# Update on ambrosia beetle biology and potential applications for management

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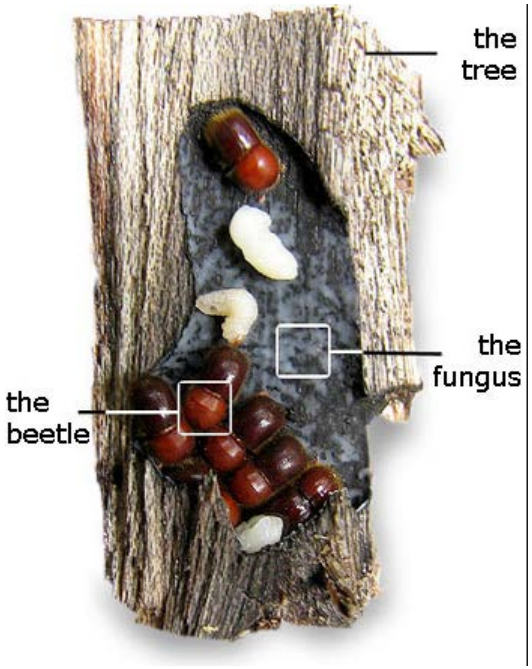
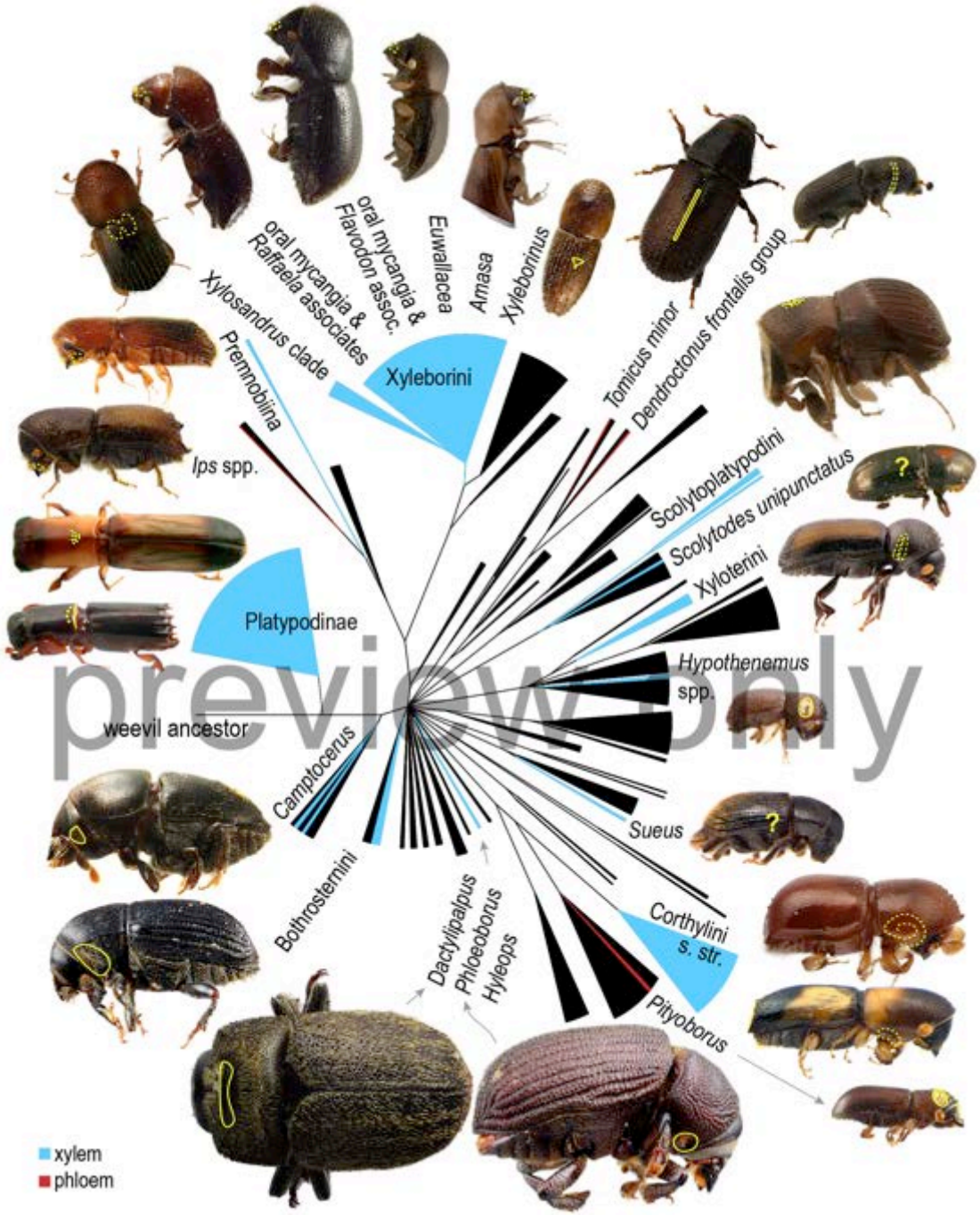
# Recent research topics

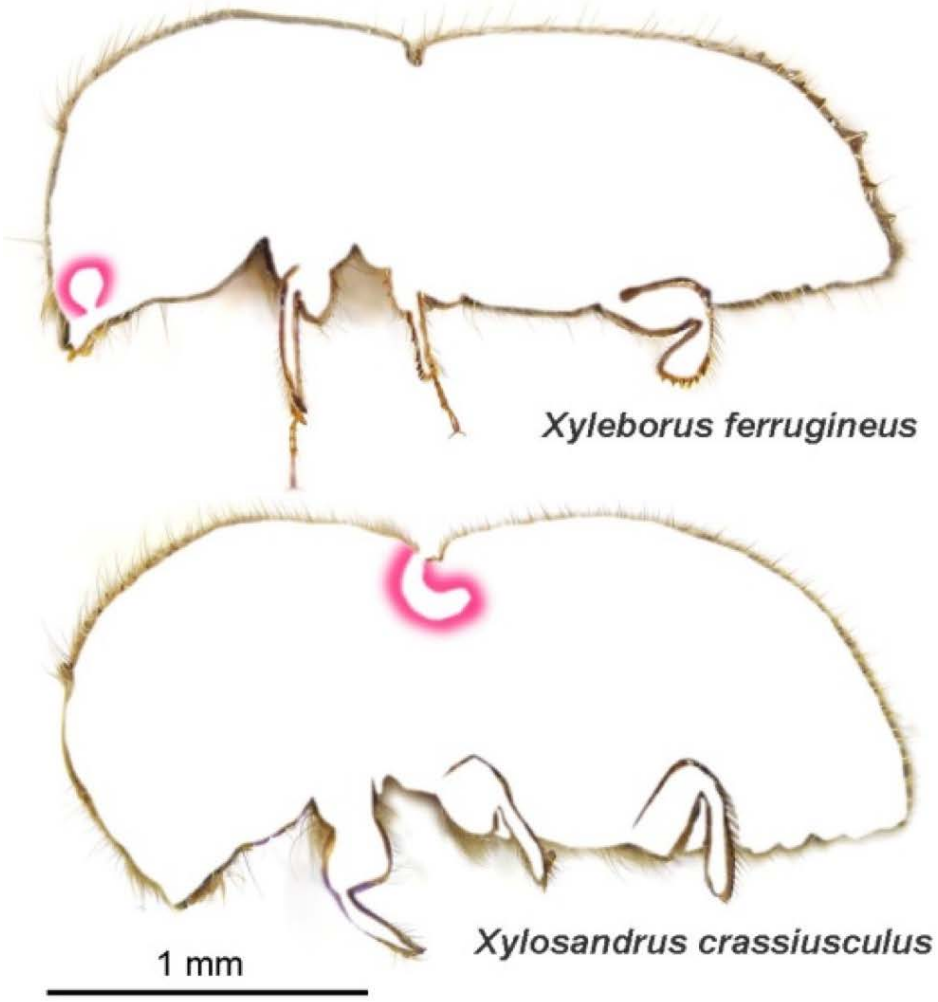



- Flight capacity of ambrosia beetles
- Transmission of the pathogen by the vectors
- Use of repellents and attractants against ambrosia beetles for management






Hulcr and Stelinski, 2017

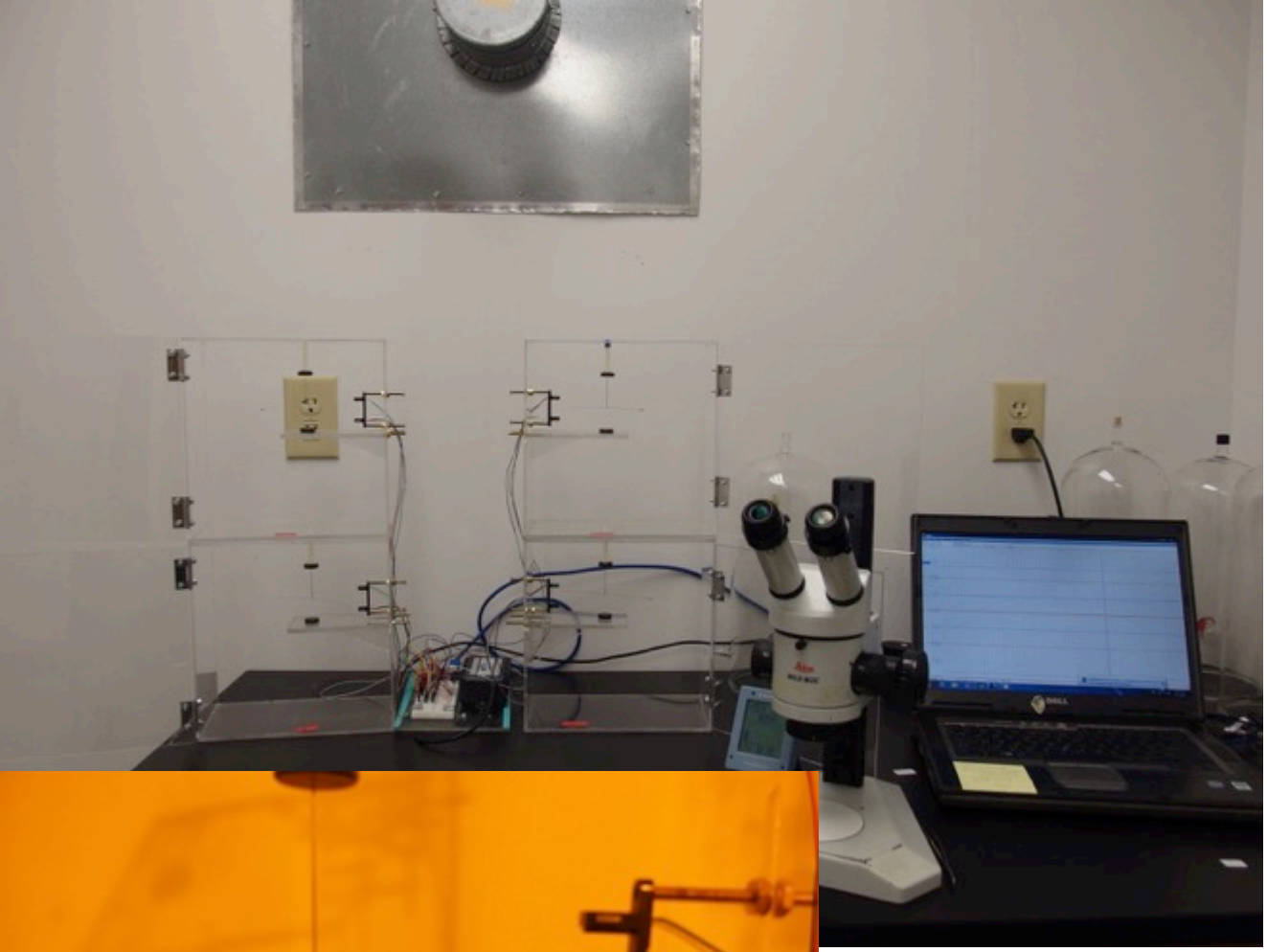


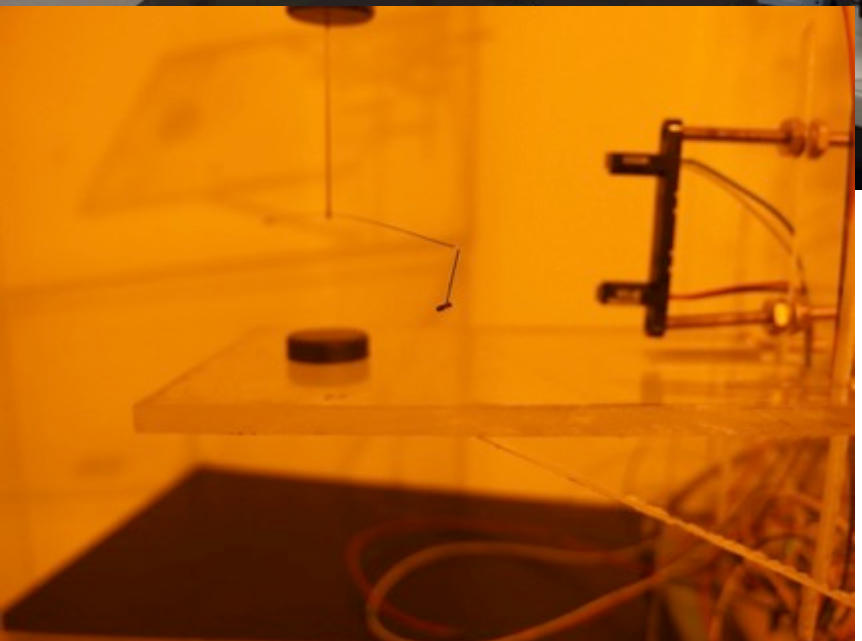

The ambrosia symbiosis is specific in some species and promiscuous in others

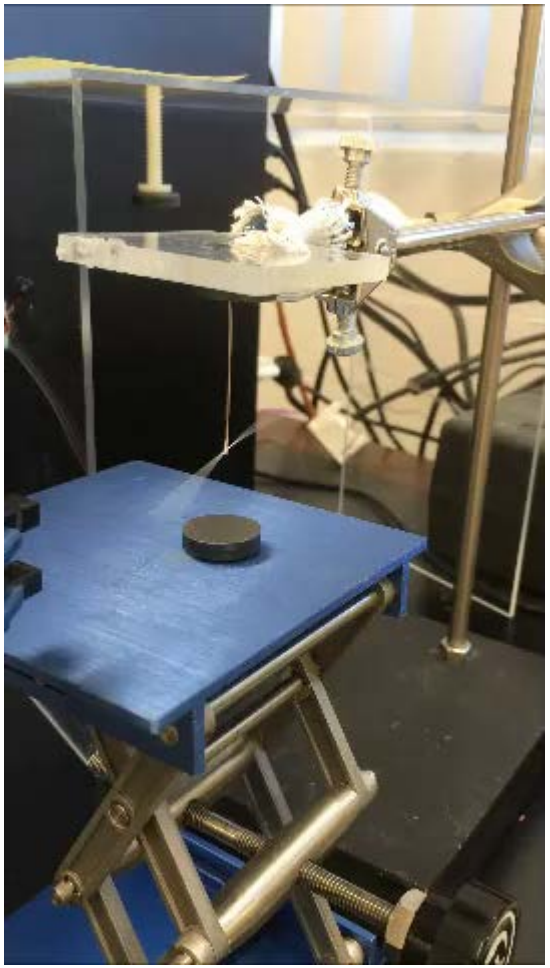
**Figure 1**: Digital cross-sections of *Xyleborus ferrugineus* and *Xylosandrus crassiusculus* showing the two different types of mycangia, mandibular and mesonotal, respectively.

Kostovcik, Bateman, Kolarik, Stelinski, Jordal, Hulcr, 2014

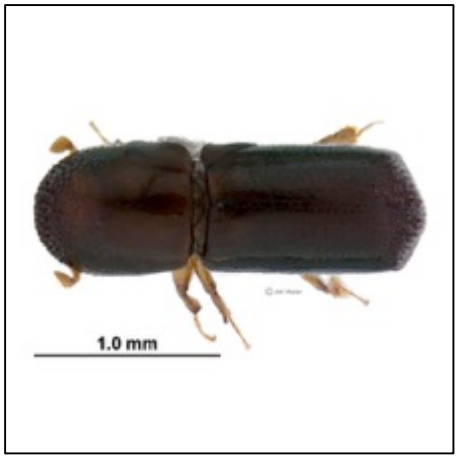
# Investigating the flight capability of the Redbay ambrosia beetle



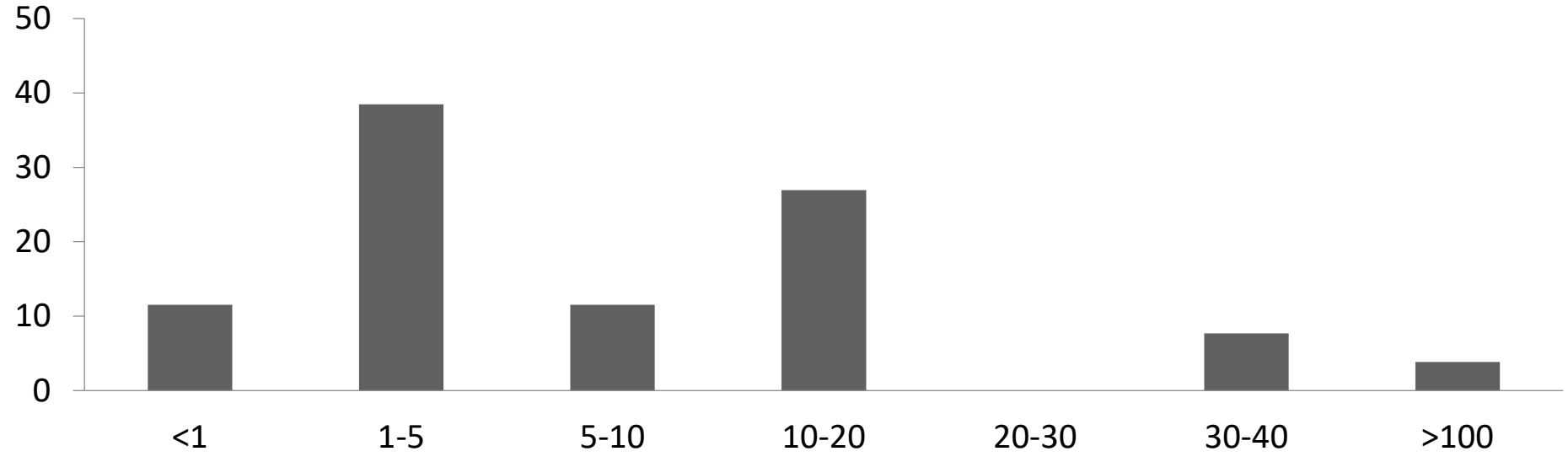




# Flight capacity of *Xyleborus glabratus*

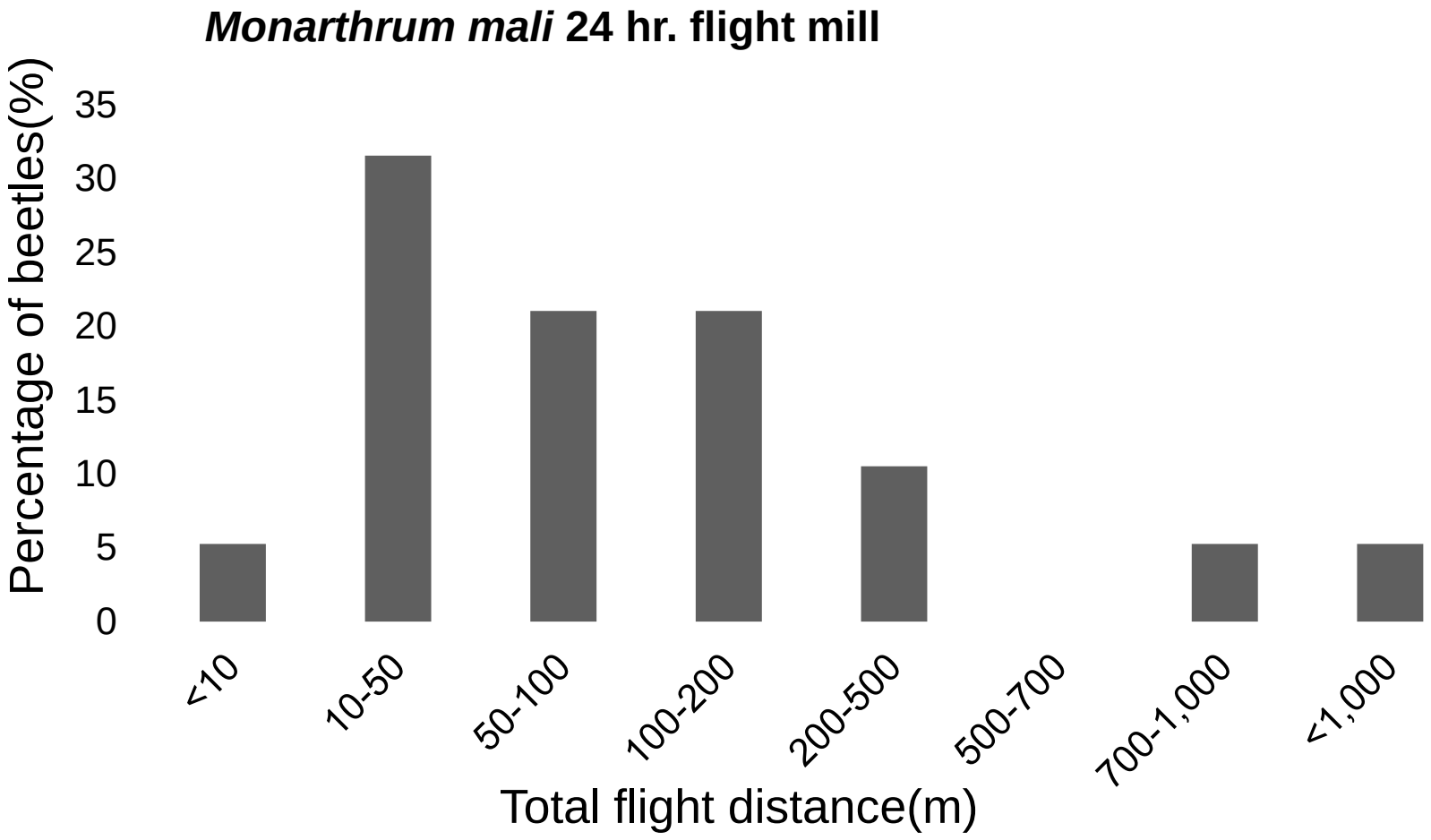

Distribution of distance covered by *Xyleborus glabratus* during 2 h of recorded flight (n=60)



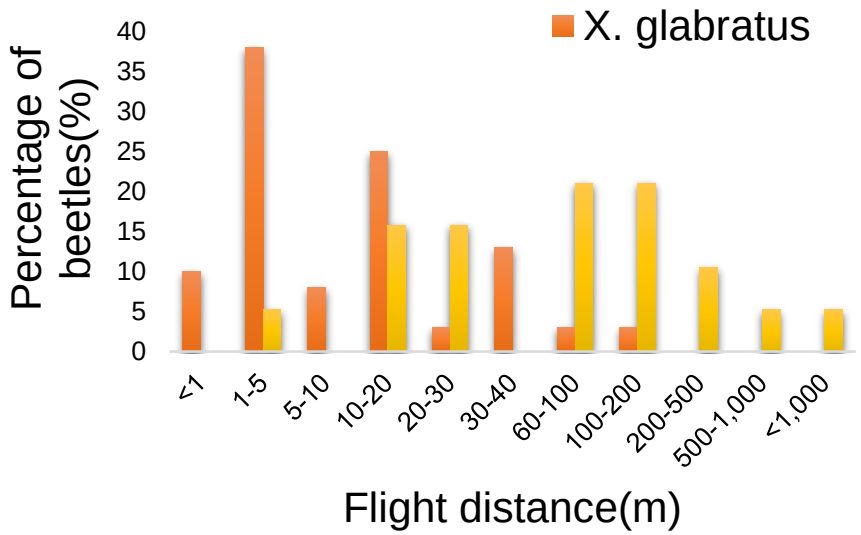
***Monarthrum mali***

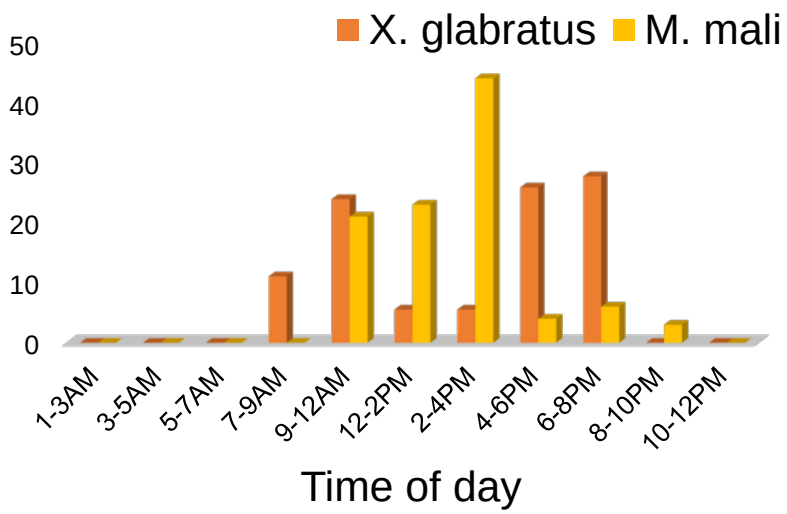
Wood boring insects

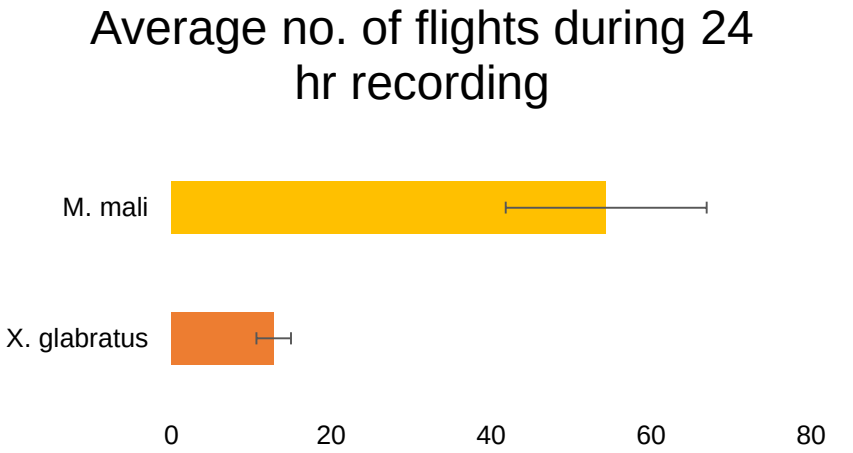
Widespead in eastern North America

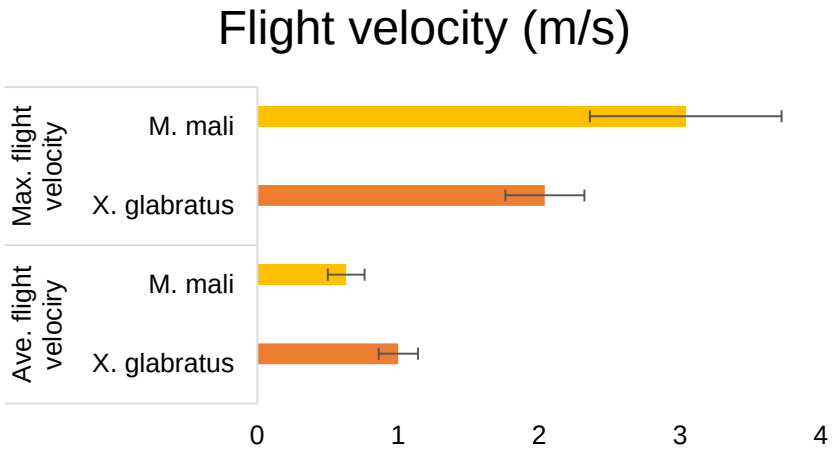


# Various species investigated have similar flight capabilities and behaviors



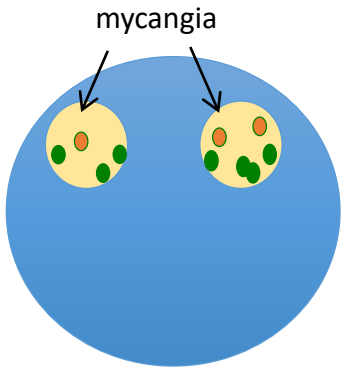



# *R. lauricola* transmission

- Propagative mechanical transmission
- Possible factors affecting transmission:
  - Background fungal community in beetle mycangia may facilitate or inhibit transmission
  - Beetle species
  - *R. lauricola* titer in mycangia
- Disruption of fungal communities may alter transmissibility of *R. lauricola*

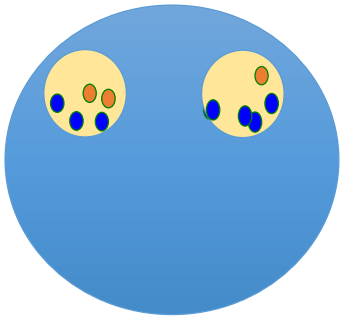
# Identify fungal symbionts that reduce transmission of *R. lauricola*

Cross section of beetle head:




- fungal symbiont 1
- *R. lauricola*

TRANSMISSION



- fungal symbiont 2
- *R. lauricola*

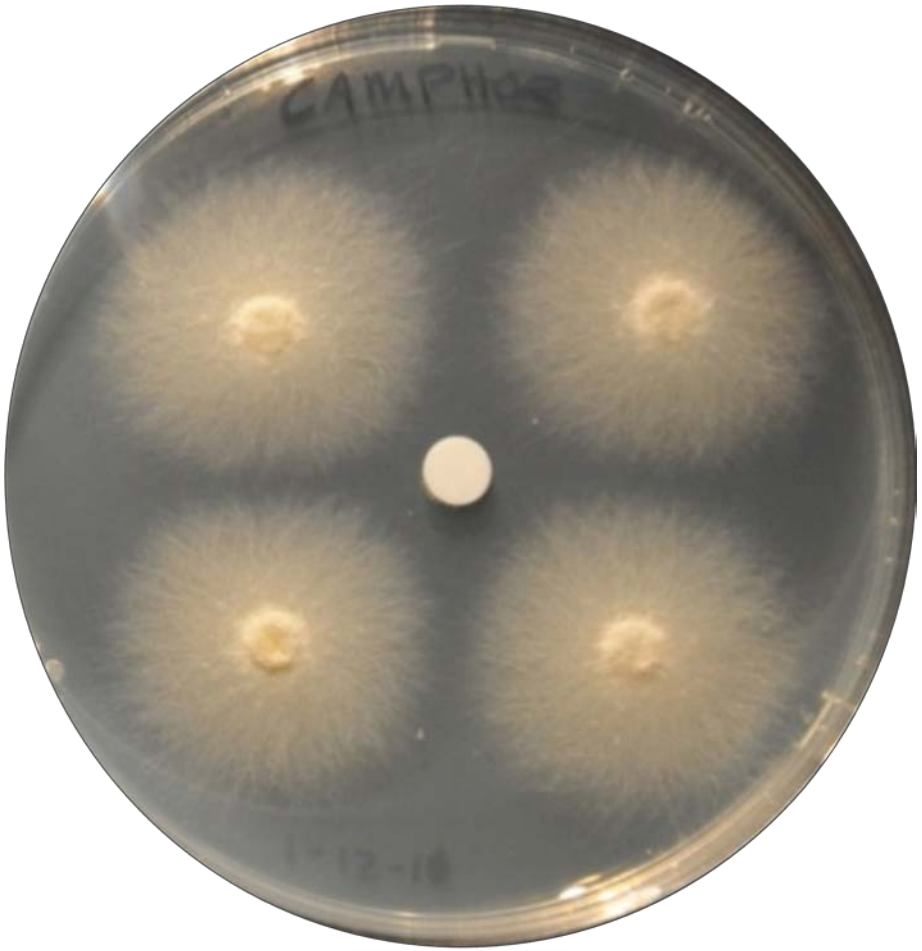
NO TRANSMISSION

*Practical Outcome*: Identification of specific combinations of symbiont communities that PREVENT efficient inoculation of *R. lauricola* for each ambrosia beetle species.

# CHEMICAL ECOLOGY

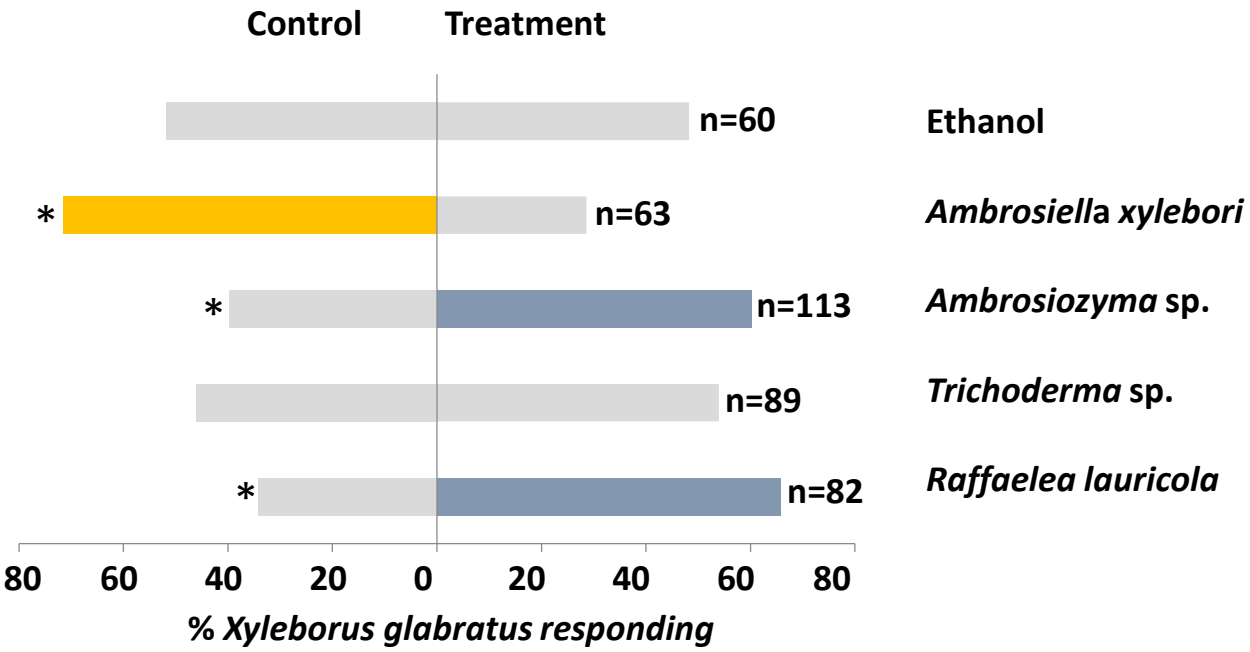
1. **Identification of new attractants for *Xyleborus* sp.**
    1. Fungal symbiont-based attractants (Part 1)
    2. Host plant-based attractants (Part 2)
2. **Development of synthetic lure attracts for Ambrosia beetles**
3. **Effects of host odors on gallery formation by ambrosia beeltes**

# Fungal symbiont odors



# Beetles are attracted to odors of their specific symbionts

Example: *X. glabratus* is attracted to the odor of its fungus.




Hulcr, J., Mann, R. & Stelinski, L. L. (2011) The scent of a partner: ambrosia beetles are attracted to volatiles from their fungal symbionts. *Journal of Chemical Ecology,* 37**,** 1374-1377.

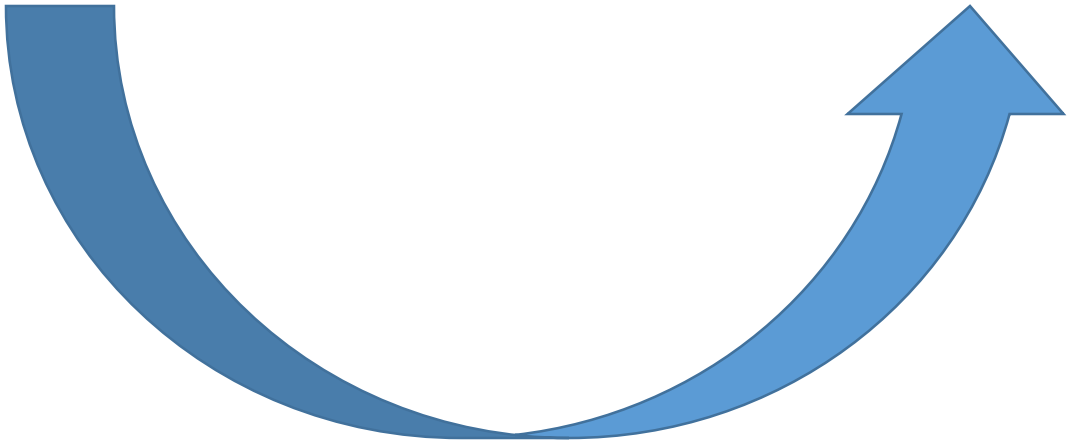
# Synthetic Raffaelea Blend (by volume)

36.5 parts ethyl acetate

29 parts ethanol

22 parts isoamyl alchohol

12.5 parts isoamyl acetate

1 mL of blend in polyethylene BEEM vial

# Prototype Lure Designs by Alpha Scents

Lure A

Lure B

Lure C

Lure D


www.alphascents.com


## FIELD TRAPPING METHODS

½ Elm beetle sticky traps on 6’ stakes.

5-6 Replicates for each lure.

>20’ between traps.

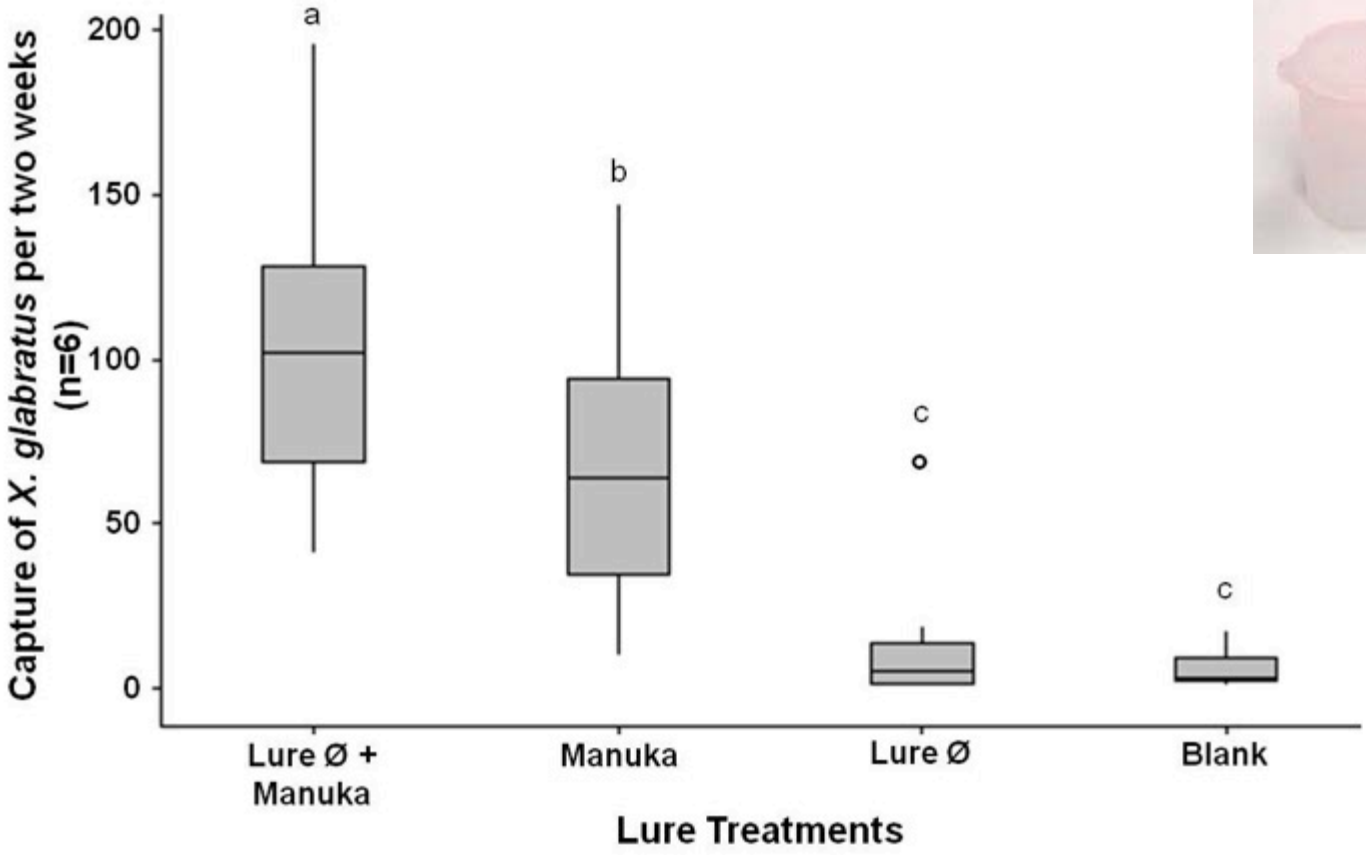
*X. glabratus* counted for 2 weeks.

Non-target Scolytinae also counted.


*X. glabratus* was abundant at Wekiwa Springs State Park.

Manuka lures work fairly well for locations like this.

More *X. glabratus* caught on Raffaelea odors when paired with manuka.


Kuhns et al., 2014

# FUNGAL CHEMICAL ECOLGOY

1. Odors of *Raffaelea lauricola* synergize with manuka lures for increased trap capture of *X. glabratus*.

2. Constituents of *R. lauricola* odor are cheap and smell like banana.

3. Formulations can be very long lasting; however, they outlast manuka lures.

4. Therefore, Raffaelea lures should be combined with a longer lasting attractant than the current commercial manuka lures.

# Host odors

## Redbay wood odors

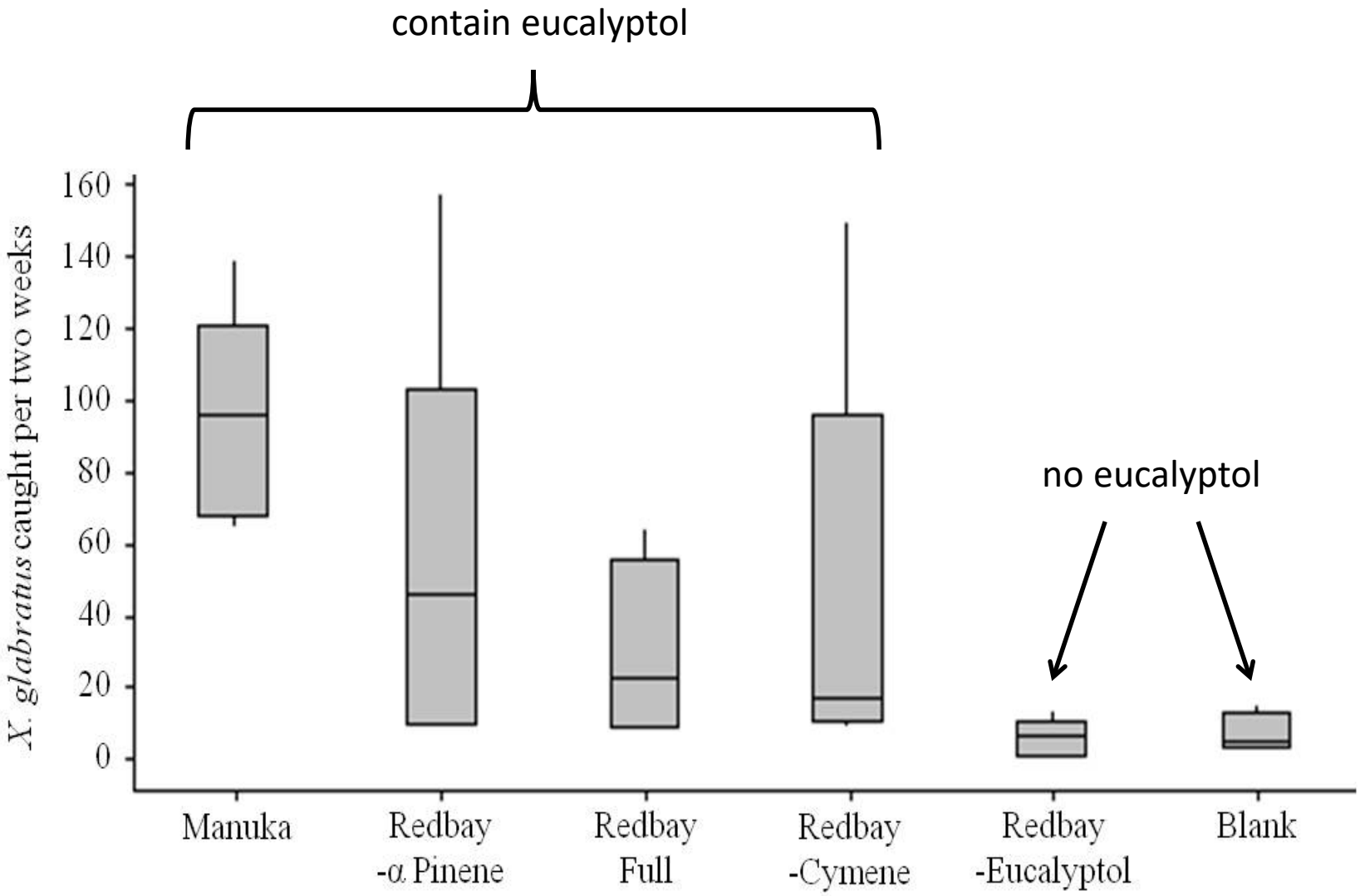
# ODOR ANALYSIS

1. Cut branches from redbay and three avocado varieties:
    1. Peterson
    2. Lula
    3. Booth

2. 1.5” wood disks were cut from replicated samples and placed in glass beaker with tin foil lid

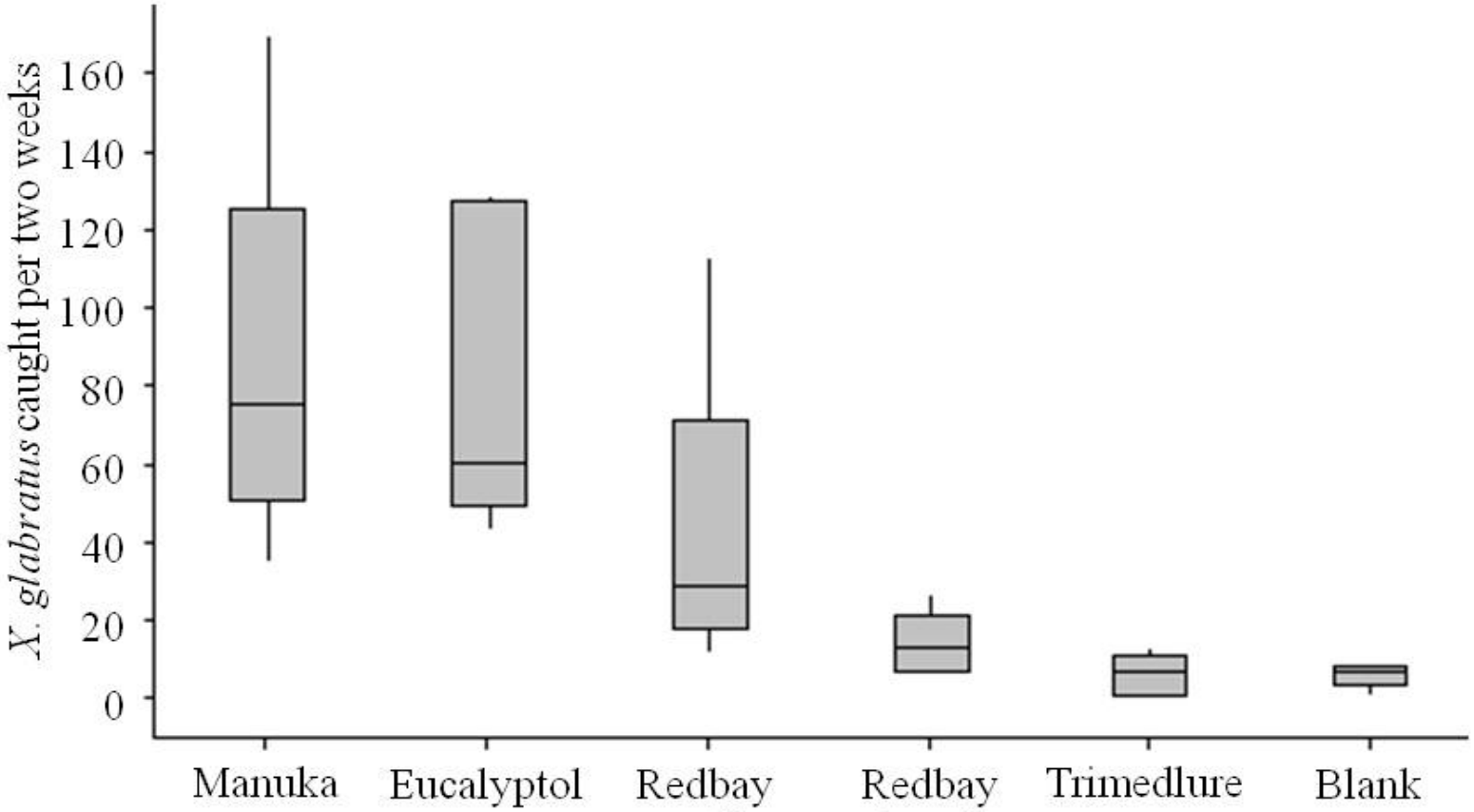
3. Odors adsorbed with solid-phase microextraction (SPME). Analysis/ID- GC-MS

# Presence of eucalyptol is correlated with capture of *X. glabratus*.

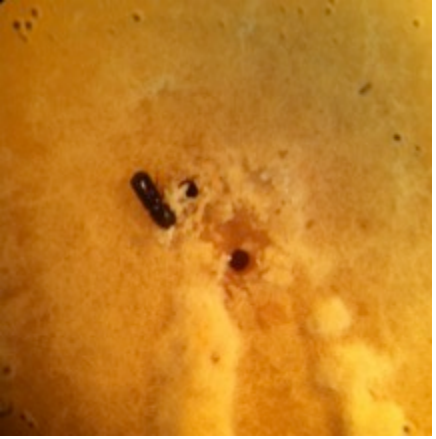



Kuhns et al., 2015

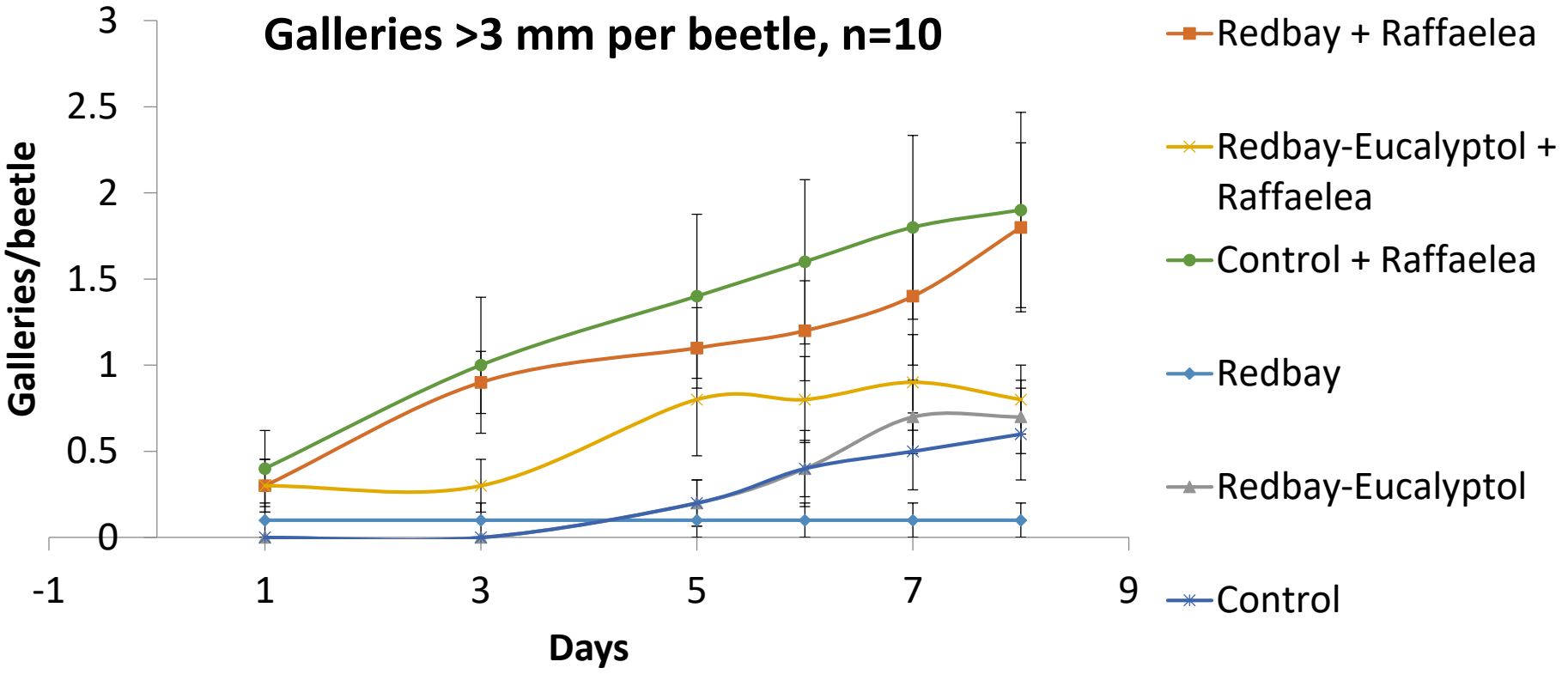
*X. glabratus* capture on eucalyptol baited traps is similar to manuka baited traps.




α-copaene mimic used for medfly



# Raffaelea; rather than Redbay, odors drive beetle boring



# Host odors—wood volatiles

1. Beetles are attracted to eucalyptol

2. Removal of eucalyptol decreases attraction considerably

3. Eucalyptol is not abundant in the avocado varieties tested.
   - -This may explain why avocado is not preferred compared with redbay
   - -Potential predictor of susceptibility
   - -May be important to examine eucalyptol content in resistant/tolerant plants/varieties

Boring behavior appears to be affected by the presence of Raffaelea rather than Redbay odors.

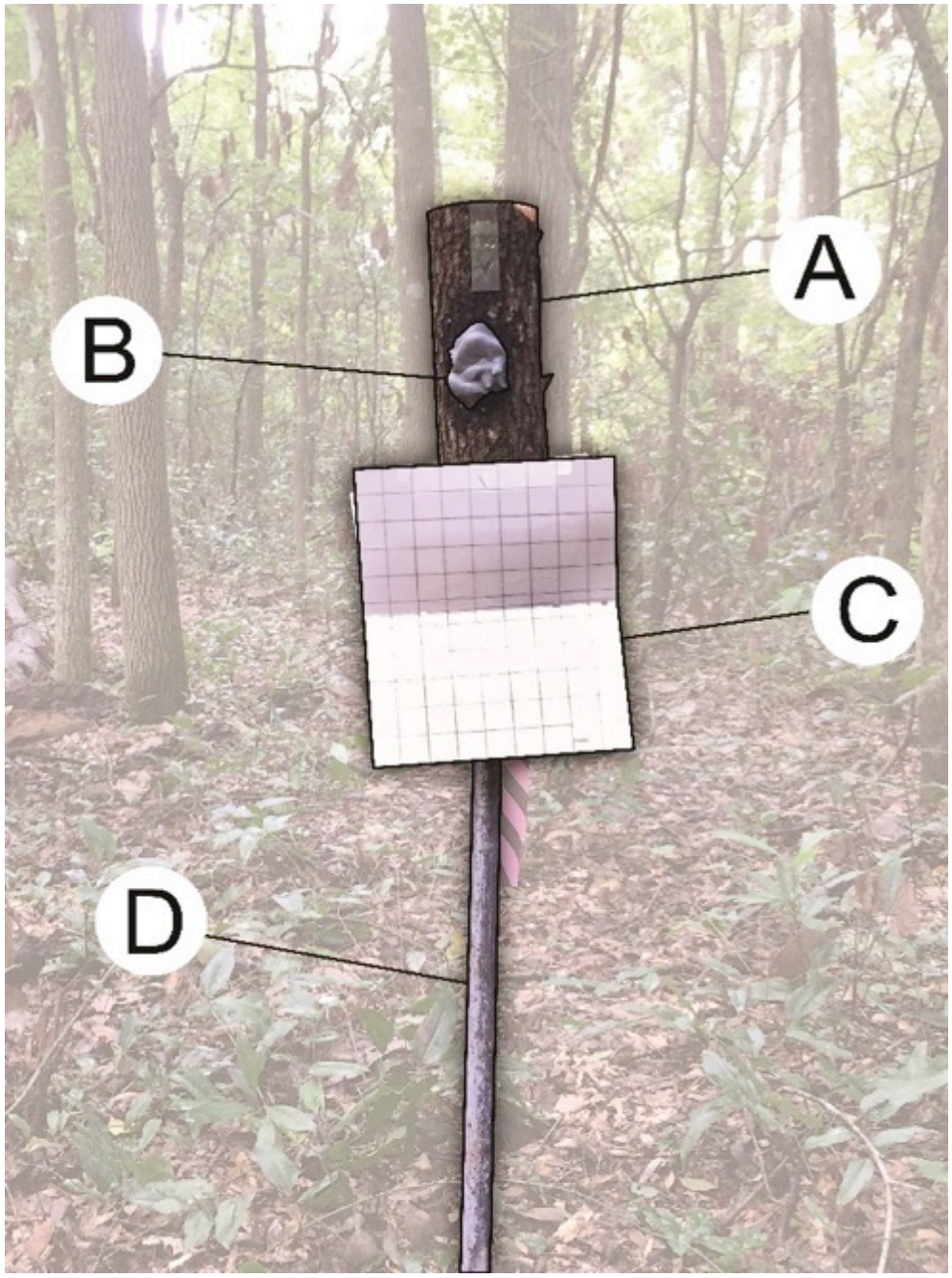
# Applications

ISCA TECHNOLOGIES
Pest Management Tools & Solutions

SPLAT® with high concentration of Methyl salicylate to apply directly on the trunk of redbay trees

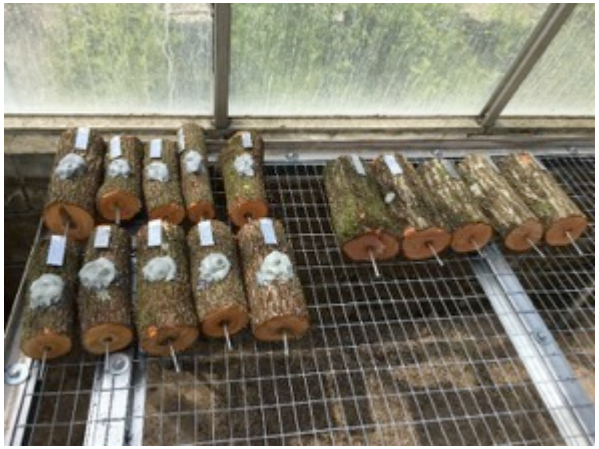
Trap Design:

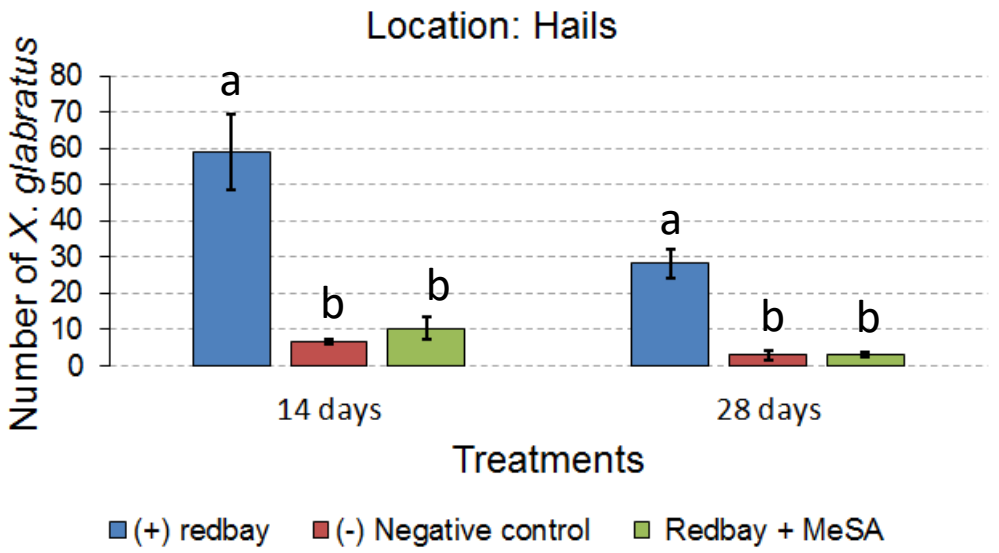
A) healthy redbay bolt (*attractant*), B) SPLAT repellent, C) sticky cards (on bolt front and back) and D) metal support pole.

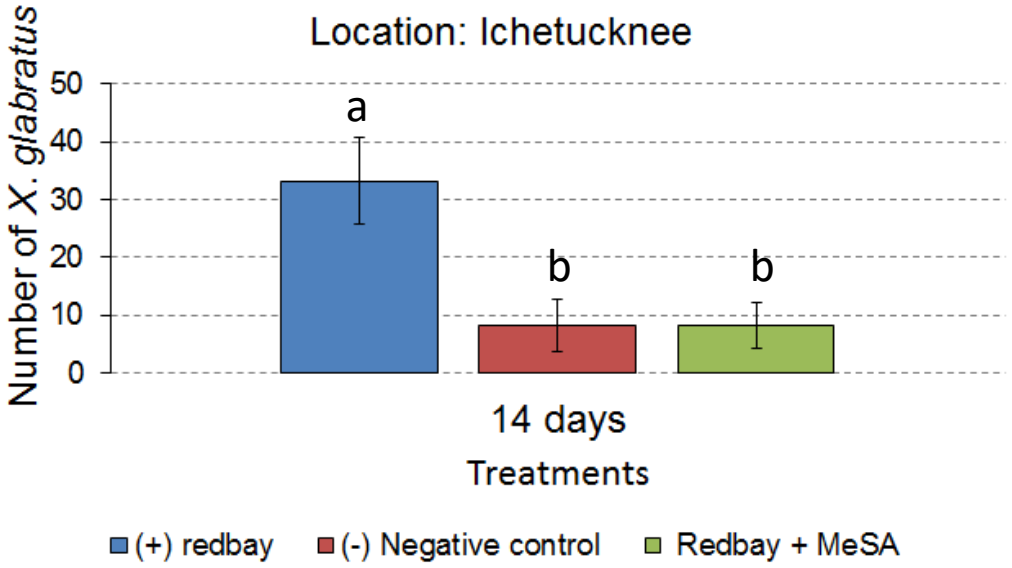


# Results

## It actually works in the field!





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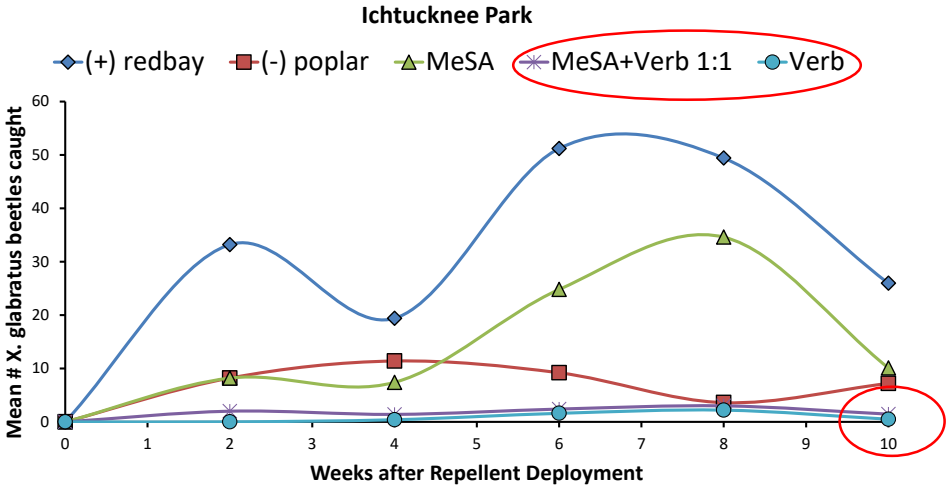


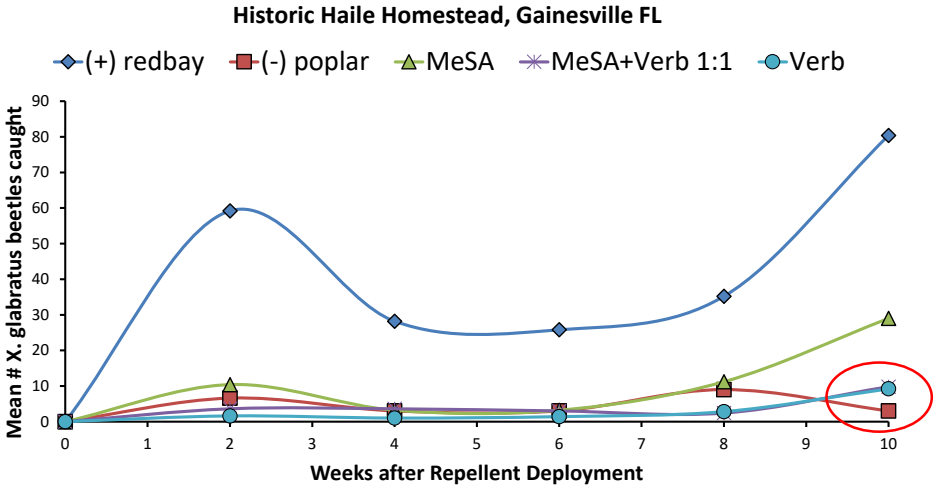


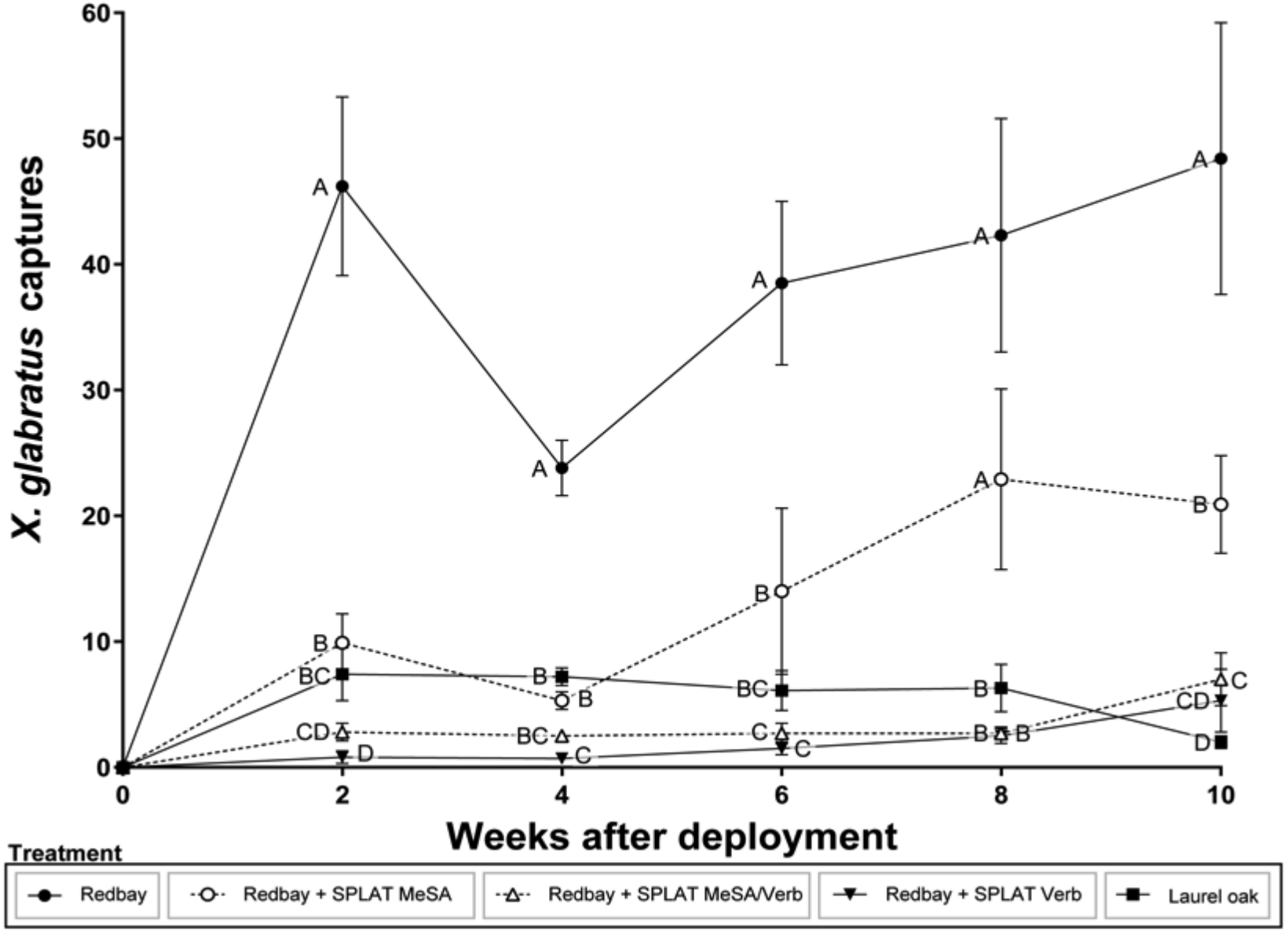
X. glabratus captures
60
50
40
30
20
10
0
0
2
4
6
8
10
Weeks after deployment
A
A
A
A
A
B
B
BC
B
B
BC
B
CD
BC
C
B
B
C
D
C
C
CD
D
Treatment
Redbay
Redbay + SPLAT MeSA
Redbay + SPLAT MeSA/Verb
Redbay + SPLAT Verb
Laurel oak

# Results

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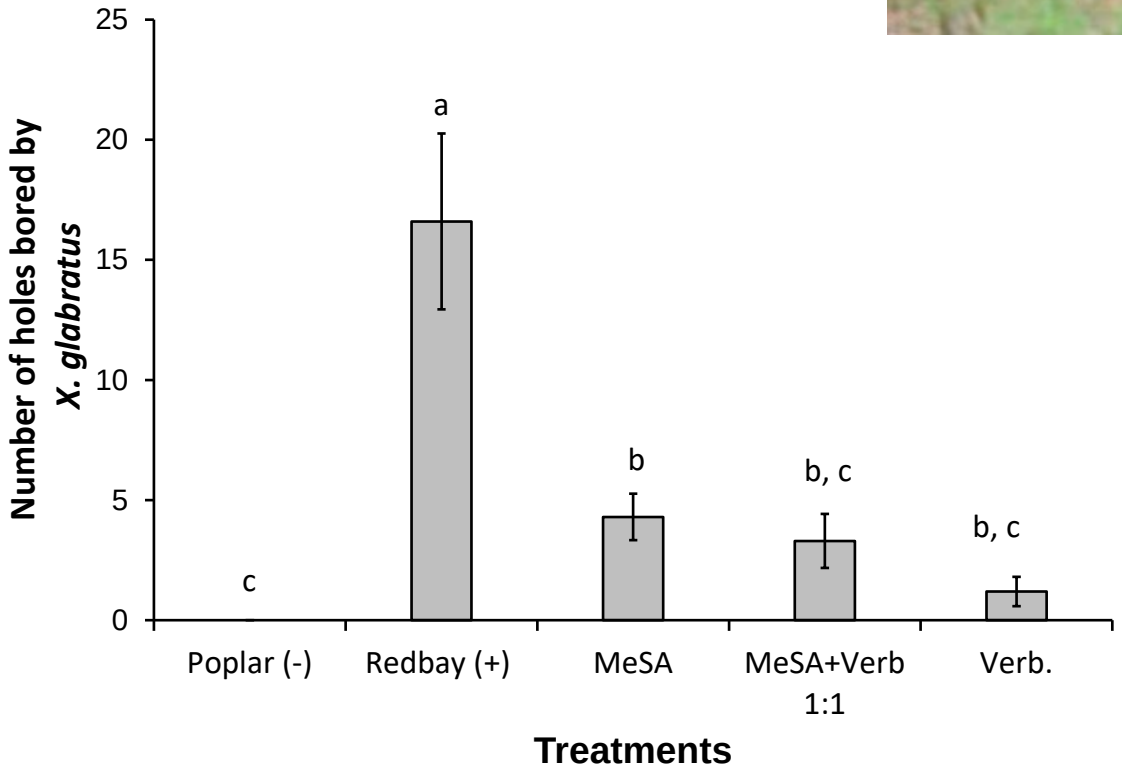


Verbenone pricing is $523 per Kg

MeSA pricing is $85 per Kg

42% Saving!
(for a 50%/50% MeSA Verb vs 100% verb formulation)