

FOLIAR NECTAR PRODUCTION BY
LYGODIUM MICROPHYLLUM, AN
INVASIVE FERN IN FLORIDA
(**STUDENT PRESENTATION**)

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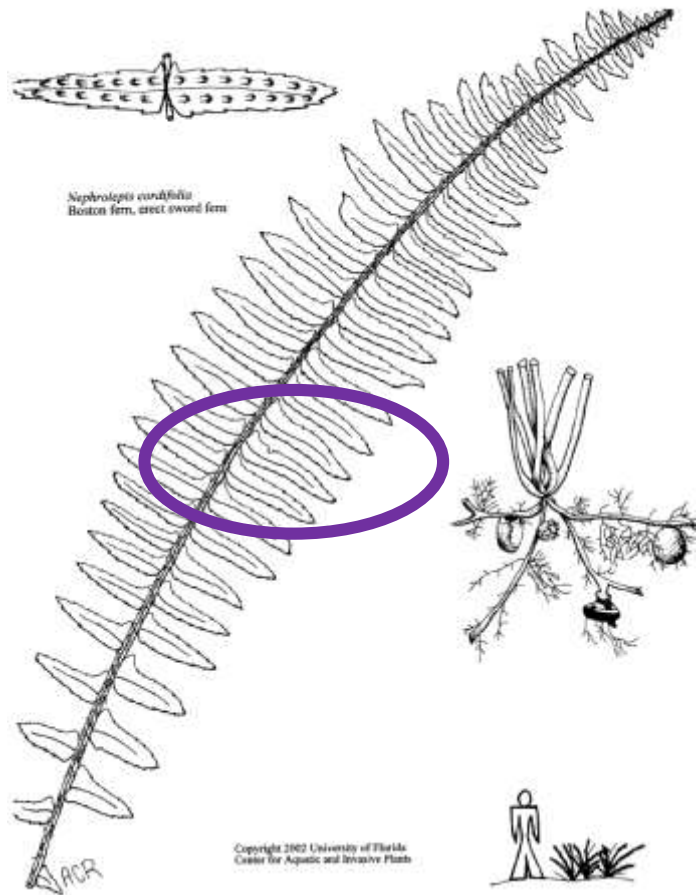
Lygodium microphyllum

- Tolerant of a range of conditions
- Fast growth
- Prodigious reproduction
- Resprout after burning, cutting

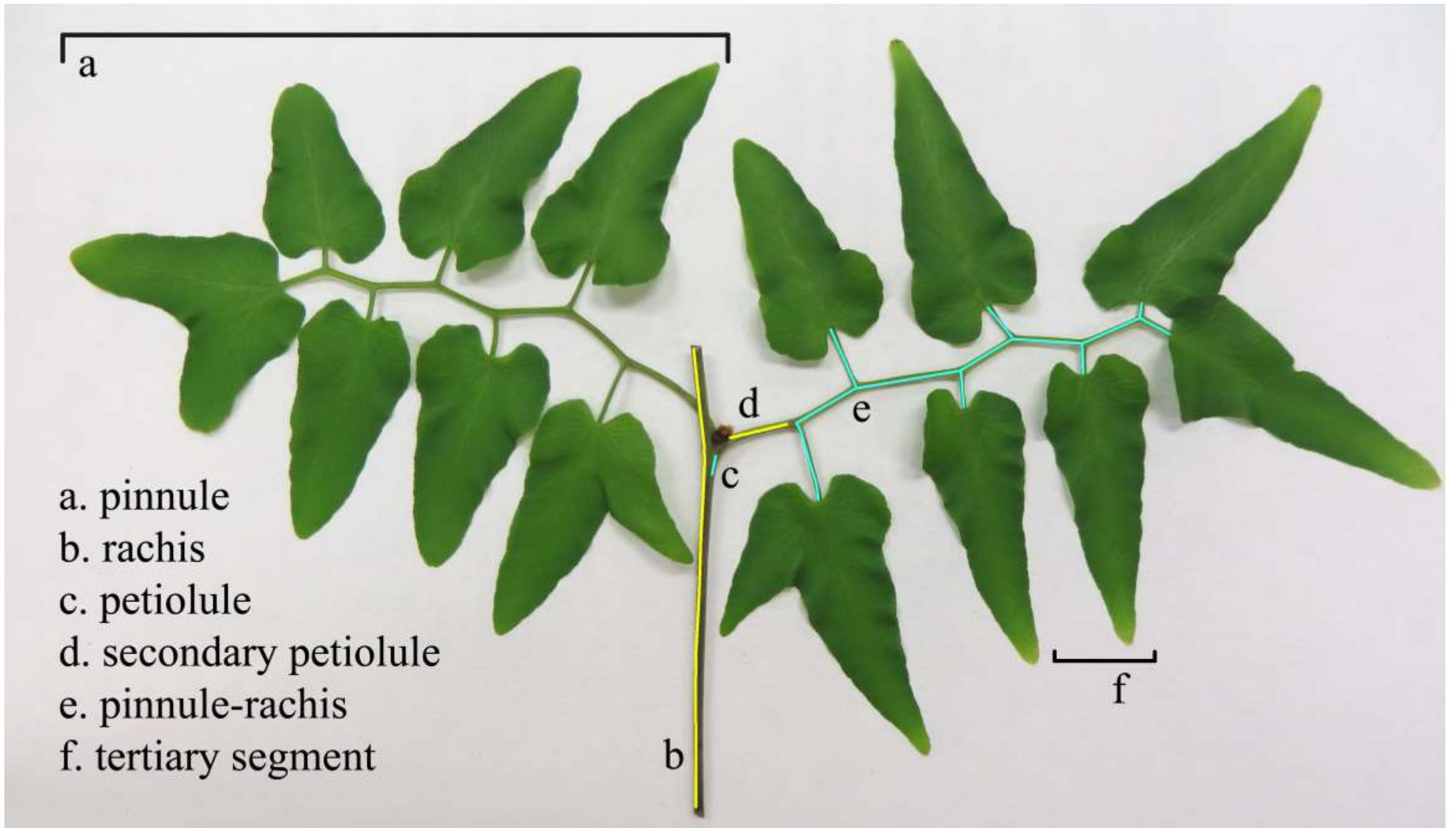
- Production of foliar nectar

First: terminology

Frond



← One pinna
pl. pinnae



a

- a. pinnule
- b. rachis
- c. petiolule
- d. secondary petiolule
- e. pinnule-rachis
- f. tertiary segment

b

f

Greenhouse *Lygodium nectar*

Regrowth post-burning

- Stickiness during harvests

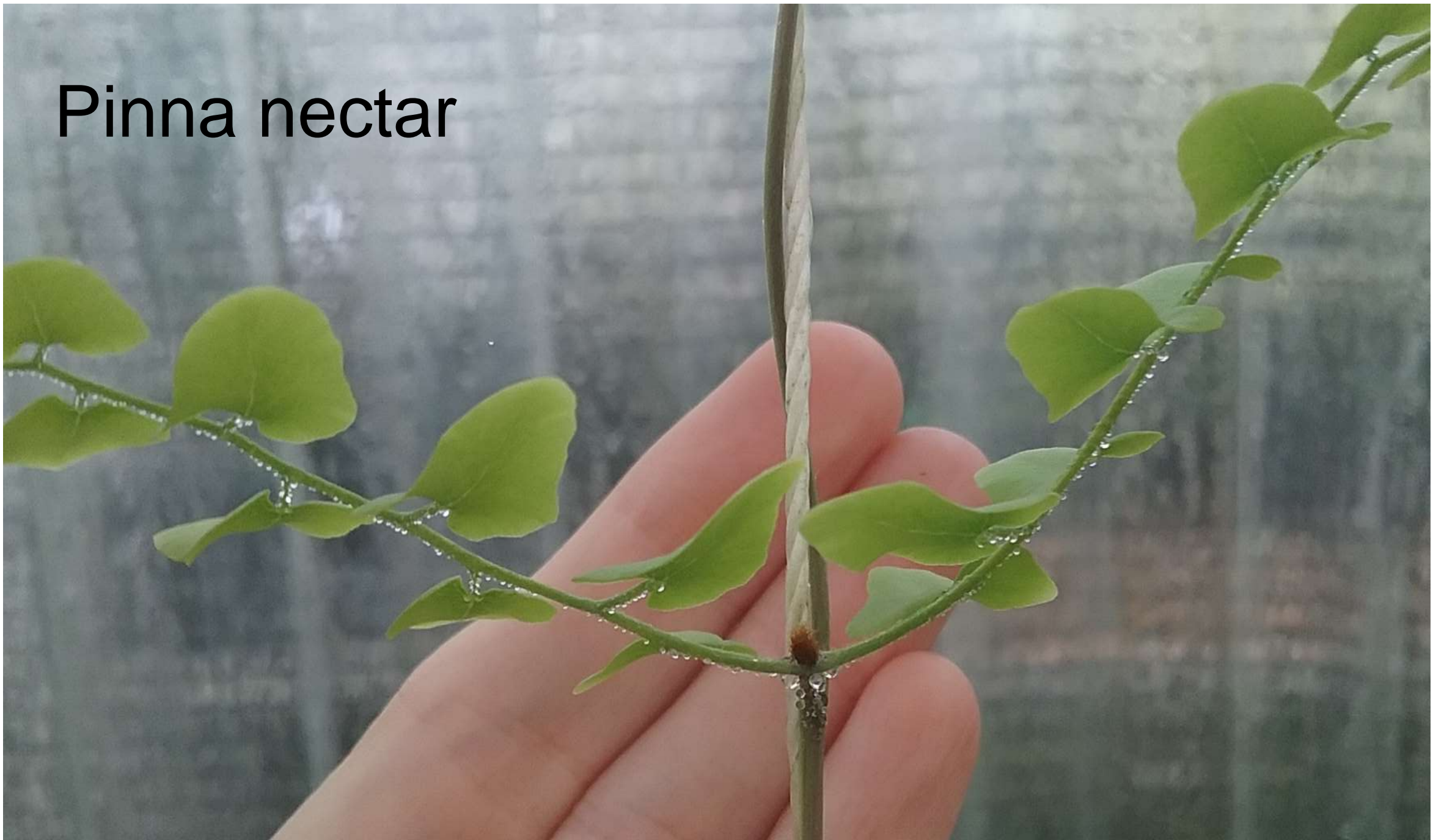
Salinity experiments

- Droplets in the morning





Pinna nectar



Greenhouse conditions

- High humidity, but not measured
- Light level: Mean 297 $\mu\text{mol}/\text{m}^2\text{s}$
- Temperatures: 25 – 45 °C (summer)
- Nectar abundant first hour of light



Nectar collected

- Single pinna: Mean 4.3 μL
max. 8 μL , SE = 0.5, n = 11
- Sugar content: Mean 14.0%
SE = 0.9, n = 7



Is nectar production inducible?

Plant defenses

- Constitutive: present regardless of herbivory
 - toxins, physical barriers
- Induced: response to damage
 - increased toxins, volatile compounds, nectar
 - Flowering plants
 - floral nectar → pollination
 - 4,000+ also have extrafloral nectaries (EFN) → defense
 - Ferns
 - 40+ species with foliar nectaries → often defense



Jee & Rani Nature Photography

Two pilots on nectar induction

Pilot 1 – cut type: *Leaflet or rachis damage*

- 4 plants (> 2 m)
- Damaged mechanically (-25% AGB)



Pilot 2 – cut time: *PM or AM damage*

- 4 treated plants, 1 control (~ 2 m)
- Rachis AND leaflet damage = 50% AGB)

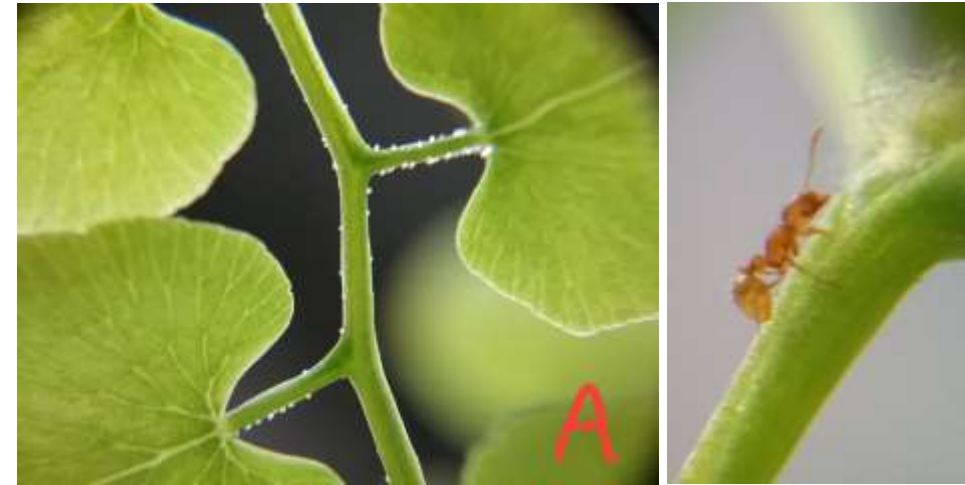


Monitored for 1 hour post cut, then at intervals over several days

Two pilots on nectar induction: Results

Pilot 1 – *Leaflet or rachis damage*

- Nectar observed 24 hours post cut (AM)
- Nectar in one leaflet-damaged
- But... ANTS on all plants



Pilot 2 – *PM or AM damage*

- Tanglefoot effective
- Nectar by next morning (13 or 1 hrs.)*
- Peak nectar ~ 3 mornings post cut
- *The control produced nectar



Two pilots: Conclusions and questions

- Type of damage
 - Nectar mostly on young, green rachis, expanding pinnae
 - Cutting rachis reduces these – ***leaflet damage preferable***
 - Timing of damage – ***AM production***
 - Tanglefoot – necessary
-
- What disturbances induce nectar?

Inducible – apparently.

Suggests defensive role

...against what?

Is nectar production defensive?

- Most common visitors to foliar nectar: ANTS
- Ants have been documented
 - *Cyathea planadae* – Regularly visited
 - *Polypodium plebeium* – Defended
 - *Pleopeltis crassinervata* – Defended
 - *Pteridium aquilinum* – Conflicting reports
- Other visitors: parasitic wasps, coccinellid beetles, flies, spiders



Arturo Hernandez



Nectar constituents?

Ants observed on *L. microphyllum* plants:

In greenhouse FIU/USDA:

- *Camponotus floridanus*
- *C. planatus* Roger



- *Wasmannia auropunctata*
- *Solenopsis invicta* Buren
- *Pseudomyrmex gracilis* Fabricius
- *Monomorium pharaonis*



In sawgrass marsh (ENP):

- *Camponotus* sp.
- *Crematogaster* ?

Ants meddling

Invasive Plant Science and Management 2011 4:332–340



Predator Interference with the Cinnabar Moth (*Tyria jacobaeae*) for the Biological Control of Tansy Ragwort (*Senecio jacobaea*)



http://www.pyrgus.de/Tyria_jacobaeae_en.html

Kimberly K. Crider*



Camponotus pennsylvanicus
Antwiki.org



C. vicinus
Bugguide.org



Tansy ragwort flowers. Photo by Michael Shephard, USDA Forest Service, available from Bugwood.org

Why the concern?

- Two biocontrols having variable success
 - *Floracarus perrepae* (Acariformes: Eriophyidae)
 - *Neomusotima conspurcatalis* Warren (Lepidoptera: Crambidae)



Ellen Lake, USDA ARS-IPR



Ants meddling...here

Austromusotima camptozonale Hampson
(Lepidoptera: Crambidae), failed establishment in part
due to predation by *Pseudomyrmex gracilis*

Boughton and Pemberton 2008



Christine A. Bennett, USDA Agricultural Research Service, Bugwood.org

Future Questions

- Can other congeners of *Lygodium* produce nectar?
- Does herbivory by biocontrols induce nectar production?
 - Is it dependent on damage level, specific biocontrol, site?
- Does nectar production affect biocontrol survival by attracting predators (ants/others)?
 - Site – dependent?

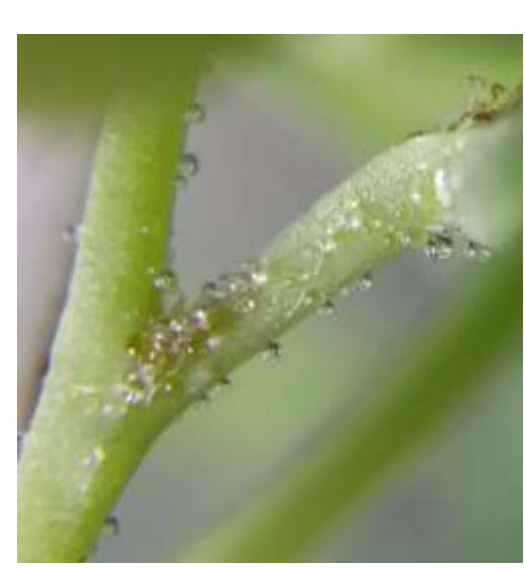
Can other congeners produce nectar?

- Nectar production tends to be conserved within genera
 - Can *L. japonicum*?
- USDA provided congeners for this exploration:
 - *L. microphyllum* - invading S/C FL
 - *L. japonicum* - invading C/N FL
 - *L. palmatum* - endemic to USA
 - *L. oligostachyum* - Caribbean
 - *L. venustum* - Central America
 - *L. volubile* - Caribbean, Central America, northern S. America

Congener Nectar Experiment (April 2019)

- 5 individuals of each congener (4 damage + control)
- Tanglefoot to exclude ants
- Monitor for baseline production (2 days pre-damage)
- Trim *leaflets* back 50%
- Monitor at dawn
 - Volume
 - Locations
 - Sugar concentration
 - Nectar constituent analyses





References

- ARENS, N. C. AND A. R. SMITH. 1998. *Cyathea planadae*, a remarkable new creeping tree fern from Colombia, South America. *American Fern Journal* 88:49–59.
- BENTLEY, B. L. 1977. The protective function of ants visiting the extrafloral nectaries of *Bixa orellana* (Bixaceae). *Journal of Ecology* 65:27–38.
- BOUGHTON, A. J. AND R. W. PEMBERTON. 2008. Efforts to establish a foliage feeding moth, *Austromusotima camptozonale*, against *Lygodium microphyllum* in Florida, considered in the light of a retrospective review or establishment success of weed biocontrol agents belonging to different arthropod taxa. *Biological Control* 47:28–36.
- BOUGHTON, A. J., R. R. KULA, M. GATES, Y. ZHANG, M. NUNEZ, J. O'CONNOR, J. B. WHITEFIELD, AND T. D. CENTER. 2012. Parasitoids attacking larvae of a recently introduced weed biological control agent, *Neomusotima conspurcatalis* (Lepidoptera: Crambidae): Key to species, natural history, and integrative taxonomy. *The Annals of the Entomological Society of America* 105(6):753–767.
- Diaz-Castelazo et al. 2005
- Jones and Paine 2012
- Nepi et al. (2009) showed that fern foliar nectar is more similar in composition to angiosperm extrafloral nectar than to angiosperm floral nectar or gymnosperm pollination drops. This similarity in composition may imply a similar ecological function. Additionally, the foliar nectaries of several species have been shown to attract ants.
- Oldenkamp and Douglas 2011
- Tempel 1983
- Wetterer 2010)

Equipment

- Nectar Collections: micropipettes (Drummond Scientific Company, Broomall, PA USA)
- Nectar Collections: 10 uL microsyringe (, Germany)
- Sugar quantification: pocket refractometer, 0-50% (wt./wt. type, Bellingham & Stanley LTD England)
- Temperatures: 8 Thermochrons (DS1922L, Maxim Integrated, San Jose California)
- Light Levels: Apogee quantum meter (Apogee Instruments, Logan UT)

Salinity Tolerance

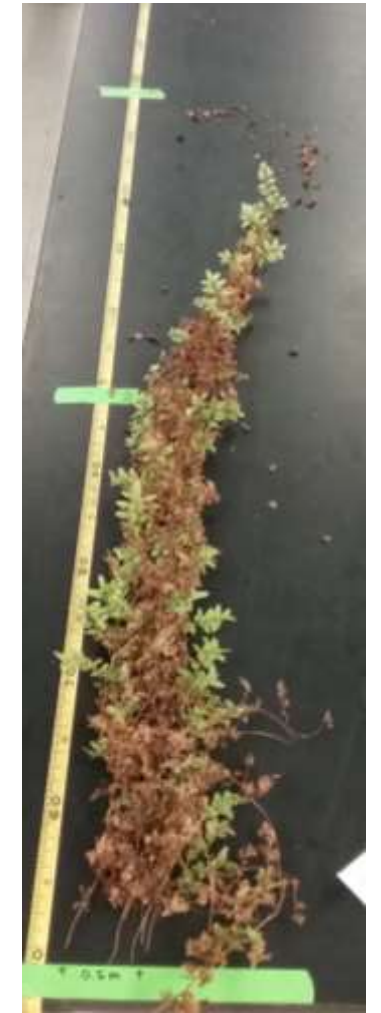
- Pilot (Sal I): 0, 10* ppt
 - 12 large, 24 medium plants
 - Own propagation from spores
 - April – June 2018

- Sal II: 0, 5, 10 ppt
 - 90 small plants
 - from USDA-ARS IPRL
 - January – March 2019



Salinity I – April 2018

- Pilot: 0, 10* ppt
 - Summer (high temp/humidity)
 - Both produced nectar
 - Salt plants exuded salt through leaflets
 - Salt plants had higher mortality*



Salinity II – Dec 2018

- Pilot: 0, 5, 10 ppt
 - Winter
 - Less obvious differences
 - Apparently lower root biomass -10
 - 2 deaths in 10



