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

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

(Photo credit: Bryan Harry, NPS)

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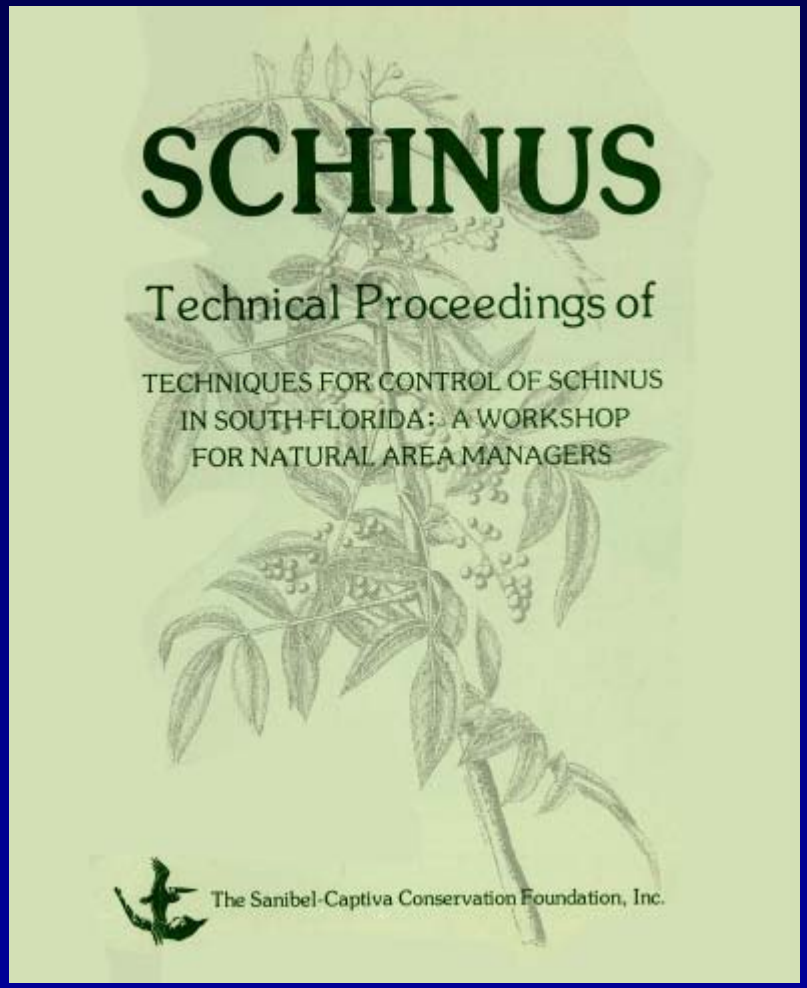
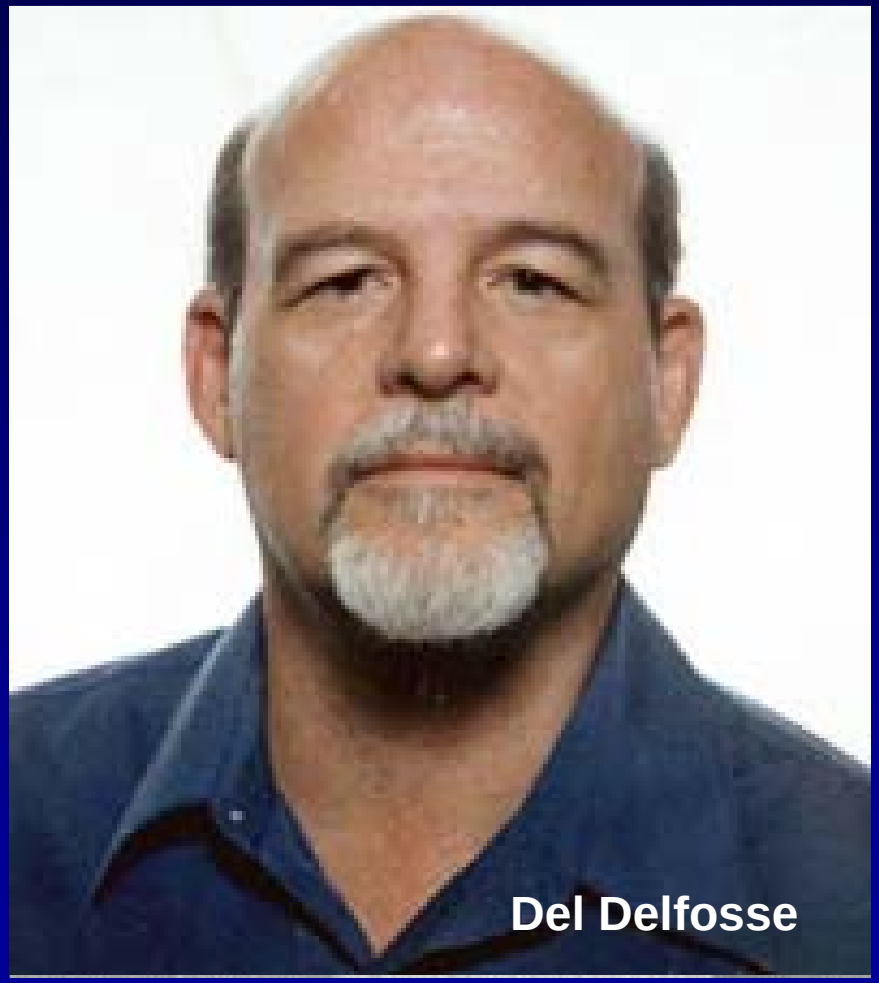
Late 1970s





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Early 1980s

John Cassani

SCHINUS TEREBINTHIFOLIUS
(ANACARDIACEAE), IN SOUTH FLORIDA

J. R. CASSANI
Lee County Hyacinth Control District
Post Office Box 06005
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 (*Cyrtoxipha* sp.). The phytophagous

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

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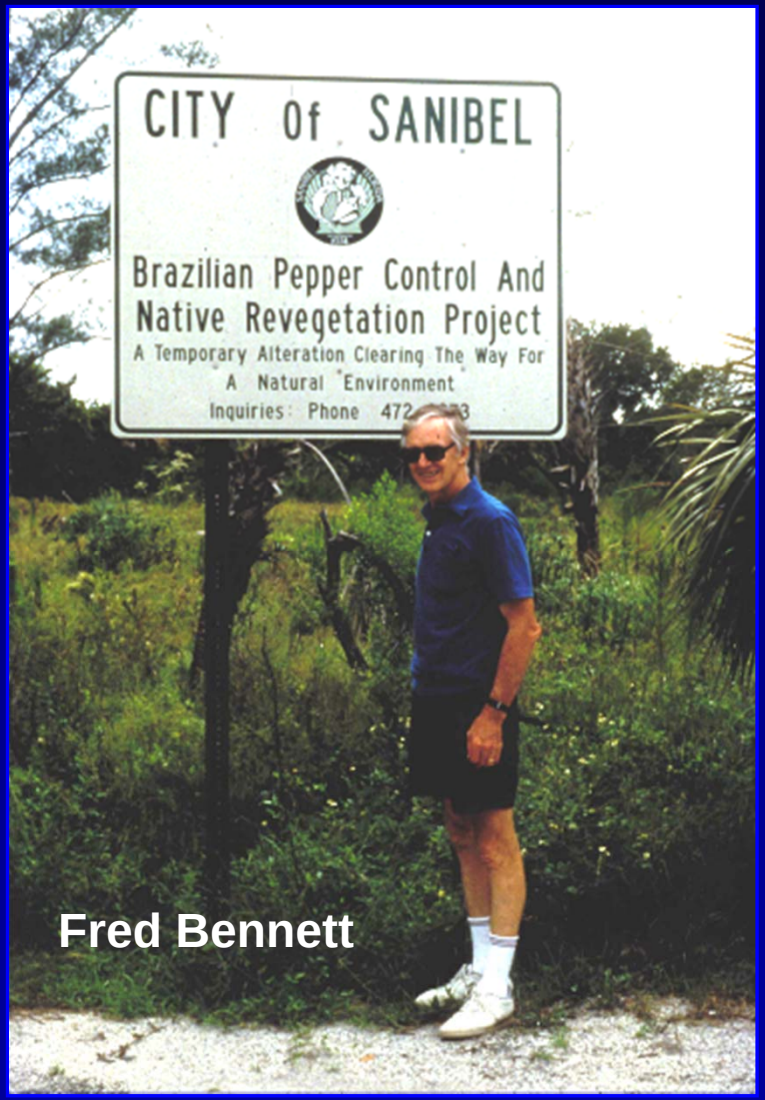
Late 1980s

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

Bennett et al. (1990)



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Outline

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

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Brazilian Peppertree
Schinus terebinthifolia Raddi

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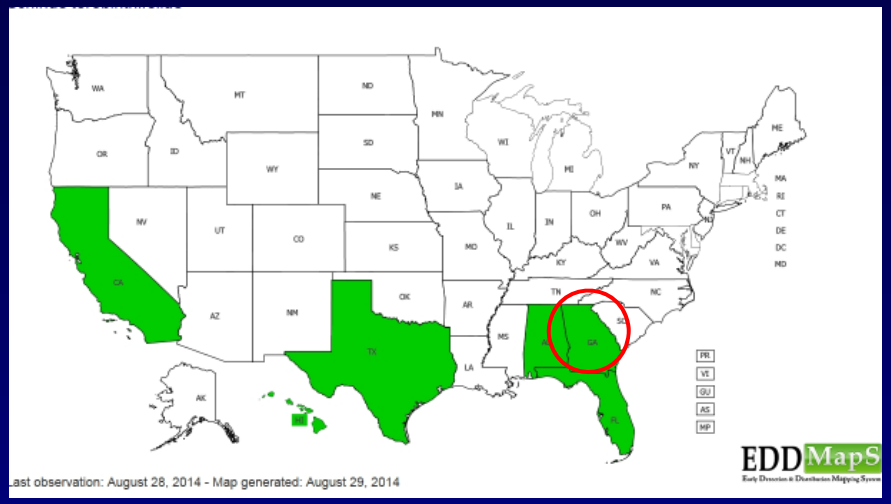
Distribution of BP

- **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)

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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

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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.

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Aroeira = Brazilian Peppertree

- **Popular Ornamental in Brazil**
  - **Street Names**
  - **Neighborhoods**

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Growth Habit of BP

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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

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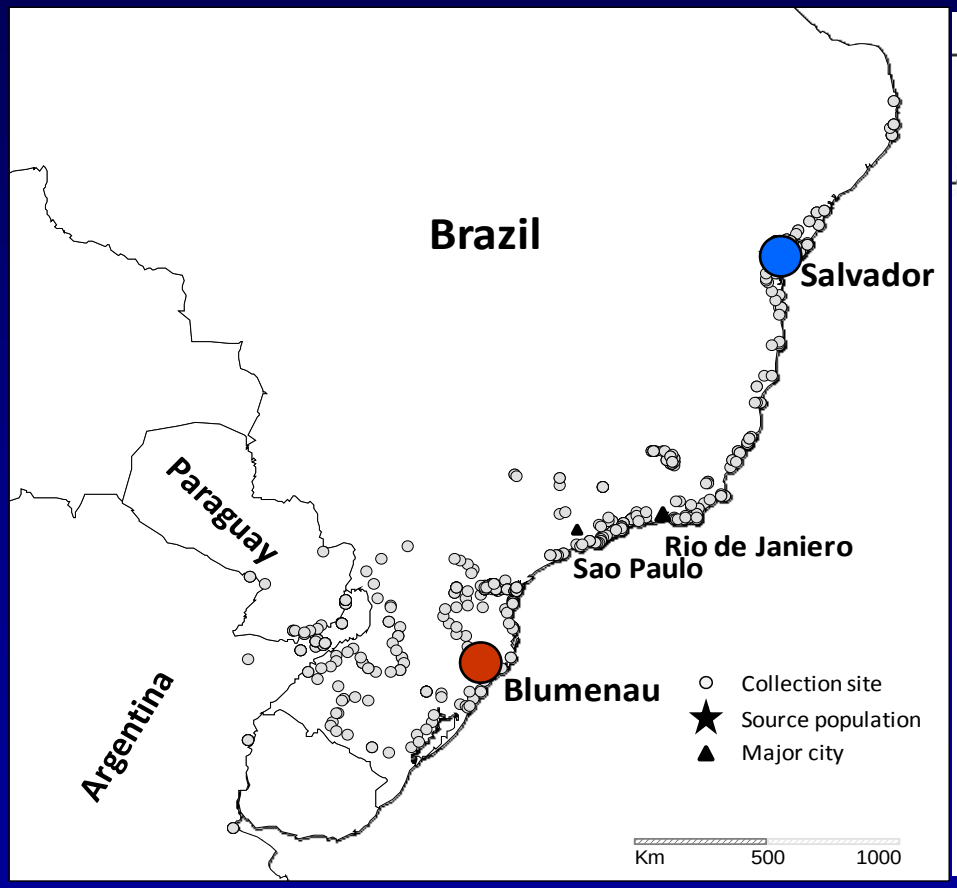
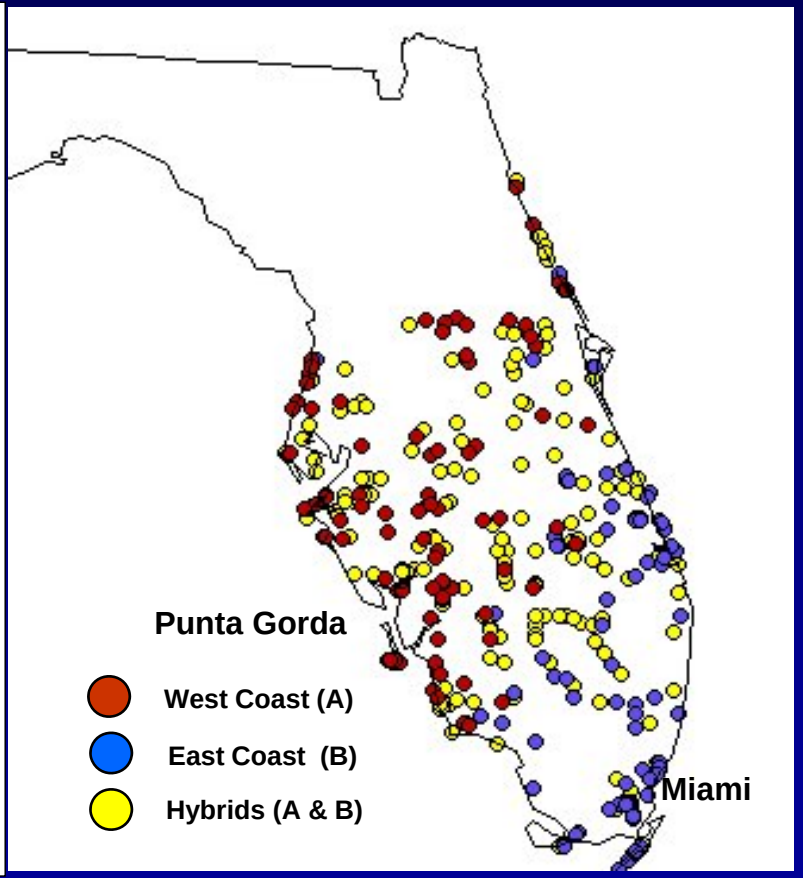
Why is BP Invasive in Florida?

- Multiple Genotypes in South America





Williams et al. (2005,2007)

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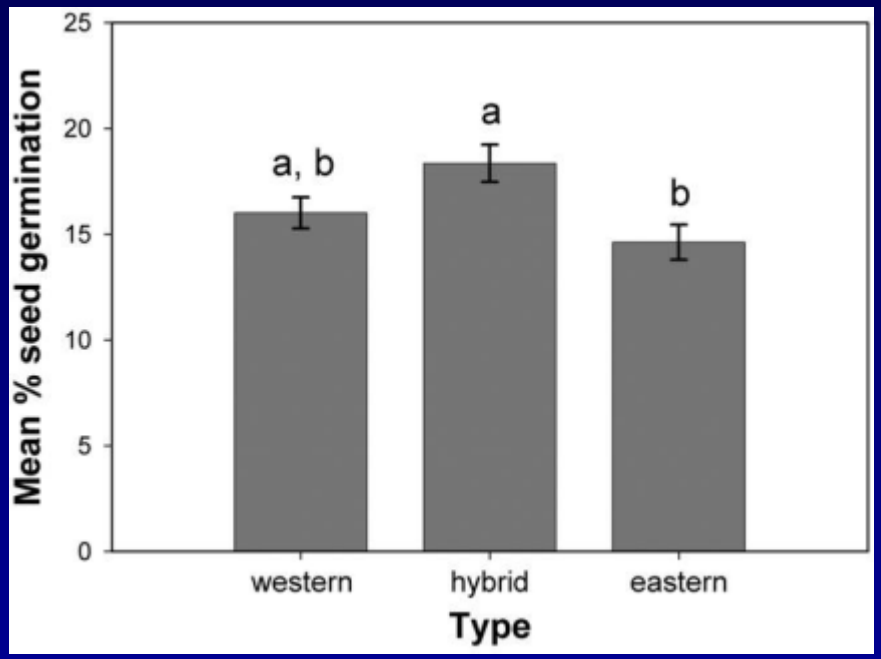
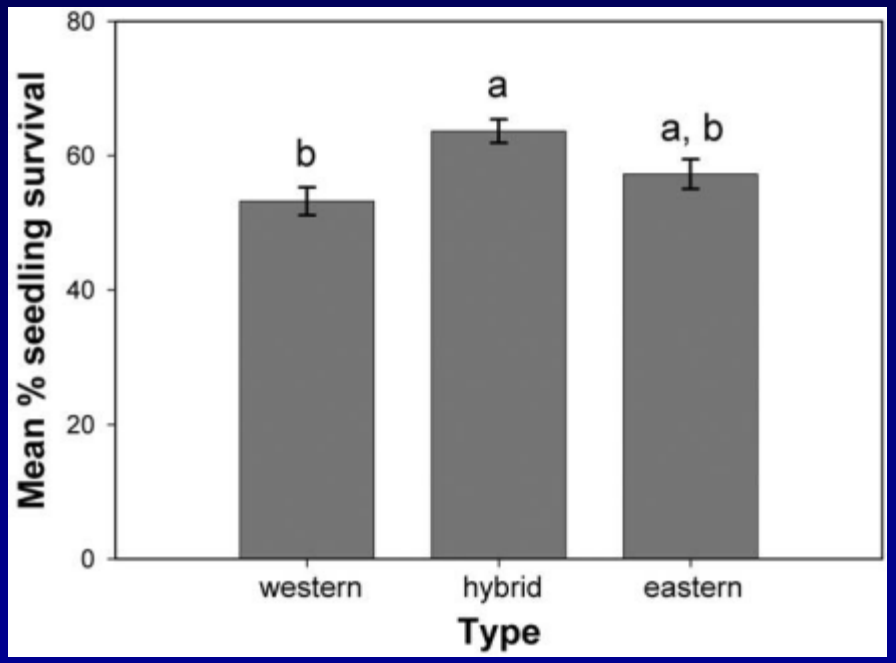
Why is BP Invasive in FL?

- **Hybrid Vigor**





Geiger et al. (2011)

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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**

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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 !!!

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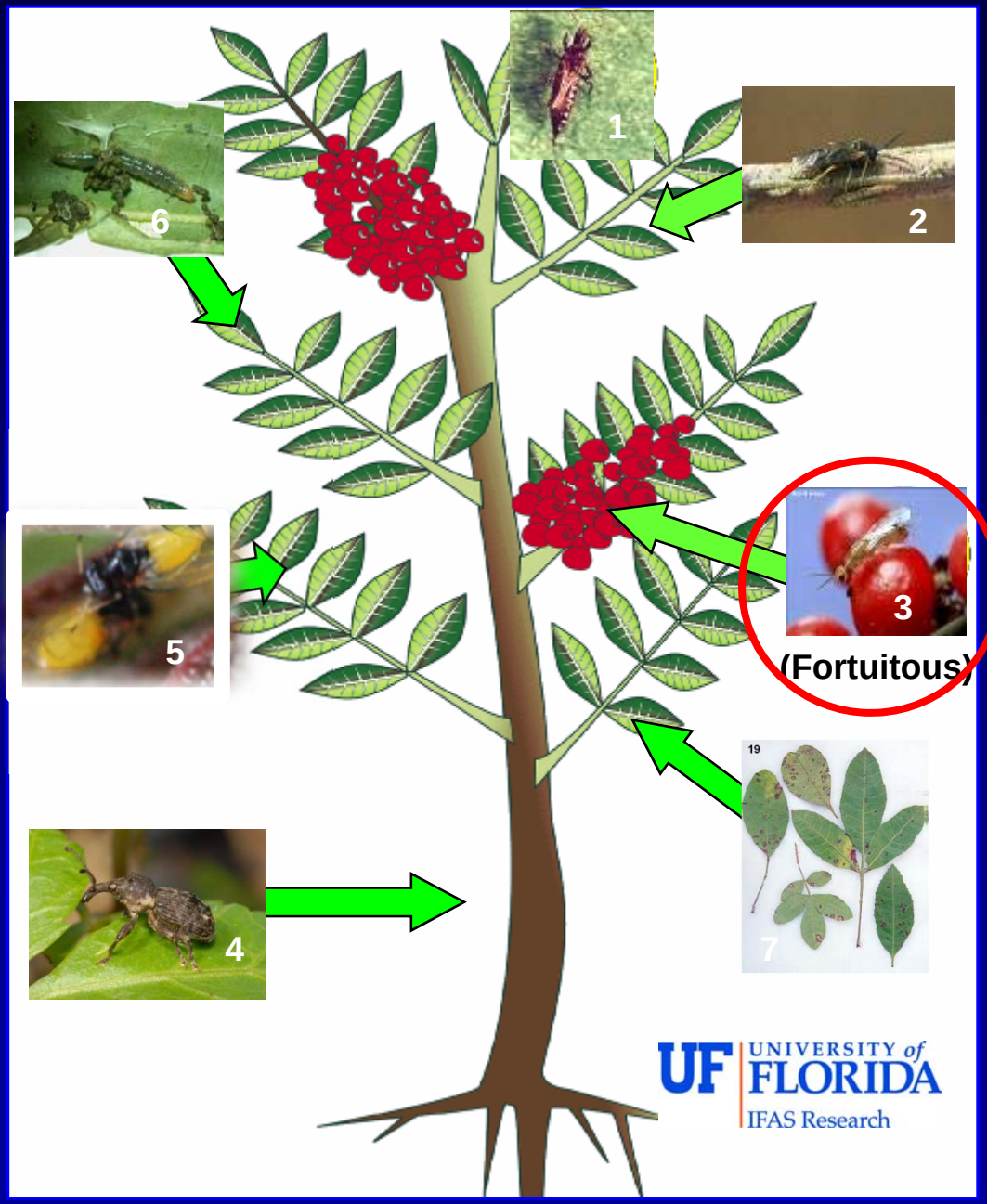
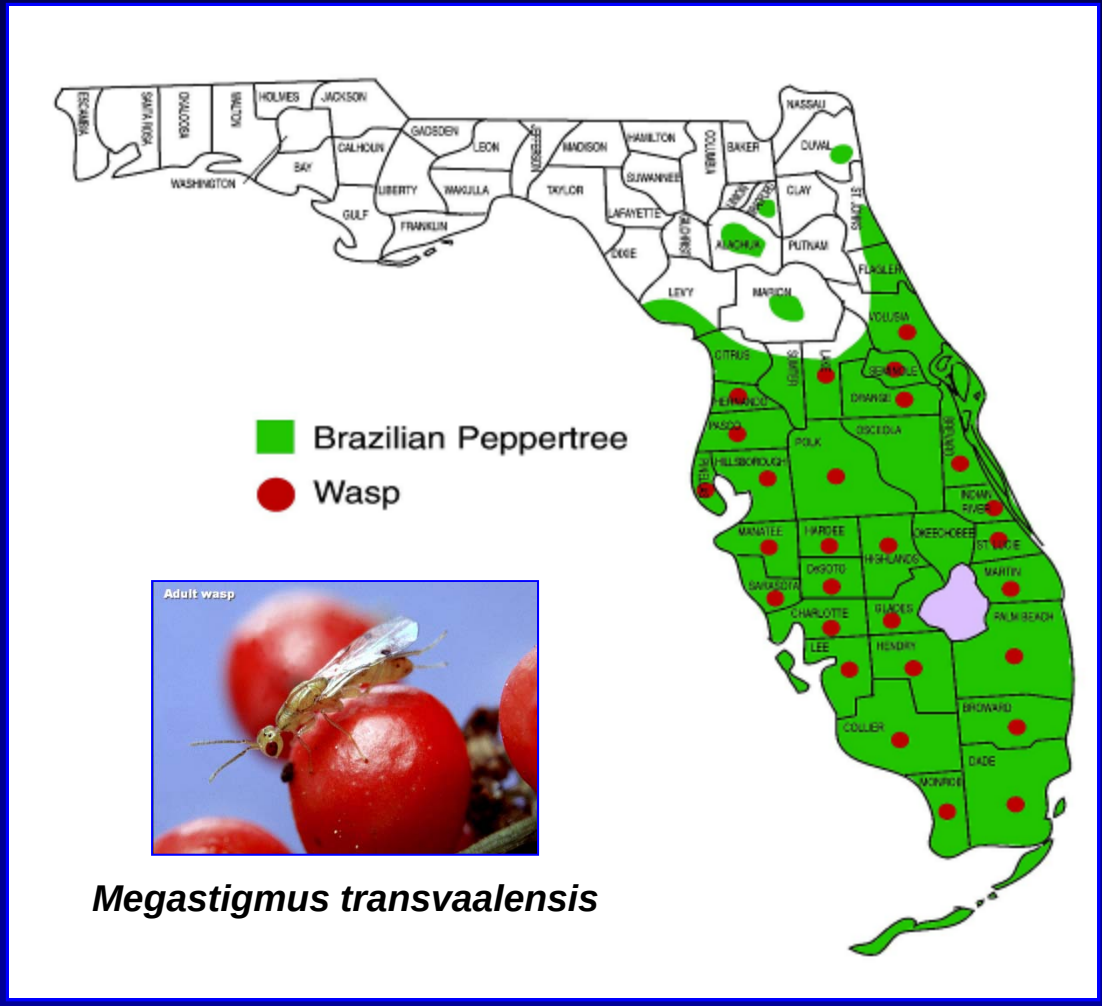
BP Natural Enemies

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**



Megastigmus transvaalensis

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

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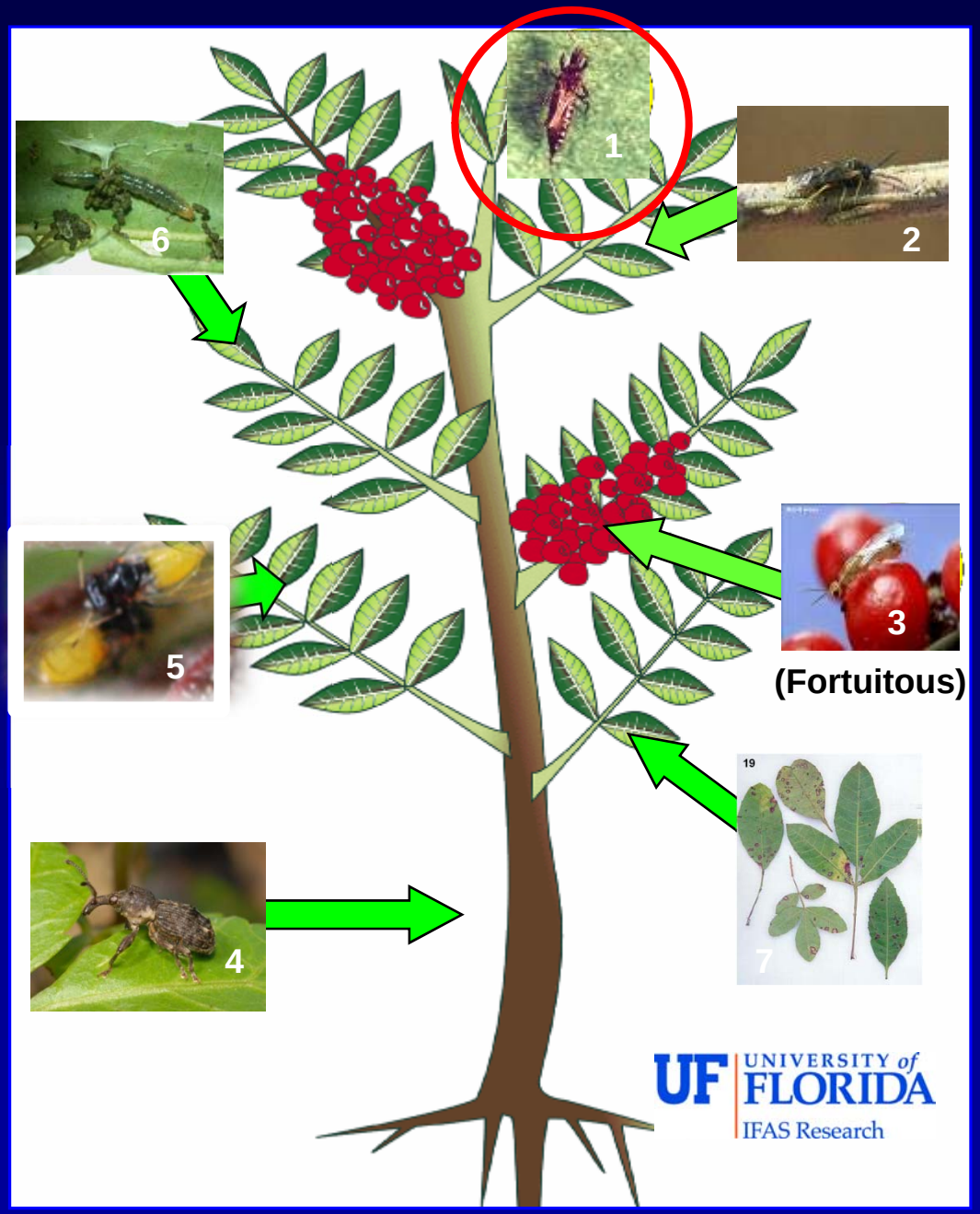

Pseudophilothrips ichini
(Thysanoptera: Phlaeothripidae)

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

(Garcia 1977)

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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)

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No-Choice Oviposition Tests

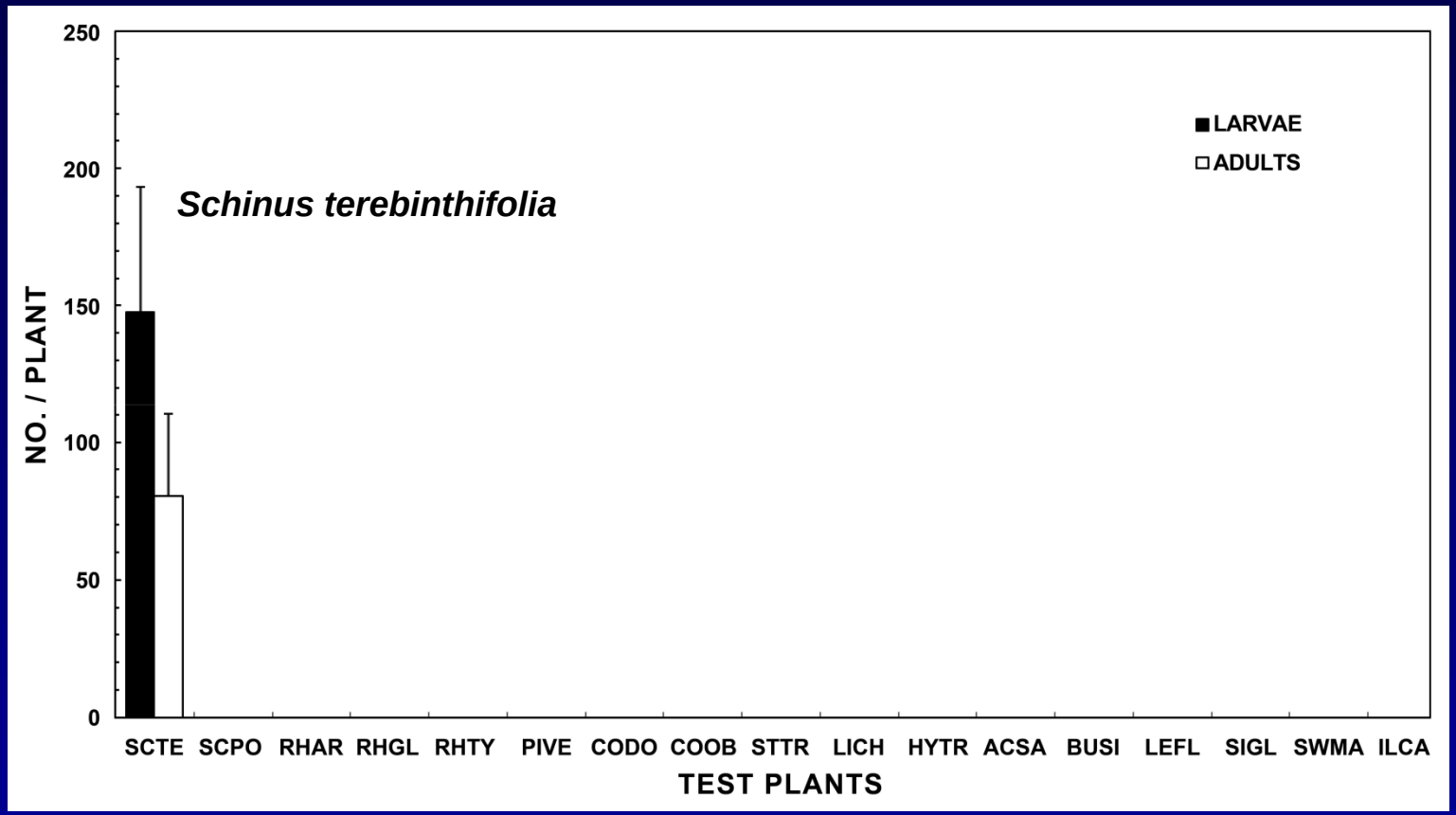

Figure 2. Performance of *P. ichini* s.l. on Caribbean and other native plants in supplemental no-choice oviposition tests conducted in Florida, June 2003-November 2005.

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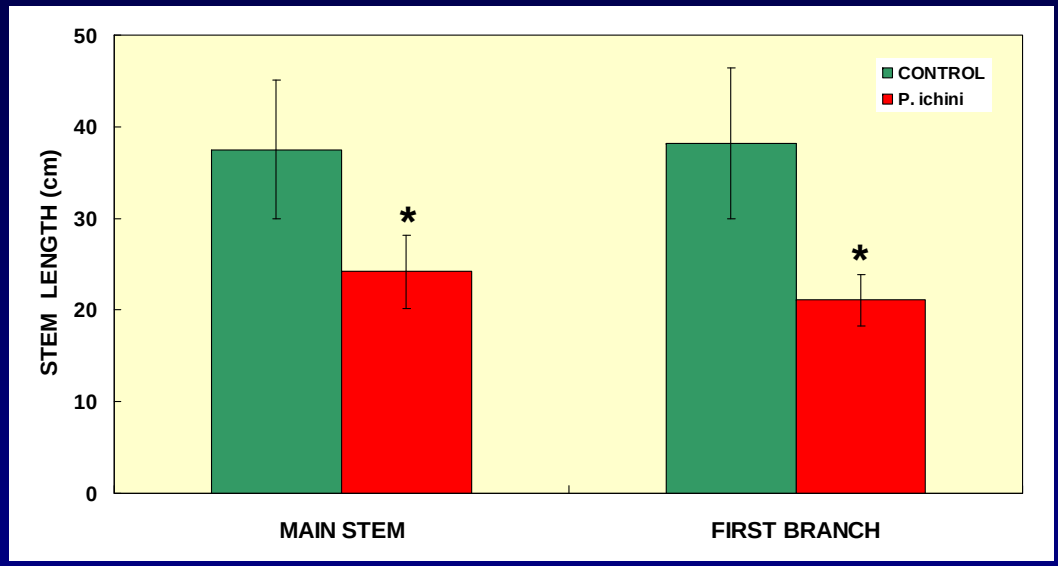
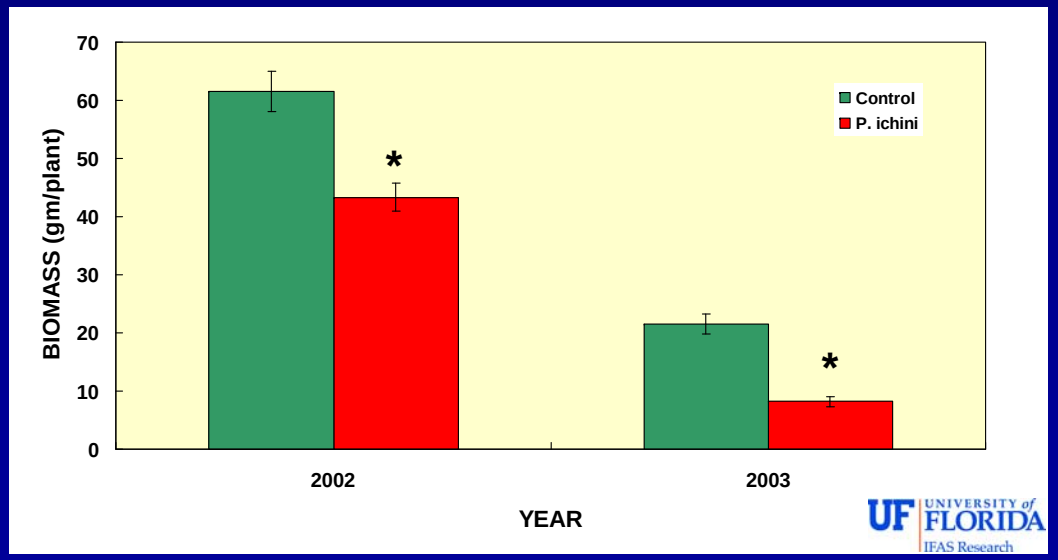
BP Thrips Field Impact Study

Curitiba, Parana, Brazil

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





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Furmann et al. 2005

P. ichini Haplotypes

Hap 5- Curitiba, Brazil

Hap 2 or 3- Ouro Preto, Brazil

Manrique et al. (2008)

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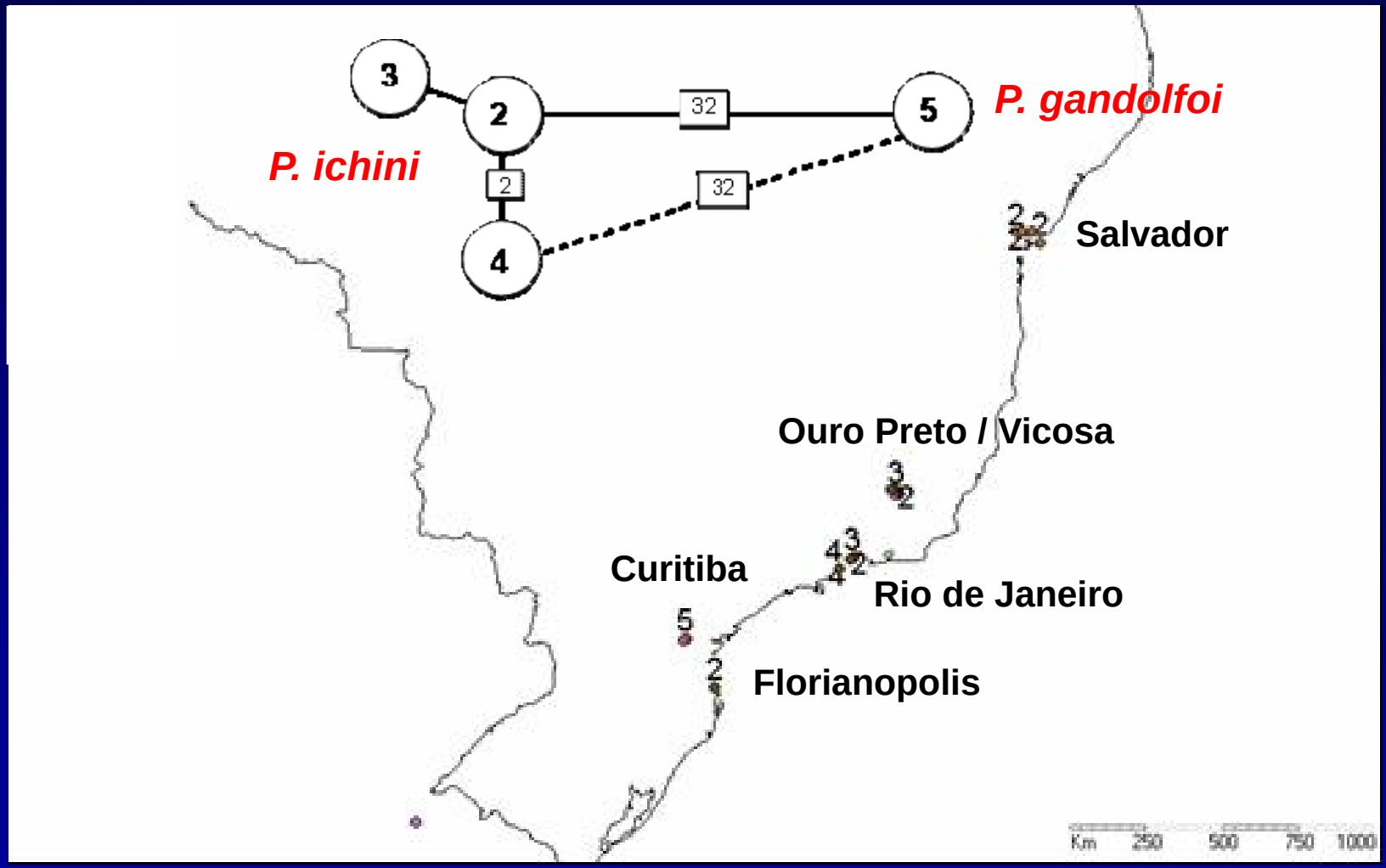
Distribution of *P. ichini* "Haplotypes"



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

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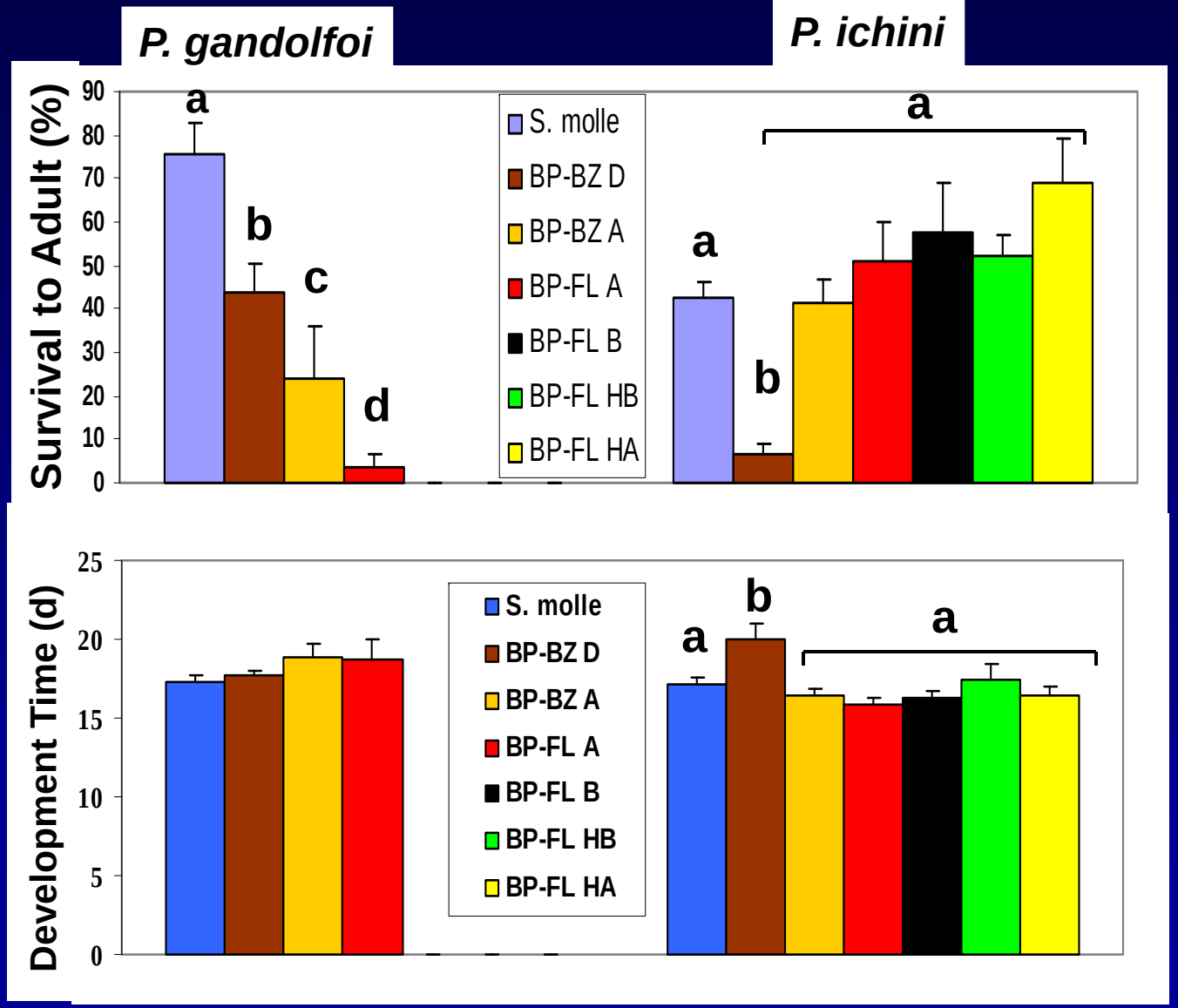
‘Fine Scale’ Adaptation to BP



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

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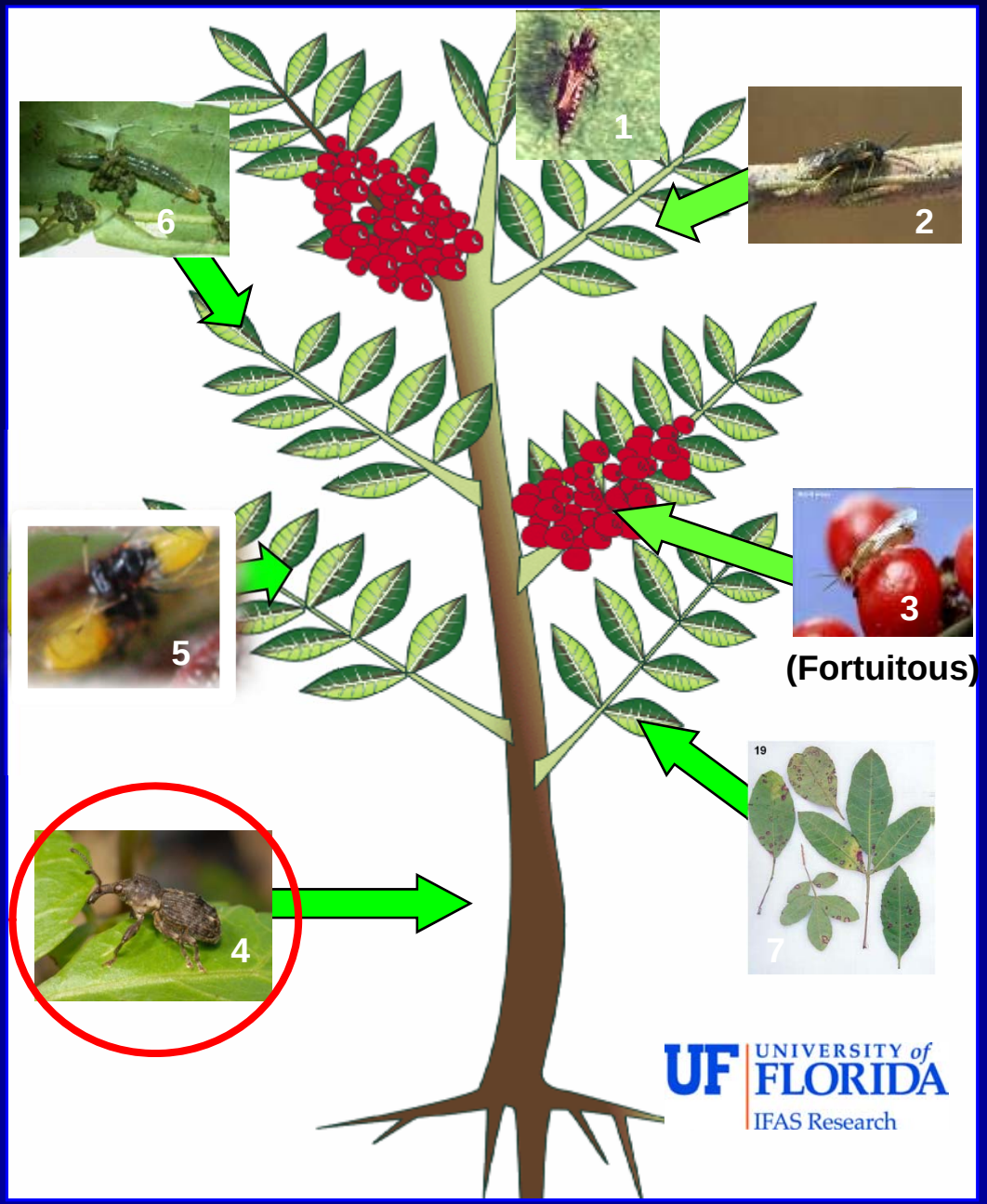
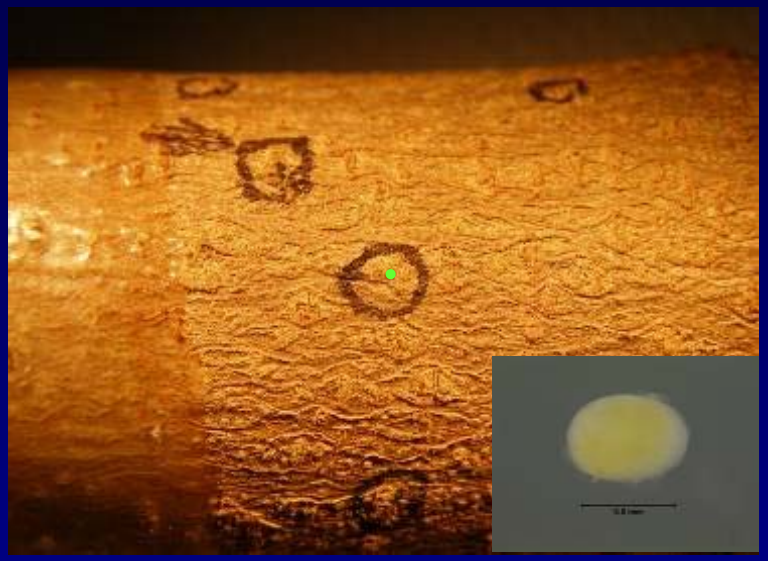


Apocnemidophorus pipitzi
(Coleoptera: Curculionidae)



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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)

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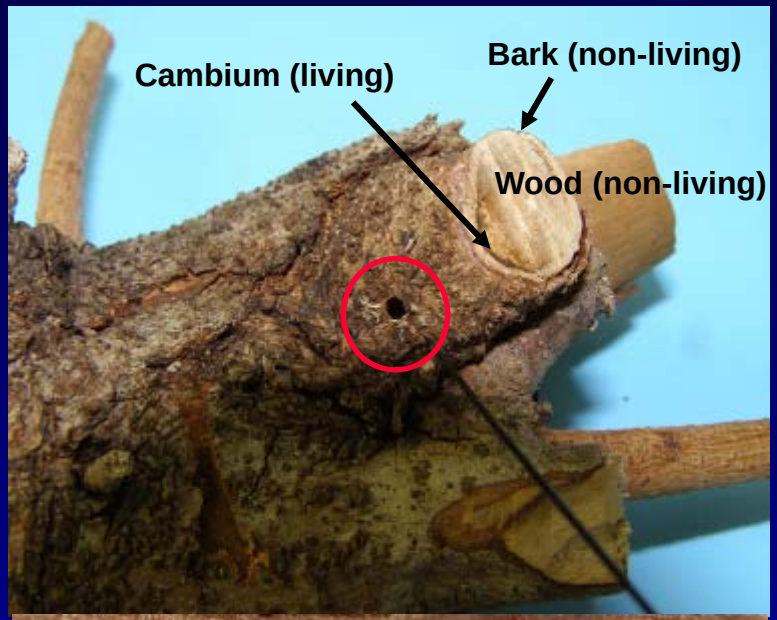
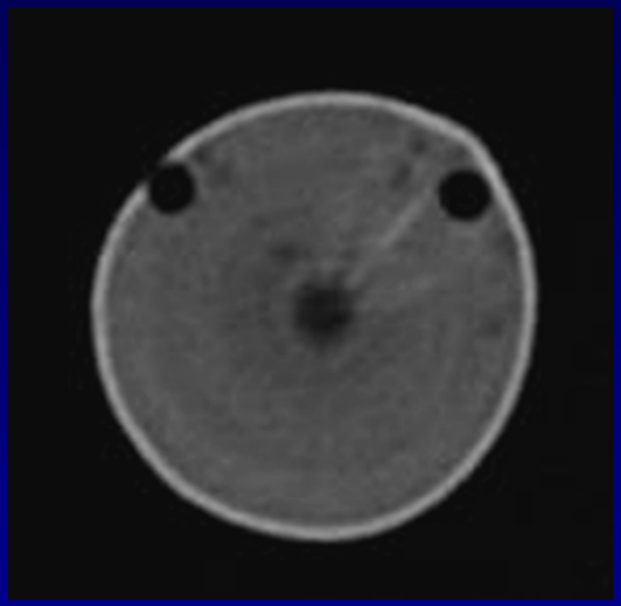
Weevil Exit Hole & Larval Tunnels





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Host Range Test: No- Choice

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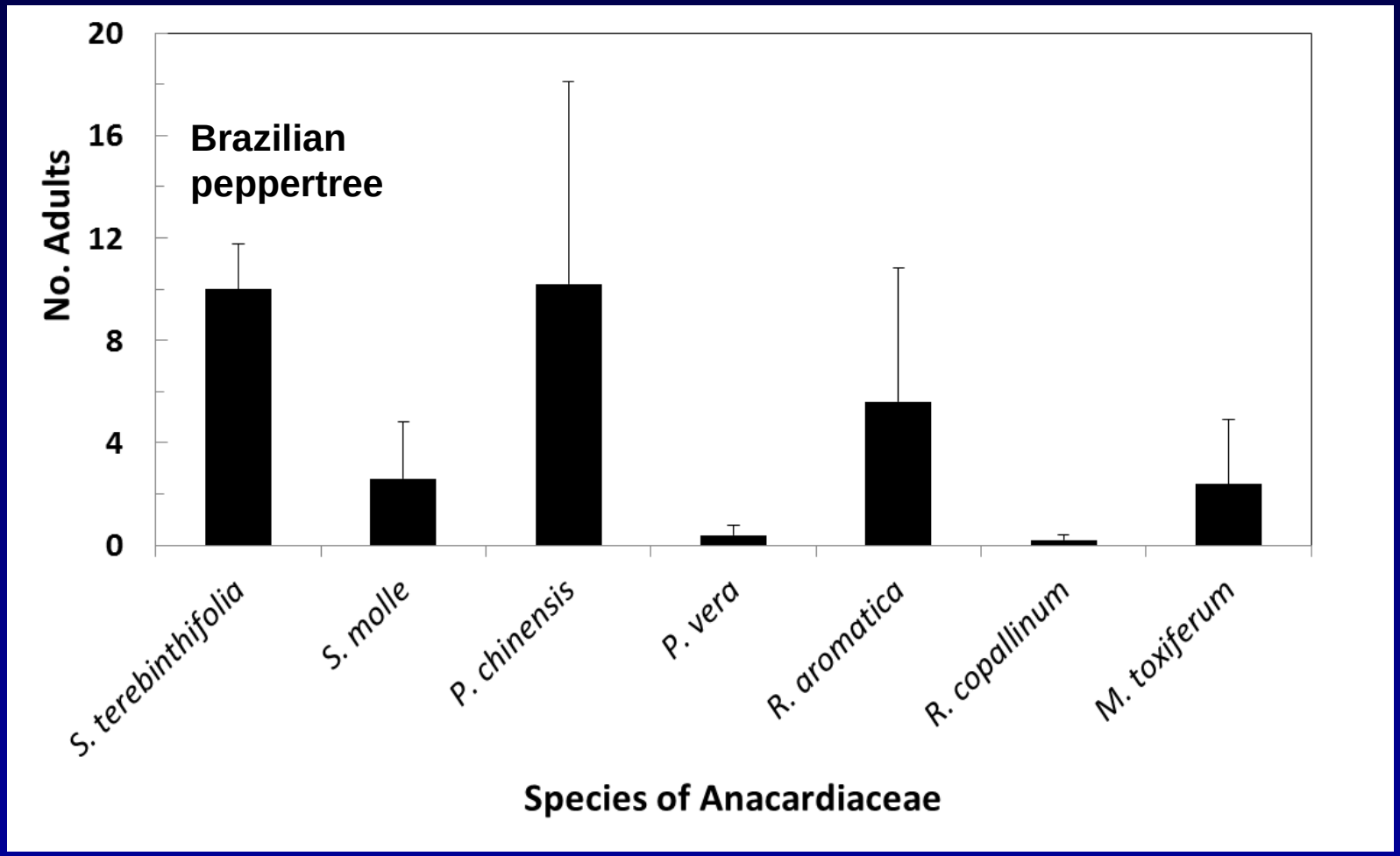
Weevil Emergence

No-Choice Host Range Tests



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Host Range Testing- Multiple Choice

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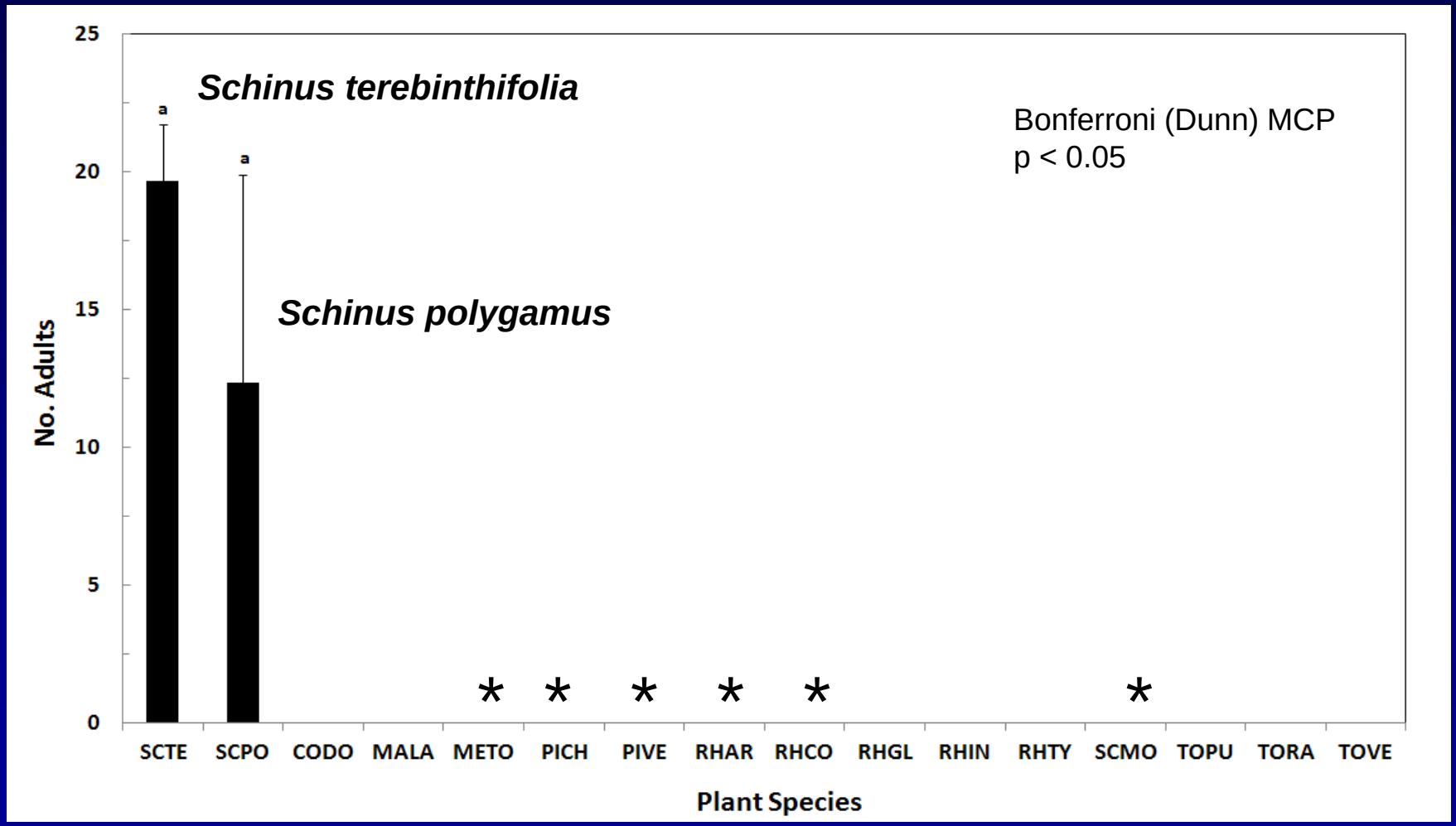
Weevil Emergence

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)

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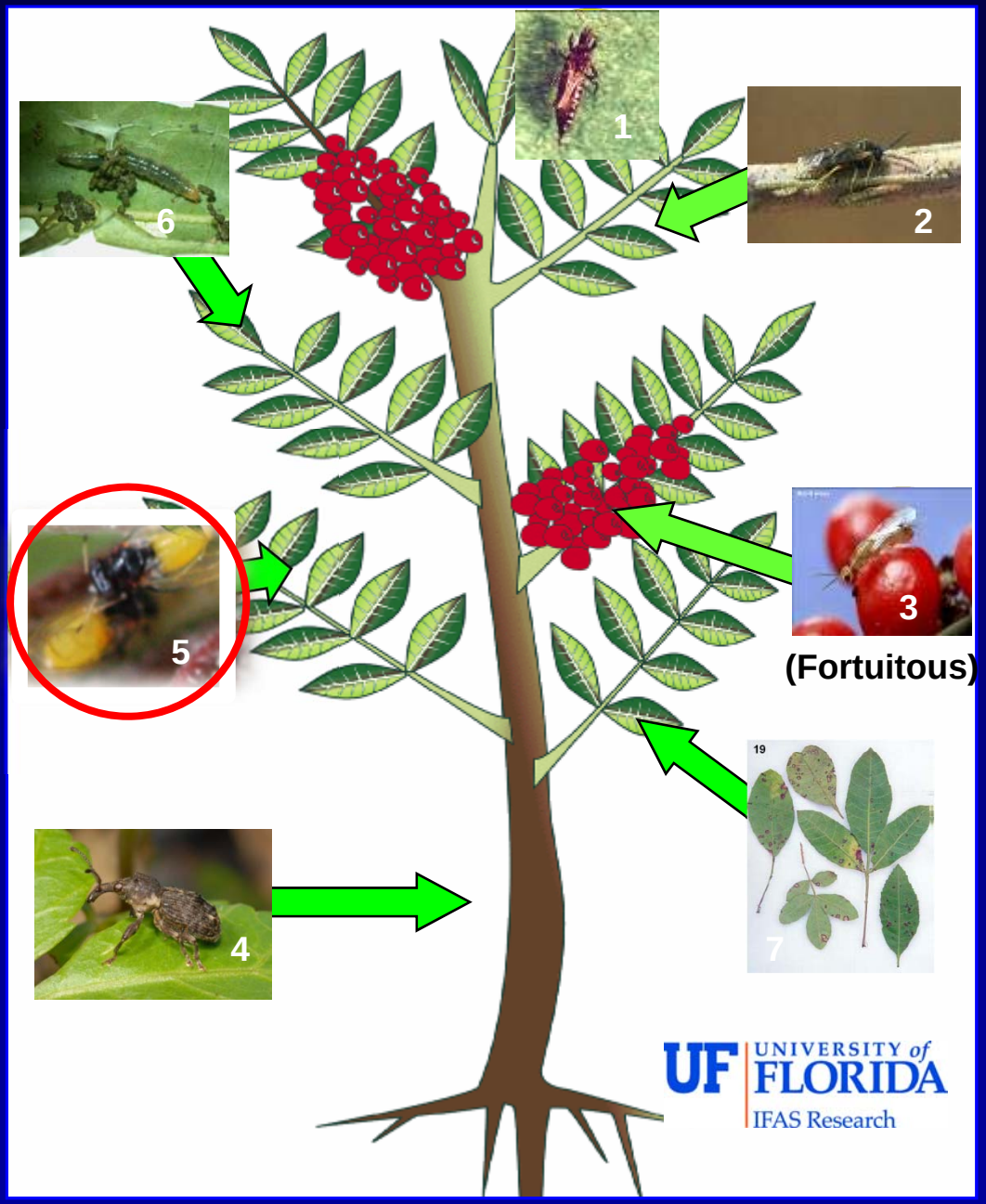

Peruvian Peppertree Model

- *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)

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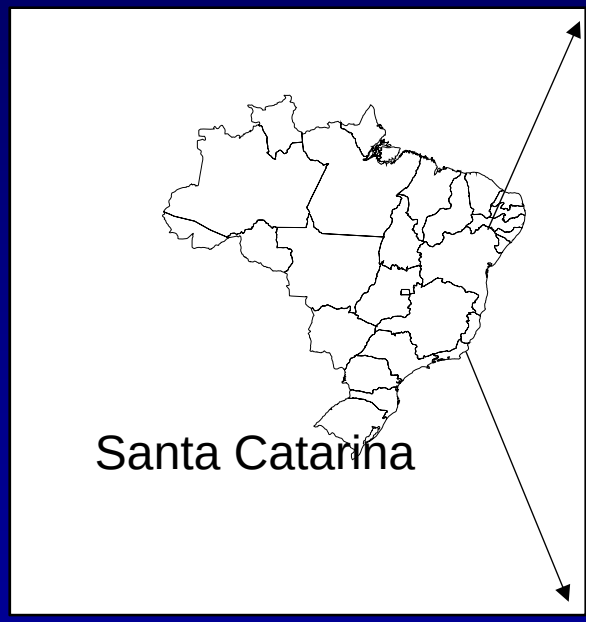
Surveys in Brazil

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



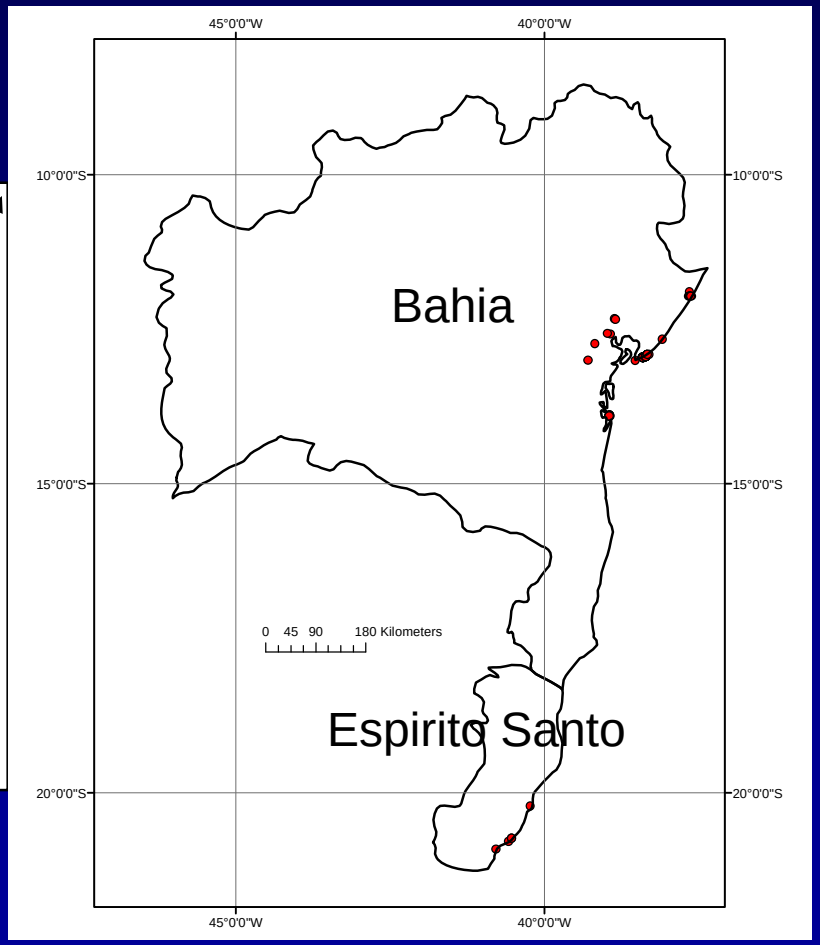


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Photo Credit: R. Diaz

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

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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

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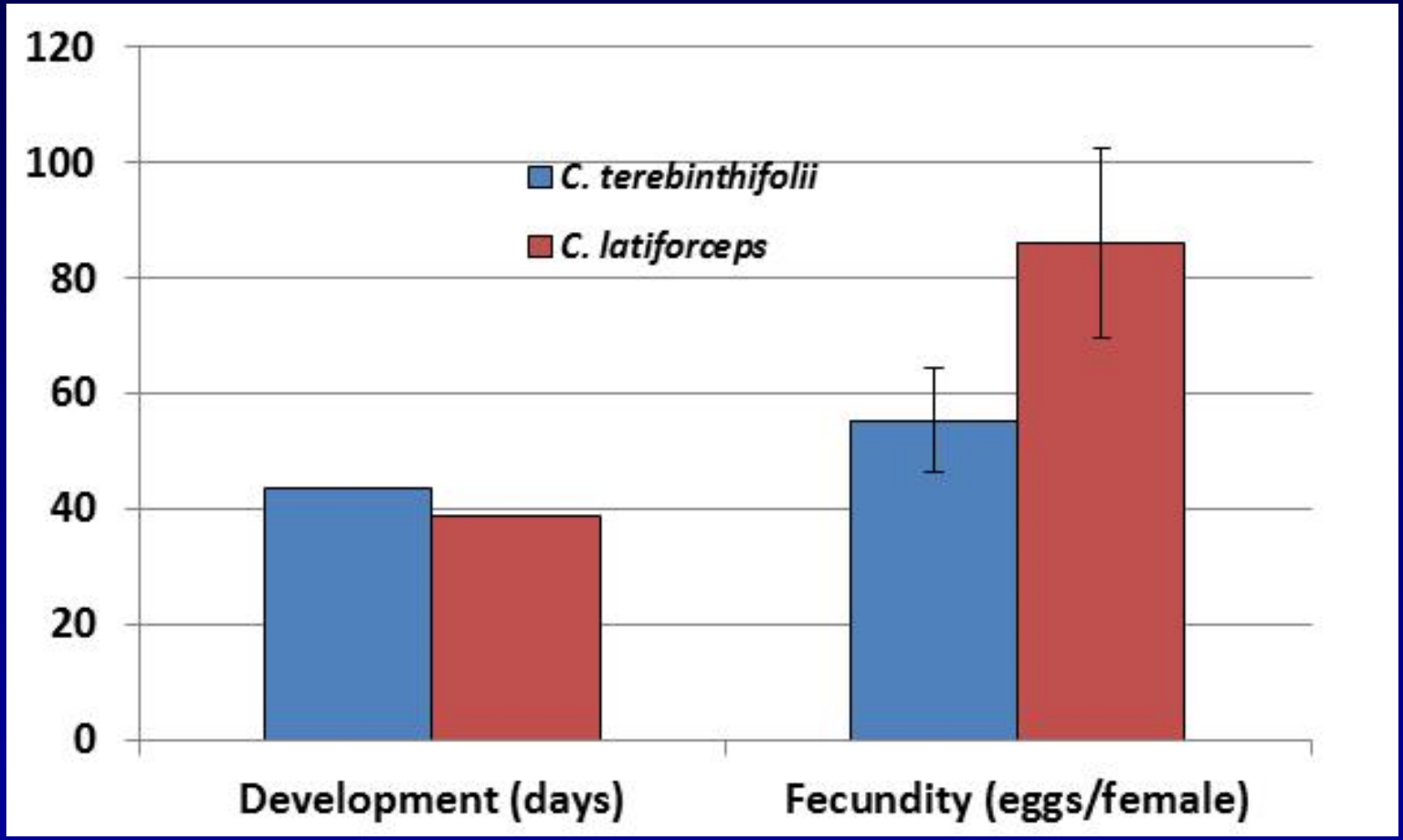
Development & Fecundity Comparison



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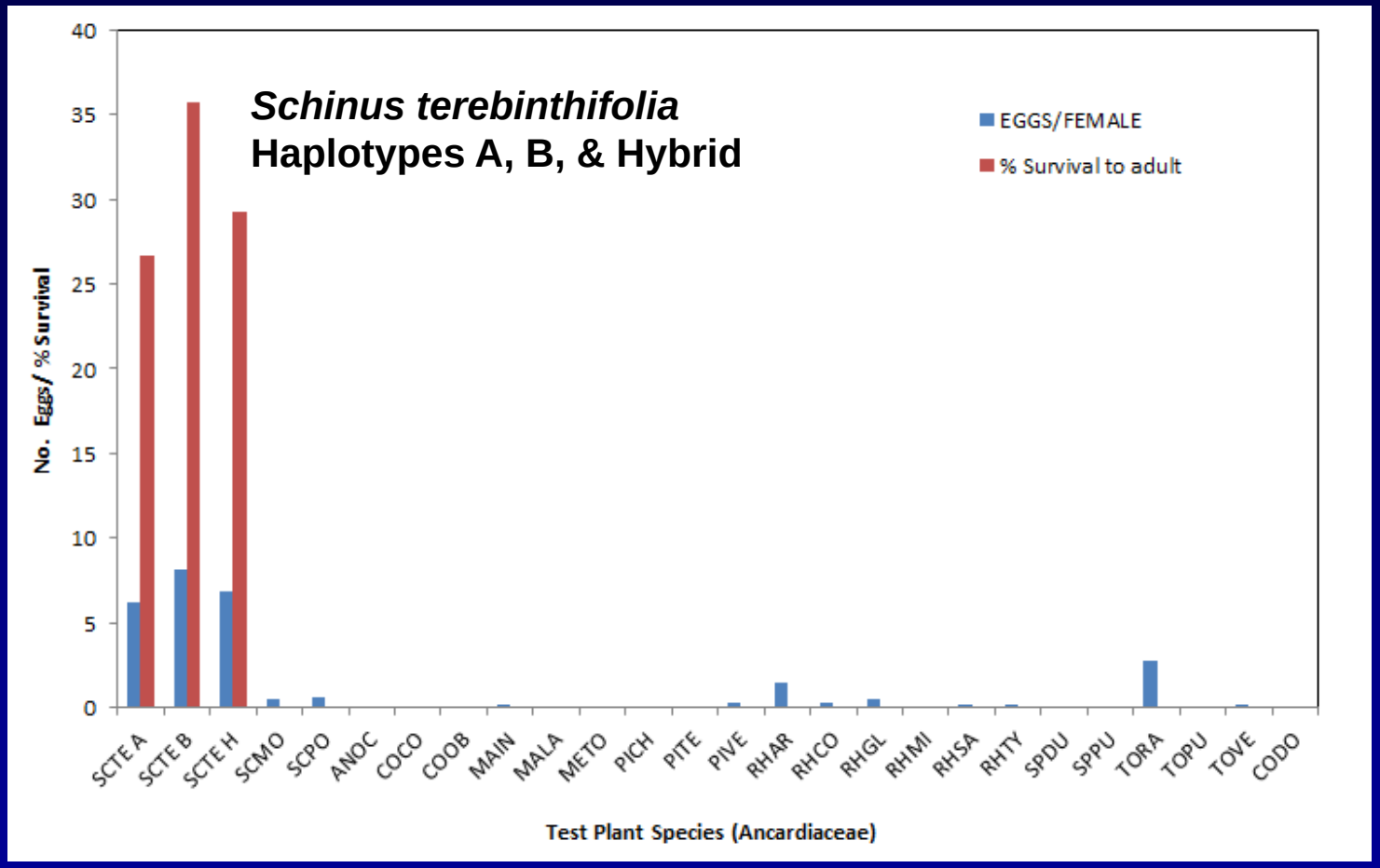
Oviposition and Survival
C. latiforceps



- **Test plants included 90 species in 48 families**
- **Gall initiation and <u>complete development</u> only on Brazilian peppertree!!**

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Impact on Plant Height
C. latiforceps

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

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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

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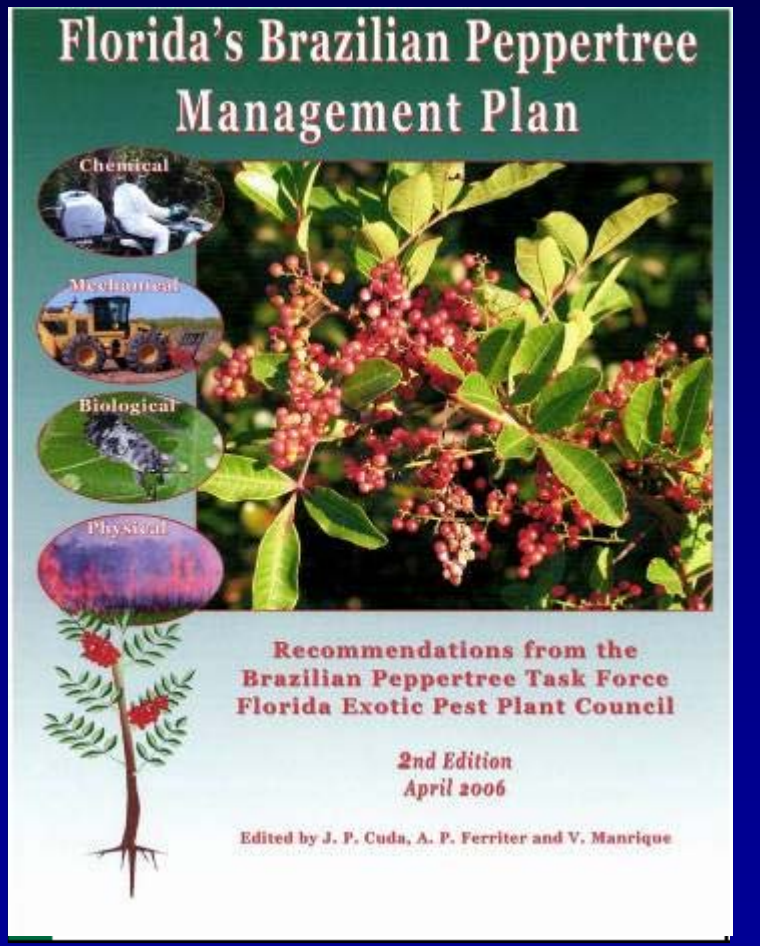
Brazilian Peppertree Management Plan

- 1997 Management Plan Revised
  - April 2006
- 2nd Edition Available
  - In Print and On-Line:

http://www.fleppc.org/Manage_Plans/schinus.pdf



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