Gall Midge *Orseolia javanica* (Diptera: Cecidomyiidae), a Candidate Biological Control Agent of Cogongrass

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Acknowledgements

• Millie Burrell
• Patricia Kline
• Purnama Hidayat

FWC, Bureau of Invasive Plant Management
Outline

• Background on Cogongrass
• Potential for Biological Control
• Research on *Orseolia javanica*
• Cogongrass IPM Model
• Questions and Comments
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Cogongrass

- *Imperata cylindrica* (L.) Raeuschel (Poaceae)
- Federal Listed Noxious Weed
- Established in southeastern US as forage grass
- Invasive in Alabama, Mississippi, & Florida
Cogongrass Impacts

- Displaces native/desirable vegetation
- Evidence of allelopathy
- Increases frequency and severity of fires
- Perennial; 4 clonal types
- Rhizotomous (60% of biomass in rhizome)
- C₄ photosynthesis

Worldwide Distribution

World distribution of *Imperata cylindrica* based on the Global Biodiversity Information Facility (www.gbif.org).
US Distribution

(www.eddmaps.org)
Genetic Diversity of US Cogongrass

US Distribution by Genotype

Burrell et al. (2015)
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Grasses as BioControl Targets

- Previously thought to have few specialized herbivores due to:
  - Simple architecture
  - Scarcity of secondary metabolites
  - Feeding deterrents (e.g. silica)
- Fear of non-target effects on crop grasses
  - 50% of human caloric intake from cereals (e.g., wheat, rice, corn, millet, etc.)
# Natural Enemies of Grasses

<table>
<thead>
<tr>
<th>GRASS</th>
<th>INSECT</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Arundo donax</em></td>
<td><em>Tetramesa romana</em></td>
<td>Goolsby and Moran, 2009</td>
</tr>
<tr>
<td></td>
<td><em>(Eurytomidae)</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>(Diaspididae)</em></td>
<td></td>
</tr>
<tr>
<td><em>Spartina alterniflora</em></td>
<td><em>Prokelisia marginata</em></td>
<td>Grevstad et al. 2003</td>
</tr>
<tr>
<td></td>
<td><em>(Delphacidae)</em></td>
<td></td>
</tr>
<tr>
<td><em>Phragmites australis</em></td>
<td>66 monophagous species outside of North America</td>
<td>Tewksbury et al. 2002</td>
</tr>
<tr>
<td><em>Hymenachne amplexicaulis</em></td>
<td><em>Ischnodemus variegatus</em></td>
<td>Diaz et al. 2010</td>
</tr>
<tr>
<td></td>
<td><em>(Blissidae)</em></td>
<td></td>
</tr>
<tr>
<td><em>Imperata cylindrica</em></td>
<td><em>Acrapex spp.</em></td>
<td>Le Ru et al. 2014</td>
</tr>
<tr>
<td></td>
<td><em>(Noctuidae)</em></td>
<td></td>
</tr>
<tr>
<td>““ “</td>
<td><em>Orseolia javanica</em></td>
<td>Mangoendihardjo (1980)</td>
</tr>
<tr>
<td></td>
<td><em>(Cecidomyiidae)</em></td>
<td></td>
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</tbody>
</table>
Why is Cogongrass Invasive?

- Anecdotal evidence for supporting ‘Enemy Release’ hypothesis  
  (Van Loan et al. 2002)

  - To date, biological control effort minimal
    - Preliminary testing of gall midge *Orseolia javanica*  
      (Mangoendihardjo 1980)
    - Limited surveys in East Africa- Suspected center of origin for cogongrass  
      (Evans 1991)

  - Discovery of potentially host specific natural enemies in Africa, Japan & Philippines  
    (Overholt et al. 2016)
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**O. javanica**

**Life Cycle**

- Adults crepuscular
- Females deposit 540 eggs on soil
- Neonates bore into leaf sheaths near apical meristem
- Induce formation of pink / white linear galls 2 days before adult emergence
- Development (egg-adult): 35 days

Mangoendihardjo (1980), Soerjani (1970)
# O. javanica Host Range

<table>
<thead>
<tr>
<th>Test Plant</th>
<th>Gall Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated Rice, <em>Oryza sativa</em></td>
<td>-</td>
</tr>
<tr>
<td>Wild Rice, <em>Oryza</em> sp. A</td>
<td>-</td>
</tr>
<tr>
<td>Wild Rice, <em>Oryza</em> sp. B</td>
<td>-</td>
</tr>
<tr>
<td>Corn, <em>Zea mays</em></td>
<td>-</td>
</tr>
<tr>
<td>Sorghum, <em>Sorghum bicolor</em></td>
<td>-</td>
</tr>
<tr>
<td>Native Grass, <em>Paspalum conjugatum</em></td>
<td>-</td>
</tr>
<tr>
<td>Native Grass, <em>Pennisetum polystachyon</em></td>
<td>-</td>
</tr>
<tr>
<td>Cogongrass, <em>Imperata cylindrica</em></td>
<td>+</td>
</tr>
</tbody>
</table>

Mangoendihardjo (1980)
Bogor Agricultural University
West Java, Indonesia
Project Collaborators
Bogor University
Cianjur District
West Java, Indonesia
Orseolia javanica
(Diptera: Cecidomyiidae)

Life stages of *Orseolia javanica*. 4\(^{th}\) instar larva (far left), prepupa (left), pupa (center), adult male (right, top), female (right, bottom) (Photo credit: Purnama Hidayat).
Figure 1. Galled stems of *I. cylindrica* induced by *O. javanica* in Cianjur, West Java, Indonesia (Buhl and Hidayat 2016).
Galls w/ Emergence Holes

Photo credits: Ragil Irianto, Ministry of Forestry, Bogor, Indonesia
Orseolia Galls / m²
West Java, Indonesia

~40 galls/m²
Parasitoid of *O. javanica*

*Platygaster orseoliae* Buhl
Hymenoptera: Platygasteridae

Buhl and Hidayat (2016)
### mtCO1 DNA Sequences of *Orseolia javanica* & *O. oryzae*

<table>
<thead>
<tr>
<th>No</th>
<th>Spesies (No. Akses Genbank)</th>
<th>Homology (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td><em>O. javanica</em> Indonesia (Cianjur)</td>
<td>ID</td>
</tr>
<tr>
<td>2</td>
<td><em>O. oryzae</em> Indonesia (Bogor)</td>
<td>90.0</td>
</tr>
<tr>
<td>3</td>
<td><em>O. oryzae</em> Indonesia (Cianjur)</td>
<td>90.0</td>
</tr>
<tr>
<td>4</td>
<td><em>O. oryzae</em> India (KM888183.1)*</td>
<td>89.8</td>
</tr>
<tr>
<td>5</td>
<td><em>Orseolia</em> sp. Kanada (KM862726.1)*</td>
<td>81.7</td>
</tr>
<tr>
<td>6</td>
<td>Cecidomyiidae Kanada (KR432674.1)*</td>
<td>83.2</td>
</tr>
<tr>
<td>7</td>
<td>Cecidomyiidae Kanada (KM868087.1)*</td>
<td>81.5</td>
</tr>
<tr>
<td>8</td>
<td><em>O. oyzae</em> India (KC506565.1)*</td>
<td>71.8</td>
</tr>
<tr>
<td>9</td>
<td><em>S. mosellana</em> Kanada (KM991223.1)*</td>
<td>83.4</td>
</tr>
<tr>
<td>10</td>
<td><em>F. acarivora</em> Jepang (AB698995.1)*</td>
<td>84.6</td>
</tr>
</tbody>
</table>

*) DNA sequences from GenBank
Project Objectives

Bogor Agricultural University

• Assess performance of *Orseolia javanica* on two Florida cogongrass clones
• Develop laboratory rearing procedure for *O. javanica*
• Conduct field and laboratory impact studies
Project Objectives (cont’d)

University of Florida

- Establish laboratory colony of *O. javanica*
- Perform molecular characterization of *O. javanica* populations (Initiated)
- Demonstrate *O. javanica* is cogongrass specialist
  - Host range tests in Florida
Laboratory Rearing

Cages for rearing *Orseolia javanica* and conducting host range tests, BCRCL, Ft. Pierce, FL (Photo credit: Patricia Prade).
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Cogongrass IWM Model

Jose et al. (2002)
Conclusions

- Cogongrass control difficult w/ only 1 tool
- Risk to native grasses from introduced cogongrass biocontrol agent(s) should be low
  - Only one native congener (*Imperata brevifolia*)
  - Gall midge *O. javanica* cogongrass specialist
- Incorporating biological control agents w/ conventional physical & chemical tools provides more complete & sustainable control of cogongrass
Thanx !
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