

Biological control of Old World climbing fern: current status and future directions



Ellen C. Lake
Melissa C. Smith, Greg S. Wheeler
USDA ARS Invasive Plant Research Laboratory
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Lygodium microphyllum
Old World climbing fern

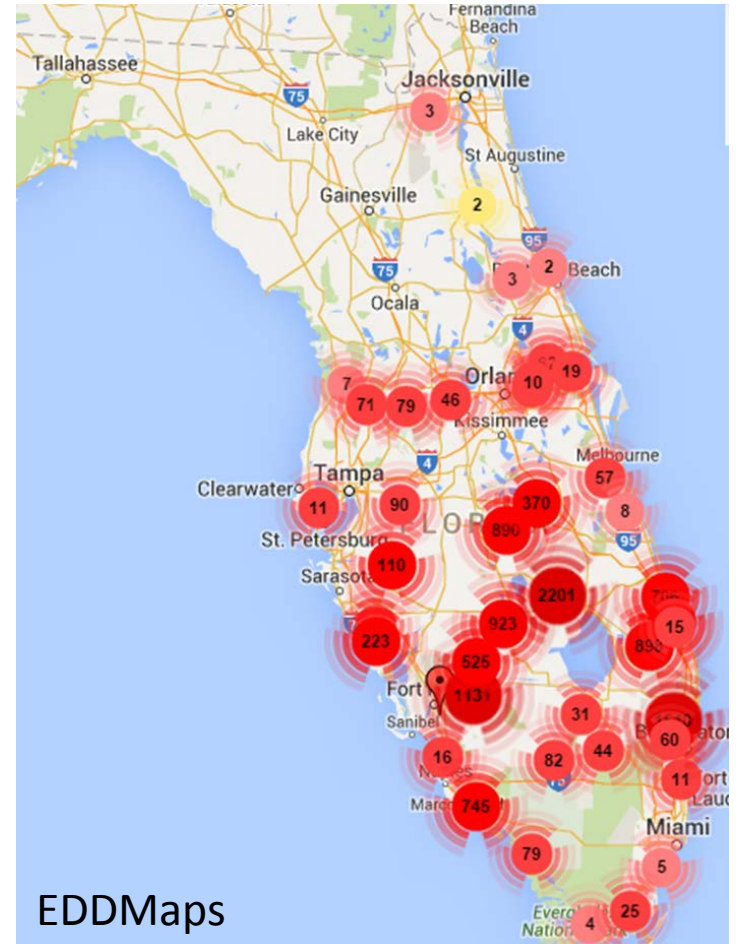


Lygodium microphyllum

Native range



Introduced range



Lygodium microphyllum in conservation areas



Flatford Swamp



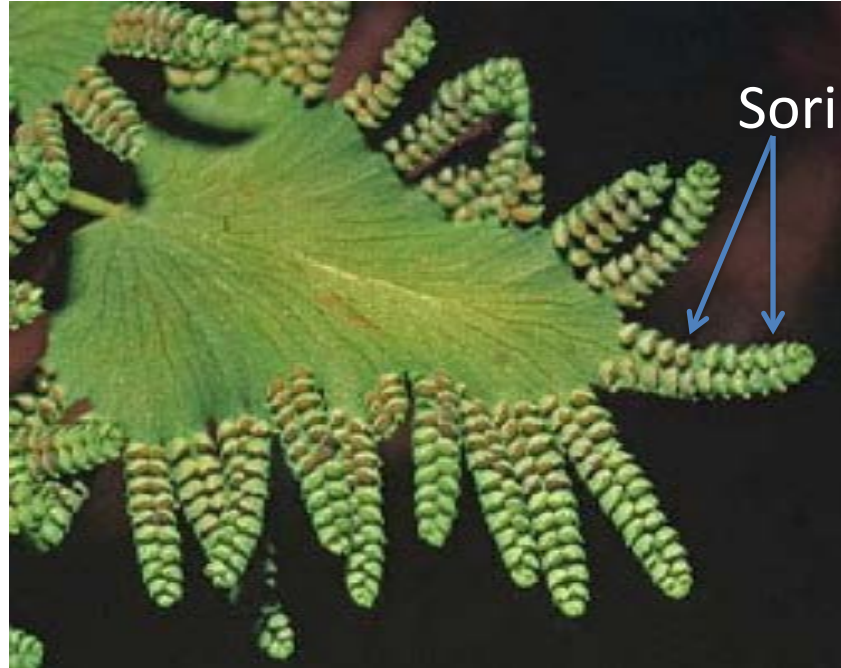
A.R.M. Loxahatchee NWR



Everglades National Park

L. microphyllum reproduction

Propagule pressure:



- Each sorus has ~ 215 spores
- Each fertile leaflet has ~ 133 sori
- $215 \times 133 = 28,500$ spores per fertile leaflet (Volin et al. 2004)



Tony Pernas, National Park Service

UGA5276001



What is biological control?

What are the goals?

- The use of populations of natural enemies to suppress pest populations to lower densities
 - Pests are not eradicated

Biological control can be highly effective in natural areas

- Agents are self-perpetuating & can spread over large areas
- Chemical or mechanical control may be too expensive and/or have too many side effects to be used repeatedly



What will these insects eat when their host plant has been reduced?

- Specialists have evolved over thousands of years to deal with specific “secondary” plant chemicals
- No instances where insects imported for biological control have switched to hosts outside their physiological range
- **Will reduce, not eliminate their host**

No-choice tests: feeding, development and survival



Dioscorea bulbifera
Dioscorea floridana
Dioscorea villosa
Dioscorea sansibarensis
Dioscorea alata
Rajania cordata



Biological Control of *Lygodium microphyllum*

- Program initiated in 1997 (Goolsby & Pemberton)
- Focus on SE Asia & Australia
 - Monthly surveys in QL
- 20 herbivores collected
 - 11 Lepidoptera*
 - 4 Coleoptera
 - 1 Hymenoptera
 - 1 Homoptera
 - 1 Hemiptera
 - 1 Thrips
 - 1 Mite***



Approved biological control agents



Austromusotima camptozonale

Lepidoptera: Crambidae

Released 2005 – 2012

Failed to establish

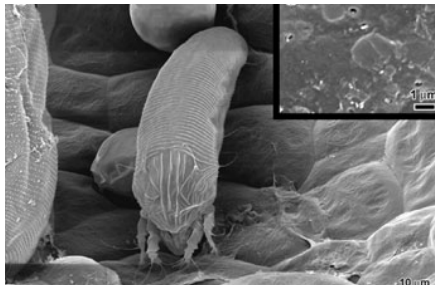


Neomusotima conspurcatalis

Lepidoptera: Crambidae

Released 2008 – Present

Established in South and Central Florida



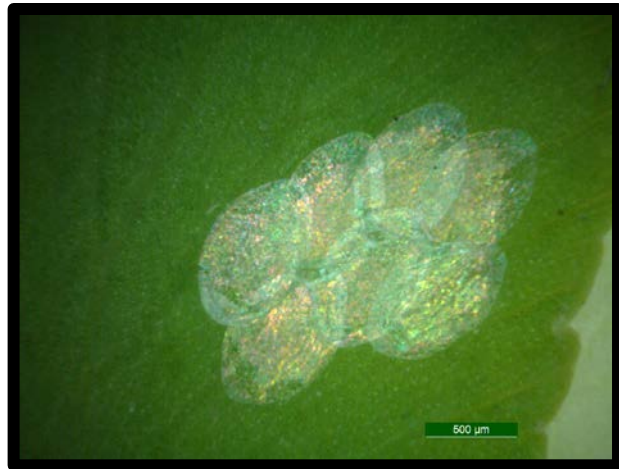
Floracarus perrepae

Acariformes: Eriophyidae

Released 2009 – Present

Established in South Florida

Neomusotima conspurcatalis, the brown lygodium moth



Egg



Larva



~ 28 days



Adult



Pupa



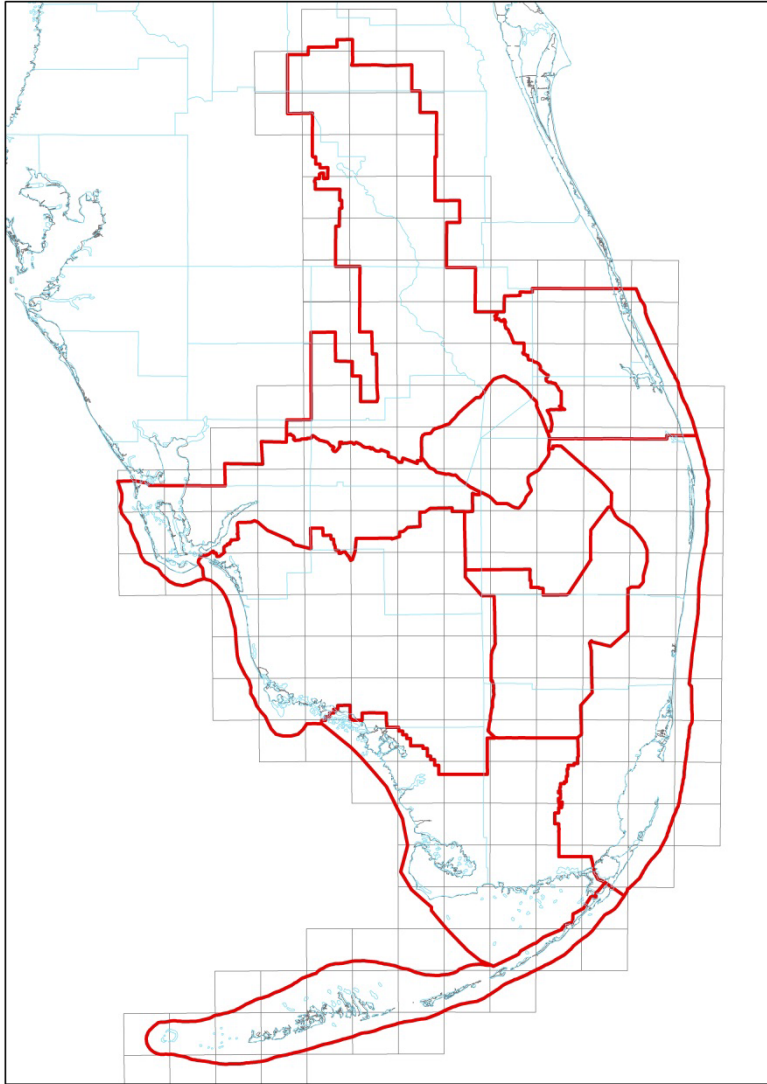
Neomusotima conspurcatalis feeding damage



N. conspurcatalis damage in the field



Invasive Plant Research Lab and the Comprehensive Everglades Restoration Plan (CERP)



Biological control of:

- Old World climbing fern
- Air potato
- Waterhyacinth



2014-2015 CERP Releases

FY 2015

N. conspurcatalis: 283,000+

F. perrepae: 227,000

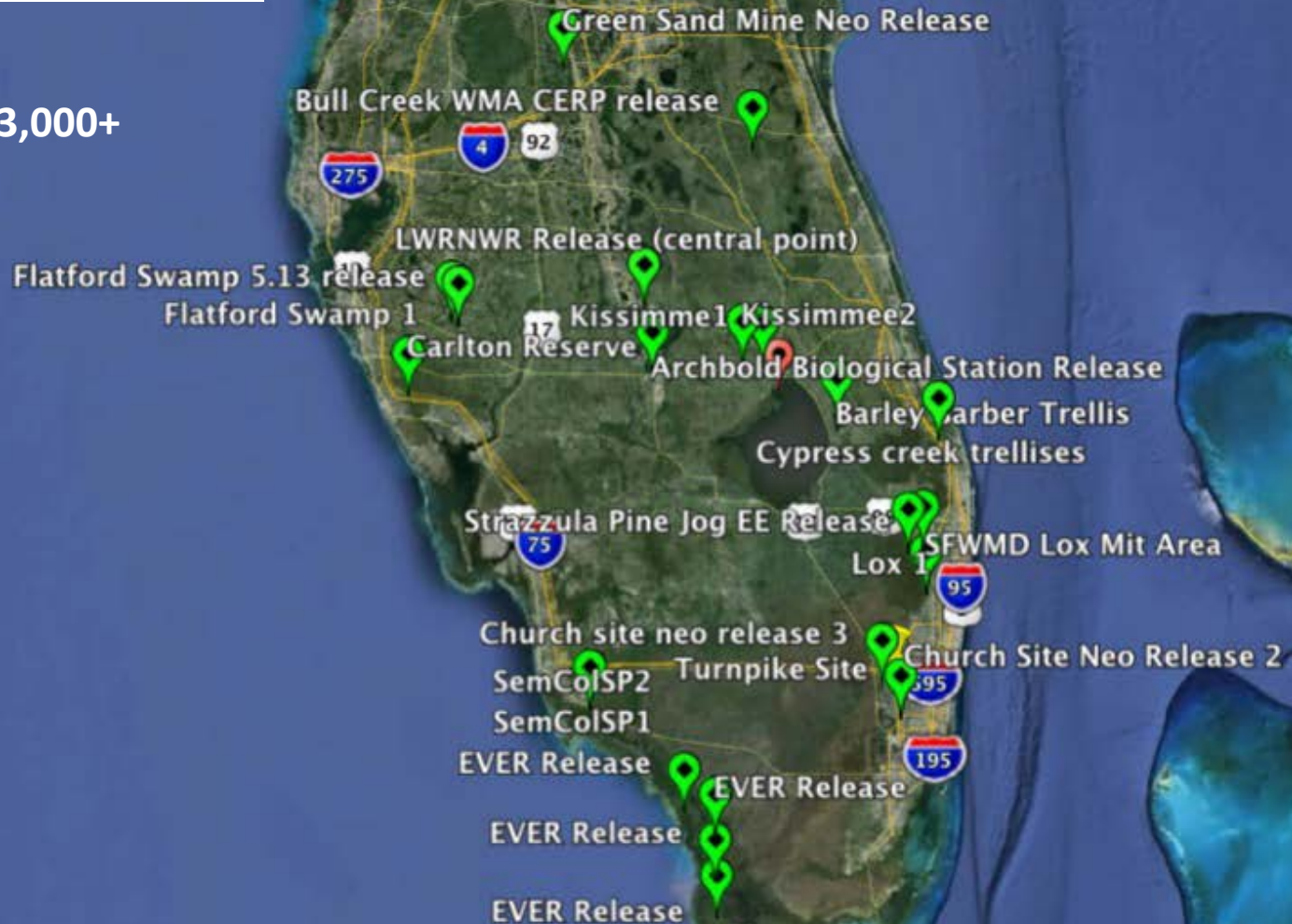




Photo credit: Christen Mason, SFWMD



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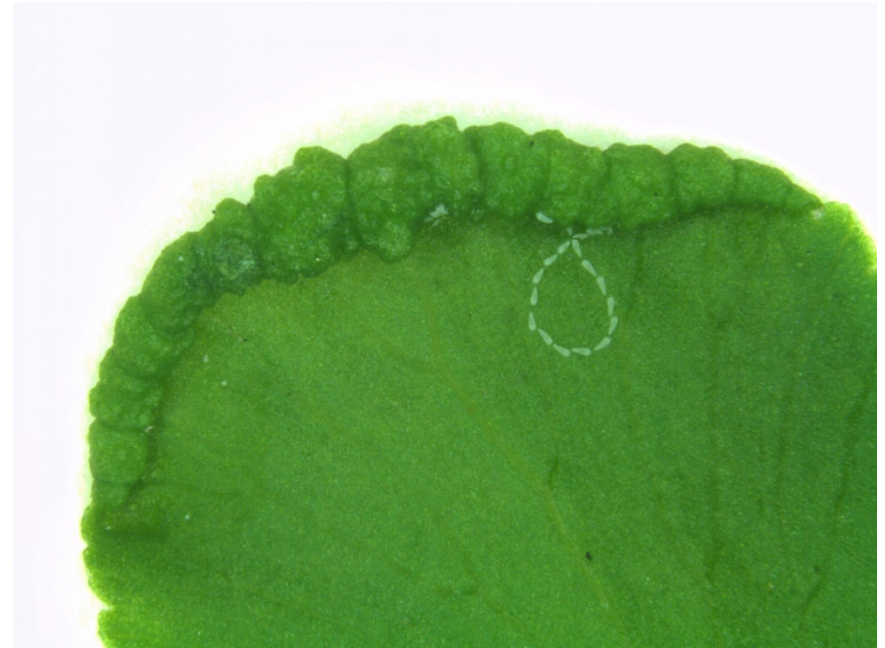
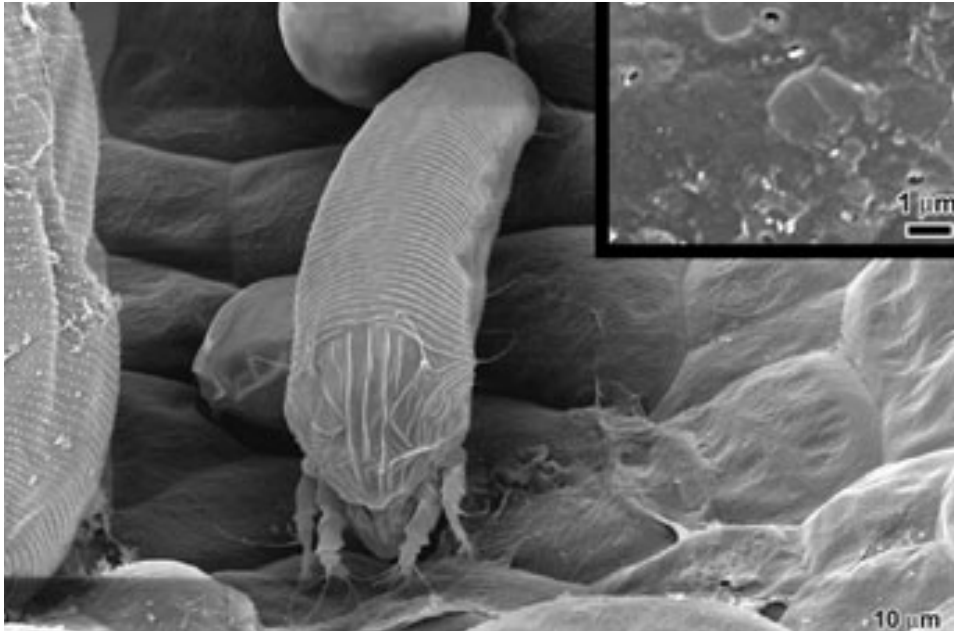
Are predators and parasitoids limiting the efficacy of *N. conspurcatalis*?



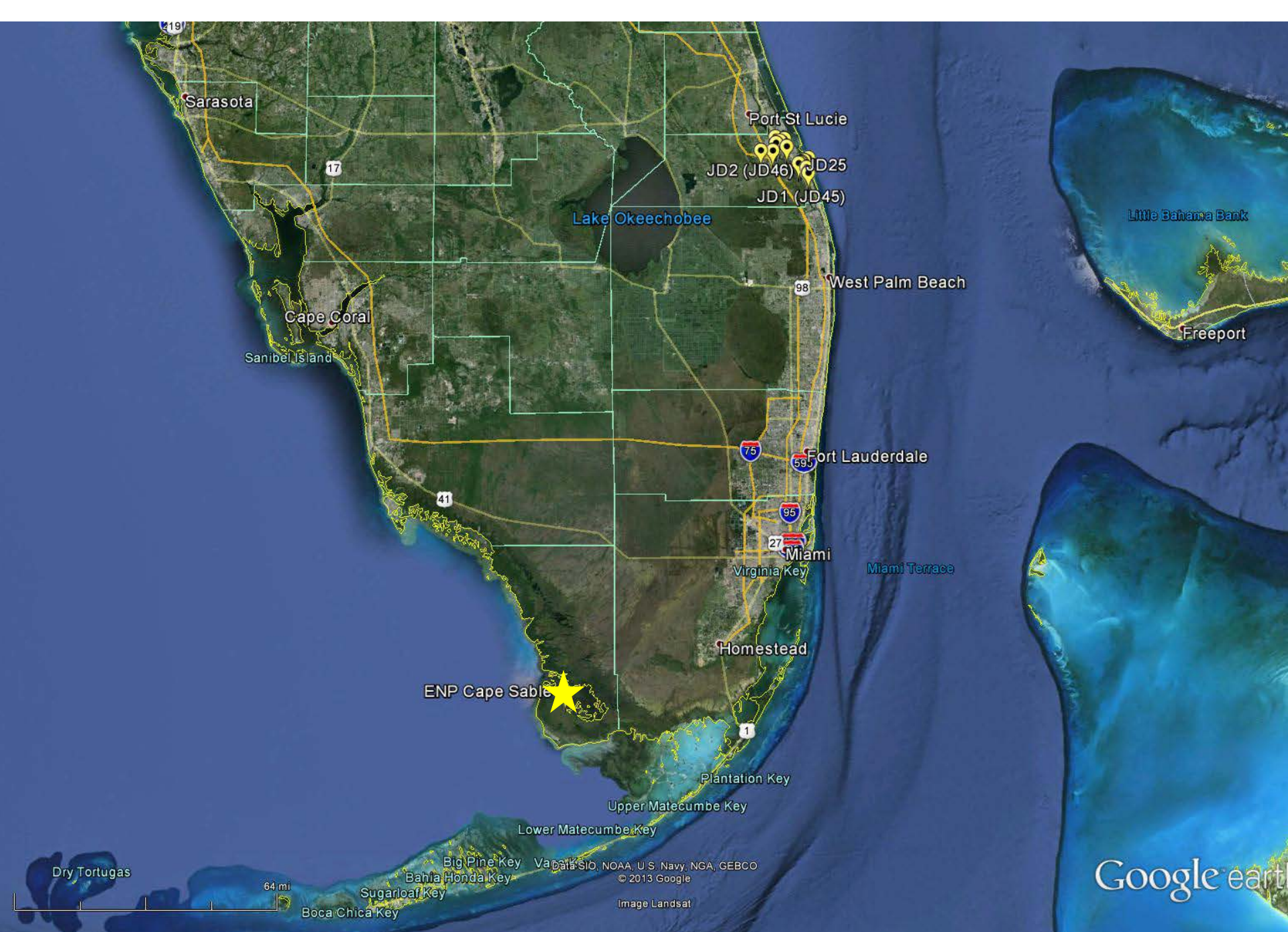
Assessing parasitism rates



Floracarus perrepa



- Transfers of galled material 2008 – 2010
- Very low establishment success measured in 2011



Sarasota

17

Port-St Lucie

JD2 (JD46)

JD25

JD1 (JD45)

Lake Okeechobee

98

West Palm Beach

Cape Coral

Sanibel Island

Little Bahama Bank

Freeport

41

75

95

Fort Lauderdale

27

Miami

Virginia Key

Miami Terrace

Homestead

ENP Cape Sable

Plantation Key

Upper Matecumbe Key

Lower Matecumbe Key

Big Pine Key

Bahia Honda Key

Sugarloaf Key

Boca Chica Key

Dry Tortugas

64 mi

NOAA, U.S. Navy, NGA, GEBCO

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Image Landsat

Google earth

Floracarus perrepa damage



Goolsby et al. (2004)

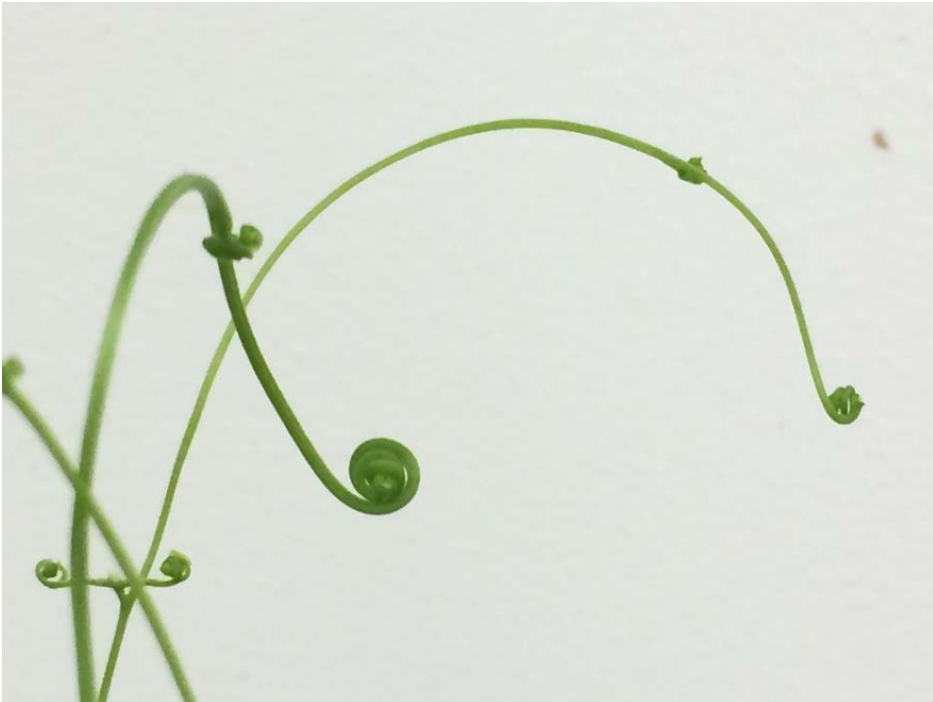
- Reduced aboveground biomass by 49%
- Reduced belowground biomass by 35%







Can *F. perrepa* reduce *Lygodium*'s ability to climb?
recover from herbicide or prescribed burns?





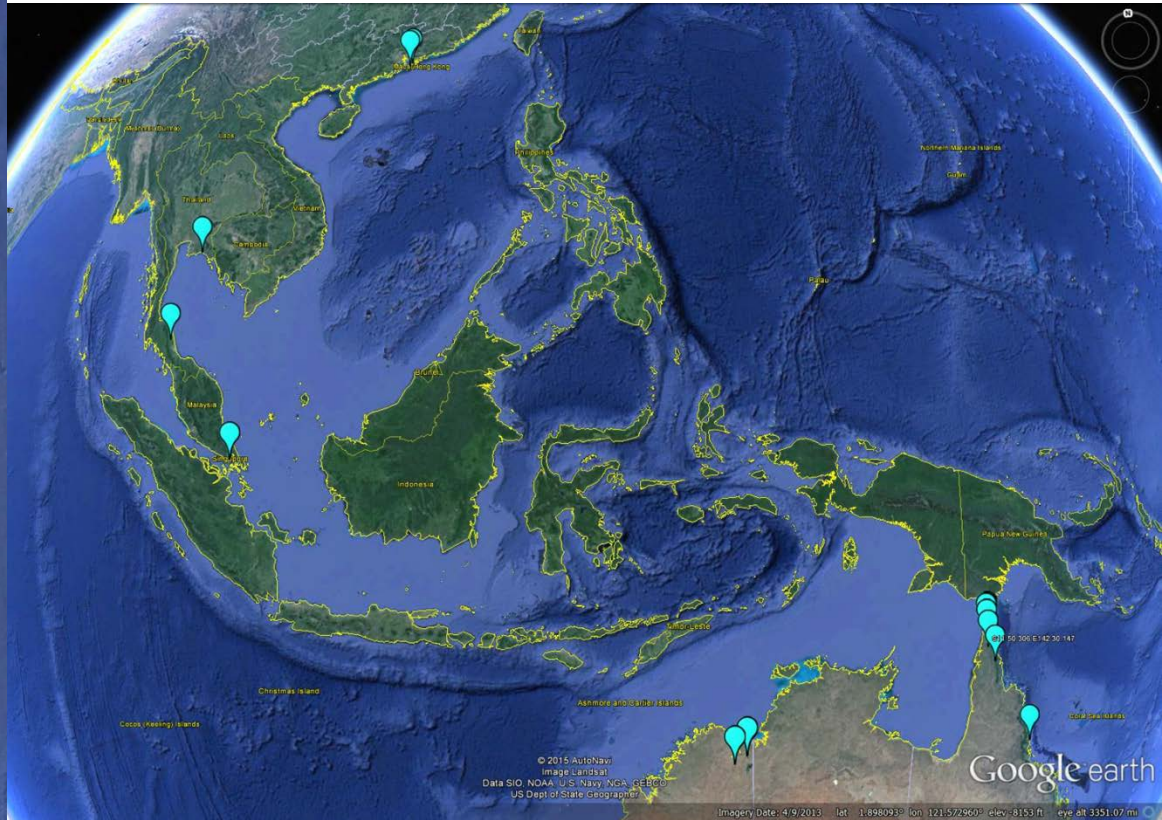
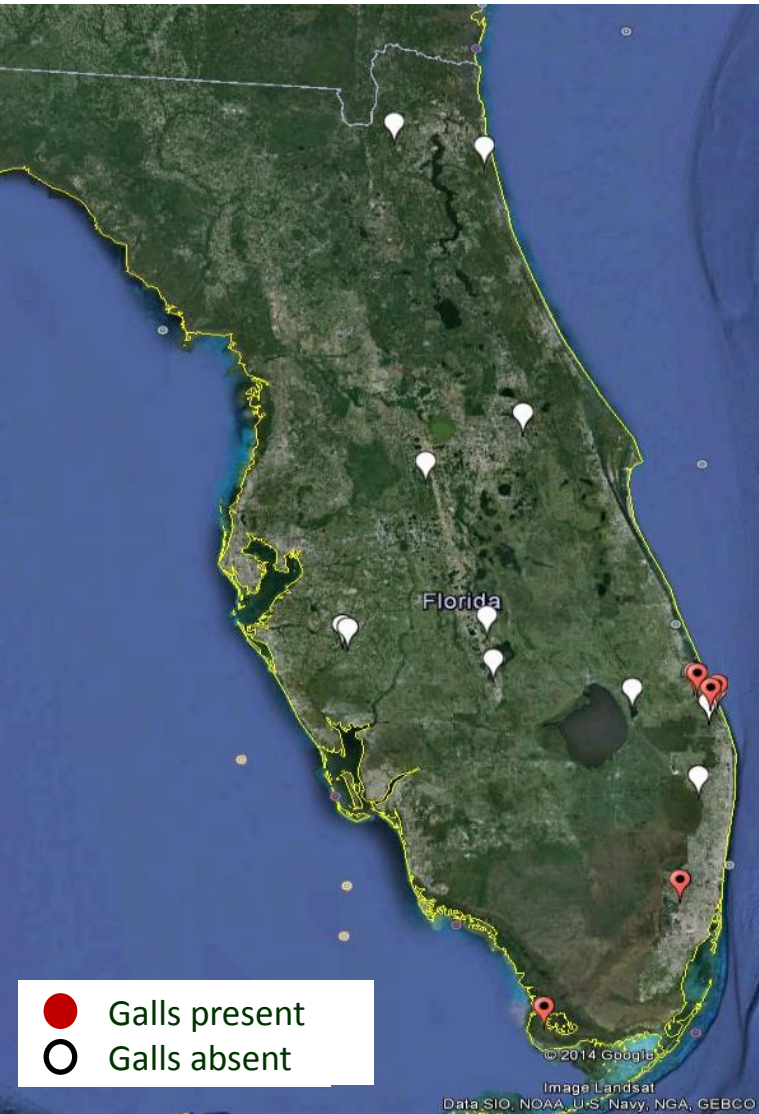


Is there a haplotype mismatch between the mite and *Lygodium* in Florida?

- Are some haplotypes resistant to galling?
 - Approximately 50% of *Lygodium* plants exposed to mites do not develop galls
 - 100% of plants produced from spores from gallable plants are gallable



Surveys of genetic diversity of *L. microphyllum* in Florida and the native range



Potential agents undergoing host-range testing

Lygomusotima stria (Lepidoptera: Crambidae)

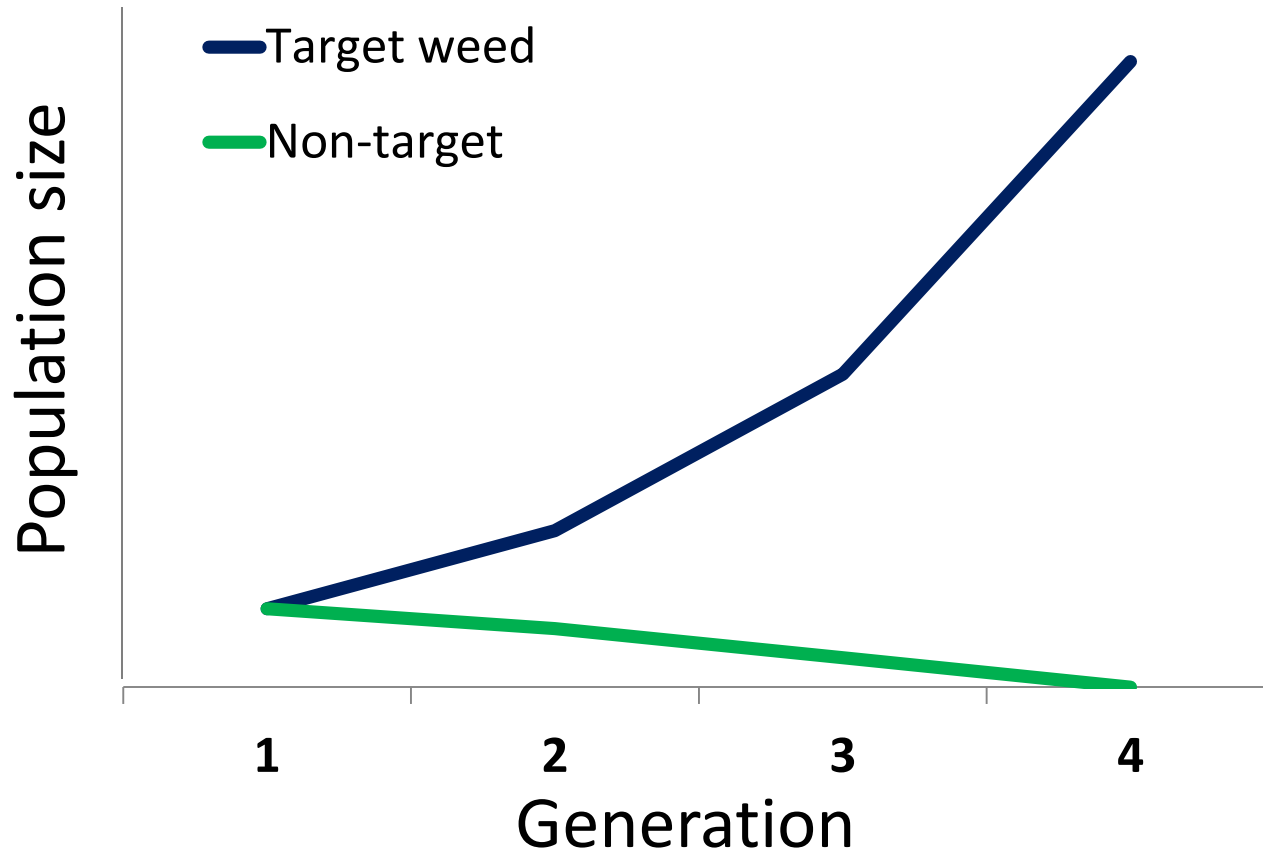


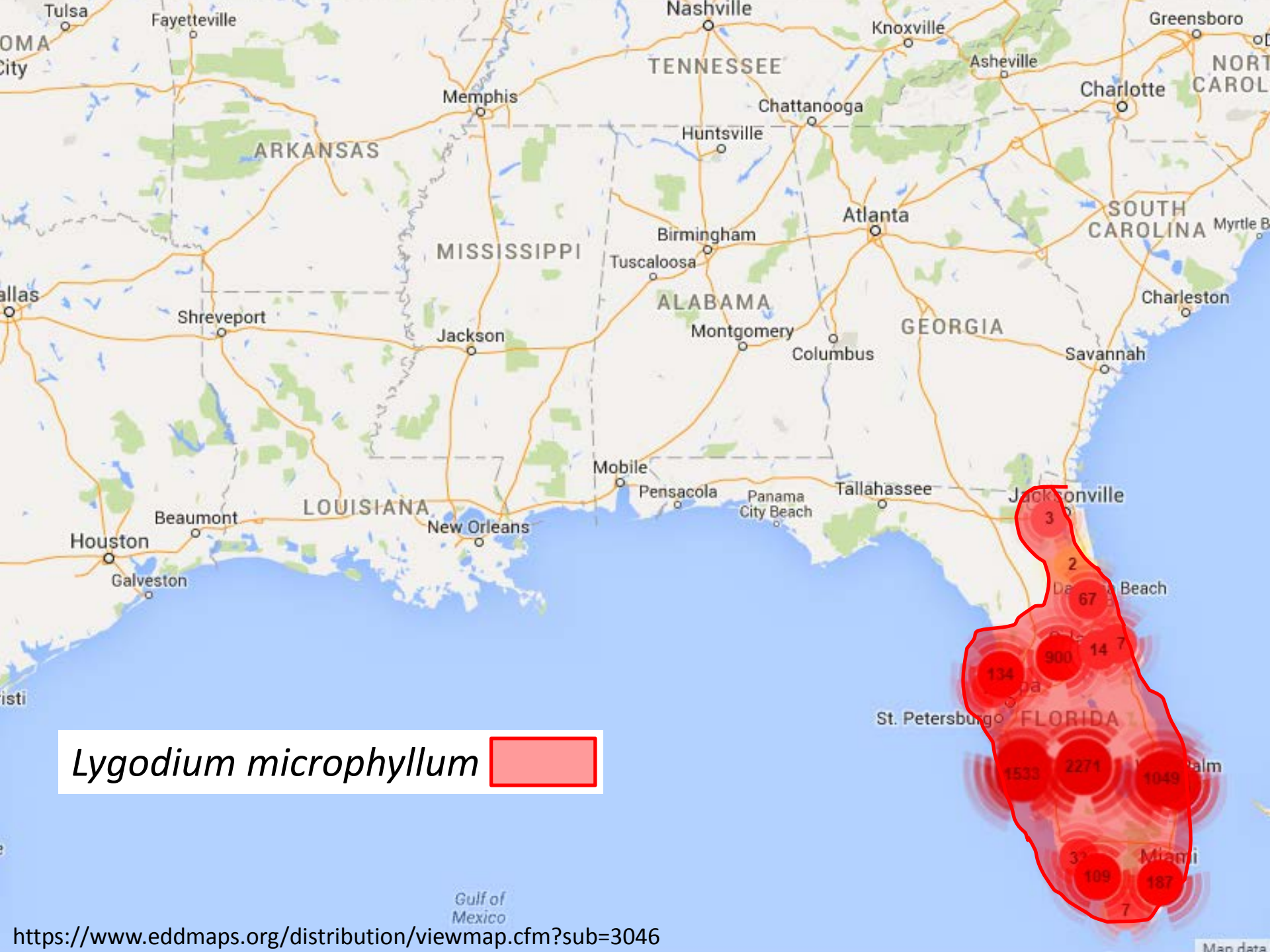
- The most damaging of the leaf-feeding crambids in the native range
- Colony established in 2010

Testing:

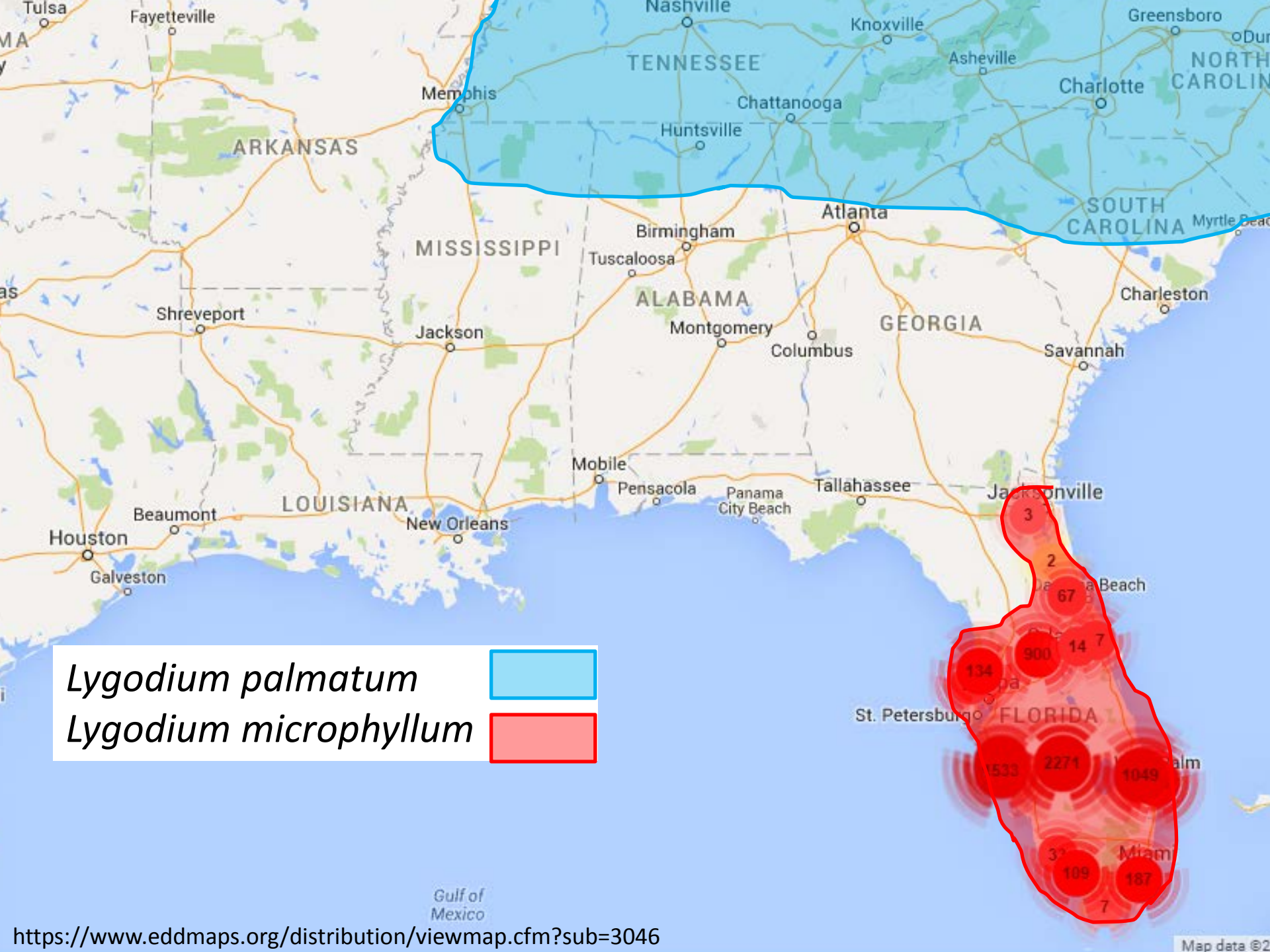
- Multiple generation tests on *Lygodium* congeners (*L. palmatum*, *L. japonicum*)
- Cold-tolerance (for northern viability)

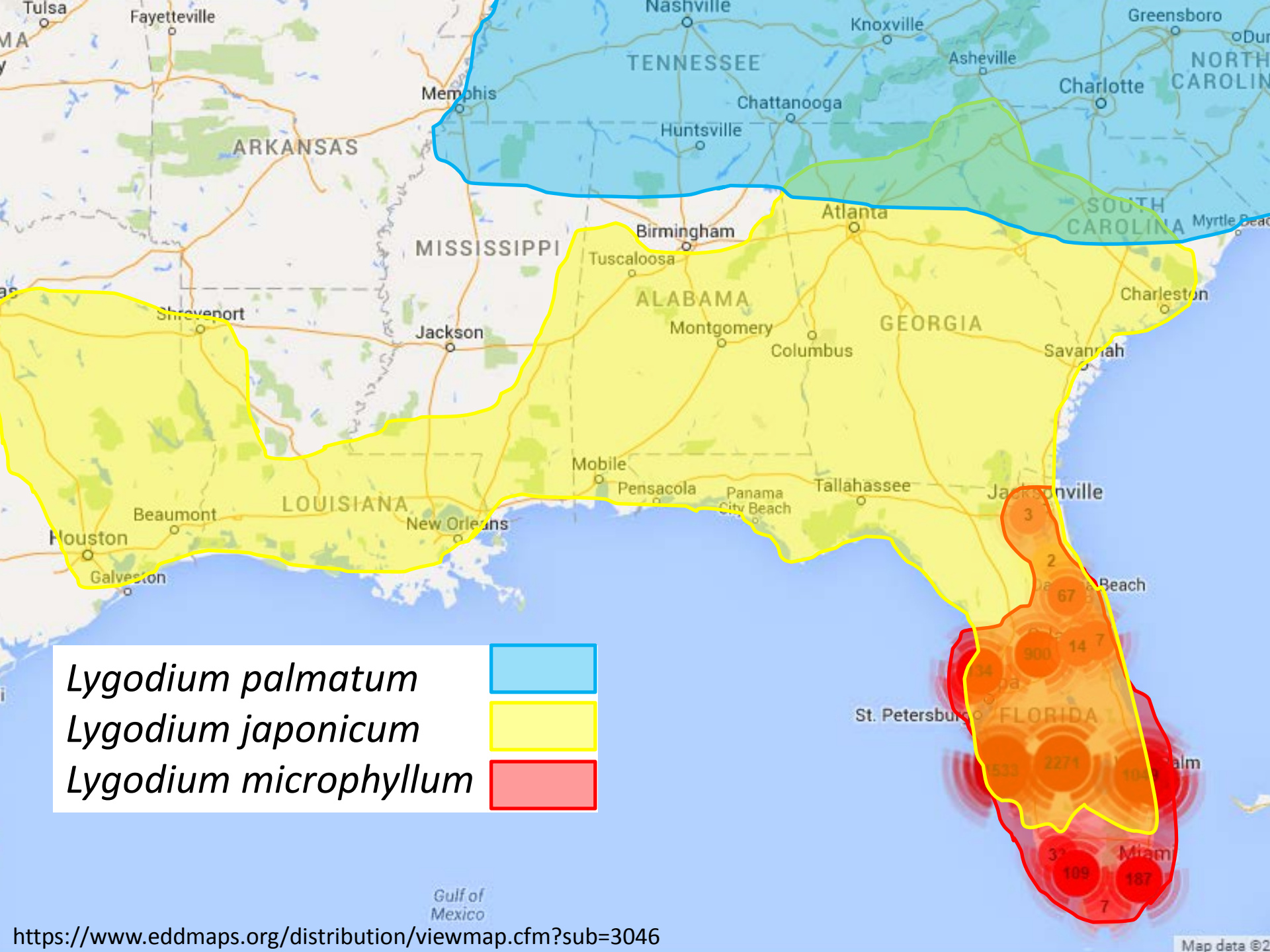
Multiple generation testing



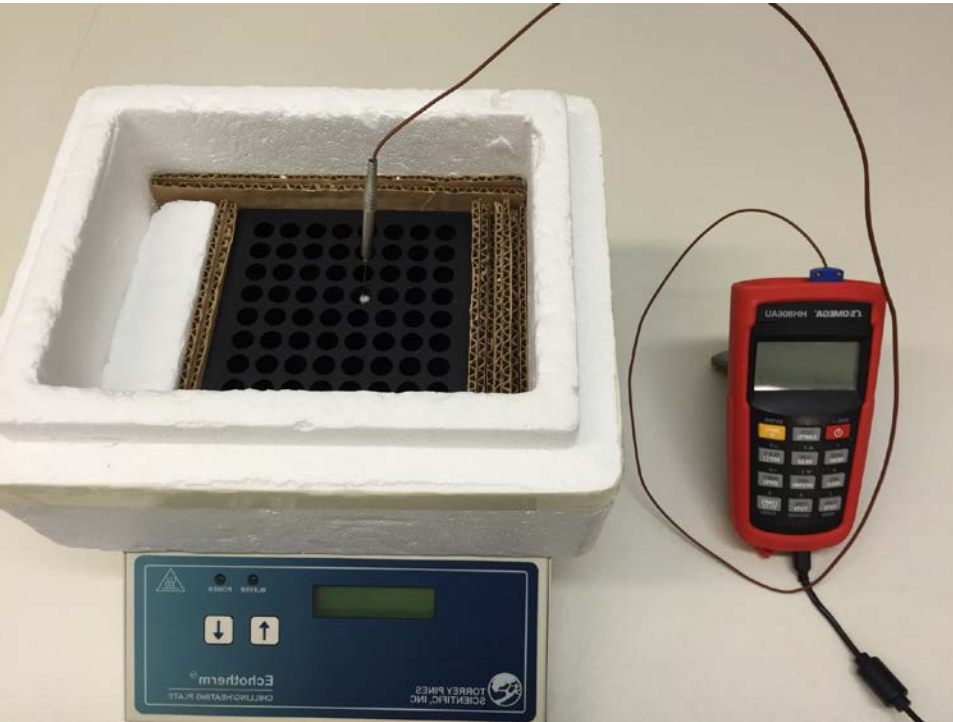


Lygodium microphyllum





Cold tolerance tests



- Lower lethal limit (LT_{50})
 - Physiological limit of the organism, no recovery is possible beyond this temperature
- Critical thermal minima (chill coma)
 - Ecological or behavioral tolerance limit of a species
 - Locomotory impairment occurs but insect is able to recover from being chilled to this temperature

Neostrombocerus albicomus (Hymenoptera: Tenthredinidae)



- Causes large defoliation events in the native range
- Colony arrived in 2005, reestablished in 2013



Testing:

- Multiple generation tests on *Lygodium volubile*
- *Lygodium cubense* will be tested if available

Foreign exploration for potential agents



Stem boring moths (4 species)

- Bore low on rachis and may kill all growth above the feeding point
- Also able to continue feeding within the rhizome, depleting the plant's nutrient supply
- Extremely difficult to colonize
- Simulated herbivory

Acknowledgments

