Polyphagous Shot Hole Borer

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Understanding the Biology

- Background Information
- Life history and reproduction
- Environmental limitations
- Hosts at risk
- Seasonal activity
- Flight distance/duration
Understanding the Biology

- What are the fungal associates?
- How do they interact with the different hosts?
- How do they interact with the success of the insect?
- How do these interactions influence spread?
Research and Implementation

- New species and new environment
- Start with the experience of others – related species or different environments
- Adapting methods to the California conditions and California stakeholders
Identification of Susceptible Trees

- Botanical Gardens - what trees are attacked, can support pathogen, can support beetle
- Urban forest
- Arborist company inventories
Identification of Symptomatic Trees
Beneath the Bark
Reproductive Hosts
from Akif Eskalen

1. **Box elder (Acer negundo)***
2. **Big leaf maple (Acer macrophyllum)***
3. Evergreen Maple (Acer paxii)
4. Trident maple (Acer buergerianum)
5. **Japanese maple (Acer palmatum)**
6. Castor bean (Ricinus communis)
7. **California Sycamore (Platanus racemosa)***
8. **Red Willow (Salix laevigata)***
9. Avocado (Persea americana)
10. Mimosa (Albizia julibrissin)
11. English Oak (Quercus robur)
12. **Coast live oak (Quercus agrifolia)***
13. **London plane (Platanus x acerifolia)**
14. Cottonwood (Populus fremontii)*
15. Black cottonwood (Populus trichocarpa)*
16. White Alder (Alnus rhambifolia)*
17. Titoki (Alectryon excelsus)
18. **Engelmann Oak (Quercus engelmannii)***
19. Cork Oak (Quercus suber)
20. **Valley oak (Quercus lobata)***
21. Coral tree (Erythrina coralloendendron)
22. **Blue palo verde (Cercidium floridum)***
23. Palo verde (Parkinsonia aculeata)
24. Brea (Cercidium sonorae)
25. Tree of heaven (Alianthus altissima)
26. Mesquite (Prosopis articulata)*
27. Weeping willow (Salix babylonica)
28. Chinese holly (Ilex cornuta)
29. Camelia (Camellia semiserrata)
30. Acacia (Acacia spp.)
31. Liquidambar (Liquidambar styraciflua)
32. Red Flowering Gum (Eucalyptus ficifolia)
33. Japanese wisteria (Wisteria floribunda)
34. Goodding's black willow (Salix gooddingii)*
35. Moreton Bay Chestnut (Castanospermum australe)

*Native species to California
Identify Risk of Movement

- Natural spread through landscape
- Pathways or corridors
- Risk to native and agricultural resources
- Facilitated movement
Pathways or Corridors

• Risk to native and agricultural resources
Facilitated Movements

- Firewood Movement
Ambrosia Beetles are difficult to control

- Generally only short time outside the tree
- Attract Sex pheromones - No
- Aggregation pheromone - No
Cultural Control and Sanitation

• Tree removal
• Treatment of slash and debris
• Chipping or grinding
• Solarization and composting
• Firewood movement
Chemical Control

- Insecticides and bark beetles – getting the material to the target
- Systemic insecticides – new materials and delivery, injections or drenches
- Contact insecticides – barrier sprays
- Value of trees and cost of treatments
Field Monitoring
Ambrosia Beetles are difficult to control

- Generally only short time outside the tree
- Sex pheromones - No
- Aggregation pheromone - No
- Host attractants - Yes
- Sibling mating before females disperse
<table>
<thead>
<tr>
<th>Name</th>
<th>Active</th>
<th>Method</th>
<th>Equipment</th>
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</thead>
<tbody>
<tr>
<td>Merit 75 WP</td>
<td><strong>Imidacloprid</strong></td>
<td>Soil injection</td>
<td>Kioritz injector</td>
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<tr>
<td>Safari 20 SG</td>
<td><strong>Dinotefuran</strong></td>
<td>Trunk spray</td>
<td>Hand sprayer</td>
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<tr>
<td>Arena 50 WDG</td>
<td><strong>Clothianidin</strong></td>
<td>Soil drench</td>
<td>Nalgene bottle</td>
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<tr>
<td>Onyx</td>
<td><strong>Bifenthrin</strong></td>
<td>Trunk spray</td>
<td>Hand Sprayer</td>
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<tr>
<td>Control</td>
<td>Untreated</td>
<td></td>
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</tbody>
</table>
• All treatments at high label rate
• Treated: Sept 19
• Taken down: Oct 18 (29 days)
• Count: Nov 27 (69 days)
active entry holes / sq ft trunk surface

- trunk spray
  - Safari
  - Onyx
- soil injection
  - Merit
- soil drench
  - Arena
- control
Trunk sprays applied to uninfested castor bean logs

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Treated logs placed in buckets with a beetle-infested log
1 log from each treatment in each bucket
Tracked for 8 weeks (1+ generation of beetles)
Pesticide treated logs exposed to beetles in buckets

Surface attacks

- Control
- Onyx
- Safari
- Danitol
Pesticide treated logs exposed to beetles in buckets

Gallery density

- Control
- Danitol
- Onyx
- Safari
Round 2: with Pentra-bark
Trunk sprays applied to uninfested castor bean logs

- Danitol (+PB)
- Arena (+PB)
- Onyx
- Safari (+PB)
- Orange oil (+PB)
- Control

Treated logs placed in buckets with a beetle-infested log
Sets of trials: insecticide+PB, control, PB only, Onyx
Tracked for 8 weeks (1+ generation of beetles)
Surface attacks after 2 weeks of beetle exposure

**Arena**

- UTC: a
- PEN: ab
- ARN: ab
- APB: ab
- ONYX: b

**Danitol**

- UTC: a
- PEN: ab
- DAN: ab
- DPB: ab
- ONYX: b

**Orange Oil**

- UTC: b
- PEN: b
- NI 7: a
- NPB: b
- ONYX: b

**Safari**

- UTC: b
- PEN: b
- SAF: b
- SPB: b
- ONYX: b
Summary: Insecticides

– BEST: **Bifenthrin**: Onyx

– Also: **Clothianidin**: Arena (trunk spray)

  **Imidacloprid**: Merit

– **Not** Danitol and Orange Oil
Cultural Control and Sanitation

- Tree removal
- Treatment of slash and debris
- Chipping or grinding
- Solarization and composting
- Firewood movement
Firewood movement
Chipping

- < 1 inch
- 1-2 inch
- >2 inch
- Control, trunk sections

Box elder (Nov 2012)
Total Emergence over 112 days

- **beetles per kg host material**
- **trunk coarse medium fine**
- >2 inch 1-2 inch <1 inch
Solarization

• Infested logs under clear or black plastic sheeting in full sun

• Test logs removed from plastic every 2 weeks

• Test logs held in bucket indoors for 2 weeks, then checked for signs of beetle activity (fresh sawdust around holes)
Fall Solarization: beginning Oct 14.

Maximum temperature under tarp:  
- clear = 120-127 deg F;
- black 100-109 deg F
Summer solarization: beginning June 25.

Maximum temperature exceeded 130 deg F
Summer Solarization: started June 17
Summary: Sanitation

- Firewood movement will spread beetle
- Chipping appears very effective
- Solarization: effective in summer
  - Ambient temperatures 95-105°F (33-40°C)
  - Otherwise, store covered logs on site for several months
Field evaluation of tree health

- Beetle Attacks
- Watering Regime
Huntington Garden Liquidambar

Graph showing the correlation between attacks and dieback in low versus watered conditions.
The most important factor was water.

Water Significant Effect ($\alpha=0.05$, $p=0.0253$)

Beetle Attacks Not Significant ($\alpha=0.05$, $p=0.2078$)
How does water stress affect attack rate?

• Box elder

Different Watering Regimes
How does water stress affect attack rate?

- Sycamore

Drought Stress at UCI
Acknowledgements

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