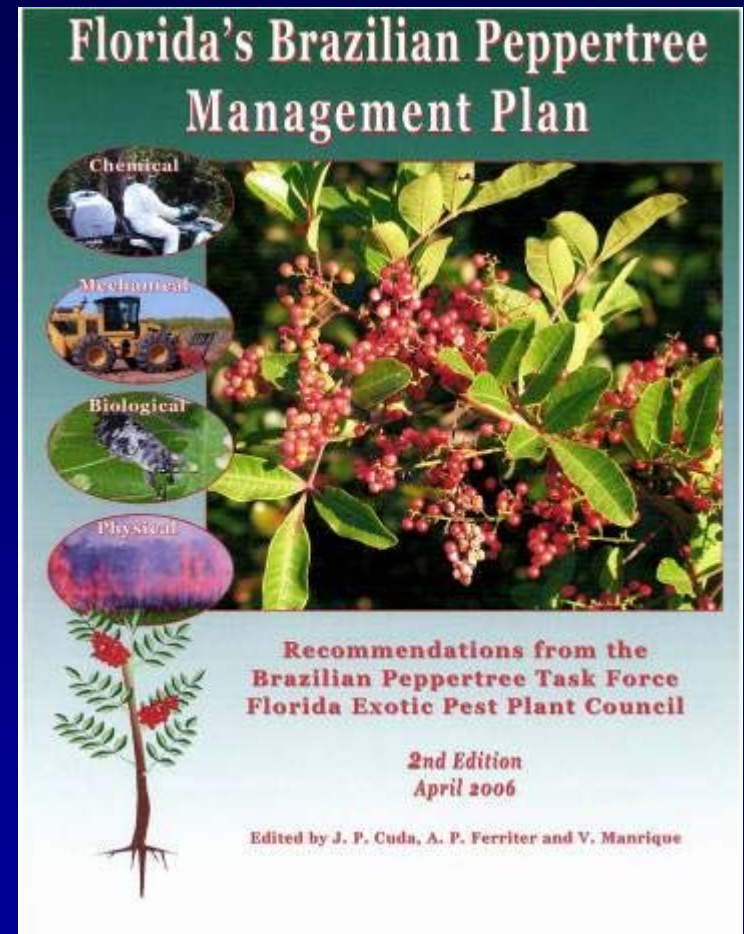
# Summary

- All Three Natural Enemies Host Specific & Impact BP Growth
- Status of Release Petitions
  - Thrips- Submitted Jointly to TAG by USDA & UF, August 2014; Under Review
  - Weevil- Submitted to TAG, October 2012; Additional No-choice Host Range Tests & Impact Study in Progress
  - Psyllids- Petition for Release of *Calophya latiforceps* Submitted to UF/IFAS for Internal Review, June 2014; Additional No-choice Host Range Tests in Progress

# Brazilian Peppertree Management Plan

- **1997 Management Plan Revised**
  - April 2006
- **2<sup>nd</sup> Edition Available**
  - In Print and On-Line:

[http://www.fleppc.org/Manage\\_Plans/schinus.pdf](http://www.fleppc.org/Manage_Plans/schinus.pdf)



# Outline

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