Biological Control of Brazilian Peppertree, *Schinus terebinthifolius*

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Aquatic Weed Control Short Course
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(Photo credit: Bryan Harry, NPS)
Outline

• Introduction
• Status of Candidate Biological Control Agents
• Questions? Comments?
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Bazillion Peppertree
Schinus howterribleyouvebeeenforus

Galveston, Texas
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

**Range of Brazilian peppertree in North America**

*Schinus terebinthifolius*

USF Herbaceous Sibie Collection
Typical Female BP Plant

M. Clark 2008
Native Range of BP

Center of origin of Brazilian peppertree and its natural enemies
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
- Distribution in North Florida Appears to be Limited by Lack of Cold Tolerance?
“New” Distribution of BP

BP Supports Other Invasive Species

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
BP May Threaten Public Health

Reiskind et al. (2009)

http://entoplp.okstate.edu/mosquito/images/aealboeggs4.jpg
http://biology.clc.uc.edu/fankhauser/Animals/mosquitoes/Aedes_albopictus_P9071863.JPG
BP Pollen Causes Problems

Jarzen and Nelson (2008)
Growth Habit of BP

Southeastern Brazil

Everglades National Park

Don Schmitz FWC
Why is BP Invasive in FL?

• Multiple Genotypes & Hybrid Vigor

Williams et al. (2005, 2007)
Why is BP Invasive in FL?

**Enemy Escape Hypothesis (Williams 1954)**

- Native Specialist Enemies Strongly Control the Abundance and/or Distribution of Native Plants
- Escape from Specialist Enemies is a Key Contributor to Exotic Plant Success
- Enemy Escape Benefits Exotics Because They Gain a Competitive Advantage Over Native Plants as a Result of Being Liberated from Their Pests
BP Targeted for BioControl

- Non-native Invasive Species
- Causes Severe Ecological Damage
- Toxic and Allergenic (Poison Ivy Family)
- Low Beneficial Value (Beekeepers?)
- Conventional Controls Temporary, Costly
- No Native Congeners in US !!!
Late 1980s

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

Bennett et al. (1990)
BP BioControl Project Objectives

• Collect Promising Natural Enemies in SA
• Conduct Biological & Impact Studies with Candidate BioControl Agents
• Import BioAgents & Develop Rearing Procedures
• Perform Host Specificity Testing Required for Release into Florida
• Release / Evaluate Performance of Approved BioControl Agents
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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

(Habeck et al. 1989, Cuda al. 2002)
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**Pseudophilothrips ichini** (Hood)

- **Adults** - Black, Winged
- **Females** Live ca. 50 days & Deposit 220 Eggs
- **Oviposit on New BP Growth**
- **Four Generations in Brazil** (Garcia 1977)
**Pseudophilothrips ichini** (Hood)

- Larvae- Red or Orange; Feed on Tender Growth
- Damage / Kill New Shoots & Young Plants
- Only Collected on BP in S. America (Garcia 1977)
- Laboratory & Field Host Range Testing Confirmed Specificity (Cuda et al. 2009)
- Recommended for Field Release by TAG
No-Choice Larval Development Tests

Two *Schinus* spp.:
- *S. terebinthifolius* sensu lato
- *S. molle*

Cuda et al. 2009
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Episimus unguiculus Clarke

A

B

C

Martin et al. (2004)
Biological Control History of *E. unguiculus*

- 1954- Introduced into Hawaii (*Episimus* sp.)
- 1955, 1956 - Additional Releases Made
- 1957- Establishment Confirmed
- 1978- Occasional Heavy Infestations
- 2002- Widely Distributed; Minimal Impact
  - Spillover of Parasitoids Released for Agric. Pests Since 1960

“...Out of [all] parasitoids reared from caterpillars collected [in Hawaii], most (83%) were biological control agents introduced against lowland agricultural pests. ...”

Hennemen & Memmott. 2001. *Science*
Colony Production

YEAR

Males
Females
Total

YEAR

2001 2002 2003 2004 2005 2006 2007 2008
Survivorship Curve of *E. unguiculus*

- Mean daily $I_x$ values
- Mean $I_x$ for beginning of each stage
- Mean daily $mx$

**Days after oviposition**

**Survival ($I_x$)**

- Egg
- Pupa
- Adult

*Martin et al. (2004)*
Effect of *E. unguiculatus* on BP

- Larvae Feed Inside Leaflet Rolls During Development
- Capable of Defoliating Entire Plants
Simulated Herbivory Studies
UF/IFAS, IRREC, Ft. Pierce

Treadwell and Cuda (2007)
Life History Parameters on BP Genotypes

Manrique et al. (2008)
Multiple Choice Test

![Chart showing multiple plant species with Brazilian Peppertree having the highest count.]

- Brazilian Peppertree: 140
- Native Sumacs: 80
- Poisonwood: 40
- Pistachio: 20

Legend:
- a: Most abundant
- b: Considered less abundant than a

Species: SCTE, COCO, CODO, RHAR, RHCO, TOVE, METO, PICH, PIVE, ANOC, EUCA

- 48 Fam., 90 Spp.
Predicted Distribution of *E. unguiculus*
WORLDCLIM Ecological Niche Model

Pistachio Crop
Conclusions

- *Episimus unguiculus* is a Precedented BioControl Agent
  - Established in Hawaii since 1950s
  - Field Host Specificity Documented
  - Impact on BP Compromised by Parasitism?
- Capable of Sustained Reproduction Only on BP
  - Demonstrated in Lab. & Open-Field Choice Tests, Lab. Multi-Generation Tests
Conclusions (cont’d)

• Larval Feeding Damage Should Impact BP Growth & Reproduction
  – Confirmed by Field & Laboratory Herbivory Studies
• Risk to Cultivated Pistachio Acceptable
  – Climate in Western US Would Preclude Establishment (= Geographical Incompatibility)
• Petition for Field Release Submitted to TAG in September 2009
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Apocnemidophorus pipitzi (Faust)
(Col: Curculionidae)
Life Cycle of A. pipitzi

No. Adults

3-4 months

Jul '07  Aug '07  Sep '07  Oct '07  Nov '07  Dec '07  Jan '08  Feb '08  Mar '08  Apr '08
Host Range Testing Procedure
Adult Survivorship Curves

Survival (%) vs. Time (Weeks)

- SCTE
- SCMO
- RHCO
- ANOC
- CODO
- RHGL
- RHSA
- RHIN

Brazilian Peppertree

Lemonade Sumac
Brazilian Peppertree
Hardee Peppertree
(Schinus polygamus)

19 Fam., 47 Spp.
Summary

• *A. pipitzi* Weevil First Stem Borer of BP Established in Quarantine
• Biological & Host Range Studies Completed
  – Results Suggest it is BP Specialist
• Stem Boring Habit of Developing Larvae Should Protect Weevil from Predation
• Release Petition is in Preparation
Brazilian Peppertree Management Plan

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

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