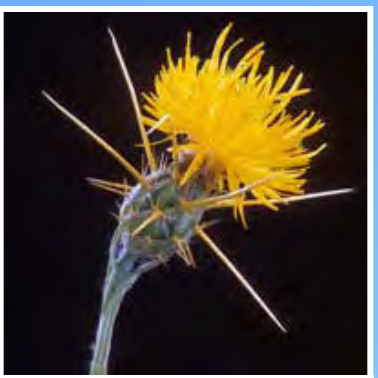
Status of Biological Control Projects on Invasive Alien Weeds in California



Lincoln Smith

Exotic Invasive Weeds
USDA-ARS
Albany, California

Michael Pitcairn

CA Dept Food & Ag

Methods of Weed Control

- Chemical
- Mechanical
- Cultural
- Biological

Factors controlling plant populations

- Abiotic limits (e.g. climate, frost, rainfall)
- Resources
- Seed germination microsites
- Plant competition
- Pollination
- Natural enemies (generalist & specialist)

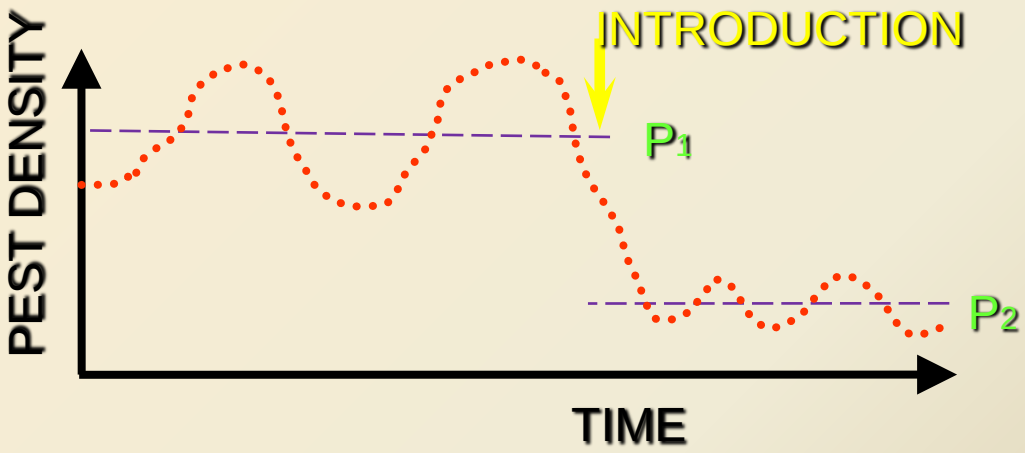
Classical Biological Control

- Most common biological control method used against weeds
- It involves introduction of natural enemies from their native range into an exotic range where their host plant has become invasive.
- The objective is for the exotic natural enemy to become self-sustaining members of the herbivore community in the new area of infestation.

Many Exotic Weeds Are Without Natural Enemies

- Only clean ornamental & crop plants are transported and sold
- Plants accidentally introduced are commonly transported as seeds or rhizome fragments, pieces too small to support natural enemies
- The benefits of reduced natural enemy pressure for exotic plants is called the “Enemy Release Hypothesis of Invasion.”

THEORY OF BIOLOGICAL CONTROL:
Density dependent mortality lowers the average density of the weed population



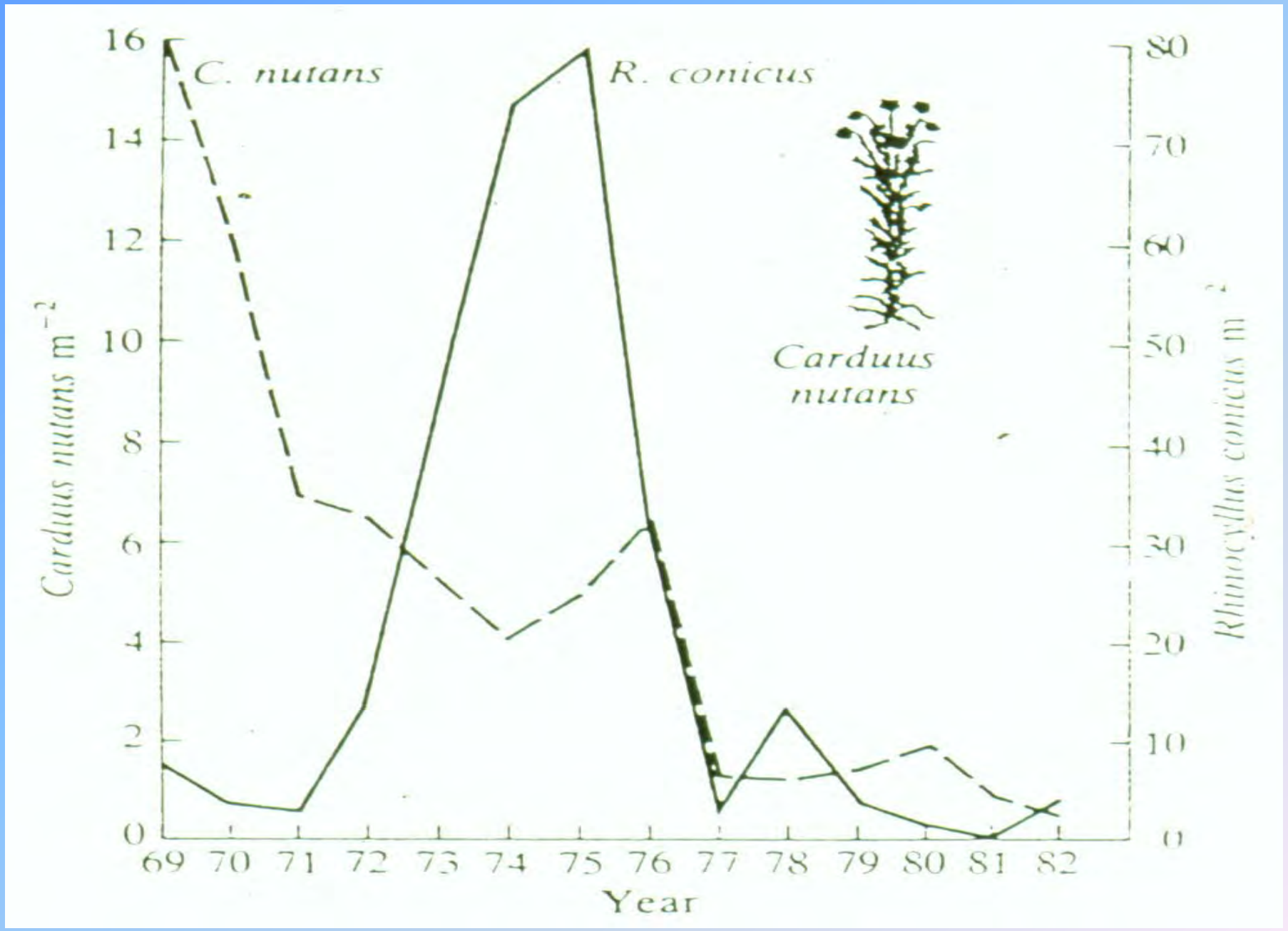
Musk Thistle (*Carduus nutans*)
Siskiyou County

Musk Thistle Control Agent

Seed Head Weevil

Adult

Larval Damage


C. nutans
R. conicus
Carduus nutans
Carduus nutans m⁻²
Rhinocyllus conicus m⁻²
Year
0
2
4
6
8
10
12
14
16
0
10
20
30
40
50
60
70
80
69 70 71 72 73 74 75 76 77 78 79 80 81 82

Tansy Ragwort (*Senecio jacobae*)

Invasive weed of pastures, grasslands, rangelands

Poisonous to cattle

Tansy Ragwort, Humboldt County

Before

After

Tansy Ragwort Control Agents

Cinnabar Moth

Larvae

Adult

Tansy Ragwort Control Agents

Flea Beetle

Adult

Larval Damage

Table 1. Tansy ragwort density (plants/m^2) in Mendocino Co., California (adapted from R. W. Pemberton and C. E. Turner, 1990, Entomophaga 35: 71-77.)

Foresti Ranch[1]	Todd Point[2]	Smith Ranch[3]
15.3 (1969)[4]	53.3 (1966)	11.7 (1973)
0 (1975)	0.6 (1975)	0.5 (1975)
0 (1987)	0 (1987)	0.2 (1987)

[1]the cinnabar moth was present since 1968, and the ragwort fleabeetle was introduced in 1968

[2]the cinnabar moth was introduced in 1966, and the ragwort fleabeetle was introduced in 1972

[3]the cinnabar moth was present in large numbers by 1975, and the ragwort fleabeetle was introduced in 1972

[4]fall sample years shown in parentheses

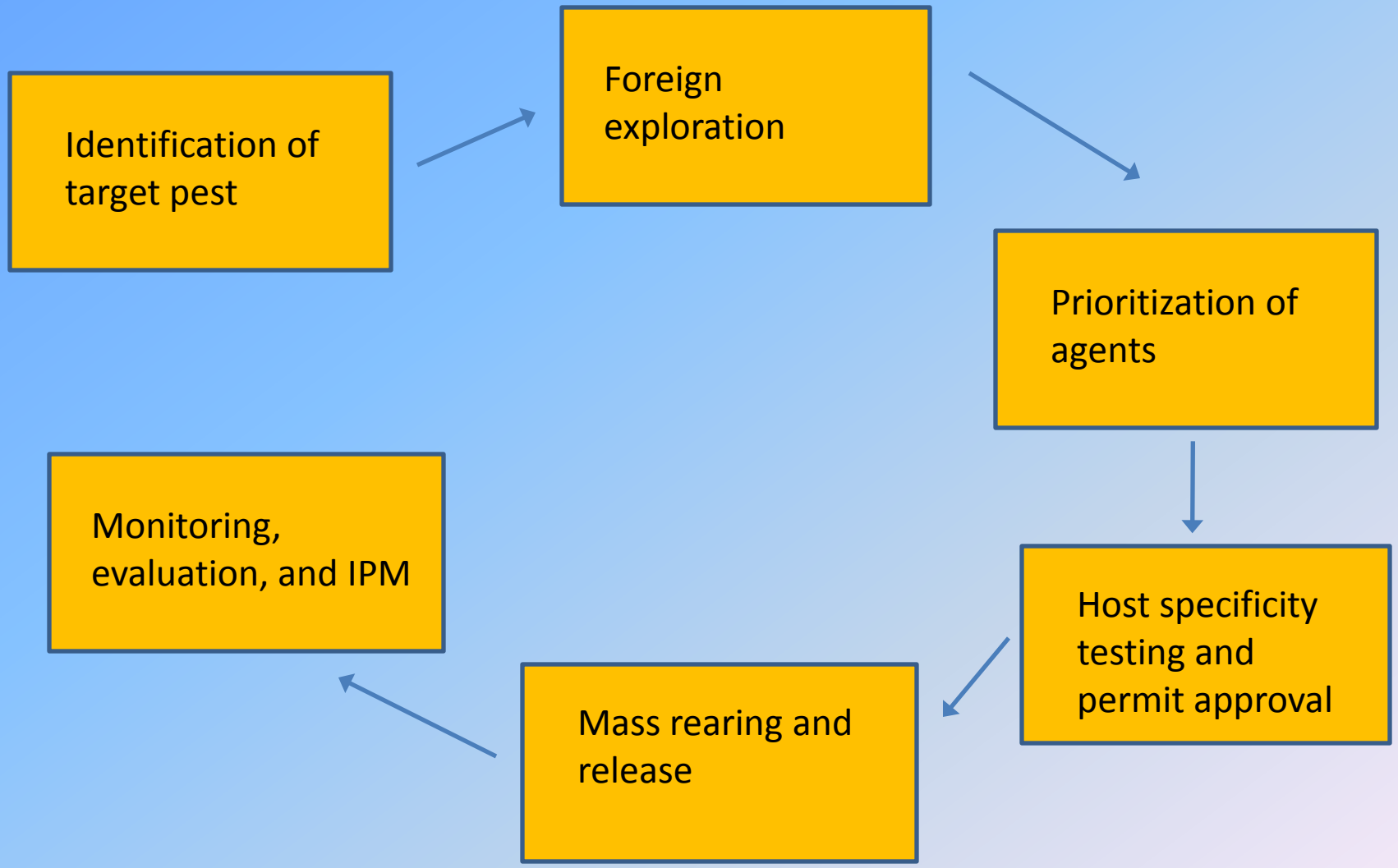
Advantages/Disadvantages

Advantages	Disadvantages
Target specificity	**Initial high costs**
Continuous action	**Protracted time until impact likely**
Cost effective long term	**Uncertainty over ultimate scale of impact**
Gradual in effect, environ-mentally non-intrusive	**Uncertain 'non-target' effects in ecosystems**
Self dispersing (even into difficult terrain)	**Irreversible**

Klamath Weed

a poisonous exotic weed
under biological control
since 1946

Steps in a biological control program



Key to Effectiveness and Safety is High Host Specificity

- Substantially reduces or eliminates risks to non-target plants
- Provides a tight coupling between natural enemy and host plant so that impacts are not diluted to other species
- Provides density dependent mortality needed to stabilized population fluctuations

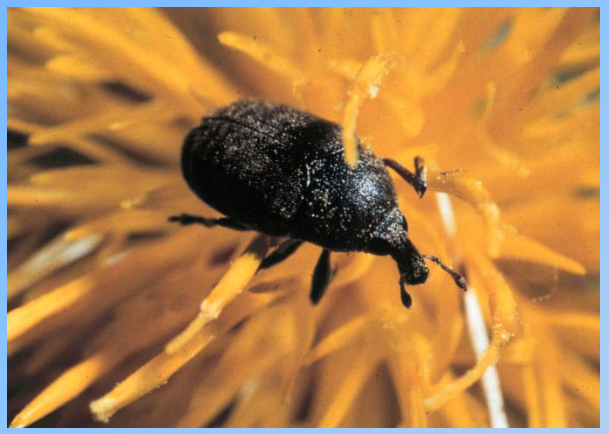
Yellow Starthistle

Centaurea solstitialis

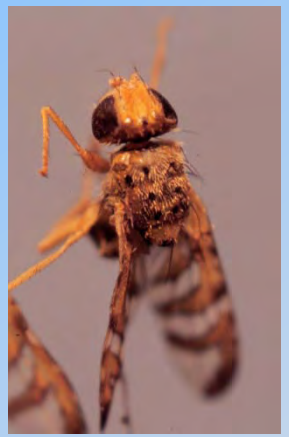
Urophora sirunaseva

Bangasternus orientalis

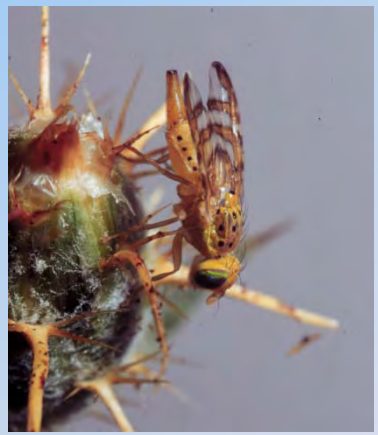
Eustenopus villosus



Larinus curtus



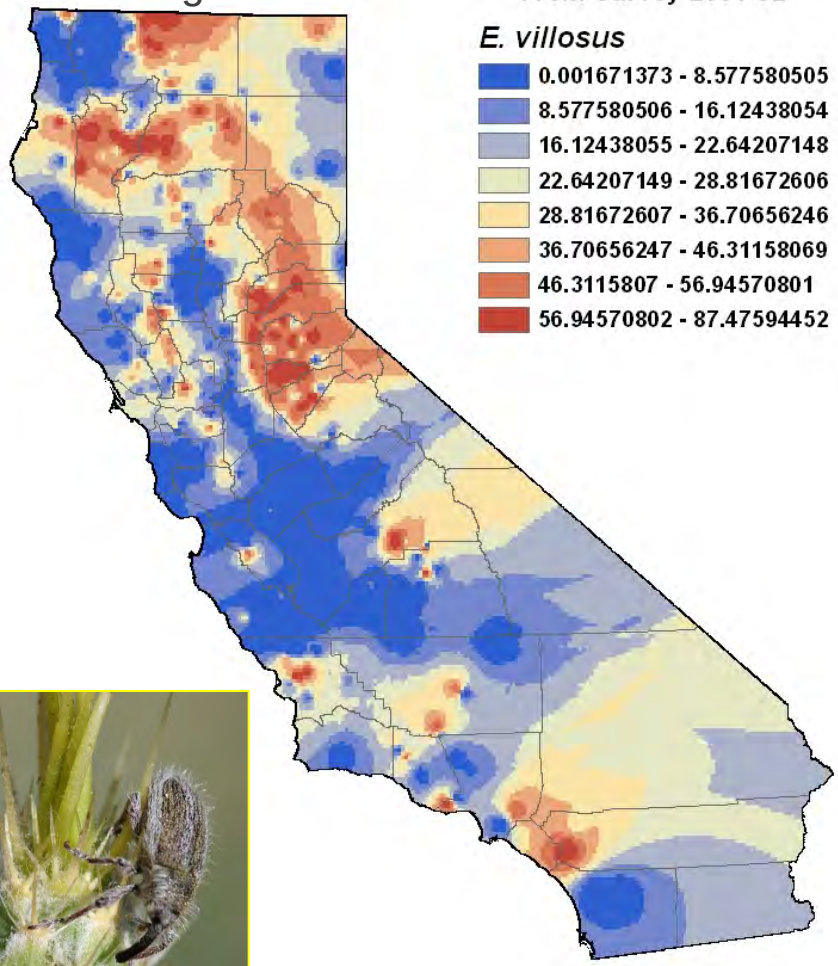
Chaetorellia australis



Chaetorellia succinea

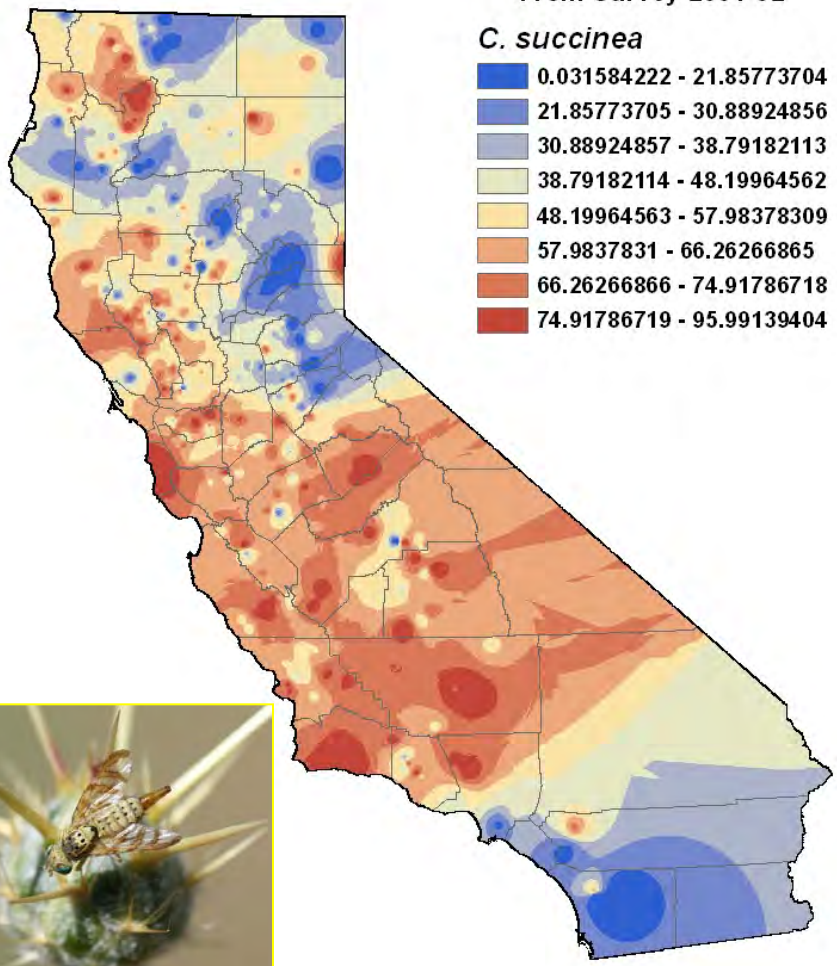
Hairy Weevil

Recovered at 80% of locations
Mean attack rate: 25%
Range: 0 - 93%



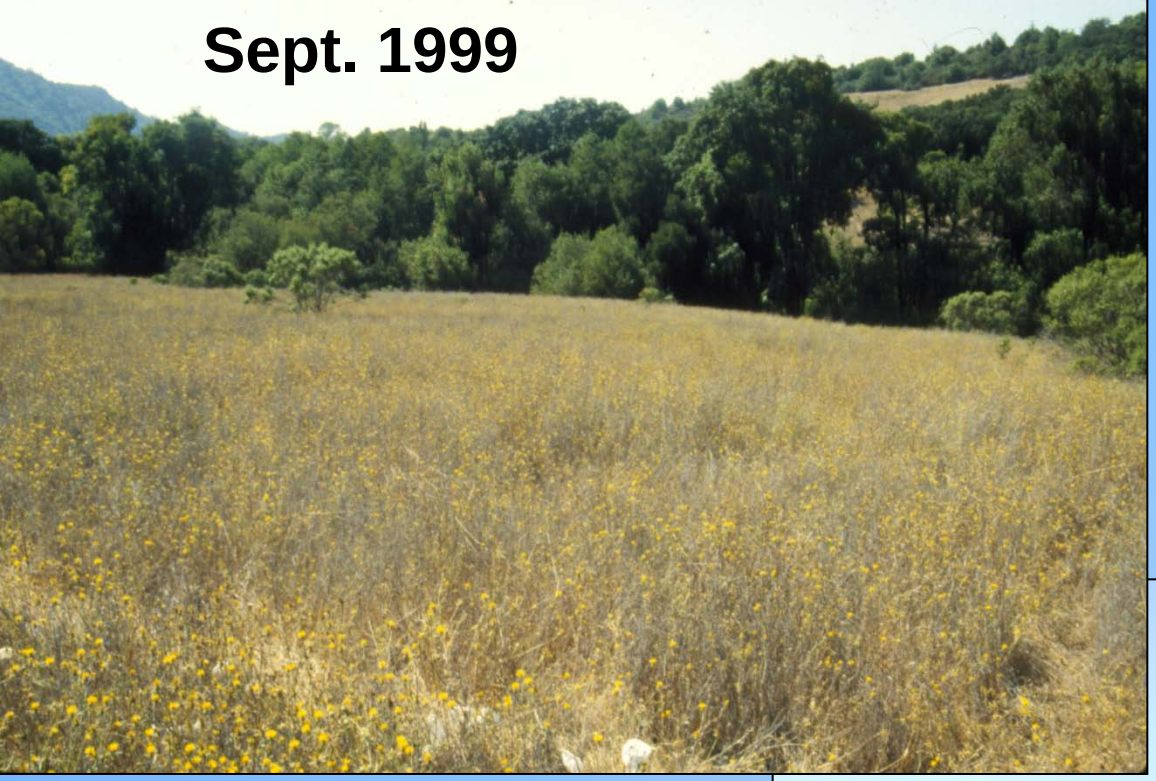
False Peacock Fly

Recovered at 99% of locations
Mean attack rate: 53%
Range: 0 - 96%



R. Yacoub & M. Pitcairn (CDFA)

Yellow Starthistle, Sonoma County



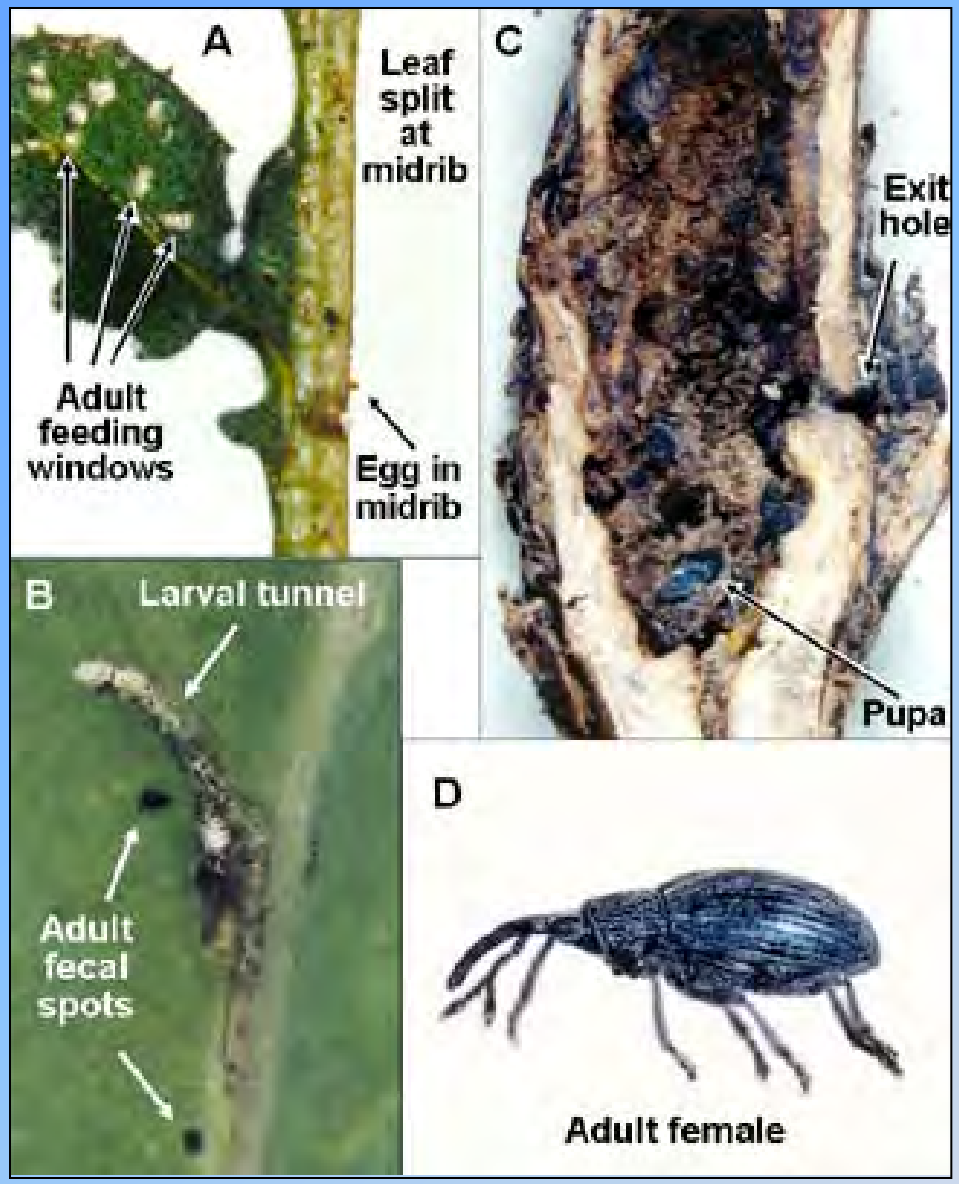
Sept. 2003

Hairy weevil, false peacock fly & not grazed by cattle

Dale Woods, CDFA

Life Cycle of *Ceratapion basicorne* (Apionidae)

YST rosette weevil

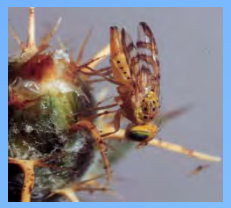


rosette

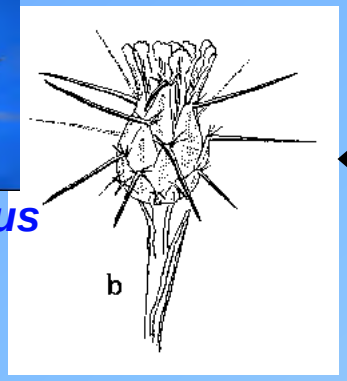
bolted plant

Other Prospective Agents

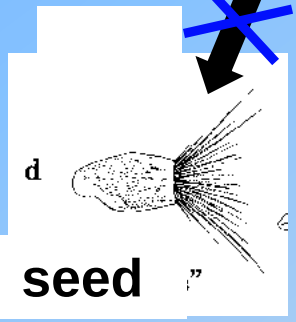
Eustenopus villosus



Chaetorellia succinea

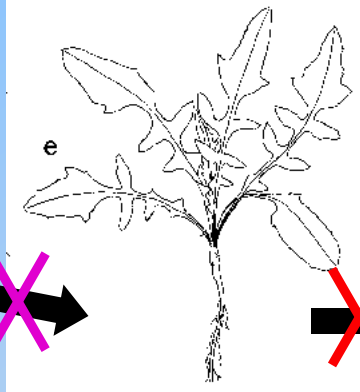


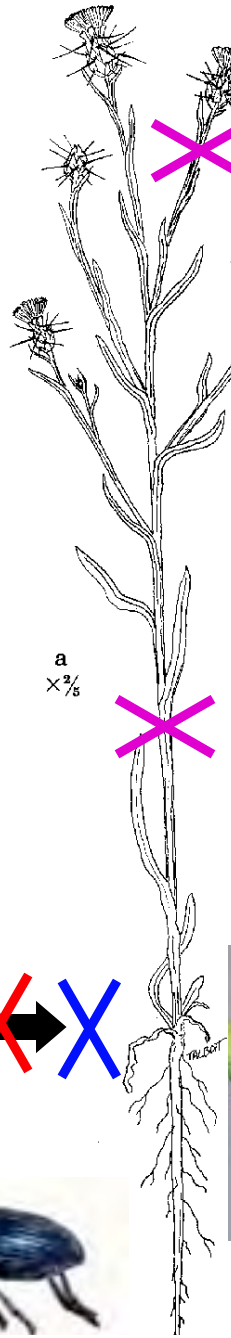
flower head



seed

Larinus filiformis





rosette

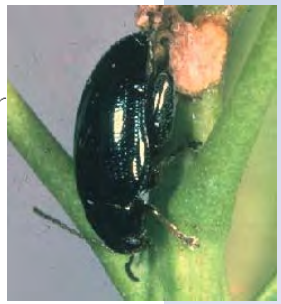
Ceratapion basicorne

Botanophila turcica

Aceria solstitialis

Rust
Puccinia jacea
var *solstitialis*

Tingis grisea



Psylliodes chalcomera

Russian thistle

Salsola australis

Salsola collina

Salsola gobicola

Salsola tragus

Salsola ryanii

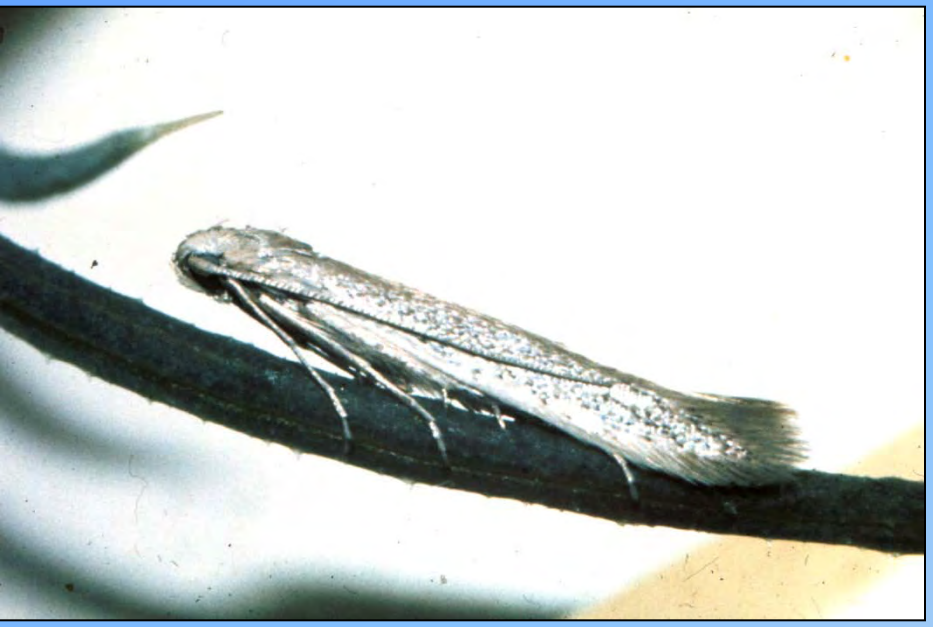
Salsola paulsenii

[not *S. kali*]

Hrusa & Gaskin. 2008. Madroño 55(2) 113–131.

Russian Thistle Casebearer

Coleophora klimeschiella



Russian Thistle Stem Miner

Coleophora parthenica

Russian Thistle Blister Mite

Aceria salsolae (Acari: Eriophyidae)

on human eyelash

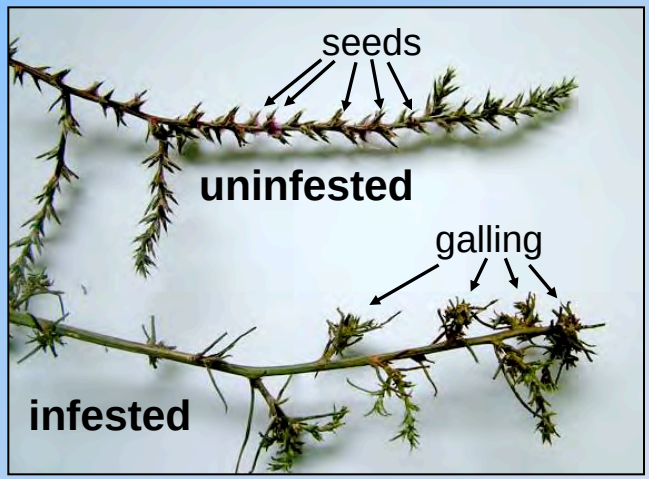
scanning electron micrograph

Damage to *Salsola tragus* by *Aceria salsolae*

Impact of mite on *Salsola tragus* (Field Expt., Sept. 2007, Italy)

S. tragus
(uninoculated)

S. tragus
(inoculated)



Inoculated plants had 20% the weight of uninoculated plants and no seeds

Smith et al. 2009. Biological Control 48: 237-243

Field Experiment in Rome, Italy

No damage to nontarget plants: *Bassia hyssopifolia, Kochia scoparia, Suaeda calceoliformis*

Future Agents for Russian thistle

- **Blister mite**, ***Aceria salsolae***
- **Seed-feeding caterpillar**, ***Gymnancyla canella***
- **Weevils**, ***Baris przewalskyi, Salsolia morgei,*** **Kazakhstan**
- **Rust fungus**, ***Uromyces salsolae,*** **Turkey — petition to TAG 2009**
- **Fungus**, ***Colletotrichum salsolae,*** **Hungary — petition to TAG 2013?**

M. Cristofaro, BBCA / ENEA, Rome, Italy
M. Dolgovskaya (Russian Academy of Sciences)
W. Bruckart, D. Berner, USDA-ARS, Frederick, MD

Cape ivy - (*Delairea odorata)*

Gall forming fly

Parafreutreta regalis

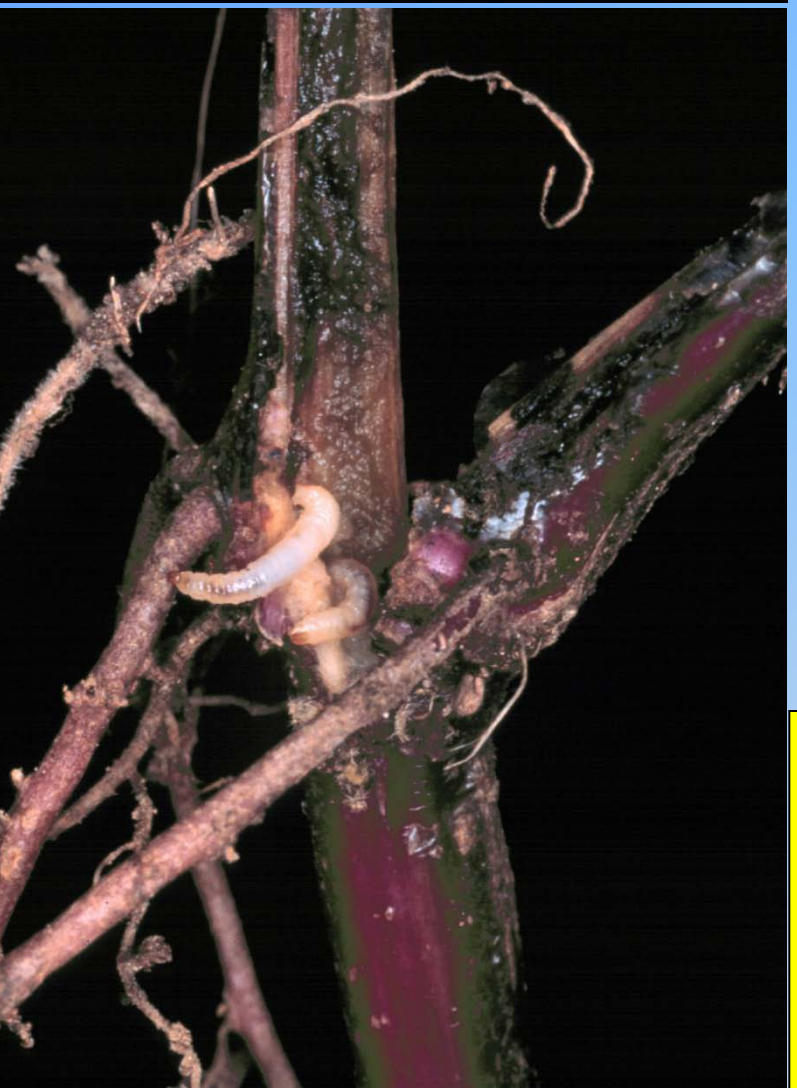
(Diptera: Tephritidae)

Petition submitted to APHIS in 2009

TAG recommended approval in 2012

APHIS processing permit application

Patrick Moran,
Joe Balciunas (retired),
Angelica Reddy, John Herr
USDA-ARS, Albany



Leaf mining and stem boring moth

Digitivalva delaireae

(Lepidoptera: Plutellidae)

Petition submitted to APHIS in 2009

TAG recommended approval in 2013

APHIS processing permit application

Patrick Moran,
Joe Balciunas (retired),
Angelica Reddy, John Herr
USDA-ARS, Albany

French broom

(*Genista monspessulana*)

psyllid

Arytinnis hakani

Evaluated for release in Australia.

Kills Fr. broom in Australia.

27 lupine species have been tested.

Can develop on some lupines.

Ongoing host specificity testing.

French broom killed by psyllid (*Arytinnis hakani*) in Australia

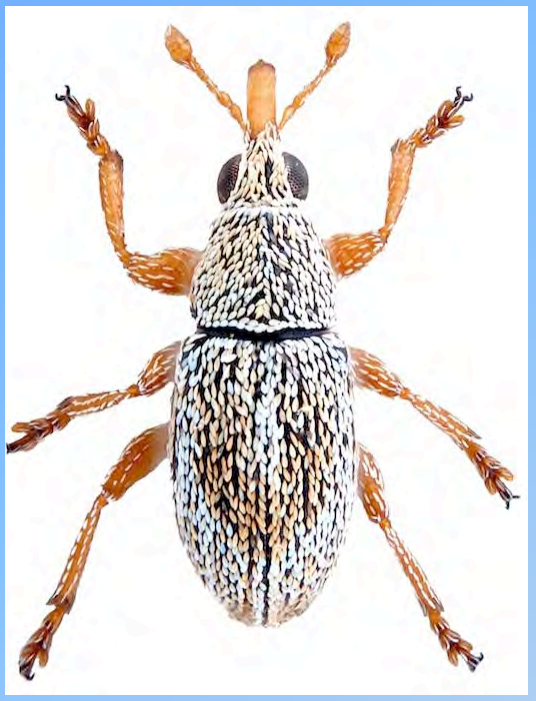
4 Sept. 2009, A. Sheppard, CSIRO

French broom

(*Genista monspessulana*)

seed-feeding weevil

(*Lepidapion* nr *argentatum*)



- Larvae feed inside seed pods.
- Adults eat flowers and pollen.
- Only found attacking French broom.
- Beginning to test in France.

image from:
http://www.gonhs.org/Lepidapionargentatum.htm

Onopordum acanthium

Seedhead weevil
Larinus latus

Stem-boring weevil
Lixus cardui

Rosette weevil
Trichosirocalus briesei

Evaluation of BC Agents for Arundo

Stem tip-galling wasp *Tetramesa romana* - adventive in So. Cal.; released in northern CA in 2010; poss. established

Root- and stem-feeding armored scale *Rhizaspidiotus donacis* - first released in CA in 2013

Evaluation of the planthopper *Megamelus scutellaris* - a new biological control agent of water hyacinth

Releases have occurred at three sites in the California / Sacramento Delta

Rearing colonies

Invaded canal, Sacramento Delta

Field survey, Whiskey Slough

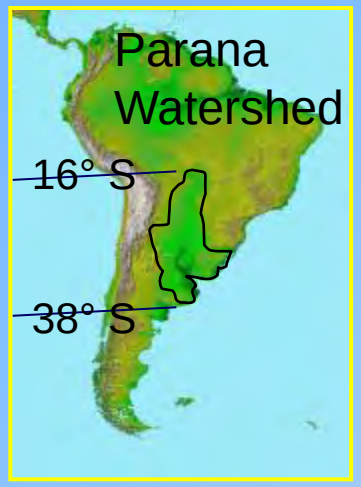
Future: Biological Control?

Altica litigata (Coleoptera: Chrysomelidae) Water flea beetle

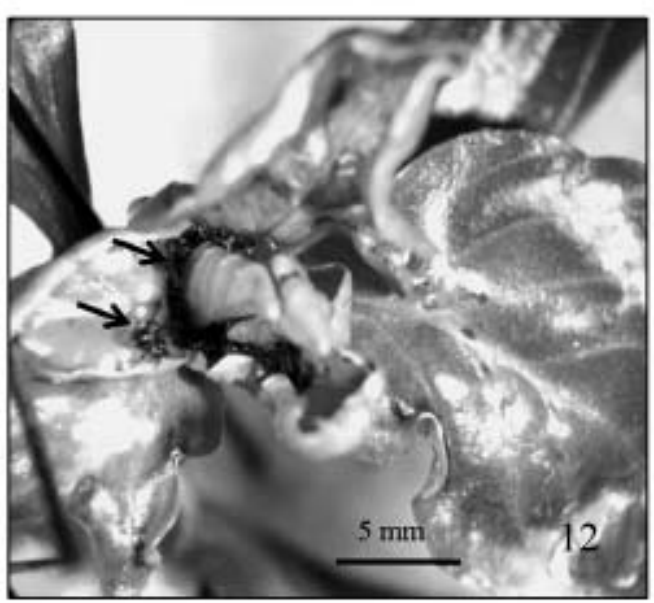
Resident water flea beetle feeding on *Ludwigia hexapetala*, Delevan National Wildlife Refuge, and on *Ludwigia peploides* Gray Lodge Wildlife Area, Butte County 2009

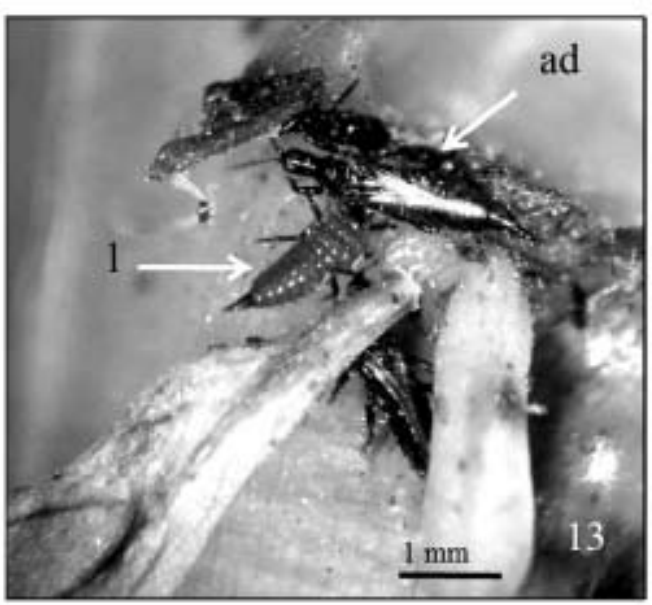
Carruthers et al. 2011. Chemoecology 21:253-259.

Liothrips ludwigi (Thysanoptera: Phlaeothripidae) Prospective Agent of Primrose-Willows *Ludwigia hexapetala* and *L. peploides*



Host specificity and potential impact are being studied in Argentina





Zamar et al. 2013. [A new Neotropical species of *Liothrips* (Thysanoptera: Phlaeothripidae) associated with *Ludwigia* (Myrtales: Onagraceae).] Revista de la Sociedad Entomológica Argentina vol.72 no.1-2.