Symposium 5

Role of Molecular Genetics in Identifying 'Fined Tuned' Natural Enemies of Invasive Weeds

James P. Cuda- Moderator

Entomology & Nematology Department,
Gainesville, Florida, USA

2010 Biological Control for Nature Conference

Hotel Northampton, Northampton, Massachusetts, USA

3-7 October 2010

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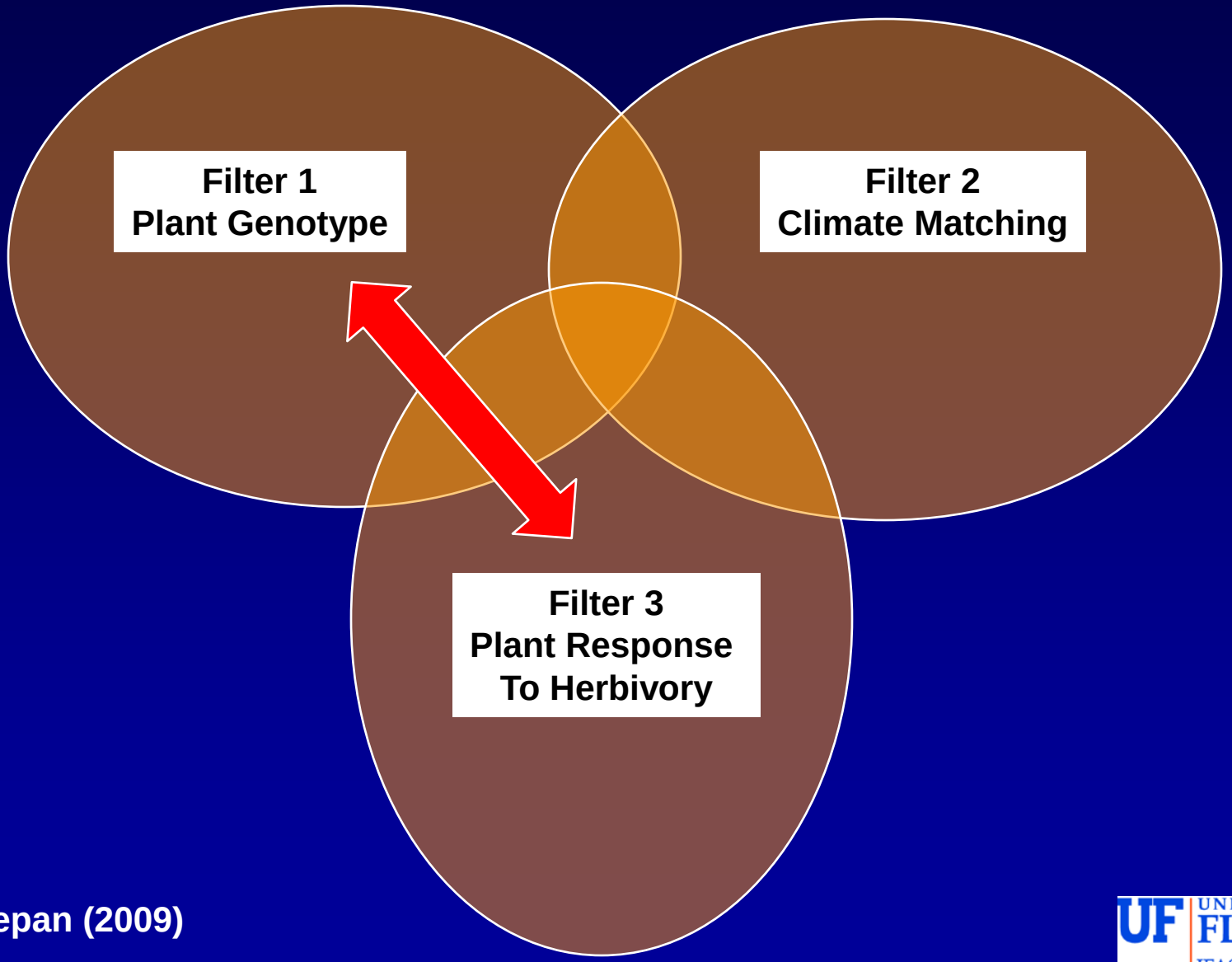
BioAgent Prioritization Process



Dhileepan (2009)

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Effect of Host Plant Genotypes on the Performance of Brazilian Peppertree Biological Control Agents

James P. Cuda[1], Veronica Manrique[2], William A. Overholt[2], Dean W. Williams[3] , Lindsey R. Christ[1] and Gregory S. Wheeler[4]

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Outline

- Introduction
- Variation in Brazilian Peppertree, *Schinus terebinthifolius*
- Natural Enemy Performance
- Conclusions
- Questions? Comments?

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Outline

- Introduction

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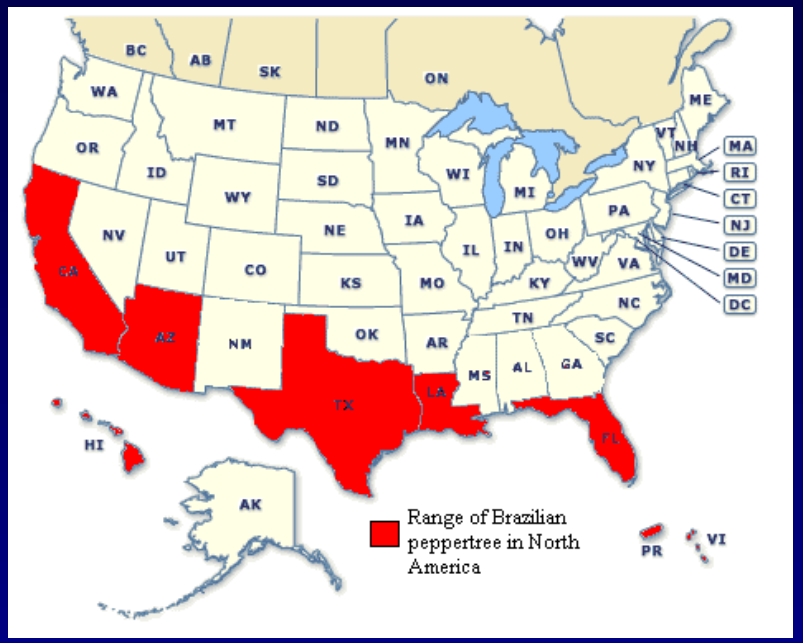
Bazillion Peppertree

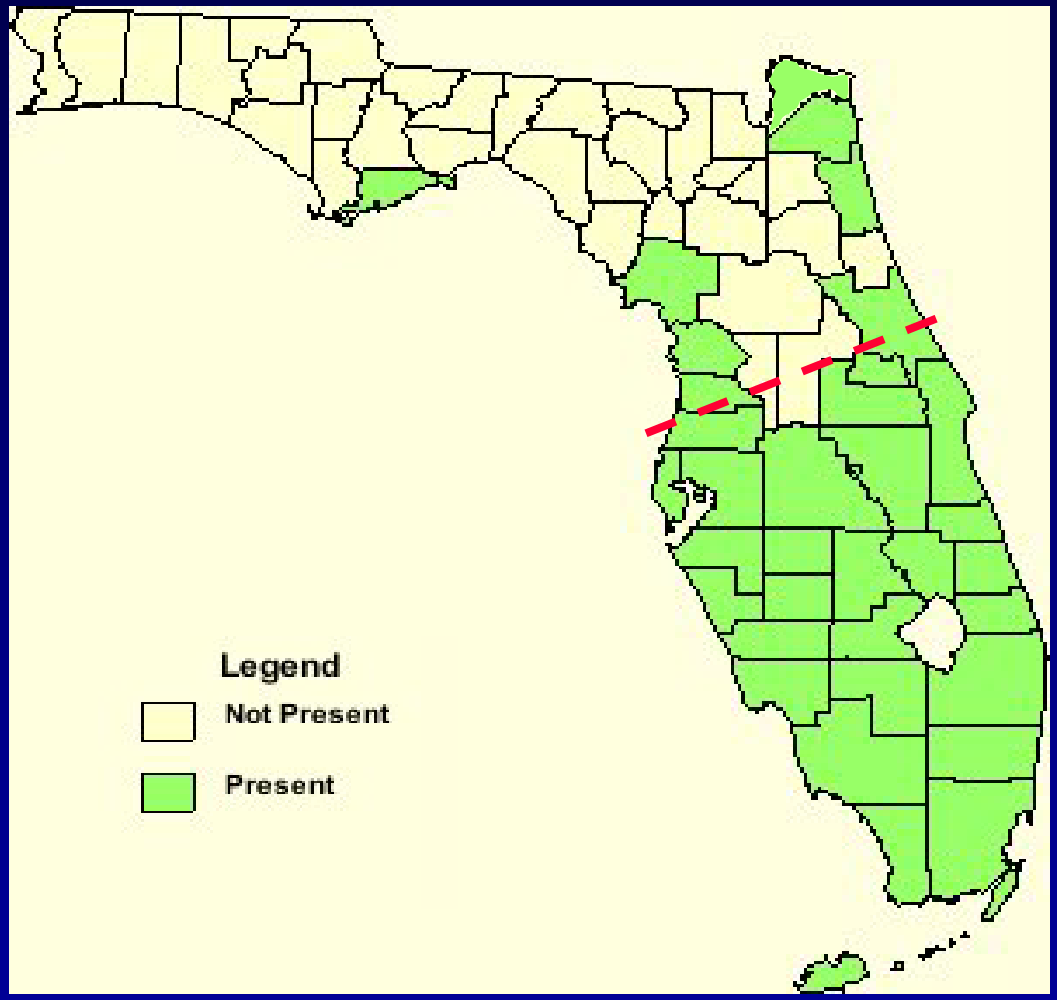
Schinus howterribleyouvebeenforus

Brazilian Peppertree (BP)

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



Current Distribution of BP



Wunderlin & Hansen (2008), *Wildland Weeds* (2007)

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BP Displacing T&E Species

Doren and Jones (1997), Langeland and Burks (1998)

Gopher Tortoise
http://www.backfromthebrink.org/speciesimages/13/1_gopher_tortoise.jpg

Beach Star
http://davesgarden.com/pics/NativePlantFan9_1116629788_162_tn.jpg

Beach Jacquemontia
http://www.humanflowerproject.com

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BP Supports Other Invasive Species

Simpson et al. (1996), McCoy et al. (2003), Jackson & Jackson (2007), Reiskind et al. (2009)

Diaprepes Weevil

http://creatures.ifas.ufl.edu/citrus/S_R_B_W_TW4.htm

Redbanded Thrips

http://entnem.ifas.ufl.edu/creatures/orn/thrips/redbanded_thrips.htm#desc

http://biology.clc.uc.edu/fankhauser/Animals/mosquitoes/Aedes_albopictus_P9071863.JPG

Black Iguana

J. Jackson, FGCU

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BP Pollen Causes Problems

Jarzen and Nelson (2008)

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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)

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Growth Habit of BP

Photo Credit: D.C. Schmitz, FWC

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BP Targeted for BioControl

- Invasive Allelopathic Species
- Alters Biodiversity
- Toxic & Allergenic (Poison Ivy Family)
- Low Beneficial Value (Beekeepers?)
- Conventional Controls Temporary
- No Native Congeners in US !!!

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Morphological Characterization

- **Barkley (1944, 1957)-**
  - **Described Five Varieties of Brazilian Peppertree from South America**
    - ***Schinus terebinthifolius* sensu stricto**
    - ***S. terebinthifolius* var. *acutifolius***
    - ***S. terebinthifolius* var. *pohlianus***
    - ***S. terebinthifolius* var. *raddianus***
    - ***S. terebinthifolius* var. *rhoifolius***
- **Descriptions Based on Morphological Characteristics**
  - **Leaflet Shape & Number**
  - **Size of Terminal Leaflets**
  - **Hairiness**

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Genetic Characterization

- Williams et al. (2005, 2007)-
  - Identified 14 Brazilian Peppertree Haplotypes from Native & Introduced Ranges
    - United States
      - California, Florida, Texas, Hawaii, US Virgin Islands
    - South America
      - Argentina, Brazil, Paraguay
  - Identifications Based on Genetic Differences
    - Chloroplast DNA
    - Microsatellite DNA

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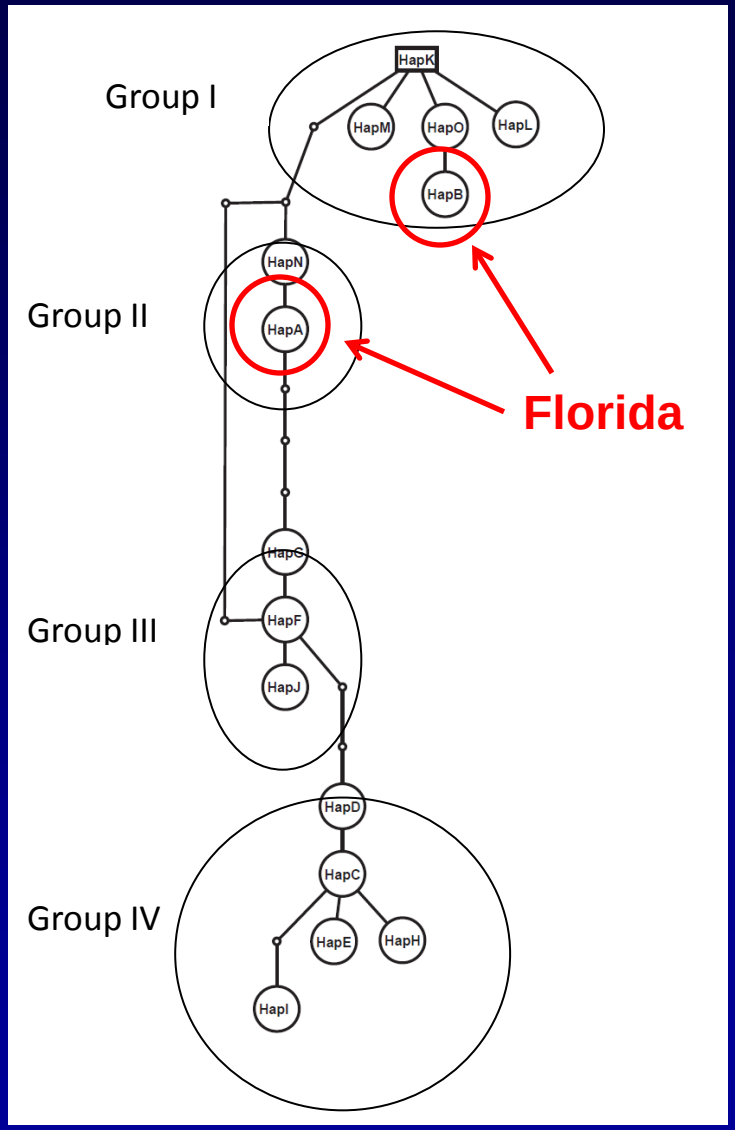
Chloroplast Parsimony Network

- Haplotype A
  - Hawaii
- Haplotypes A & B
  - Florida
  - Texas
  - Virgin Islands
- Haplotypes C, D, F, G, H
  - Argentina
- Haplotypes A, (B?) C, D, E
  - Brazil
- Haplotypes I & J
  - Paraguay



Williams et al. 2005; Williams et al., unpubl.

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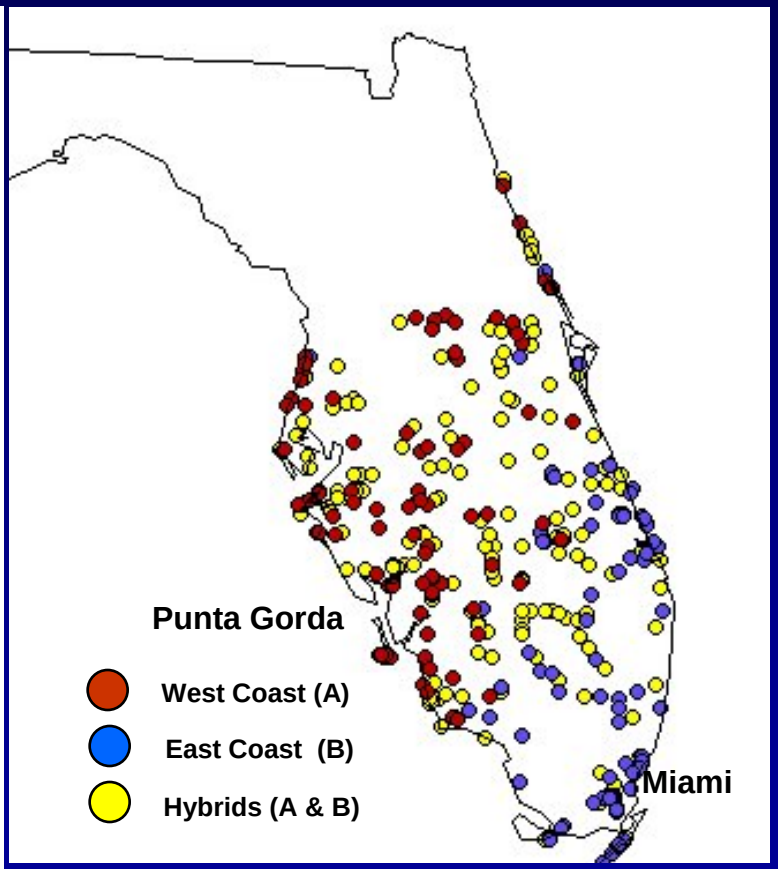
Invasion Pattern of BP in Florida

- Two Different Genotypes & Hybrids



Williams et al. (2005, 2007)

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- Natural Enemy Performance
  - Thrips, *Pseudophilothrips ichini* s.l.

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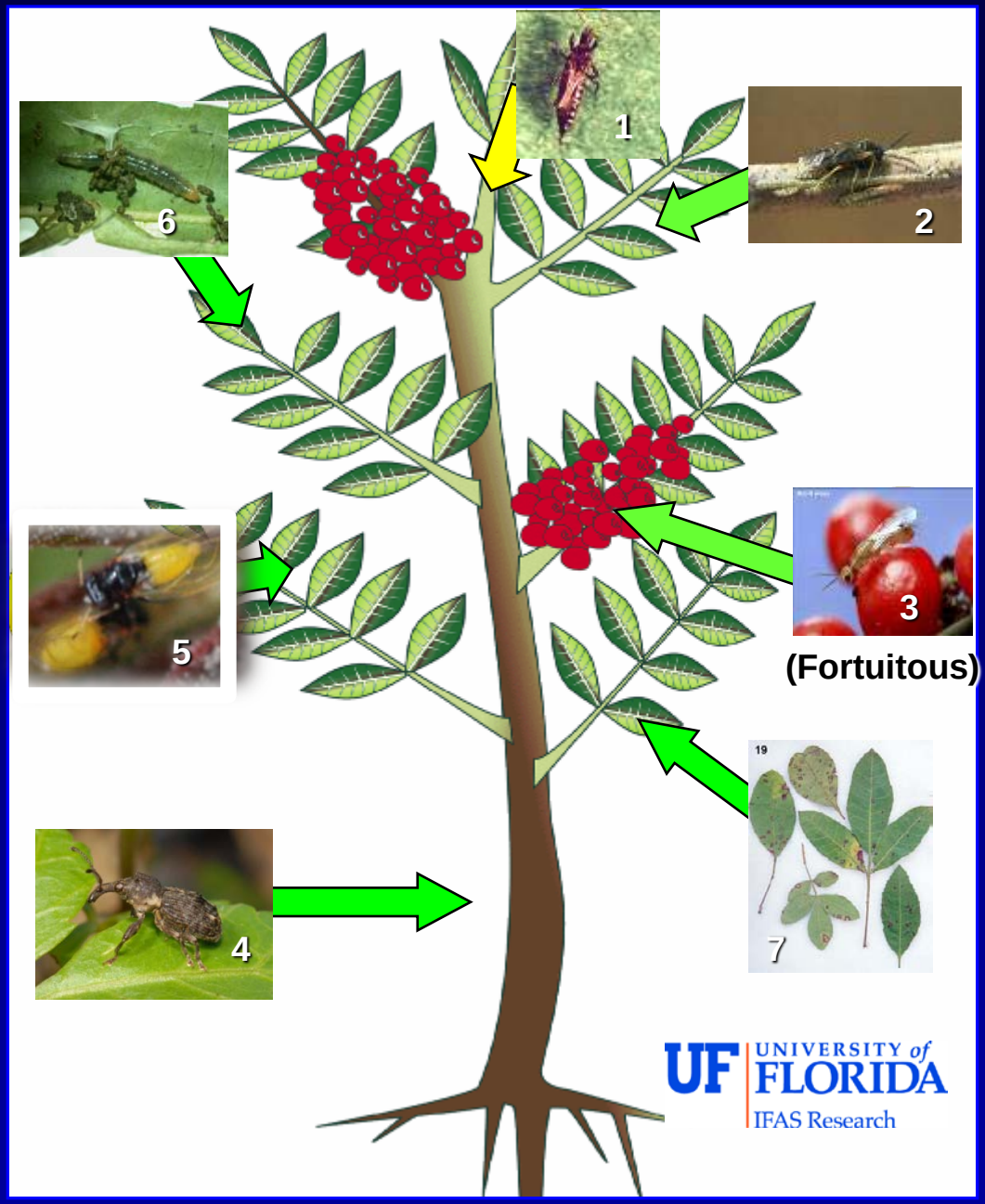
BP Natural Enemies

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



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

- Adults- Black, Winged
- Females Live ~ 50 days
- Oviposit on New Growth
  - Deposit 220 Eggs
- Four Generations in Brazil
- Flower Feeding Induces Abortion

(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
- Field Host Specificity
  - Collected Only on Brazilian Peppertree in South America (Garcia 1977, Mound et al 2010)

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P. ichini s.l. Haplotypes

Hap 5- Curitiba, Brazil

Hap 2 or 3- Ouro Preto, Brazil

Manrique et al. (2008)

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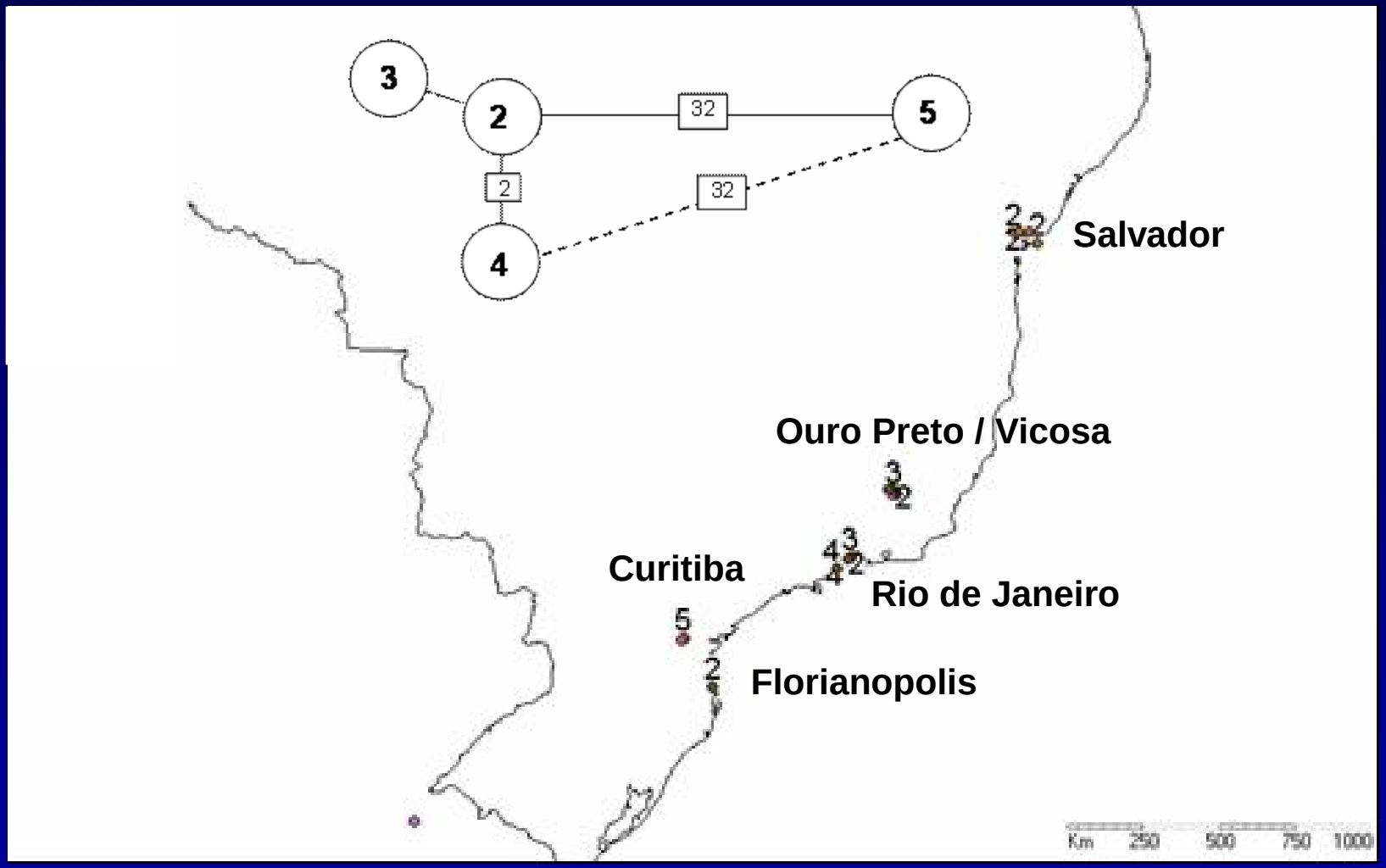
Distribution of *P. ichini* Haplotypes



W. A. Overholt, unpubl.

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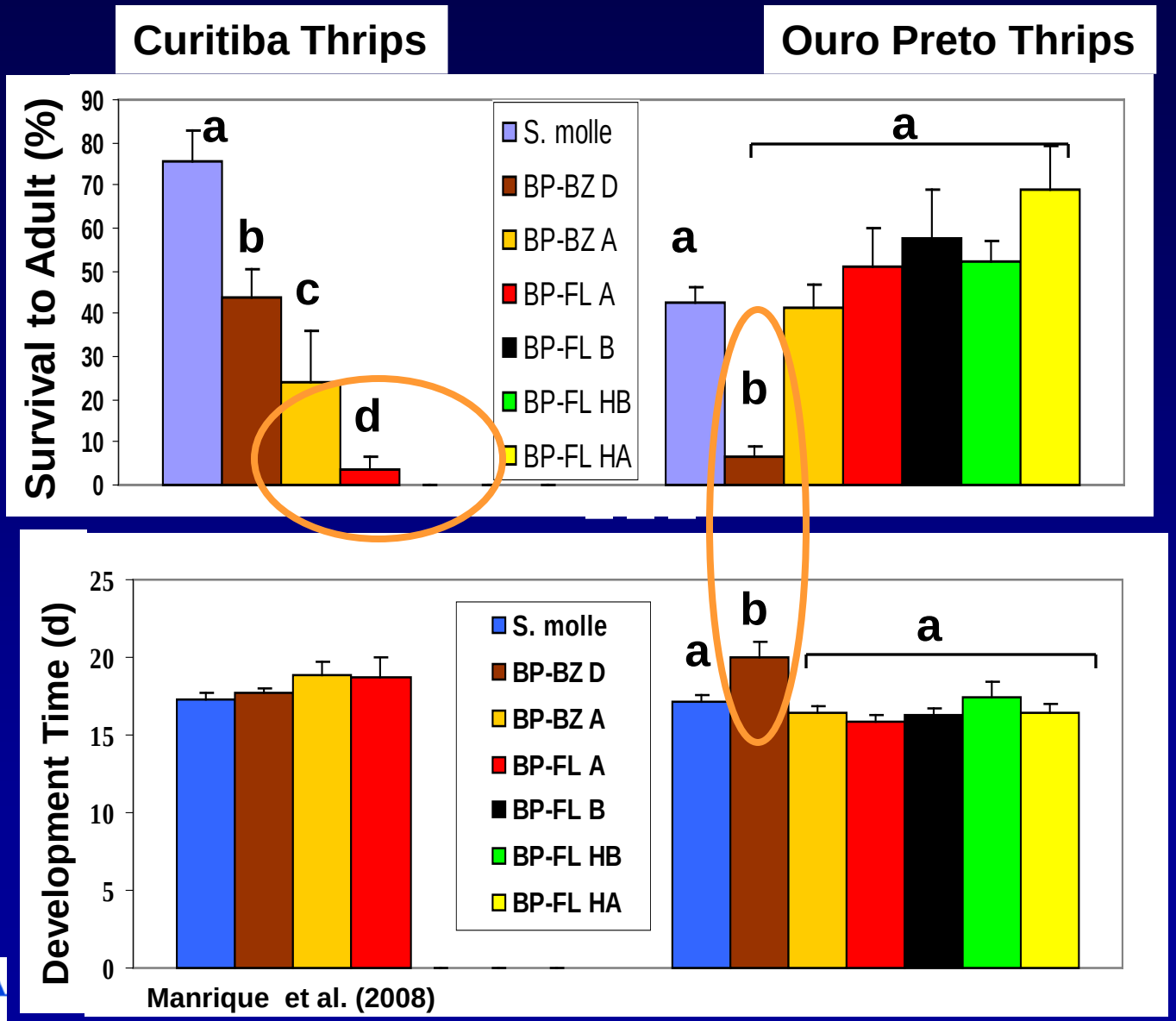
‘Fine Tuned’ Adaptation to BP



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MASS REARING OF *PSEUDOPHILOTHRIPS ICHINI* (THYSANOPTERA: PHLAEOTHRIPIDAE), AN APPROVED BIOLOGICAL CONTROL AGENT FOR BRAZILIAN PEPPERTREE, *SCHINUS TEREBINTHIFOLIUS* (SAPINDALES: ANACARDIACEAE)

J. P. CUDA[1,3], J. L. GILLMORE[1], J. C. MEDAL[1] AND J. H. PEDROSA-MACEDO[2]

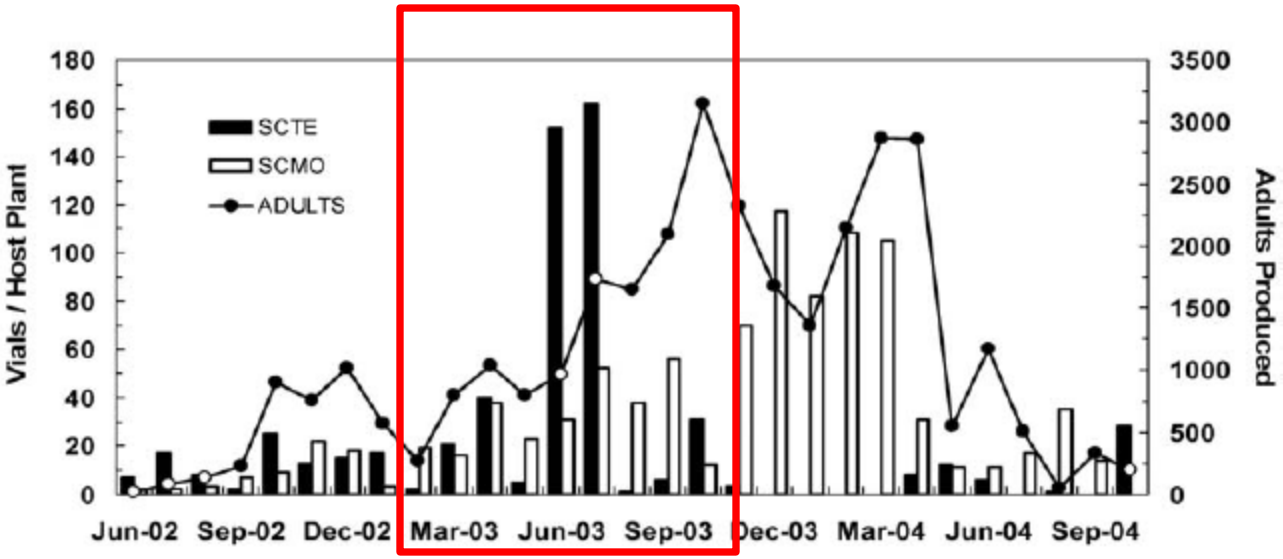

Fig. 2. Total number of vials per host plant and *P. ichini* adults produced monthly in the UF/IFAS Entomology and Nematology Department quarantine laboratory, Jun 2002-Oct 2004. SCTE = *Schinus terebinthifolius*, SCMO = *S. molle*.

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BIOLOGICAL CONTROL—WEEDS

Fundamental Host Range of *Pseudophilothrips ichini* s.l. (Thysanoptera: Phlaeothripidae): A Candidate Biological Control Agent of *Schinus terebinthifolius* (Sapindales: Anacardiaceae) in the United States

J. P. CUDA,[1,2] J. C. MEDAL,[1] J. L. GILLMORE,[1] D. H. HABECK,[1] AND J. H. PEDROSA-MACEDO[3]

Environ. Entomol. 38(6): 1642–1652 (2009)

Location (No.)	Thrips Haplotypes	Collection Dates
Curitiba (37)	5	1994-2002
Juruqui (4)	5	2003-2004
Juveve (1)	5	2006
Tangua (4)	2,3,4	(Jan) 2003-2007
Tabao (1)	??	2003
Vicosa (1)	2,3	(Mar) 2003

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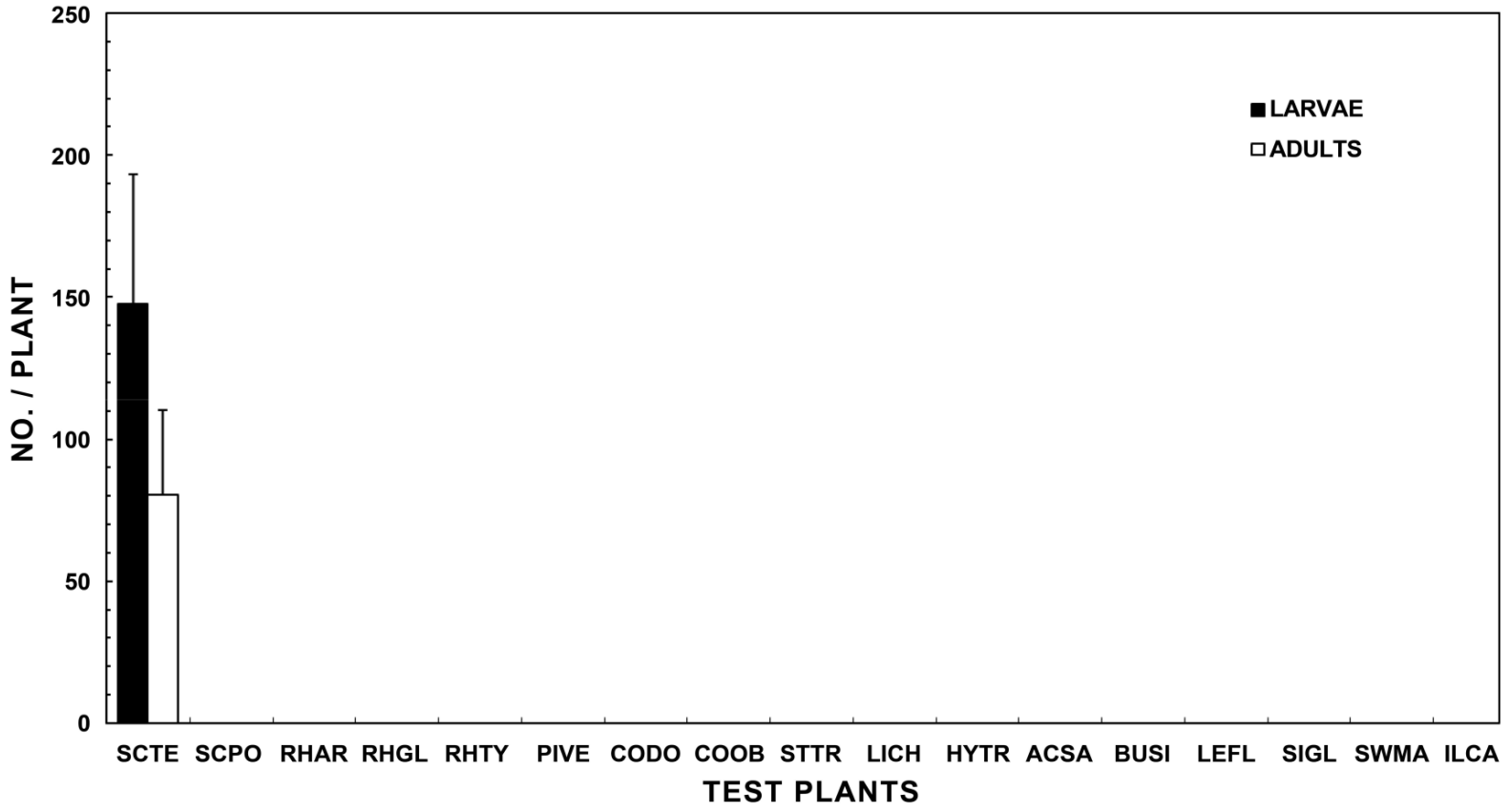

Figure 2. Performance of *P. ichini* s.l. on Caribbean and other native plants in supplemental no-choice oviposition tests conducted in Florida, June 2003-November 2005.

Source: J.P. Cuda 2009, unpubl. rpt.

Resolving cryptic species with morphology and DNA; thrips as a potential biocontrol agent of Brazilian peppertree, with a new species and overview of *Pseudophilothrips* (Thysanoptera)

L.A. MOUND[1], G. S. WHEELER[2], & D.A. WILLIAMS[3]

Zootaxa 2432: 59–68 (2010)

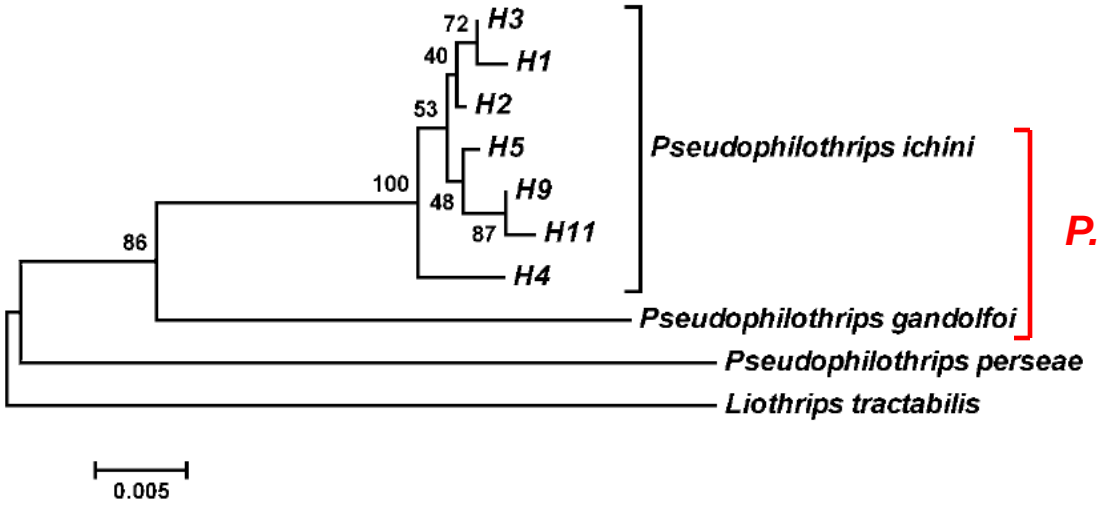

FIGURE 5. Relationships of thrips inferred using the neighbor-joining method and Kimura 2-parameter pairwise distances of mitochondrial COI sequences. Bootstrap values are shown next to the branches.

" *Pseudophilothrips gandolfi* sp.n. Known only from Curitiba in southern Brazil on *Schinus terebinthifolius*.

***Pseudophilothrips ichini*. . .widespread in eastern Brazil on *Schinus terebinthifolius*. . ." Mound et al. (2010)**

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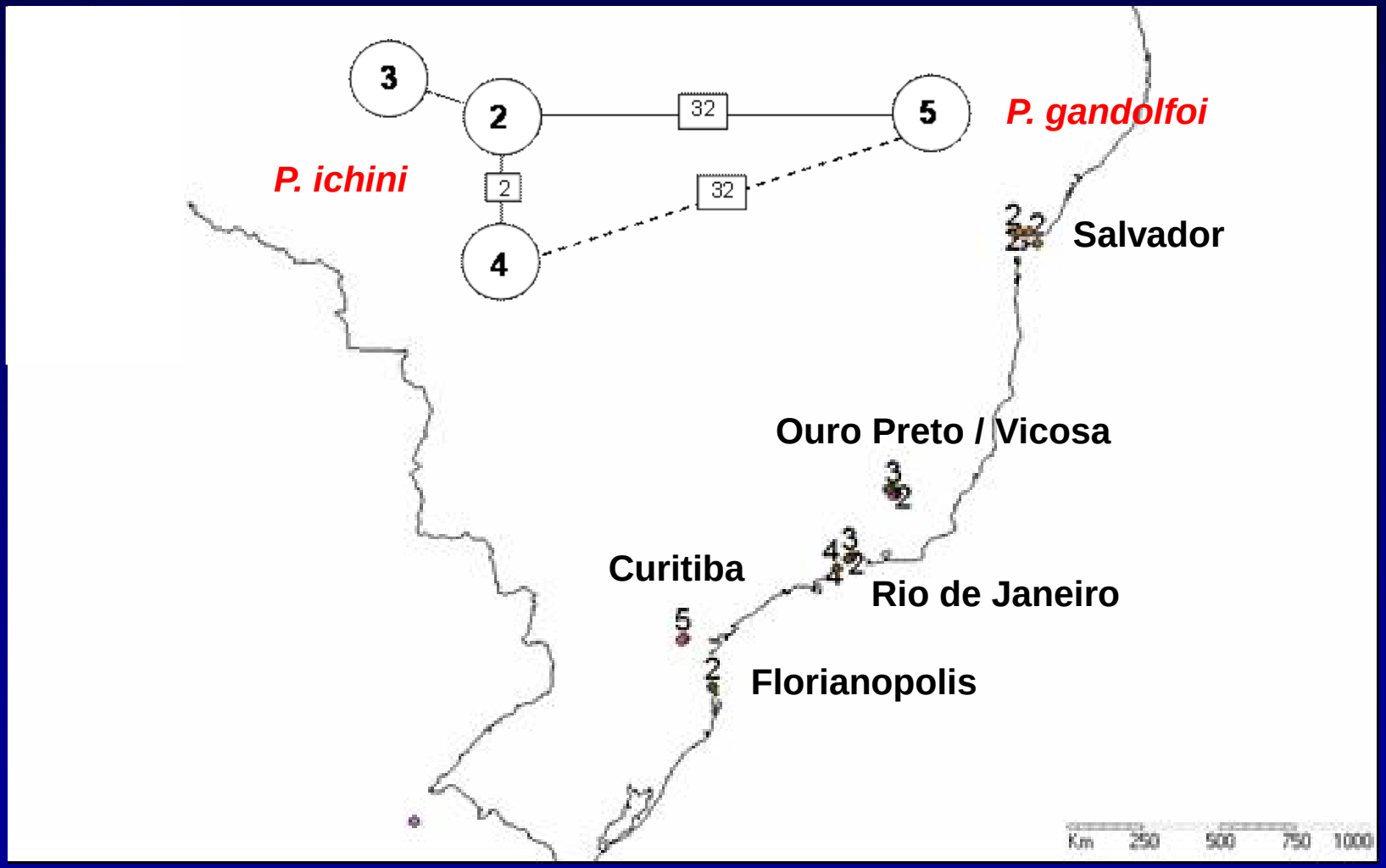
Distribution of *Pseudophilothrips* spp.



W. A. Overholt, unpubl.

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Summary

- ***P. ichini*** **and** ***P. gandolfoi*** **are** ***Schinus terebinthifolius*** **Specialists (Cuda et al. 2009, Mound et al. 2010)**
  - **California Peppertree (*S. molle*) May Sustain Minor Damage But Listed by Cal-IPC as Invasive Species**
- **Experimental Evidence for Specialization on Different BP Haplotypes**
  - **Contrary to Manrique et al. (2008), Tested Thrips from 4 Different Source Populations**
  - **Higher Survival on FL BP Haplotypes in 2003 Coincided with Addition of Thrips from 3 *Non*-Curitiba Locations (Cuda et al. 2008)**

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1. Thrips
   - Damages Shoots
2. Sawfly
   - Defoliator
3. Seed Wasp
   - Attacks Fruits
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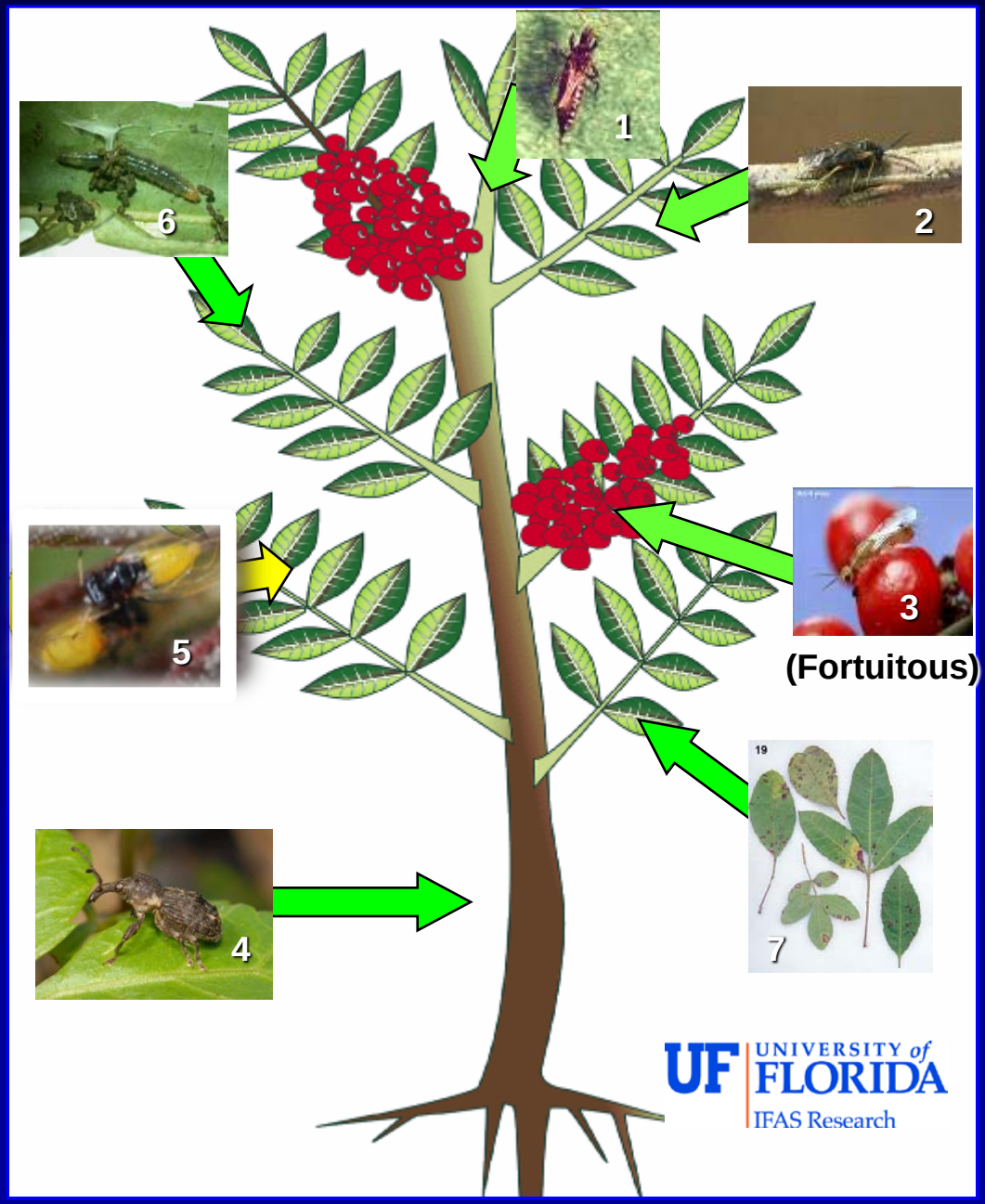


Calophya terebinthifolii Burckhardt & Basset (Hemiptera: Psyllidae)

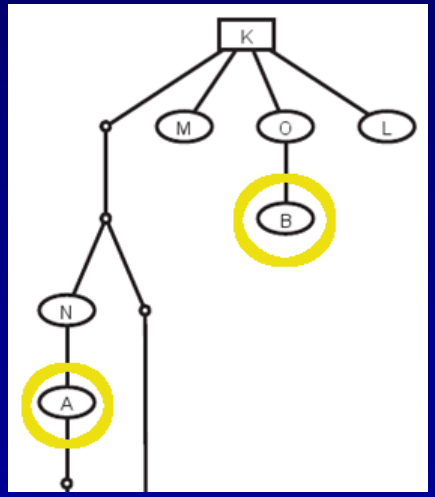
- Native to Brazil, Paraguay & Argentina
- Adults
  - Black & Yellow
- Nymphs
  - Forms Circular Pit Galls
    - Dorsal Surface Sclerotized

Photo Credit: L. Christ

Performance of Psyllid on Different BP Haplotypes

Table 1. Results from Plants Used for Rearing *C. terebinthifolii* at LAMPF, Blumenau, Brazil, 2009

Brazilian Peppertree cpDNA Haplotype	N	Success	Failure	% Success
A	12	8	4	75%*
O	5	1	4	20%
K	2	0	2	0%
D	2	0	2	0%
M	1	0	1	0%



***Psyllids performed significantly better on A than other types (G=7.63; *P*<0.01), α=0.05**

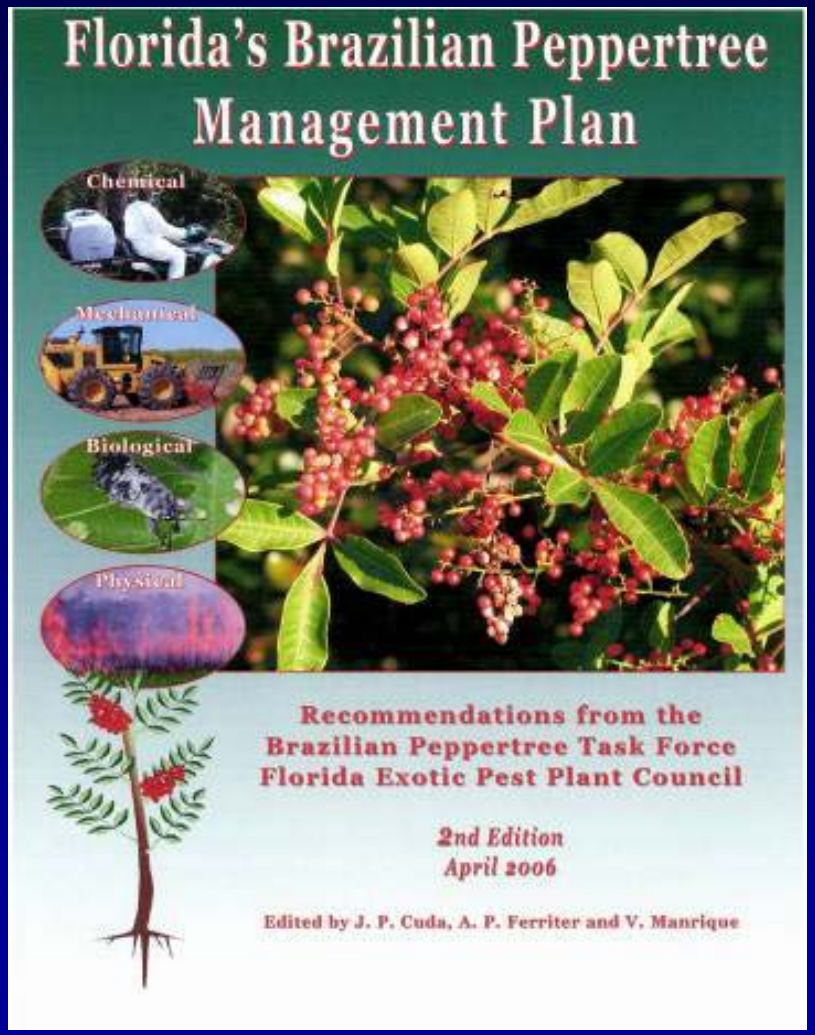
L. Christ, unpubl. data

Conclusions

- **Both the Thrips *Pseudophilothrips* spp. and the Psyllid *Calophya terebinthifolii* Share the Following Characteristics:**
  - **Short-Lived Sedentary Herbivores**
  - **Feed on Long-Lived Host Plants**
  - **Complete Thousands of Generations on Single Host Genotype**
  - **Exhibit Lower Fitness on Other Genotypes**
- **Findings Consistent with 'Fine Scale' Adaptation Hypothesis**
  - **Karban (1989) *Nature* 340: 60- 61**

Brazilian Peppertree Management Plan

- 2nd Edition Available On-Line
  - IPM Florida
    - http://ipm.ifas.ufl.edu/
  - FLEPPC
    - http://www.fleppc.org/



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Thank You

Go Gators!!

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