BioControl of Brazilian Peppertree-Thrips and Psyllids on the Horizon

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Central Florida Invasive Species Workshop
Lakeland, FL, 24 May 2016
Acknowledgements

- Kenia Duran-Aguirre
- Judy Gillmore
- Kenyatta Nichols
- Marcelo Vitorino
- J.H. Pedrosa-Macedo
- Dean Williams

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

(Photo credit: Bryan Harry, NPS)
Outline

• Historical Perspective
• Rationale for the Project
• Progress to Date
  – Thrips
  – Psyllids
• Questions & Comments
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Brazilian Peppertree

*Schinus terebinthifolia* Raddi
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
Late 1970s

SCHINUS
Technical Proceedings of
TECHNIQUES FOR CONTROL OF SCHINUS
IN SOUTH FLORIDA: A WORKSHOP
FOR NATURAL AREA MANAGERS

The Sanibel-Captiva Conservation Foundation, Inc.

Del Delfosse
• 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
Mid 1990s

- Importation & Host Specificity of Testing
  Natural Enemies Initiated

- Sawfly & Thrips

*Heteroperreyia hubrichi* Malaise (Hymenoptera: Pergidae)  
Medal et al. (1999)
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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 . . .”

Aroeira = Brazilian Peppertree

- Popular Ornamental in Brazil
  - Street Names
  - Neighborhoods
Growth Habit of BP

Southeastern Brazil

Everglades National Park

Don Schmitz, FWC
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
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 !!!
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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
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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)
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)
Pseudophilothrips ichini (Hood)
(Thysanoptera: Phlaeothripidae)

- 1997- TAG Recommended No Release
  - Insufficient Data (Biology, Oviposition)
- 2002- New TAG Petition Submitted
- 2004- TAG Recommended No Release
  - Requested Field Efficacy Data & Testing of Caribbean Anacardiaceae
- 2006- New TAG Petition Submitted
- 2007- TAG Recommended Release
• Growth Reduction
  - Stem Length, 40%
  - Biomass, 46%

Furmann et al. 2005

Control

Damaged
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.

Cuda et al. (2009)
P. ichini Haplotype types

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)
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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)
Intimate Relationship with the Host => Highly Host Specificity

- Plant responds to insect feeding by inducing galls
Surveys in Brazil

- Conducted near Salvador, Bahia; Ubu, Espírito Santo; Itajai, Santa Catarina
- August 2012
- March 2014
Calophya terebinthifolii
(Hemiptera: Calophyidae)

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

Mc Kay et al. (2009); Christ et al. (2013)
**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

![Graph comparing development and fecundity of two species. The graph shows that C. terebinthifolii has a shorter development time and lower fecundity compared to C. latiforceps, which has a longer development time but higher fecundity.](image-url)
Oviposition and Survival

*C. latiforceps*

- Test plants included 90 species in 48 families
- Gall initiation and complete development only on Brazilian peppertree!!
  
  *Schinus terebinthifolia*
  
  Haplotypes A, B, & Hybrid

Diaz et al. (2014)
Adult Survival on Non-target Plants

C. terebinthifolii

Graph showing adult survival over time (days) on various plants. The x-axis represents times in days, ranging from 0 to 35, and the y-axis represents adult survival, ranging from 0.0 to 1.0. Different plant species are indicated by various lines on the graph.
Impact on Plant Height

*C. latiforceps*

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

• Thrips and Psyllid Natural Enemies Host Specific & Impact BP Growth

• Host Range Testing/ Impact Studies of *Calophya terebinthifolii* in progress

• Status of Release Petitions:
  – Thrips- Submitted Jointly to TAG by USDA & UF, August 2014; Under Review
  – Psyllid- Petition for Release of *Calophya latiforceps* Submitted to TAG, April 2015;
  – TAG Recommended Field Release of *Calophya latiforceps*, April 2016; Undergoing Biological & Environmental Assessments by APHIS PPQ
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
Thanx !!
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