The Redbay Ambrosia Beetle and Laurel Wilt: Biology, Impact, and Thoughts on Biological Control

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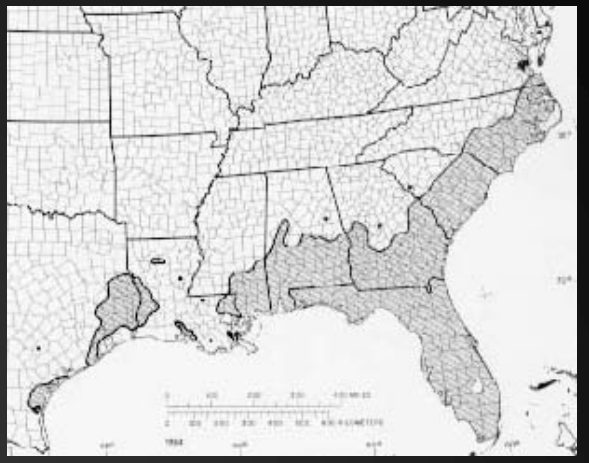
So, what is a redbay?

Persea borbonia (Lauraceae)



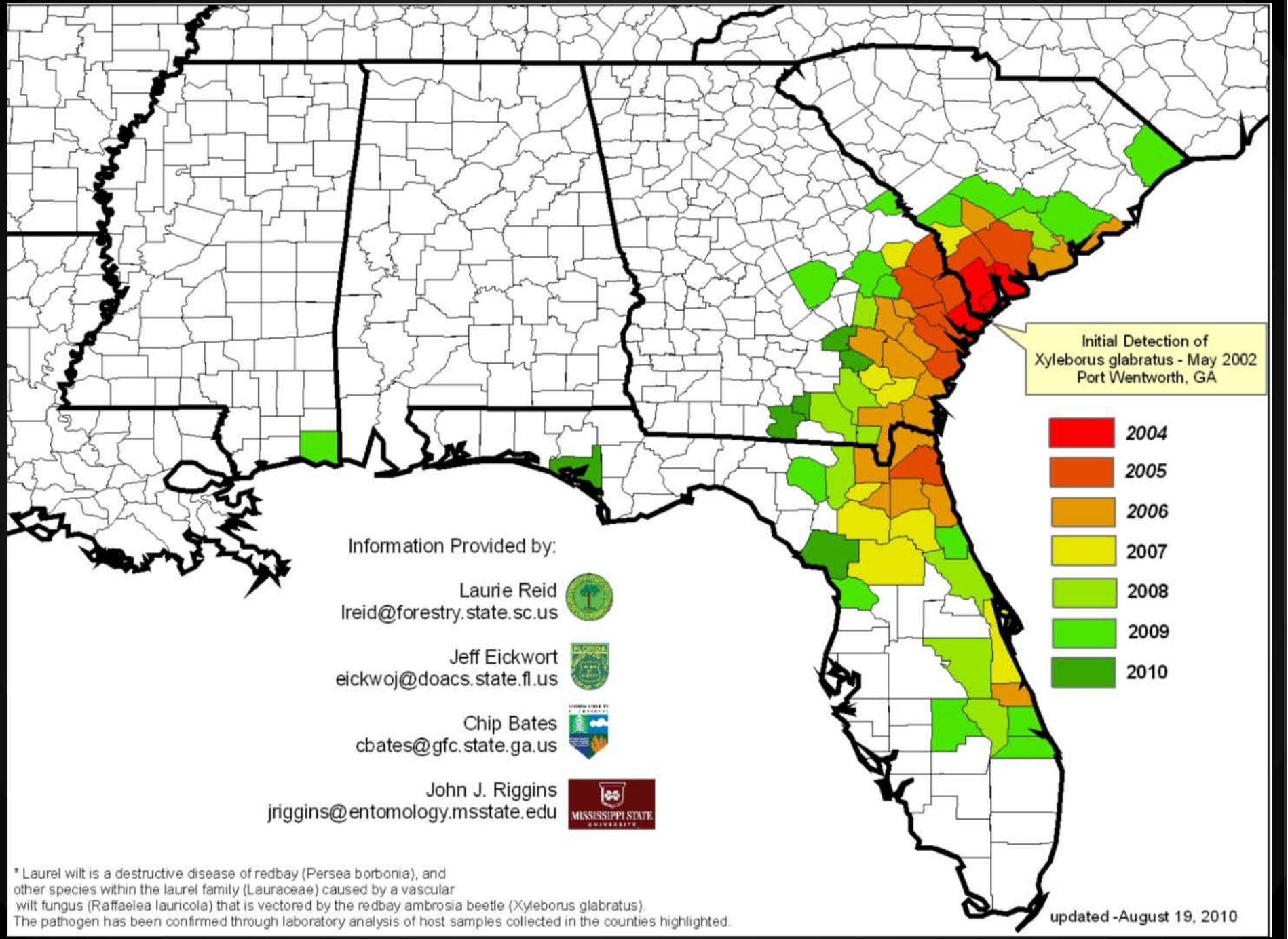
- Aromatic, broadleaved, evergreen of the US Southeastern Coastal Plain

Exotic Scolytinae (bark and ambrosia beetles) in the US

- 59 exotic spp. established
  - 30 last 30 yrs, 12 since 2000
- Majority ambrosia beetles
- Easily transported and established in wood and solid wood packing material

Brief History of Laurel Wilt

- 2002: An Asian ambrosia beetle (*Xyleborus glabratus*) detected near Savannah, GA
- 2004-2005: Beetle determined to be vector of fungus (*Raffaelea lauricola*) causing wilt disease and widespread redbay mortality (SC, GA, FL)
- 2005-2010: continued range expansion in Southeastern US


Initial Detection of
Xyleborus glabratus - May 2002
Port Wentworth, GA
2004
2005
2006
2007
2008
2009
2010
Information Provided by:
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* Laurel wilt is a destructive disease of redbay (Persea borbonia), and
other species within the laurel family (Lauraceae) caused by a vascular
wilt fungus (Raffaelea lauricola) that is vectored by the redbay ambrosia beetle (Xyleborus glabratus).
The pathogen has been confirmed through laboratory analysis of host samples collected in the counties highlighted.
updated -August 19, 2010

Redbay Ambrosia Beetle (*Xyleborus glabratus*)

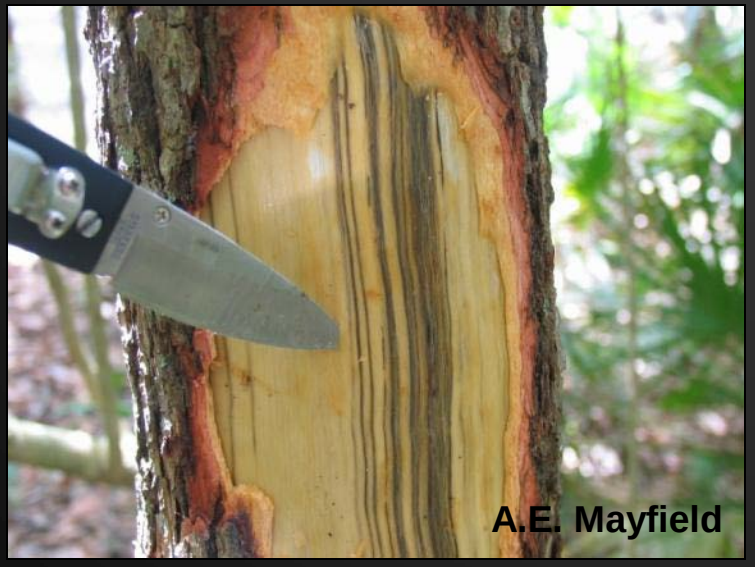
- Coleoptera: Curculionidae: Scolytinae
  - Symbiont fungi, mandibular mycangia
  - Partial parthenogenesis, sib mating
  - Sex ratio strongly skewed to female

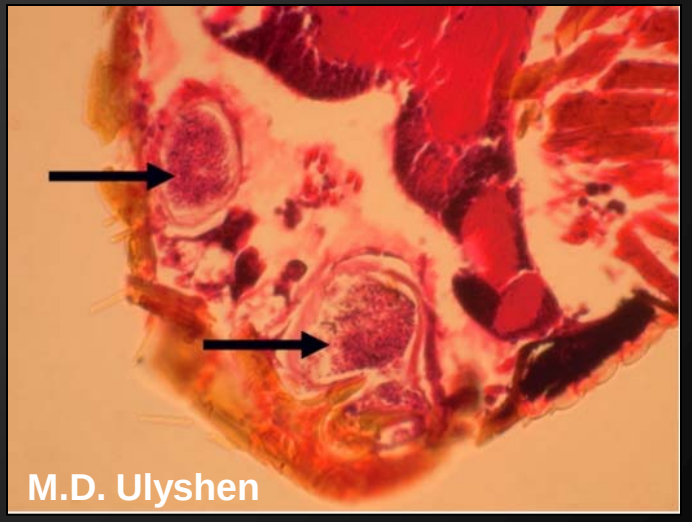
Redbay Ambrosia Beetle (*Xyleborus glabratus*)

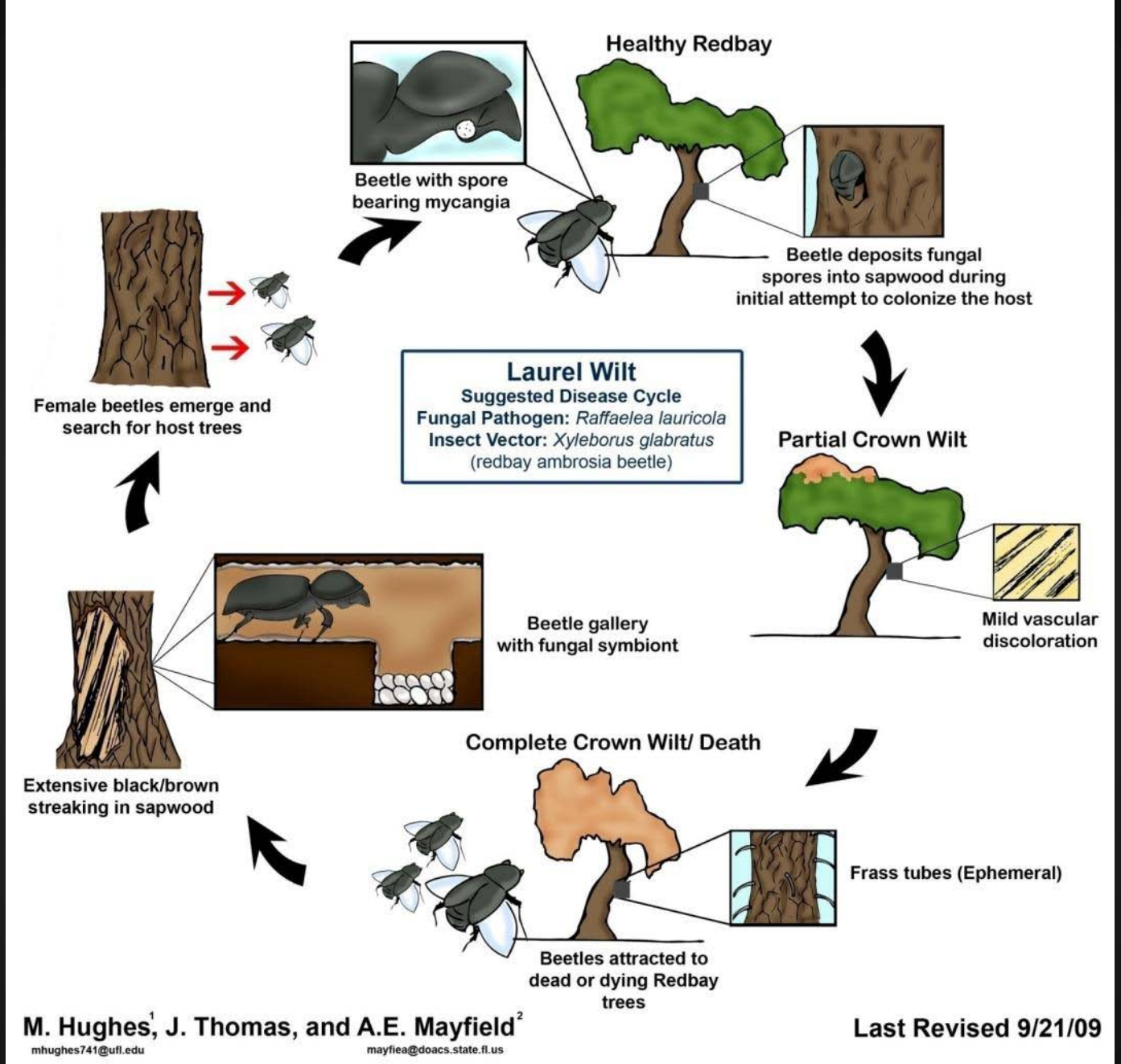
- Native to India, Bangladesh, Myanmar, Taiwan, Japan
- Reported Asian host families (genera):
  - Lauraceae (*Lindera, Litsea, Phoebe*)
  - Dipterocarpaceae (*Shorea*)
  - Fagaceae (*Lithocarpus*)
  - Fabaceae (*Leucaena*)

Laurel wilt pathogen (*Raffaelea lauricola*)

- Recently described as one of 6 *Raffaelea* spp. in the mycangia (*Harrington* et al. 2010)
- Presumed to have arrived with vector
- Transmitted to host sapwood via RAB and moves systemically in the xylem







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RAB Biology and Host Attraction

Hanula, J.L. et al. 2008. J. Econ. Entomol. 101:1276

Hanula, J.L and Sullivan, B. 2008. Environ. Entomol. 37:1403

- Adults active year round, peak in September (GA and SC)
- Brood development takes about 60 days; multiple gen/year
- Diseased + beetle-infested redbay wood is not more attractive than uninfested wood

RAB Biology and Host Attraction

Hanula, J.L. et al. 2008. J. Econ. Entomol. 101:1276

Hanula, J.L and Sullivan, B. 2008. Environ. Entomol. 37:1403

- Trap catch positively correlates with number of recently-dead redbay trees (leaves attached)
  - After mature redbays gone, beetle populations drop dramatically but do not disappear
- Manuka oil and phoebe oil are attractive lures

Confirmed Laurel Wilt Hosts Plants in US

Confirmed in the field:

- Redbay (*Persea borbonia)*[1]
- Swamp bay (*Persea palustris)*[1]
- Sassafras (*Sassafras albidum)*[1]
- Pondspice (*Litsea aestivalis)*[1] - endangered
- Pondberry (*Lindera melissifolia*)[1] - endangered
- Camphor (*Cinnamomum camphora*)[3]
- Avocado (*Persea americana)*[2]

Susceptible in inoculation trials:

- Spicebush (*Lindera benzoin*)[1]
- California laurel (*Umbellularia californica*)[4]

1 Fraedrich, S.W. et al. 2008. Plant Dis. 92:215

2 Mayfield A.E., III et al. 2008. Plant Dis. 92:976

3 Smith, J.A. et al. 2009. Plant Dis. 93:198

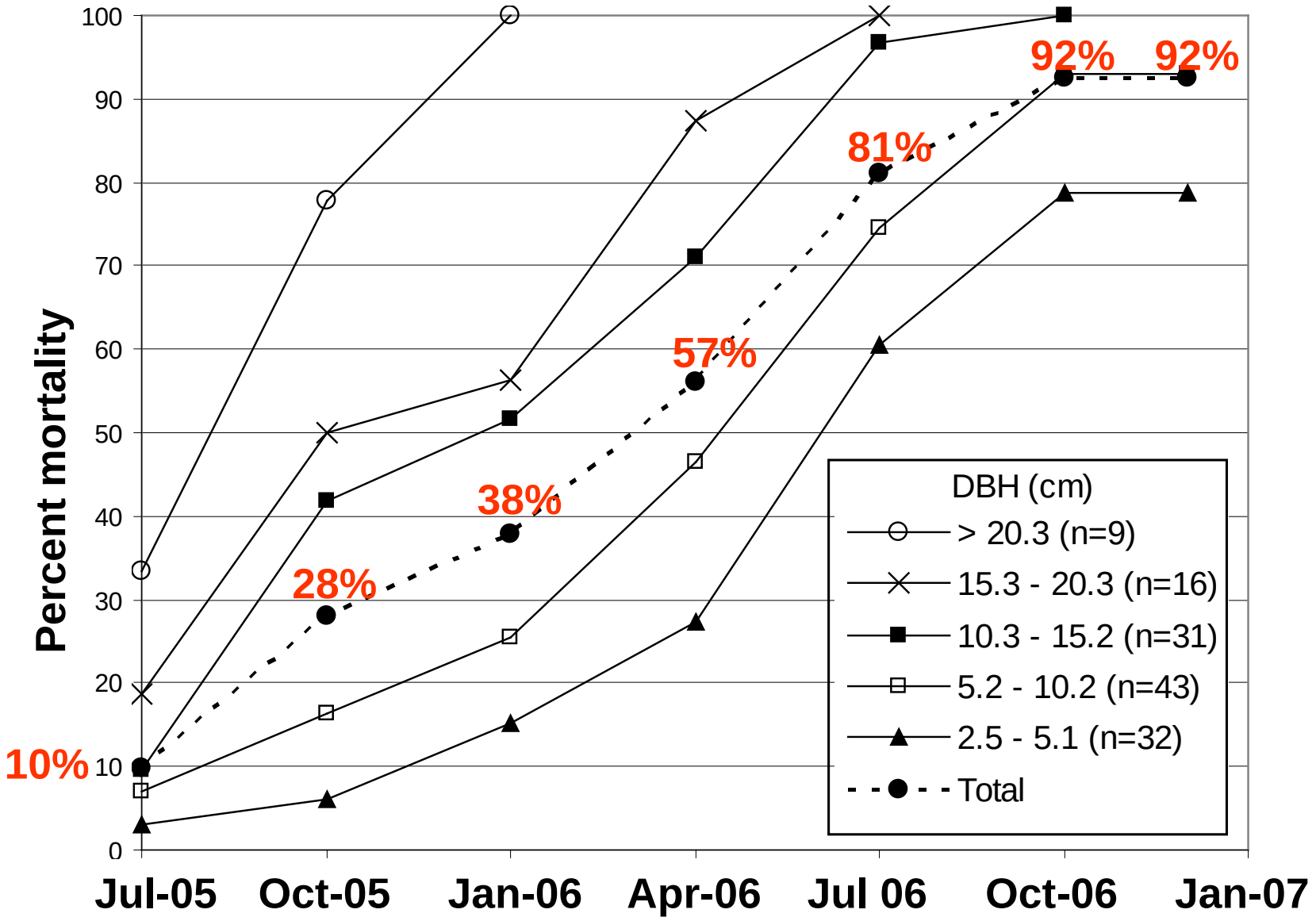
4 Fraedrich, S.W. 2008. Plant Dis. 92:1419

Impact

"Bayhead" site near Claxton, GA (photo: S. Cameron)

Impact

Redbay mortality curve at Ft. George Island, FL



S.W. Fraedrich et al. 2008. Plant Disease 92: 215-224

Some small redbay saplings and many seedlings remain in aftermath of laurel wilt outbreaks

Impact on Avocado

- Landscape trees have been killed, RAB attracted to wood
- Certain cultivars susceptible to fungus in inoculation trials
- RAB detected in Miami-Dade County (main FL production)
- No infestations in production groves yet

Management

- Restrict transport of infested wood
- Sanitation
- Chemical Treatments
  - Mayfield et al. 2008. Arboric. Urban Forestry 34: 317-324
- Propagation of resistant trees
- Biological Control?

Biological Control of Redbay Ambrosia Beetle?

- Some Challenges:
  - Spends most of life cycle in the sapwood, small galleries
  - Single female may start new population, initiate disease
  - Presumably no pheromone on which natural enemies might cue
  - Population levels extremely low after preferred host material eliminated
  - Scant information from native range
  - No precedent cases of biological control of ambrosia beetles

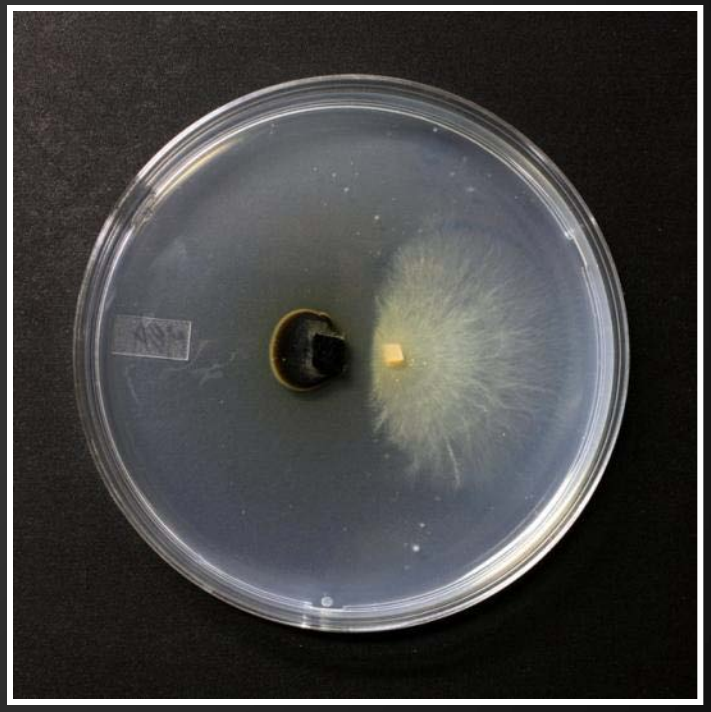
Biological Control of Redbay Ambrosia Beetle / Laurel Wilt:

2 preliminary studies at the University of Florida

Inhibitory Endophyte

Shin, Keumchul, Hughes, M.A., Smith, J.A., and Ploetz, R.C.
University of Florida

- Endophytes isolated from putatively resistant trees and susceptible controls at same locations
- *Phaeomoniella sp.* (ascomycete)
- Consistently isolated from some asymptomatic trees only
- Completely inhibits growth *R. lauricola* in vitro
- Studies to determine biocontrol potential underway using this and other species



Potential natural enemies from infested host material

(J. Peña et al, Universtiy of Florida)

- Collect predators, and parasitoids that emerge from infested bolts
- Infest clean bolts with lab-reared beetles, deploy in field and collect periodically
- Florida and Taiwan

Emergence of possible natural enemies from infested host material in Florida (Peña et al, unpubl.)

Natural enemies of xylem-inhabiting ambrosia beetles: Literature

- **Parasitoids:** Hymenoptera
  - Eulophidae: *Phymasticus xylebori*
    - Kills adult *Xyleborus perforans* associated with macadamia trees in Hawaii, low (15%) parasitism rate (Chang 1993), other specimens from Costa Rica, South Carolina - hosts unreported (LaSalle 1995)
  - Pteromalidae: *Perniphora* spp.
    - *P. robusta,* assoc. w/ *Trypodendron lineatum* (Novak 1960), *T. domesticum* and *Xyleborus dispar* (Kenis et al. 2004)
    - *P. americana*, assoc. w/ *T. betulae* in Maine/NB (Miller 1965)
  - Braconidae: *Cryptoxilos* spp.
    - *C. beaveri*, low adult parasitism rate of *Hypothnemus* spp. in *Commersonia* trees ("kurrajong") in Fiji (Shaw & Berry 2005)
  - Euytomidae: *Eurytoma polygrahi* (Kenis et al. 2004)
    - Suspected larval ectoparasitoid of *Trypodendron lineatum and T. domesticum*

Natural enemies of xylomycetophagous ambrosia beetles: Literature

- **Parasitoids:** Hymenoptera (cont.)
  - Perilampidae: *Monacon* spp. (Darling & Roberts 1999)
    - *M. robertsi:* larvae (planidia) follow adult *Crossotarsus barbatus* (Platypodidae) into gallery, parasitize eggs, larvae
      - Tree: *Xanthophyllum papuanum* in Papua New Guinea, Indonesia
      - Low parasitism rate, poor biocontrol potential

Natural enemies of xylomycetophagous ambrosia beetles: Literature

- **Parasites:** Coleoptera
  - Colydiidae: *Sosylus* spp. (Roberts 1969)
    - Larvae are pupal parasites of Platypodidae, adults of some species are AB predators (Americas, Africa, Asia)
- **Parasites:** Nematodes
  - Tylenchid larva found in *Trypodendron lineatum* B.C., effect unknown (Thong & Webster 1983)
  - Review by Kanzaki and Kosaka (2009):
    - Only small fraction of nematode records from ambrosia beetles compared to rest of Scolytinae
    - Some groups (e.g. *Ruehmaphelenchus*) specific to ambrosia beetles, almost nothing known RE biological relationships

Natural enemies of xylomycetophagous ambrosia beetles: Literature

- **Predators:** Coleoptera
  - Cleridae: *Thanasimus spp.*
    - *T. dubius* adults attacked adult *Platypus flavicornus* (Platypodinae) during SPB infestation (Clarke & Menard 2006)
    - *T. rufipes* preys on *Trypodendron lineatum* (Kenis et al. 2004)
  - Brentidae: *Cyphagogus* spp.
    - Adults prey on adult Platypodidae entering galleries (Thompson 1996)
  - Rhizophagidae: *Rhizophagus* spp.
    - *R. depressus* and *R. dispar* prey on *Trypodendron lineatum* (Kenis et al 2004)
    - Note: *Rhizophagus grandis* is mass-reared biological control agent for *Dendroctonus micans* in Europe, Middle East

Natural enemies of xylomycetophagous ambrosia beetles: Literature

- **Pathogens:** Bacteria
  - *Bacillus thuringiensis* subsp. *tenebrionis:*
    - isolated from *Xyleborus dispar,* being explored as possible coleopteran biopesticide in Turkey (Sezen et al. 2010)…Effects?
  - Several genera (*Pseudomonas, Cloaca, Bacillus*) found in *Xyloterus lineatus* (Lynseko 1959)…Effects?
  - *Pseudomonas septica* found in *Trypodenron lineatum* (Nowak 1960)…Effects?

"…no bacterium is known at the moment to act effectively in bark beetles" (Review by Wegensteiner 2004)

Natural enemies of xylomycetophagous ambrosia beetles: Literature

- **Pathogens:** Fungi
  - *Beauveria bassiana* (ascomycete)
    - Worldwide, soil-inhabiting, insect pathogen
    - Spore suspensions sprayed on bark caused moderate mortality levels in *Trypodendron lineatum* (Prazak 1988, 1991, 1997)
    - Non-specific “bio insecticide”

Closing Thoughts

- More research on natural enemies of ambrosia beetles and their roles in regulating populations is warranted
  - RAB in native and introduced ranges
- A number of factors (habitat, reproduction biology, population patterns) make RAB a challenging case for biological control
- Is there enough interest and potential for success for a biological control program?

Laurel Wilt / RAB Resources:

- www.fs.fed.us/r8/foresthealth/laurelwilt
- Redbay Recovery Plan - USDA-ARS National Plant Disease Recovery System

Thank you

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