Biological Control of Aquatic Plants: the USDA's Research Program and Status Update

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Aquatic weeds

- Difficult to control
  - Transient (float away!)
  - Disperse easily (fragmentation, clones)
  - Inaccessible (below water surface, remote locations)
  - Management can affect other species (low O)
  - All hands on deck!

Biocontrol of Aquatic Weeds

- Long history
  - Alligatorweed (*Alternanthera philoxeroides*)
  - *Agasicles hygrophila*
    - Released: 1964
  - Complete control in the southern US!
    - No other management required.

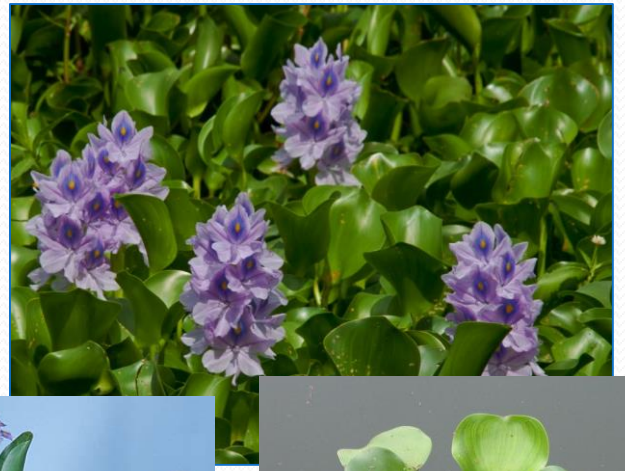
What have you done for me lately?

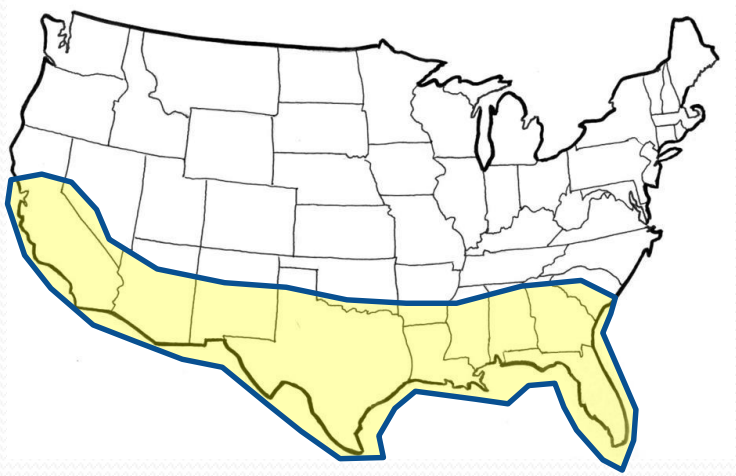
- “Success on the first try was the Achilles heal of biocontrol” J. Madsen
- Expectations are high.
- Seeking to replicate this success ever since.
- Benefits of aquatic weed biocontrol are more nuanced.

Featured target list

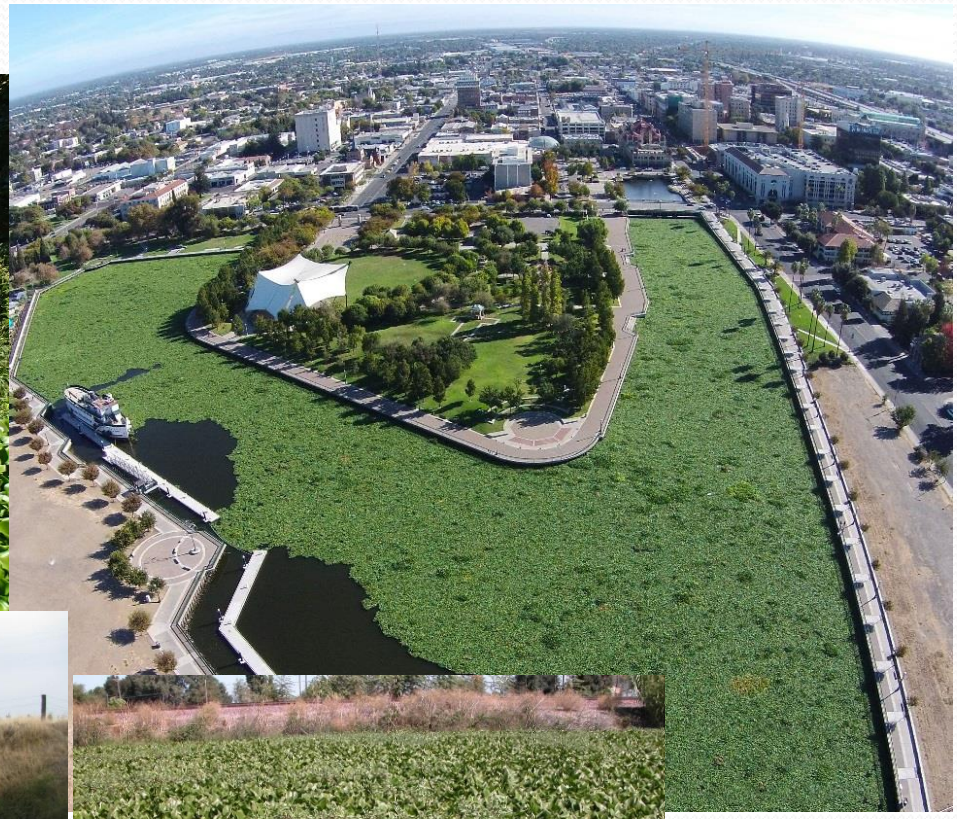
- Water hyacinth (*Eichhornia crassipes*)
- Giant reed (*Arundo donax*)
- Invasive water-primrose (*Ludwigia* spp.)
- Brazilian waterweed (*Egeria densa*)
- Alligator weed (*Alternanthera philoxeroides*)
- Pampas and jubata grass (*Cortaderia* spp.)

Water hyacinth





Delta drama



Water hyacinth

Water Hyacinth Biological Control Agents Released in California

Niphograpta albiguttalis
1983-85

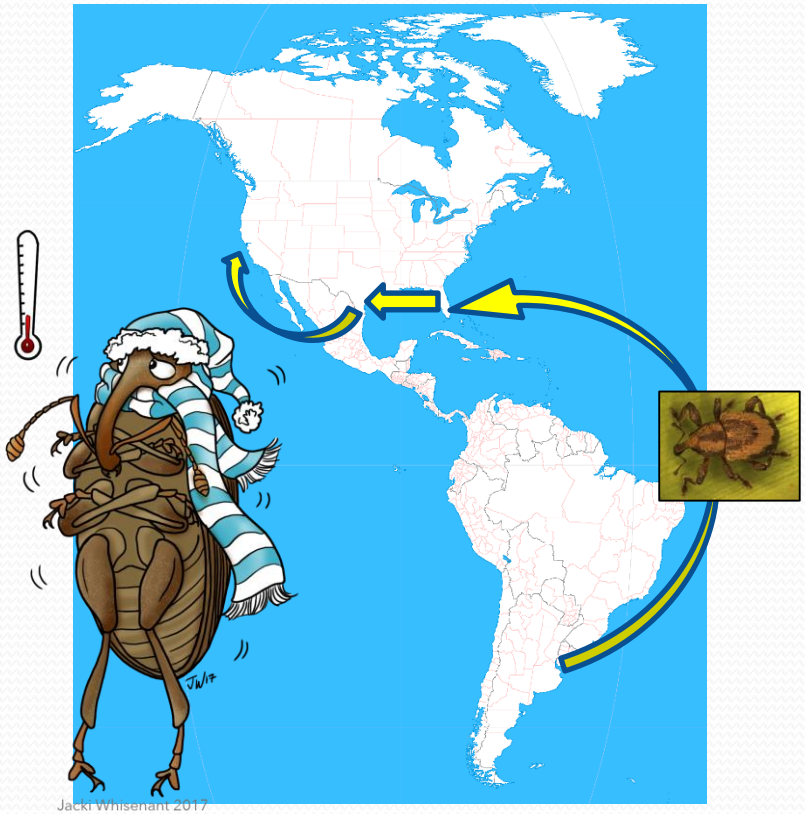
Neochetina eichhorniae
1982-85

Neochetina bruchi
1982-85

Megamelus scutellaris
2013

Hopper JV, Pratt PD, McCue KF, Pitcairn MJ, Moran PJ, Madsen JD. 2017. Spatial and temporal variation of biological control agents associated with *Eichhornia crassipes* in the Sacramento-San Joaquin River Delta, California. Biological Control. 111:13-22.

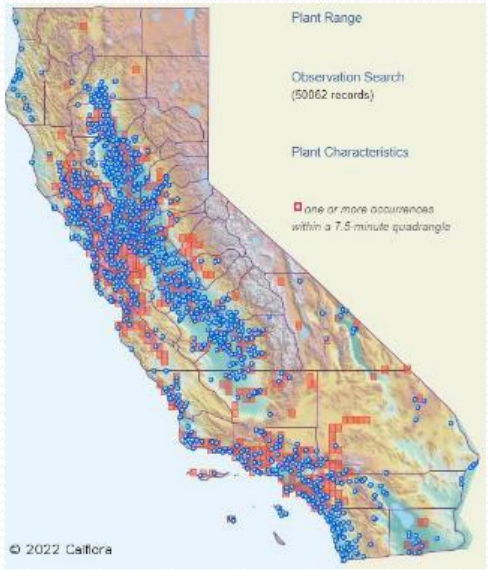
What is good for Florida is not necessarily good for California.



- Search for better adapted biotypes:
- *N. eichhorniae* (weevil)
  - 2x more eggs at “fall” temps
- *N. albigutalis* (moth)
  - Collecting this spring
- New agents from Argentina

Reddy, A. M., **Paul D. Pratt**, *Julie V. Hopper*, et al. 2019. Variation in cool temperature performance among populations of *Neochetina eichhorniae* (Coleoptera: Curculionidae) and implications for the biological control of water hyacinth, *Eichhornia crassipes*, in a temperate climate. Biological Control. 128: 85–93.

Arundo (*Arundo donax*)



- Consumes/wastes water and blocks access.
- Obstructs flood control channels.
- Fuels wildfires.
- Displaces native plants and animals.
- Hides illegal activities that damage environment.
- At least $100M spent on control; $70M needed for full control

Stem-galling wasp: *Tetramesa romana*

- Adult females live 4-5 days and reproduce asexually
- One female produces an avg. of 26 new adults; max of 66.
- Larvae develop inside cane (endophagy) in 30-35 days.
- Almost all (90%) of egg-laying and feeding occur at shoot tip.
- The wasp can develop only on the genus *Arundo.*

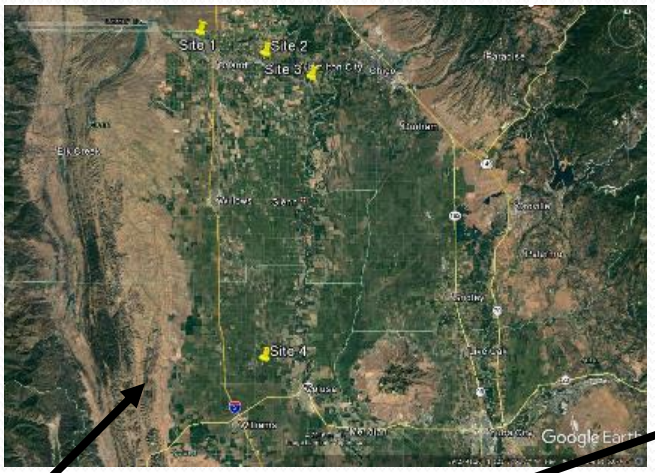
Stem-galling wasp: *Tetramesa romana*

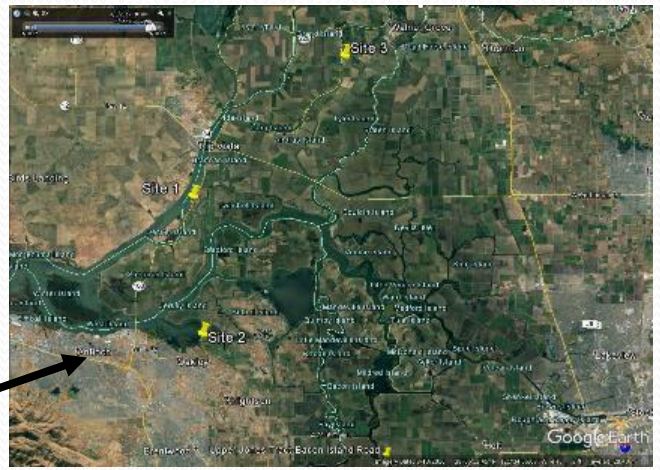
Original releases in the Lower Rio Grande Basin of Texas and Mexico (2009-2012)

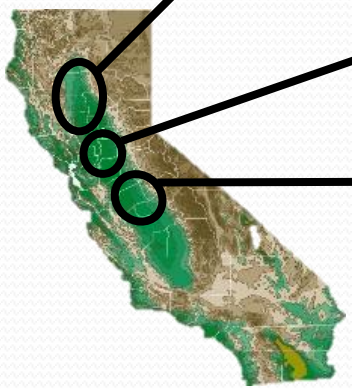
- **Reduced live biomass by 22% by 2014.**
- **Further 20% reduction by 2016.**
- **Increased mortality of side shoots.**
- **Two to three-fold increase in diversity of other plants occurred.**

- **Released in California since 2010, established and spreading.**

Stem-galling wasp: *Tetramesa romana*





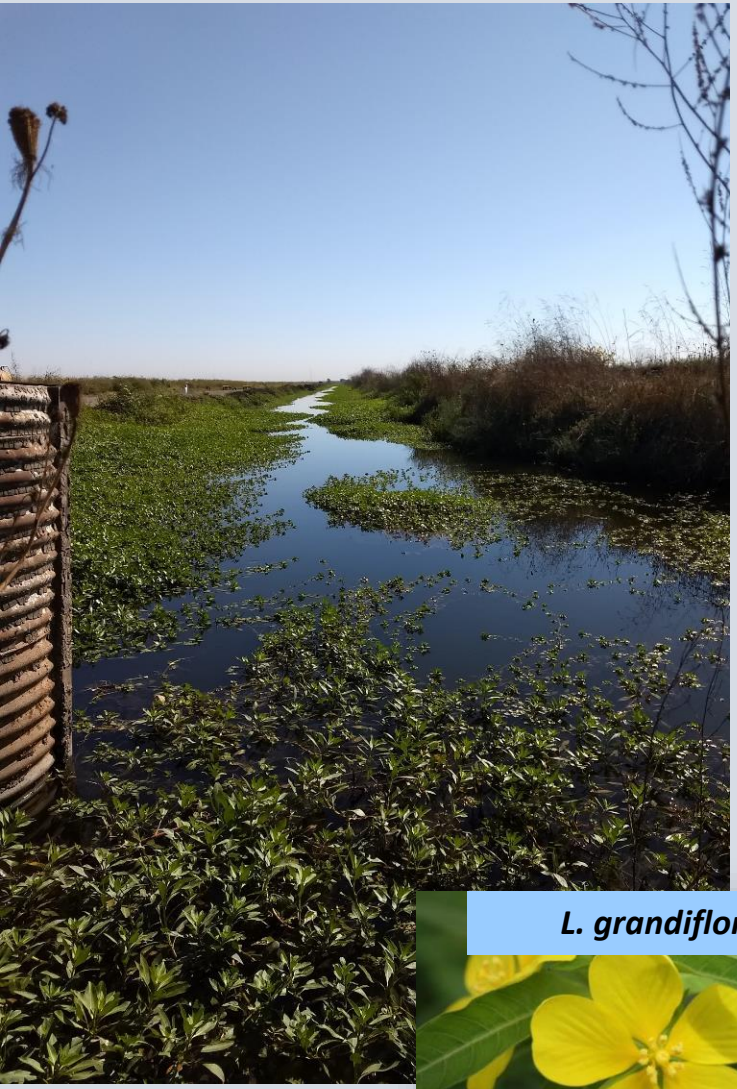


Arundo armored scale: *Rhizaspidiotus donacis*

- Causes distortion, death of young lateral shoots.
- In combination with arundo wasp, decreases new main and side shoot growth.
- Can decrease arundo rhizome (root) size.
- Released and now established in northern California- 7 sites

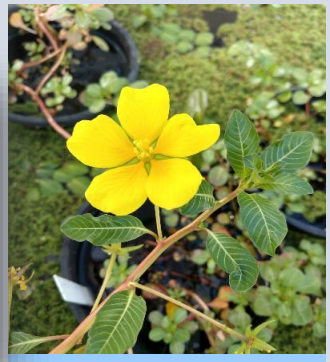
The Arundo leafminer: *Lasioptera donacis*

Exotic *Ludwigia* (water primroses) in the U.S.



- 4 *Ludwigia* taxa:
  - *L. hexapetala, L. grandiflora, L. peploides* subsp. *montevidensis, & L. peploides* subsp. *peploides*
- Perennial forbs
- Sexual and asexual (clonal) reproduction
- Forms dense mats across water surfaces
- Introduced via ornamental plant industry
- Invasive in aquatic and riparian ecosystems
  - wetlands, edge of water bodies, ponds, irrigation ditches, etc.
- Found in South Atlantic, Gulf, and Pacific coastal states
- All four are exotic taxa.

L. grandiflora

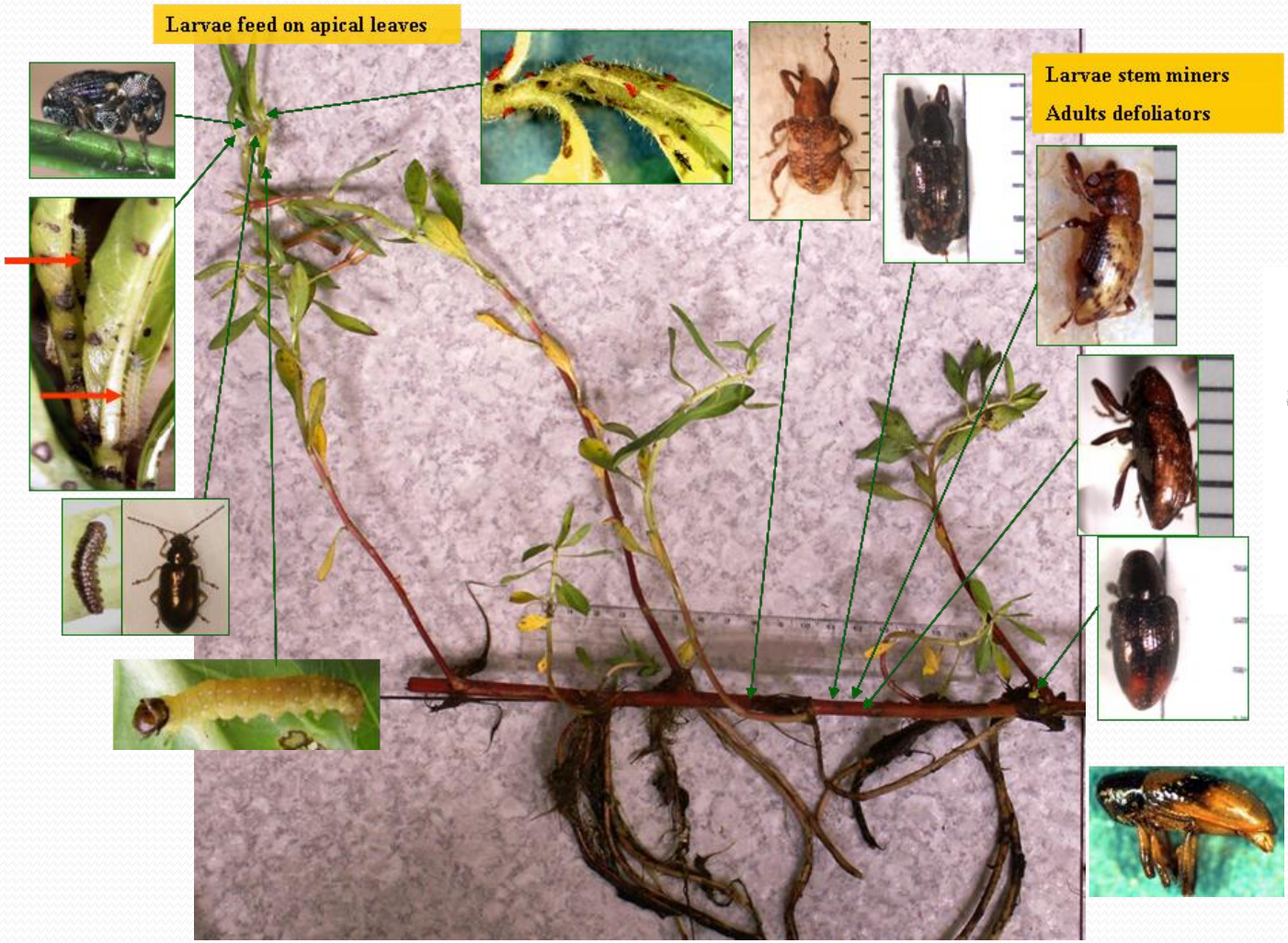


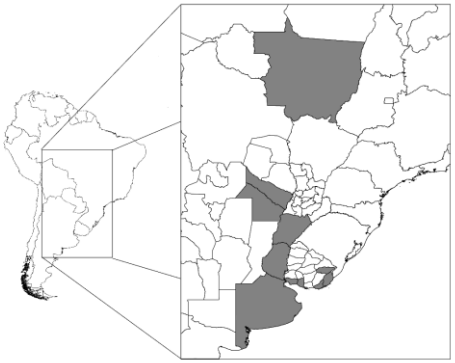
L. p. ssp. ***montevidensis***

L. p. ssp. ***peploides***

L. hexapetala

Surveys in Uruguay and Argentina





Tested 4 insects

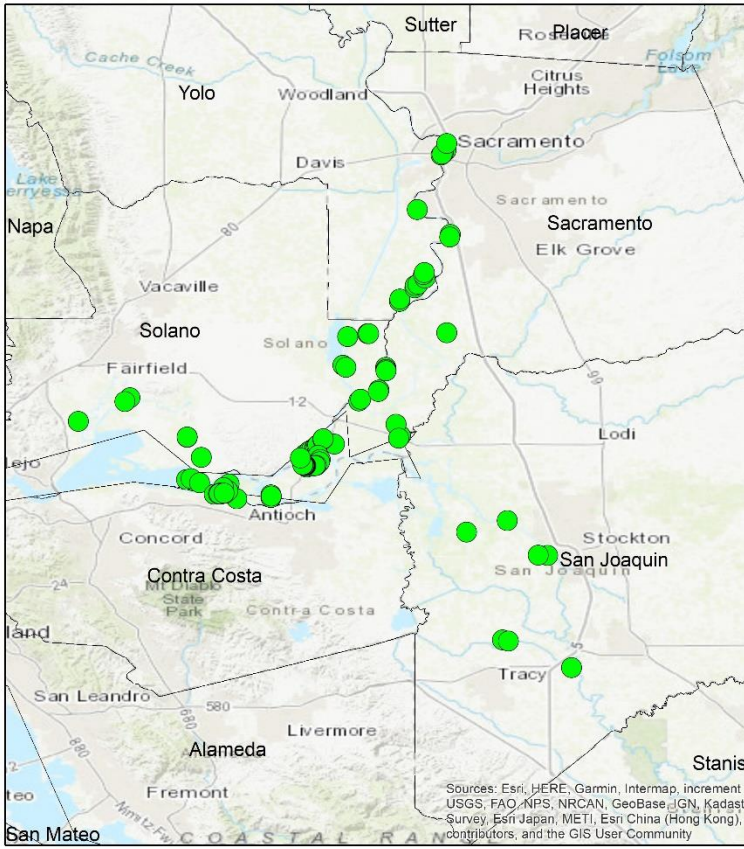
- Thrips: *Liothrips ludwigi*
- Beetle: *Lysathia flavipes*
- Weevil: *Sudauleutes bosque*
- Moth: *Paracles azollae*
- All attacked native species
- No immediate plans to test more species

Brazilian water weed: *Egeria densa*

- Very few herbivores in South America
- *Hydrellia egeriae*
  - Completes development on *Elodea*
- Not actively searching for new insects

Alligator weed (*Alternanthera philoxeroides*)

- Discovered in the Delta
  - 2017 first report
  - 2019 100s of patches
    - Anderson (near Sac. R.)
    - Feather River (near Afterbay)
    - Laird Park, Modesto



Textbook example of success…

- Complete control in southeastern US
- Three insects:
  - Flea beetle (*Agasicles*)
  - Thrips (*Amynothrips*)
  - Moth (*Vogtia*)
- Poorly adapted to NorCal
- Found better adapted beetle, seeking permit to release in California.

Cortaderia selloana (Poaceae)

- Native to South America
- Introduced into Europe in the early 1800s
- Introduced from Europe to California in 1848
  - Dried flower arrangements
  - Horticulture trade
  - Soil stabilization
  - Animal forage

Photo: Joseph DiTomaso

Cortaderia selloana (Poaceae)

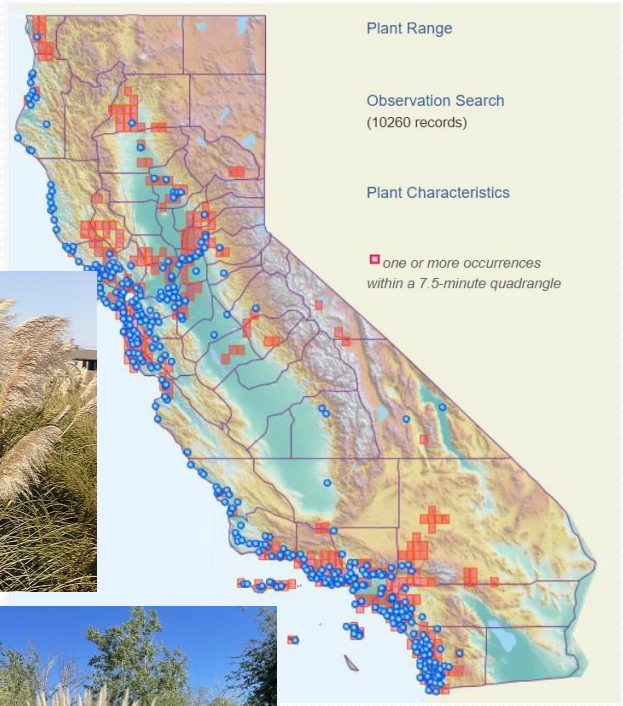
- Sexual reproduction:
  - Female plants: only female flowers
  - Hermaphrodite plants: pollen donors (effectively male)
  - Female plumes: >100,000 seeds
- Horticultural industry propagates female plants
  - From cuttings, maintains features of interest
  - Avoids viable seed in environment
- Hermaphrodites introduced

Pampasgrass: female (L) and male (R) inflorescence; photo: JM Di Tomaso

Cortaderia selloana (Poaceae)

- Considered invasive in Mediterranean climates worldwide:
  - Africa, Australia, Europe, New Zealand, and North America
  - California: naturalized ~1929
  - Widespread by the 1950s
    - San Francisco Bay Area
    - Southern California
  - Invades coastal systems, riparian areas, cliffsides, forestry plantings, common in disturbed areas

Cortaderia selloana (Poaceae)



- Biological control:
  - New Zealand:
    - Floral smut (pathogen)
    - Planthopper (insect)
  - USA:
    - Decades of interest but…
    - Many conflicts of interest
      - Horticultural industry
      - Homeowners
      - Demonstration gardens
    - Focus on other weeds….

Pampas grass Midge: *Spanolepis selloanae*

Phytoparasitica (2021) 49:229–241
https://doi.org/10.1007/s12600-020-00844-1

ORIGINAL ARTICLE

Check for updates

A new gall midge species (Diptera, Cecidomyiidae) as a potential candidate for biological control of the invasive plant *Cortaderia selloana* (Poaceae)

Jaime Fagúndez · Raymond J. Gagné · Marta Vila

Received: 30 November 2019 / Accepted: 27 August 2020 / Published online: 15 September 2020

Abstract A gall midge (Diptera, Cecidomyiidae) is reported here for the first time from spikelets of *Cortaderia selloana*, a prominent alien invasive grass species in southern Europe. The insect is described as a

Introduction

The Enemy Release Hypothesis (ERH) states that the lack of natural enemies provides invasive alien species

Pampas grass Midge: *Spanolepis selloanae*

- Discovered in Spain
  - Has spread to Portugal
- Appears to only attack seeds of pampas grass
- Midge lays eggs in flowers (ovaries)
- Larvae feed on developing seed
- One larva per seed
- Pupate in the seed shell

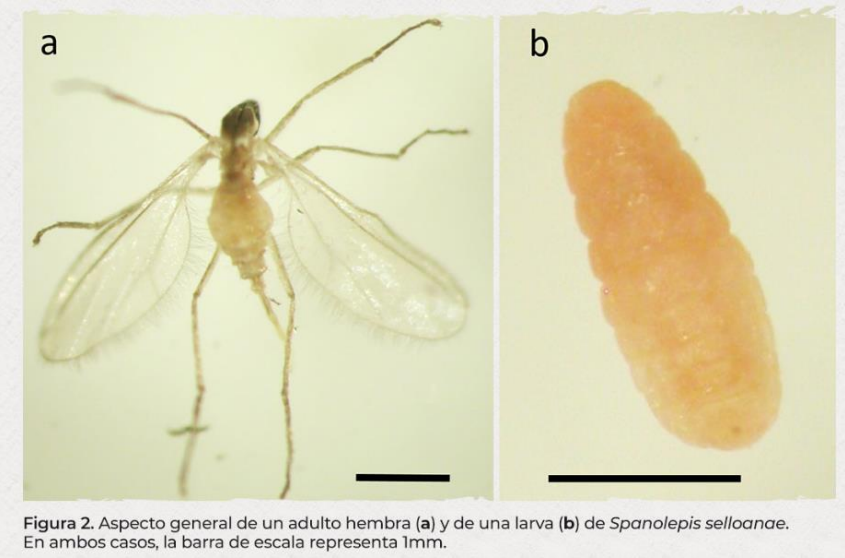


Figura 2. Aspecto general de un adulto hembra (**a**) y de una larva (**b**) de *Spanolepis selloanae*. En ambos casos, la barra de escala representa 1mm.

Pampas grass Midge: *Spanolepis selloanae*

- Midge doesn't
  - attack leaves
  - change architecture
  - affect plume appearance
- Midge does
  - Reduce seed production by ~80%
  - Spread quickly

Spanish plants with many damaged seeds

Pampas grass Midge: *Spanolepis selloanae*

- Is this the perfect biological control agent?
  - Sterilizes plants
  - Without affecting aesthetics
  - Attack *C. jubata*?
  - Host specific?
    - Must test natives and other horticultural plants
- Is it already here????

Spanish plants with many damaged seeds

So many weeds, so little time

- Invasive plants are not on the decline!
  - Spongeplant (*Limnobium)*, curlyleaf pond weed, etc.
- Biological control needs greater support
  - Too often the option of last resort
- Critical to use all the tools in the toolbox

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