Biological Control of lygodium and hydrilla: progress, process, and possibilities

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USDA ARS Overseas Laboratories

- Australian Biological Control Laboratory (ABCL)
- European Biological Control Laboratory (EBCL)
- Sino America Biological Control Laboratory Sino (ABCL)
- South American Biological Control Laboratory (SABCL)

Mission: To conduct research projects to search for, identify, evaluate and prioritize potential biological control agents for use against invasive species, with emphasis on species, which are invasive to US
*Hydrilla verticillata*, Hydrilla

*Lygodium microphyllum*, Old World Climbing Fern

*Rhodomyrtus tomentosa*, Downy Rose Myrtle

*Melaleuca quinquenervia*, Broad-leaved Paperbark Tree

*Casuarina spp*, Australian Pine
Biological Control of
*Lygodium microphyllum*

- Indigenous to the Old World wet tropics, including Australia and Southeast Asia
- Delicate understory fern in its native habitat
Lygodium microphyllum
Exploration
Lygodium agents

Defoliators

Stem-borers

Mite

Sawfly
Stem-Boring Moths

Thai borer - *Siamusotima aranea*

Hong Kong borer - *Ambia sp.*

Singapore borer - *?Ambia sp.*
Australian lygodium stem borer

- Difficult access due to the remote location and monsoonal rains
- Limited range of the moth
- Difficult conditions
Difficult conditions for collection

- 600 miles north of the nearest city
- 4wd only during the dry season
Damage caused by stem-boring moths
Australian Lygodium stem borer

Rearing cage for larval rearing, adult emergence, mating and oviposition
Australian lygodium stem borer

Field collections during 2014

<table>
<thead>
<tr>
<th>Method</th>
<th>Plant Activity</th>
<th>Jul</th>
<th>Sep</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Collection</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stems</td>
<td></td>
<td>251</td>
<td>195</td>
<td>117</td>
</tr>
<tr>
<td>rhizomes</td>
<td></td>
<td>60</td>
<td>89</td>
<td>20</td>
</tr>
<tr>
<td>early damage</td>
<td></td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL Collection</td>
<td></td>
<td>314</td>
<td>284</td>
<td>137</td>
</tr>
<tr>
<td><strong>Observation (material not collected)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>early damage</td>
<td></td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>rhizomes - larva not recovered</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>larva killed during coll</td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>larvae found dead in stem</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Coll. + Obs.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL Activity Found</td>
<td></td>
<td>322</td>
<td>284</td>
<td>137</td>
</tr>
<tr>
<td><strong>Dissection of collected material</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>larvae onto live plants</td>
<td></td>
<td>240</td>
<td>193</td>
<td>98</td>
</tr>
<tr>
<td>dead larvae found</td>
<td></td>
<td>23</td>
<td>13</td>
<td>6</td>
</tr>
<tr>
<td>killed in dissection</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>pre-pupae</td>
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<td>2</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>pupae</td>
<td></td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Parasitised larvae</td>
<td></td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Diss.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total specimens retrieved</td>
<td></td>
<td>269</td>
<td>216</td>
<td>107</td>
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</table>
Summary

• Considerable improvements in rearing success in 2015 but more needs to be done so that host range testing can be initiated
• Second to third generation larvae generated at ABCL in Brisbane
• We need to conduct field evaluations to determine seasonal traits in larvae in the field which may improve colonisation
Lygodium Hong Kong stem borer – *Lygomusotima* sp.

- Difficult to find
- Present in large numbers when temperature and humidity are extremely high
- Found in thin stems as well as thick
• Large numbers of larvae shipped to the USDA ARS in Fort Lauderdale
• Diminishing returns from field collected larva
• Improved rearing techniques need to be developed so we can begin host range testing
Defoliating moths

**Austromusotima camptozonale**
- Tropical & subtropical Queensland
- Defoliates lygodium
- Genus specific

**Lygomusotima stria**
- Tropical Southeast Asia
- Defoliates lygodium
- Genus specific

**Neomusotima conspurcatalis**
- Tropical and subtropical SE Asia and Australia
- Defoliates lygodium
- Genus specific
Neomusotima conspurcatalis (Pyralidae)
Damage in South Florida
New defoliating Pyralidae moth species

- Lygomusotima stria under final evaluation on US and Caribbean lygodium species in quarantine
- The defoliating pyralid, *Austromusotima metastictalis*, known only from north Queensland and Papua New Guinea, has yet to be tested as a potential biocontrol agent for *L. microphyllum*
- A Pyraustinae species also occurs in New Caledonia
• Continue to progress rearing of the Australian and Hong Kong stem borers and move to host range testing
• Import the Pyraustinae species defoliator into ABCL quarantine from New Caledonia
• Collect and colonize the defoliating pyralid, *Austromusotima metastictalis*, from northern Australia
• Conduct further exploration in India, Sri Lanka and the Philippines
Biological Control of Hydrilla verticillata
Four agents released, two leaf-mining *Hydrellia* fly species and two *Bagous* weevils

Only the leaf-mining flies have permanently established

Partial control

More agents are desperately needed!
Hydrilla Exploration – Why are we in surveying in China and Korea?

- Substantial surveys were conducted on the Indian sub-continent and Australia in the 60’s, 70’s and 80’s agents selected and released.
- More recent surveys for biocontrol agents in Africa and southeast Asia have discovered mostly non-specific agents.
- Genetic characterization of hydrilla indicated that the greatest diversity of hydrilla occurs in southern China.
- There is a need to target agents that feed on monoecious hydrilla, genetic characterization of plant samples to find the sites which match the US biotype.
Hydrilla in China and South Korea

Environment is highly modified, largely polluted but there are some excellent and diverse natural areas.
2010-2012 hydrilla collections in China
2013 hydrilla collections in China
2014 hydrilla collections in China
2014 hydrilla collections in South Korea
Hydrilla agents: the usual suspects
Chironomidae damage near Beijing

Cricotopus sp.??
China hydrilla insects – *Bagous* weevils

*Bagous new sp.*

*Bagous chinensis*

*Bagous new sp.*
Hydrellia flies on monoecious hydrilla

Monoecious sites discovered that match US monoecious hydrilla

Republic of Korea

• Yeonpori West
• Munsanri

China

• Houhe
• Tongli Town

**All four sites are to be intensively surveyed in 2015**
Hydrellia species group

Hydrellia new sp.?
Hydrilla – 2015 plans

• Preliminary testing of Bagous spp. weevils from central China
• Evaluation of the defoliating midge from northern China
• Evaluation of the Hydrellia flies and other herbivores from monoecious hydrilla
• Genetic characterisation of all of the moths Asia to identify cryptic species
• Continue exploration in new areas of China and Korea
Appreciation

- FWC
- South Florida Water Management District
- U.S. Army Corps of Engineers
- USDA ARS collaborators in the US
- Chinese Academy of Science, Wuhan