Biological control of the invasive weed, Brazilian peppertree, *Schinus terebinthifolia*: A review

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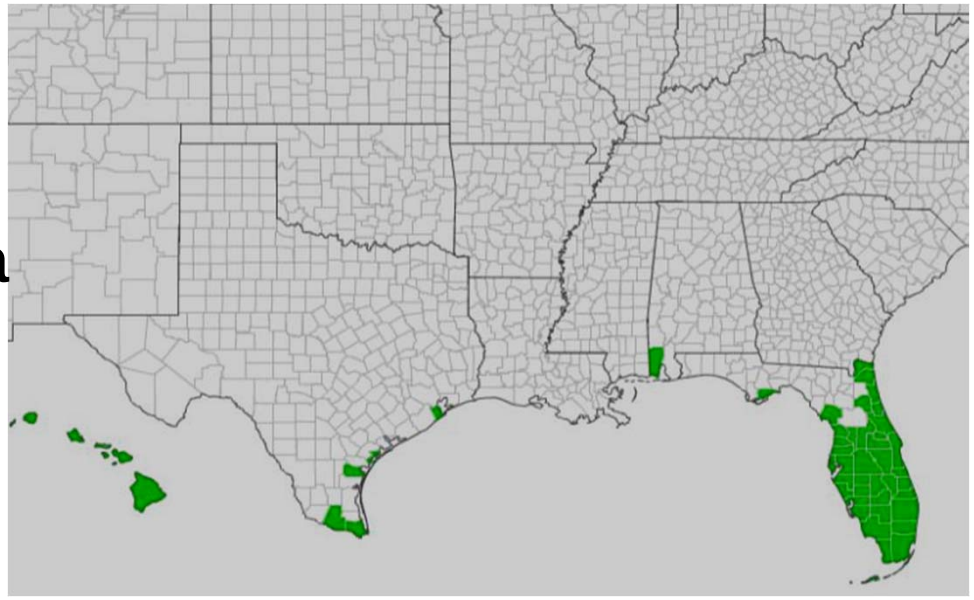
Schinus distribution in the US

Classic tree invader damaging native habitats (Richardson & Rejmanek 2011)

- **Introduced for horticulture**
- **Bird dispersed**
- **Invasive in several regions of the world, North America, Australia, South Africa**
- **In Fla & HI one of our most invasive spp**



Classical Biological Control of Weeds

- **Overseas surveys**
  - **15-30 million insect spp, 90% herbivorous; 90% specific to a taxon**
- **Host range determination**
  - **Phylogeny – coevolution of taxa**
  - **Overseas**
  - **Quarantine**
    - **No-choice – starvation; choice tests**
- **Petition for release – TAG/APHIS**

Worldwide distribution of USDA/ARS biological control efforts

FuEDEI South American Biological Control Lab, Buenos Aires, Argentina

ARS/USDA Australian Biological Control Lab, Brisbane, Australia

Generalists vs. specialists

Pandas eat bamboo, and little else

Examples of biological control success

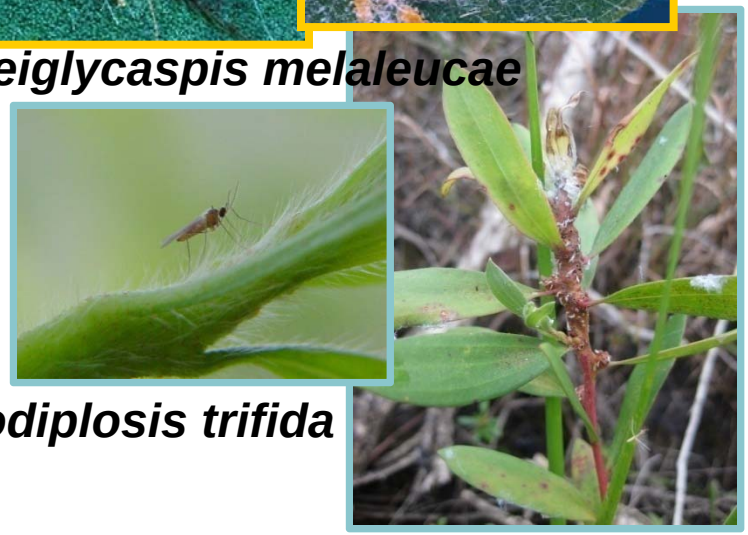
Recent examples

- ***Melaleuca quinquenervia***

Melaleuca quinquenervia

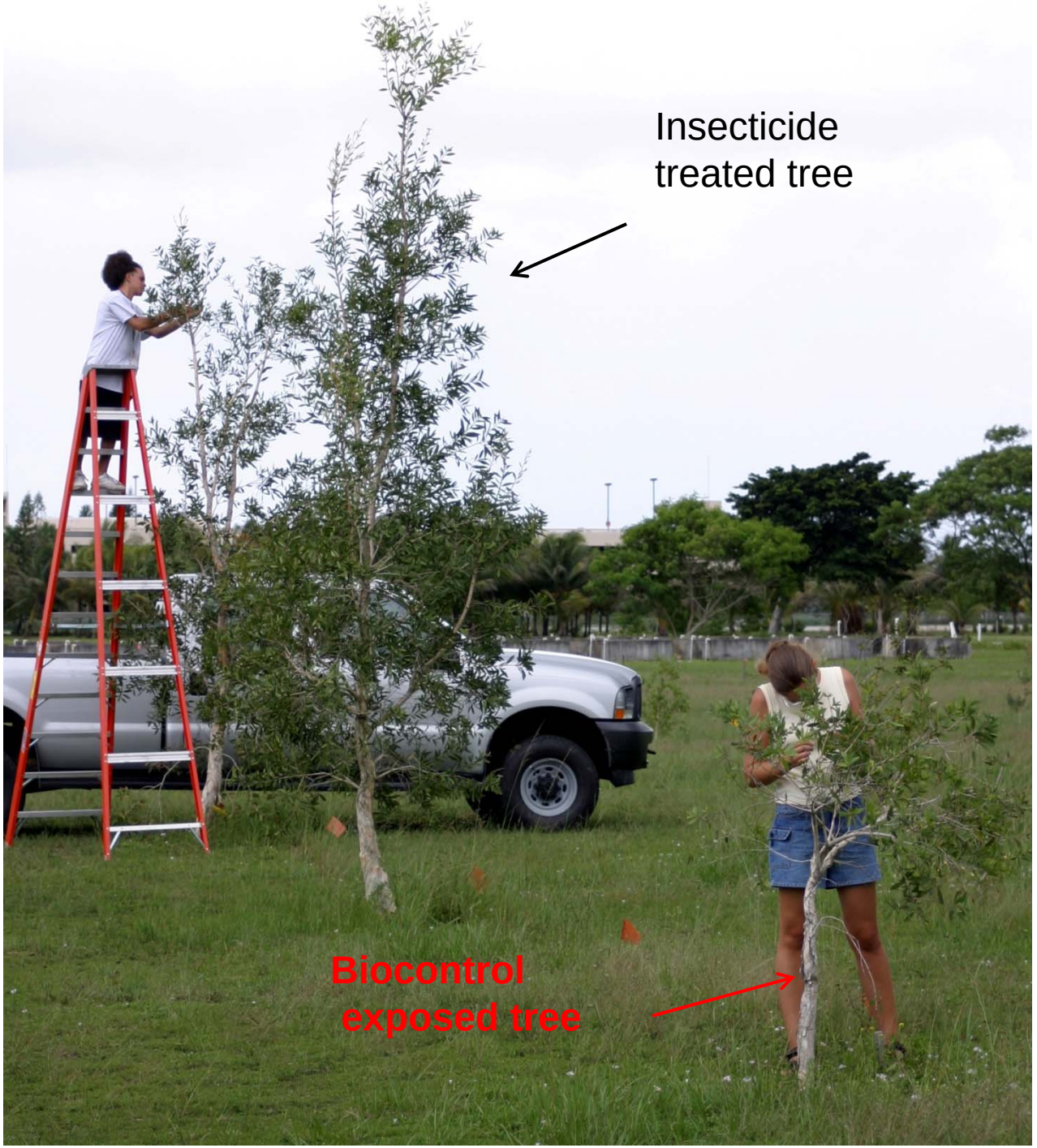
- **Biological control**
  - **Reduces plant growth**
  - **Limits reproduction**
  - **Suppresses seedling survival**
  - **Initiates leaf abscission**
  - **Decreases plant density**
  - **Has no non-target effects**

Boreiglycaspis melaleucae



Lophodiplosis trifida

Biological control of Melaleuca stunts tree growth and tree reproduction



Schinus biological control research

Began in HI 1950s-60s

Introduced 3 spp in HI

1. leaf roller *Episimus unguiculus* (Tortricidae) **established**
2. seed feeder *Lithraeus atronotatus* (Bruchidae) **established**
3. stem borer *Crasimorpha infuscata* (Gelechiidae)

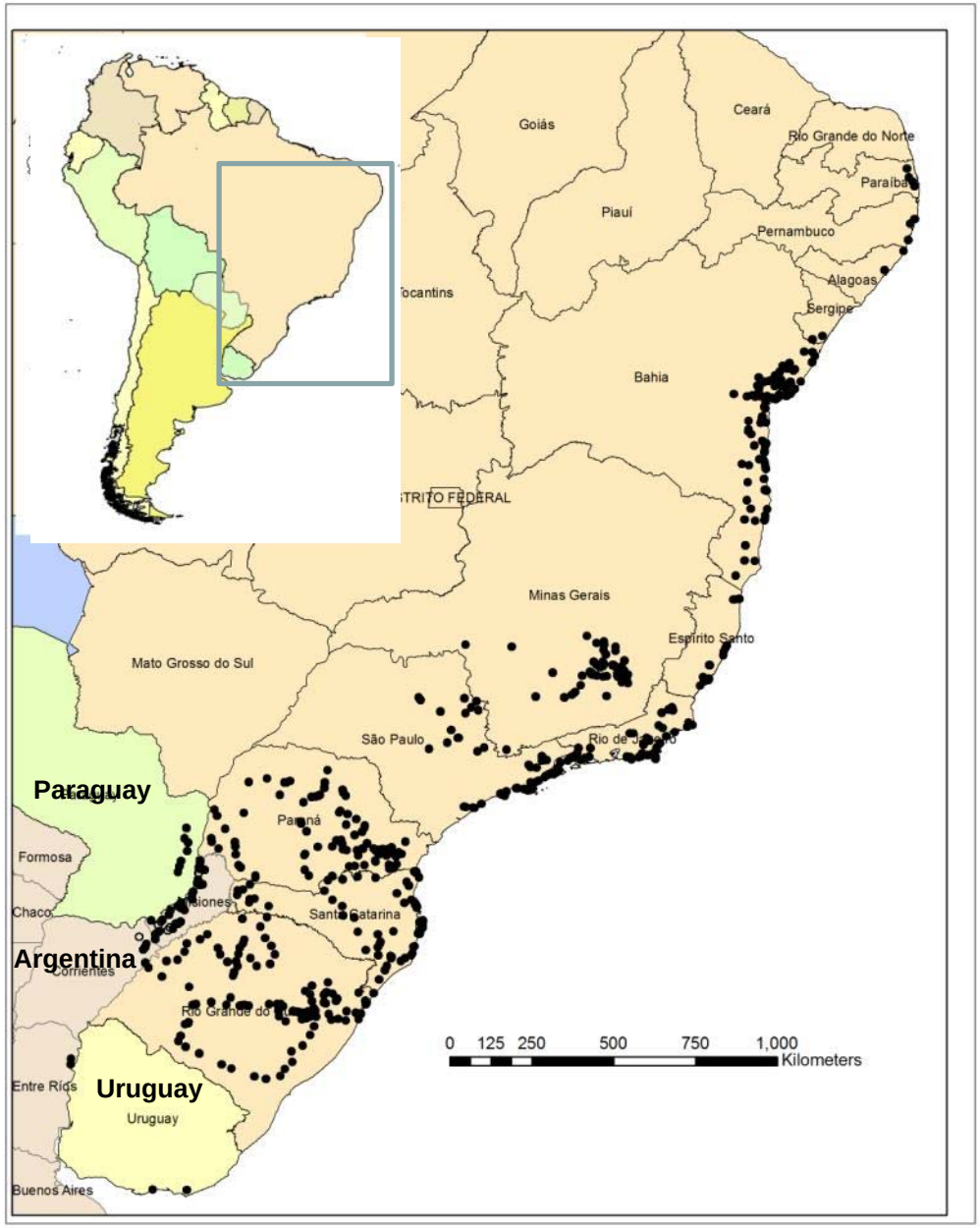
Schinus still big problem

Where have we searched for biological control agents?

Surveys of Brazil 2005 to Aug 2014

<u>Defining the range</u>

- **Herbaria from 1) Rio de Janeiro Botanical Garden, 2) NYBG, 3) Tropicos distribution data**
- **Other biological control work HI, UF**
- **Our surveys, 20 trips to Brazil; > 900 sites**
- **Clusters of plants – gaps in distribution due to agriculture**



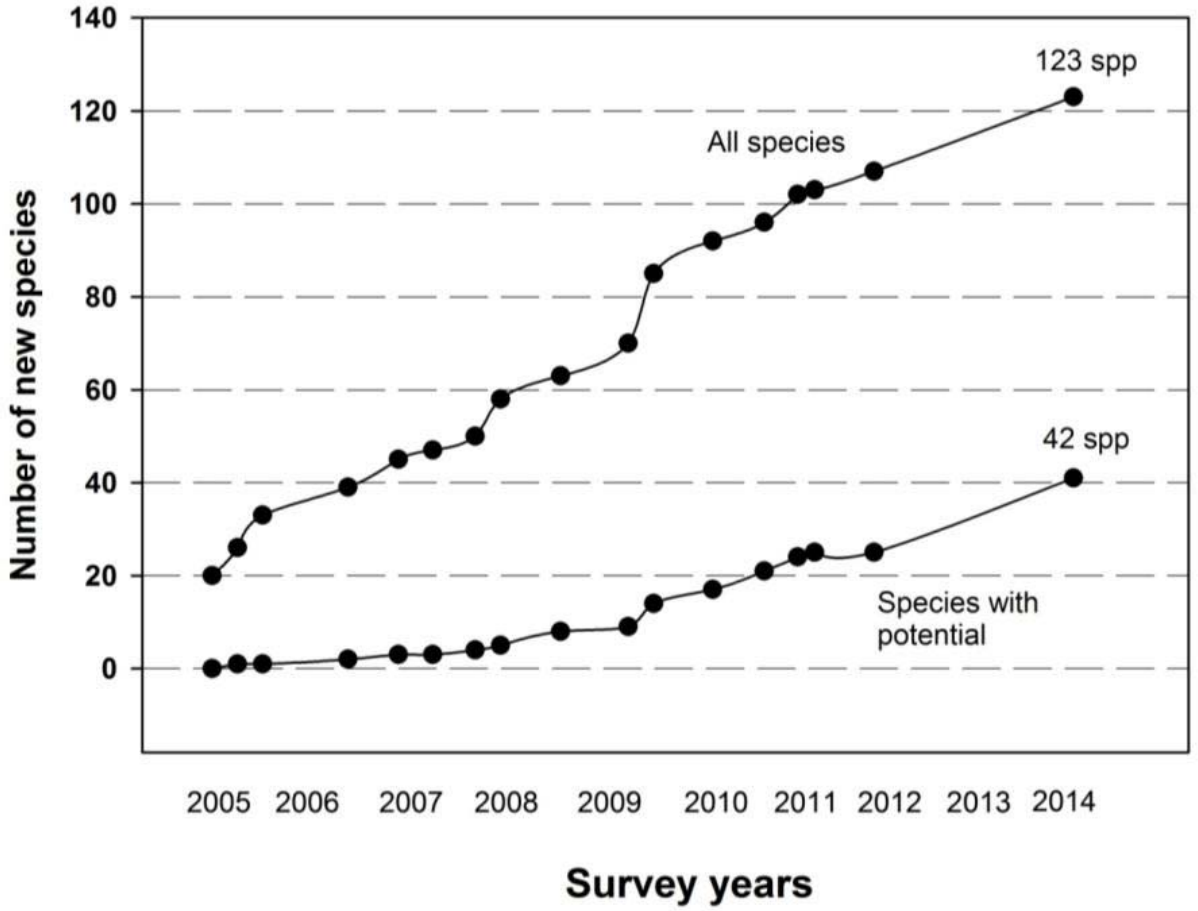
What have we found?

- Total number of spp 124 +
  - Caterpillars (Lepidoptera) 65 spp
  - Beetles (Coleoptera) 27 spp
  - Bugs (Hemiptera) 10 spp
  - Diseases 4 + spp (Barreto, Bruckart & de Macedo)
- Number potentially suitable, not already rejected or being worked on: 42 spp

Species accumulation curve

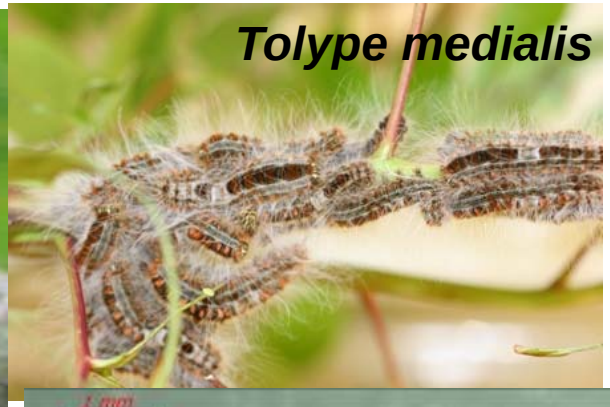
- **Did we find everything?**
- **Asymptotic curve?**

- **More agents will be found with additional surveys**



Potential candidates of *Schinus* control


Pseudophilothrips ichini


Tolype medialis


Omolabus piceus


Leurocephala schinusae


Nystalea ebalea


Oospila pallidara


Tecmessa elegans


Plectrophoroides lutra

Geometridae from Brazilian pepper native range surveys

Iridopsis sp.

Prochoerodes sp.

One of 4 boxes sent to Geometridae specialists

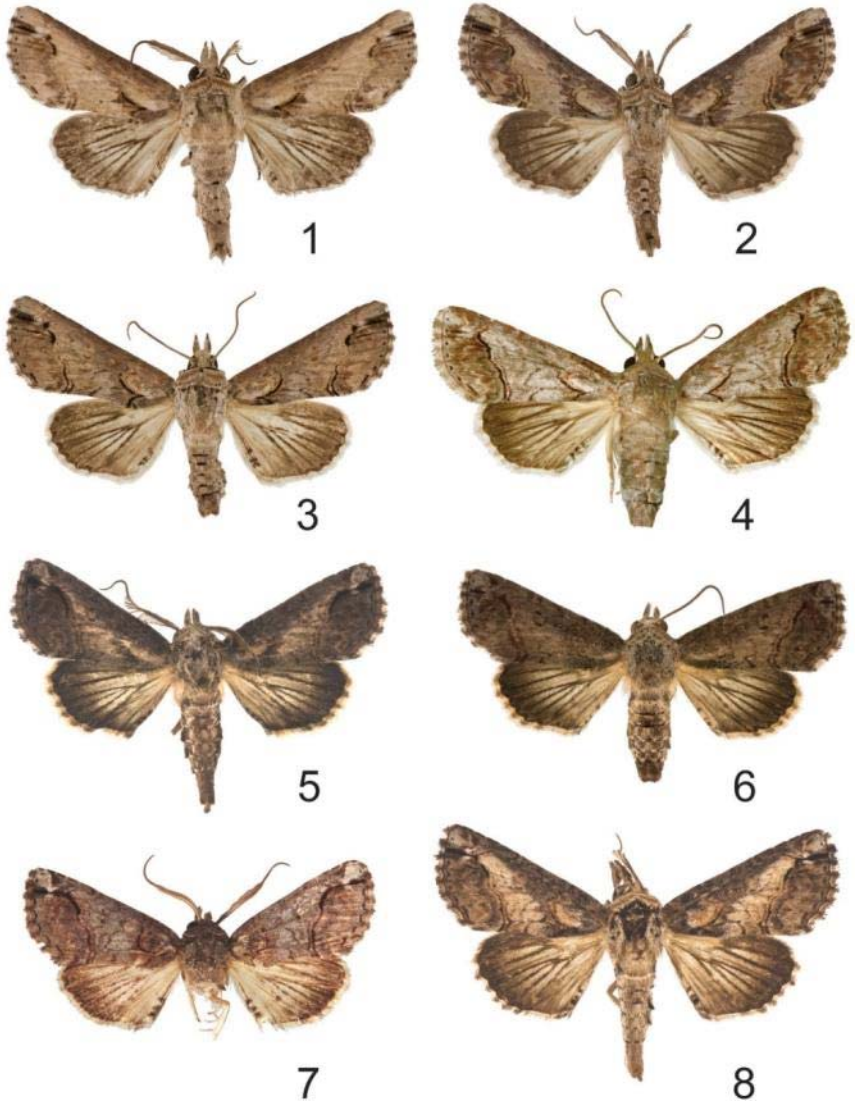
Diversity of potential agents: *Paectes* spp. (Euteliidae)

DNA reveals many species

Paectes obrotunda

Florida spp.:
Paectes nana* & *P.asper

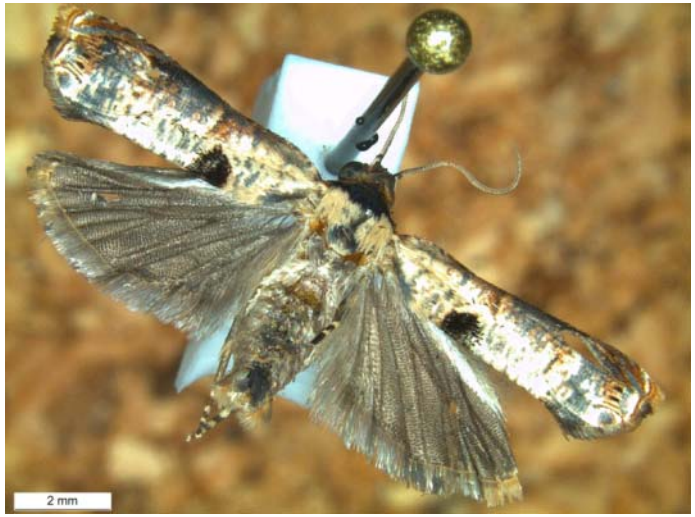
Brazilian spp.:
***P. longiformis, P. similis, P. sinuosa,* and more**



Diversity of potential agents: *'Episimus'* spp.

Diversity of potential agents: *'Episimus'* spp.

- Brazilian sp. *Episimus unguiculus* released in HI



- Florida native sp. *Episimus transferranus*

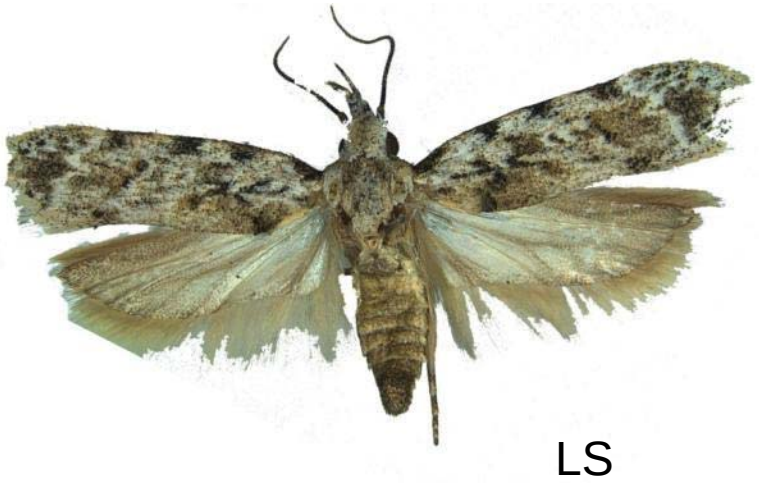
Diversity of potential agents: *'Episimus'* spp.

PD

SH

2 mm

C



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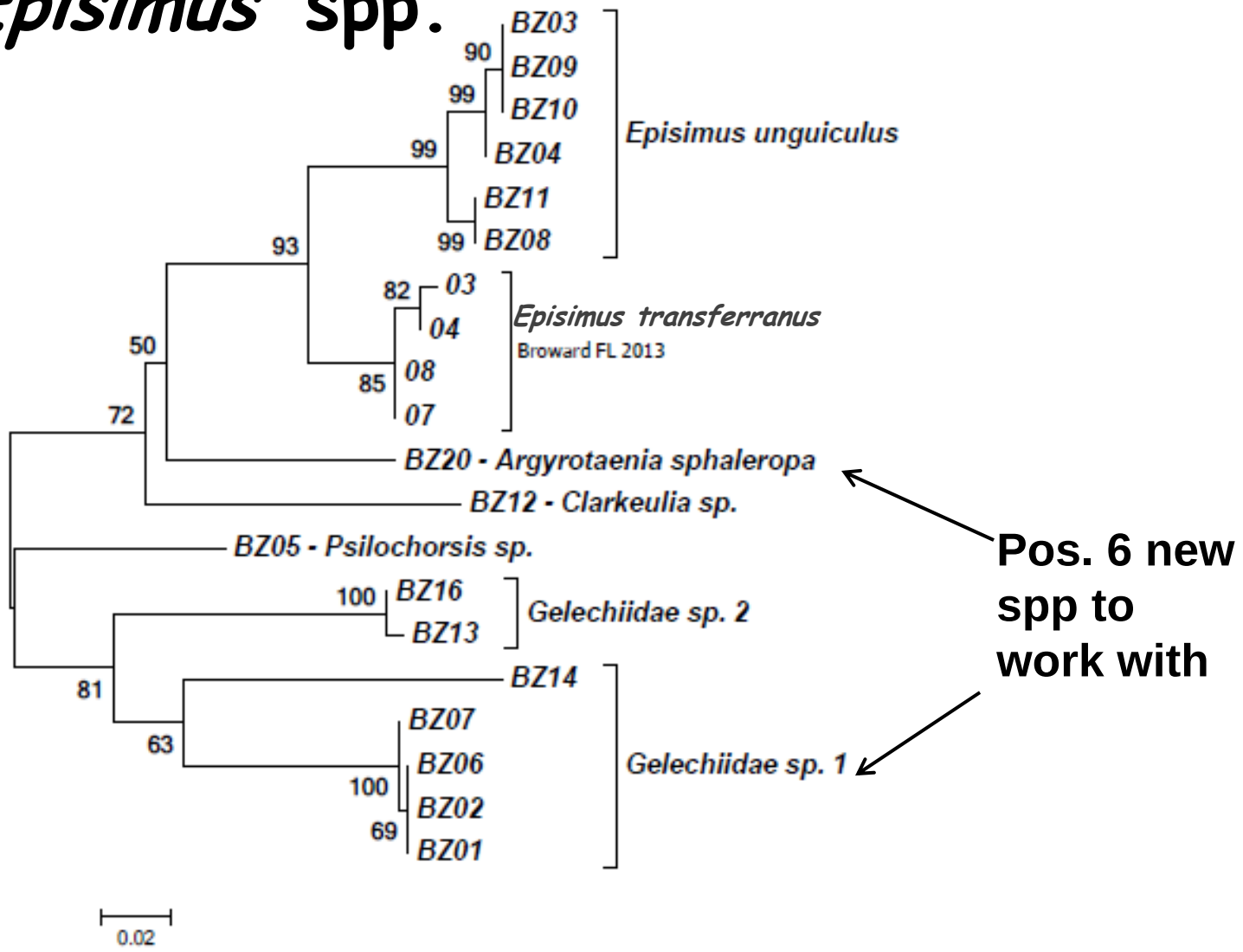
Diversity of potential agents:

- *Episimus unguiculus* (Tortricidae) target
- Gelechiidae sp.1
- Gelechiidae sp.2
- *Psilocorsis* sp. (Depressariidae)
- *Argyrotaenia sphaleropa* (Tortricidae)
- *Clarkeulia* sp. (Tortricidae)

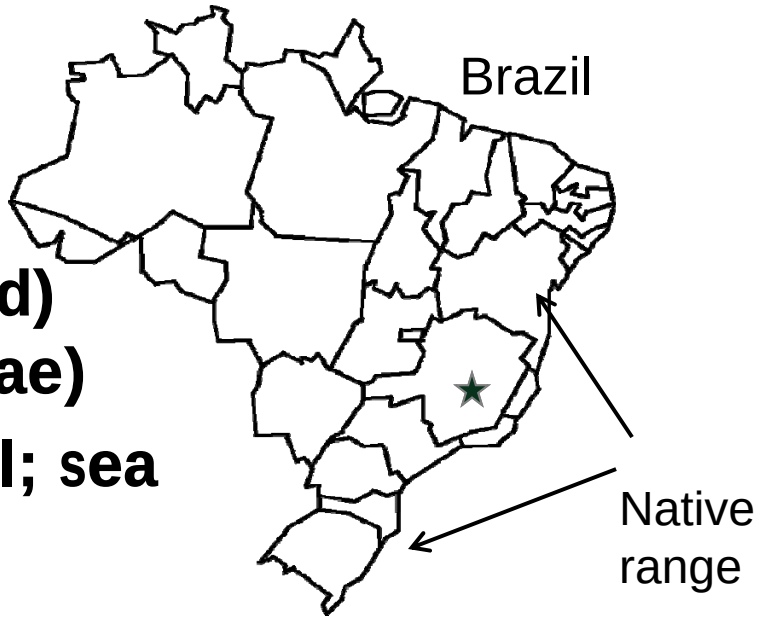
Diversity of potential agents: *'Episimus'* spp.



Pos. 6 new spp to work with

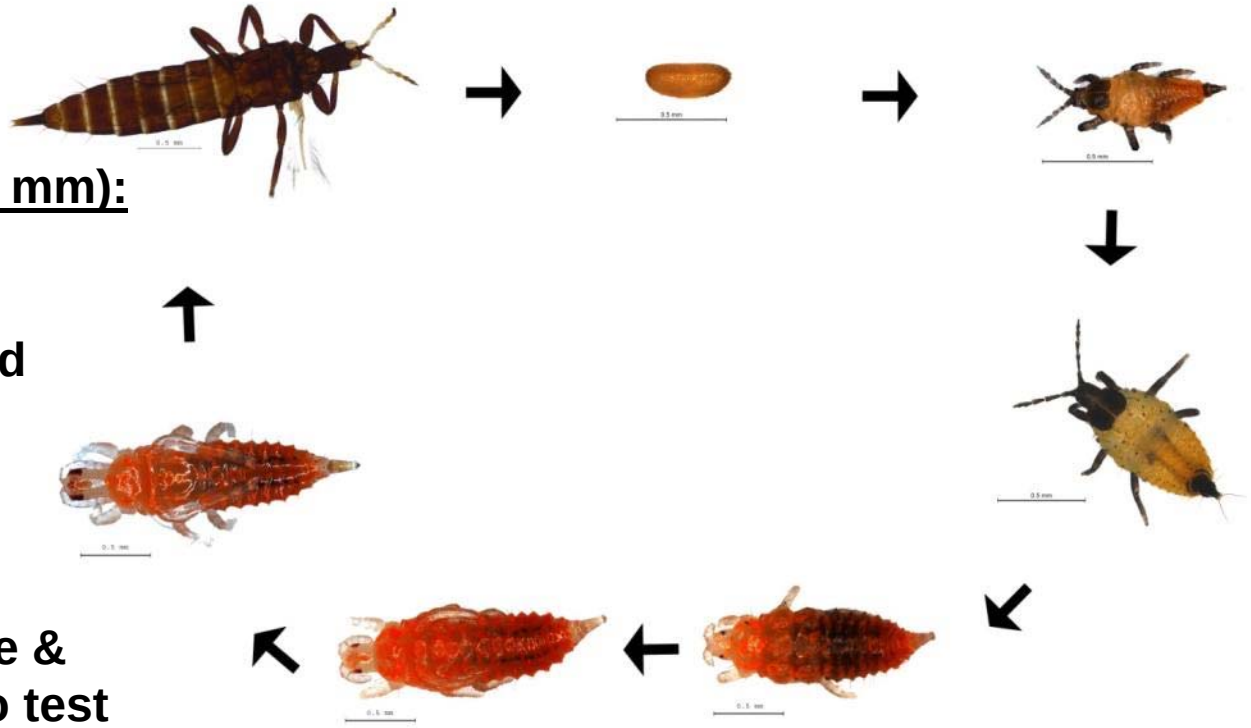
Pseudophilothrips ichini Thrips

Feed and distort flushing leaf tips



- ***Pseudophilothrips ichini* (Hood) (Thysanoptera: Phlaeothripidae)**
- **Wide range Bahia to SC, Brazil; sea level to 1300 m**
- **High degree of host specificity**

Pseudophilothrips ichini Thrips life cycle



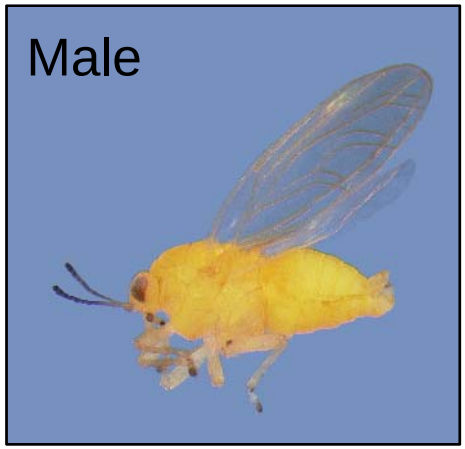
Life stages (scale 0.5 mm):
Adult > 50 d
Egg 5-6 d
Larvae – 2 stages 13 d
Pupae – 3 stages 6 d

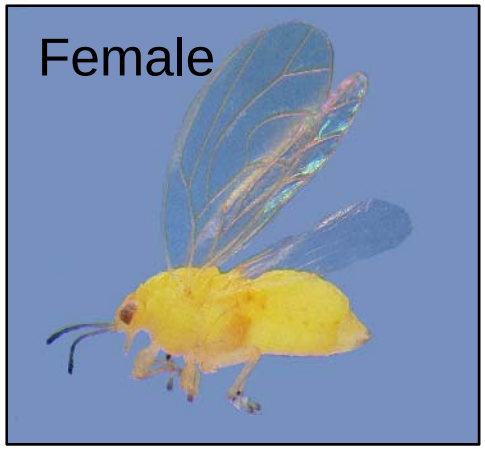
Total dev time ~ 20 d

Feeding stages larvae & adults only. Stages to test

Psyllid from Bahia: Candidate for biological control

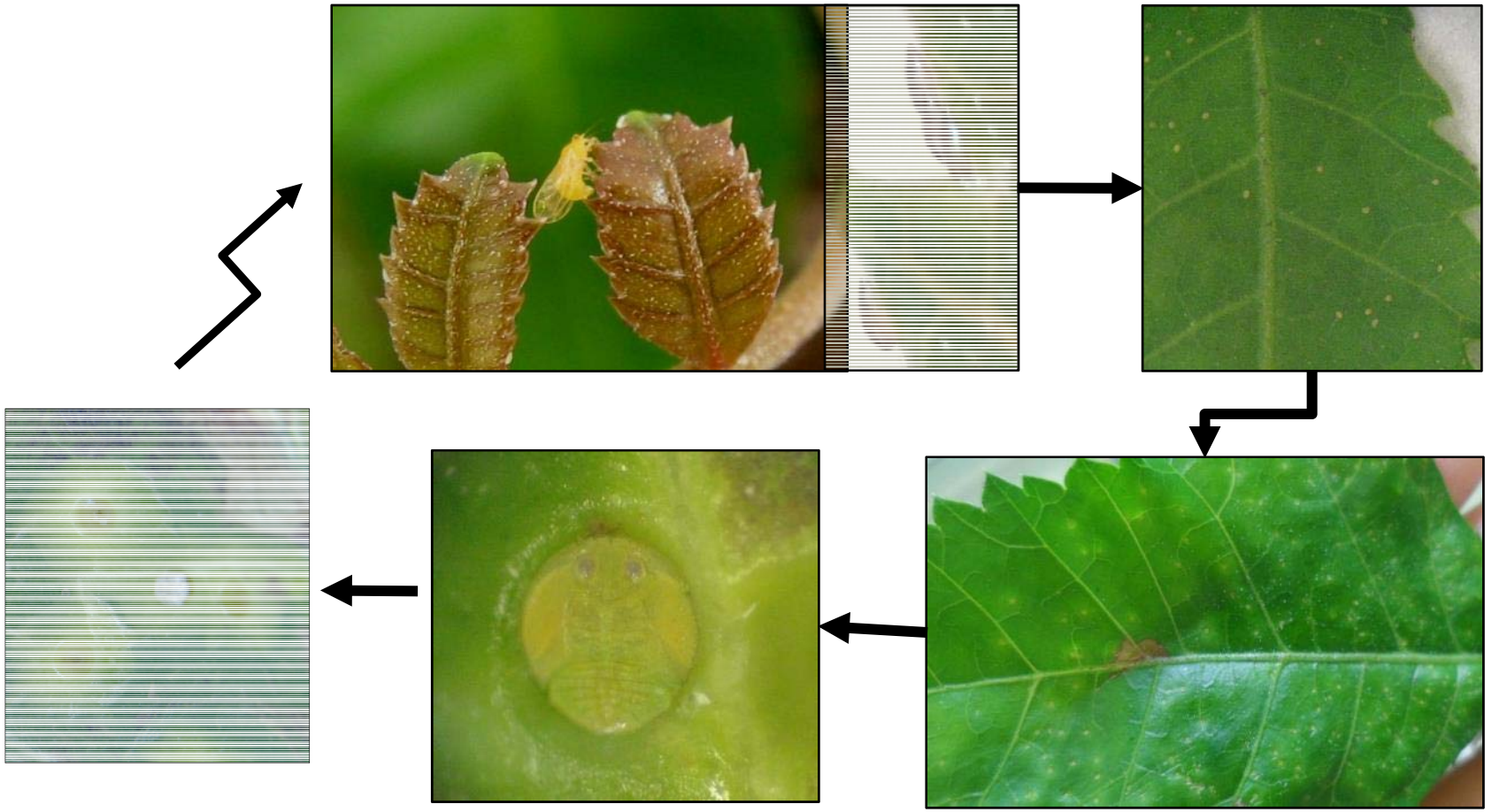
- *Calophya latiforceps* Burckhardt (Hemiptera: Calophyidae)
- Discovered in 2010 in Bahia, Brazil
- High degree of host specificity
- High mortality due to parasites/pathogens in native range





Burckhardt *et al*, 2011
Diaz *et al*, 2014

C. latiforceps **life cycle: 45 days**



Diaz *et al*, 2014

Determination of safety

Plant spp tested:

- **Thrips 117 spp, 58 genera**
- ***Calophya* 89 spp**

<u>Protocol</u>:

1) No-choice (Starvation)
2) Choice
3) Multi-generation

<u>Results</u>:

Thrips – some reproduction on *S. molle, R. sandwicensis* (Hl sp.)
***Calophya* – all crawlers died on non-targets**

Calophya latiforceps damage

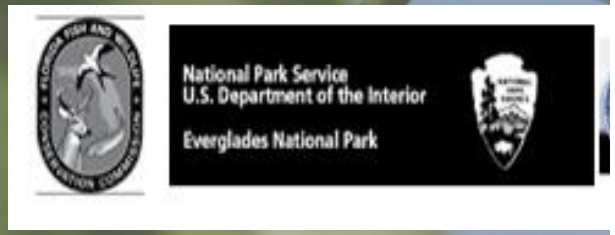
After 3 months
***Calophya* damage**
- **reduced chlorophyll**
- **plants 31% shorter,**
- **25% greater leaf abscission,**
- **12% reduced RGR**

TAG petition for thrips submitted for biological control of Brazilian pepper

TAG No.	Petitioner	Petition Type	Agent (Biological Control Organism)	Target Weed	TAG Recommendation (date)
15-01	Jeffrey Littlefield, et al	Field Release	*Cheilosia urbana* Meigen (Diptera: Syrphidae)	Hawkweeds: *Pilosella aurantiaca, P. caespitosa, P. flagellaris, P. floribunda, P. glomerata, P. officinarum, P. piloselloides* (Asteraceae)	Under Review
14-03	John A. Goolsby, Ph.D.	Field Release	*Lasioptera donacis* Coutin (Diptera: Cecidomyiidae)	Giant reed, *Arundo donax* L. (Poales: Poaceae)	Under Review
14-02	Gregory S. Wheeler, Veronica Manrique, William A. Overholt, Fernando Mc Kay, and Kirsten Dyer	Field Release	*Pseudophilothrips ichini* (Hood) (Thysanoptera: Phlaeothripidae)	Brazilian peppertree, *Schinus terebinthifolia* Raddi (Anacardiaceae)	Under Review
14-01	Dana K. Berner (Contact), Craig Cavin, Dan Bean, and William L. Bruckart, III	Field Release	***Colletotrichum salsolae*** B. Weir & P. R. Johnst. (Phylum Ascomycota, Order Glomerellales, Family Glomerellaceae)	Russian thistle, ***Salsola tragus*** L. (Chenopodiaceae)	Under Review
13-05	Alec McClay and Urs Schaffner	Field Release	*Dichrorampha aeratana* Pierce & Metcalfe (Lepidoptera: Tortricidae), *Cyphocleonus trisulcatus* Herbst (Coleoptera: Curculionidae), *Apion stolidum* Germar (Coleoptera: Curculionidae), and *Tephritis neesii* Meigen	Oxeye daisy, *Leucanthemum vulgare* (Vaill.) Lam. (Asteraceae)	Under Review

http://www.aphis.usda.gov/wps/portal/aphis/

Acknowledgements



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