Current Research at the European Biological Control Laboratory

Lincoln Smith

USDA, Agricultural Research Service

Montpellier, France

Biological Control of Invasive Weeds

- **Is it safe? Is it effective?**

  Smith. 2007. Biocontrol 101: Classical biological control of weeds. Cal-IPC Newsletter 17(4): 4-7.

- **What is available in California?**

  Pitcairn et al. 2014. Weed Biological Control Agents Approved for California. Cal-IPC Newsletter 22(1): 6-7, 12-13.

- Smith et al. 2014. **Biological Control of Weeds**. *In*: S. Fennimore and C. Bell (eds.), ***Principles of Weed Control***, 4th edition. California Weed Science Society, Thompson Publications, Fresno, CA, pp. 84-115.

St. Johnswort (*Hypericum perfoliatum*)

- Released 4 insects in 1940s-50s,
- extensive control
- still continuing

How to Control an Invader ?

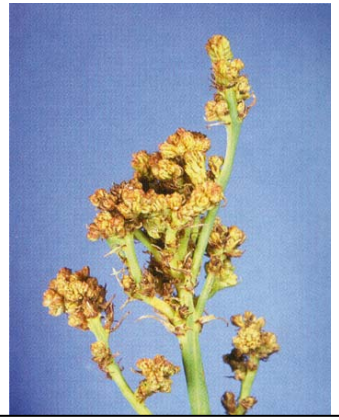
- Herbicides
- Controlled burns
- Mowing
- Grazing management
- Planting competitors
- Hand-pulling
- Biological control

Appropriate targets

- Alien species.
- No close relatives that are native.
- Widespread (not feasible to eradicate).
- Not manageable by other methods.
- Important enough to sustain a 10-20 year project ($5 to $10 million total).

Historical Successes in Pacific West

- Klamathweed
- Tansy ragwort
- Mediterranean sage
- Puncturevine
- Rush skeletonweed



Australia: 23:1 benefit-to-cost ratio for all 36 projects

European Biological Control Laboratory

Quarantine for insects and pathogens

Field garden experiments

Glasshouses

EBCL labs in France and Greece

Other USDA-supported labs:

Argentina – South American Biological Control Laboratory (FuEDEI)
Australia – Australian Biological Control Laboratory
China - Sino-American Biocontrol Lab

★**CABI** – Delemont, Switzerland

Collaboration with CABI, BBCA (Italy) & foreign scientists

CSIRO	EBCL	CABI
French broom	**French broom**	Canada thistle
	giant reed	common reed
	medusahead	common tansy
rush skeletonweed	**rush skeletonweed**	dyer's woad
	Russian thistle	field bindweed
	saltcedar	garlic mustard
Scotch thistle	**Scotch thistle**	hawkweeds
	yellow starthistle	houndstongue
		Japanese knotweed
		oxeye daisy
		perennial pepperweed
		Russian knapweed
		Russian olive
		toadflax
		whitetop

Weed Targets

French broom (*Genista monspessulana*)

Giant reed (*Arundo donax*)

Hoary cress (*Lepidium draba*)

Medusahead (*Taeniatherum caput-medusae*)

Yellow starthistle (*Centaurea solstitialis*)

Also support:

African wire grass (*Ventenata dubia*)

Russian thistle (*Salsola tragus*)

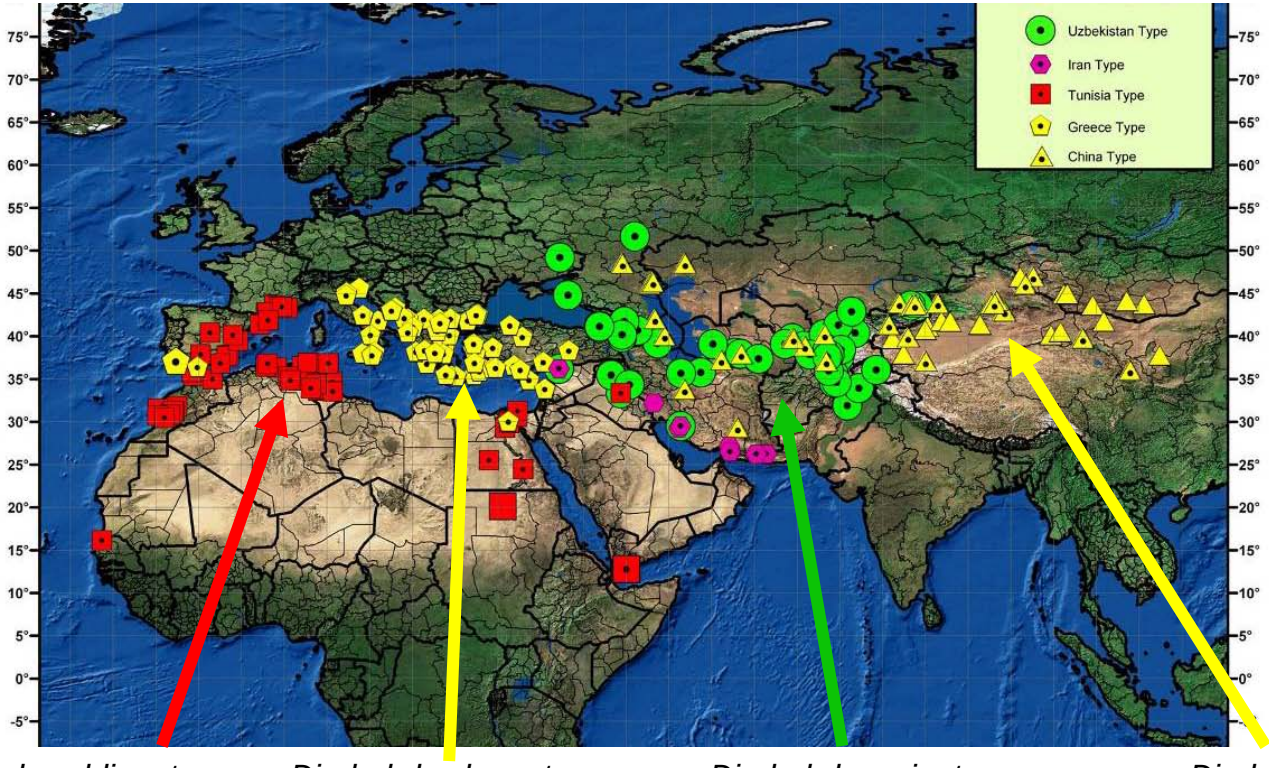
Saltcedar (*Tamarix* spp.)

Scotch thistle (*Onopordum* spp.)

Swallow-worts (*Vincetoxicum* spp.)

? Sahara mustard (*Brassica tournefortii*)

Four closely related flea bettle species for saltcedar control



Diorhabda sublineata *Diorhabda elongata* *Diorhabda carinata* *Diorhabda carinulata*

Tunisia

Crete

Uzbekistan

Chilik, Fukang, Turpan

courtesy: Dan Bean, Colorado Dept. of Agriculture

Saltcedar leaf beetle

Diorhabda carinulata from China

defoliates *Tamarix ramosisima*

Southwestern Willow Flycatcher (SWFL)

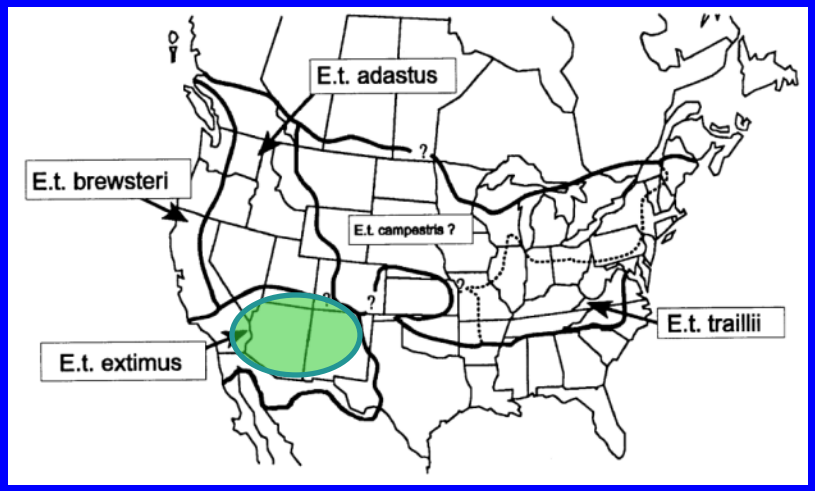
(*Empidonax traillii extimus*) listed as Endangered Species in 1995

Reasons: Loss of Cottonwood/Willow vegetation

Tamarix Invasion listed as major factor in decline

Nests in about 40 species of native trees and shrubs but can nest in *Tamarix*, mixed stands

(parts of Arizona, New Mexico, Nevada, Utah)



Giant Reed (*Arundo donax*)

Glen county CDFA gall wasp release site

Biological Control Agents for Arundo

Stem tip-galling wasp

Tetramesa romana

adventive in southern CA;
Released in TX in 2007;
20% decrease biomass in 5 yrs

Root- and stem-feeding armored scale

***Rhizaspidiotus donacis* -**

Released in TX, CA

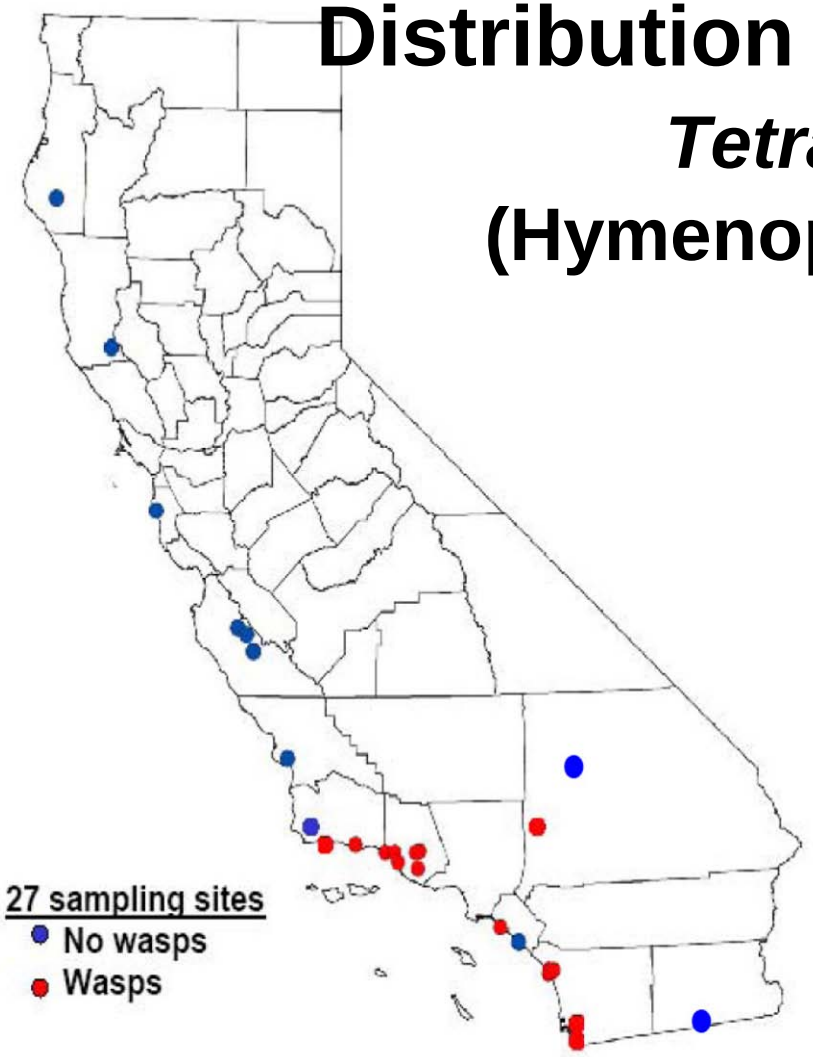
Goolsby et al. 2015. Biocontrol Science and Technology

Arundo insects found in California

Distribution of Arundo wasp (2004)

Tetramesa romana

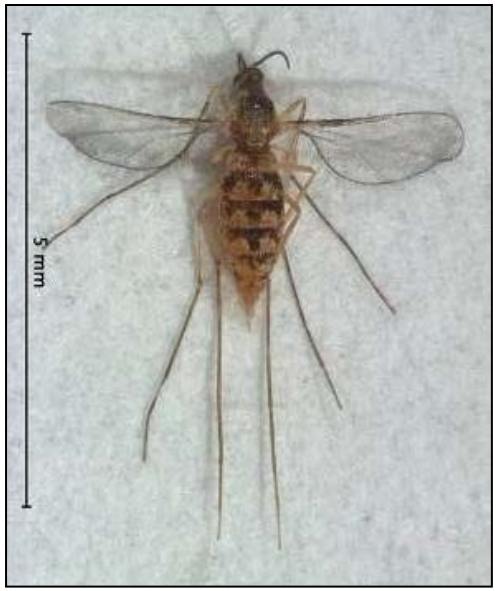
(Hymenoptera: Eurytomidae)



infested 0-80% of stems

Tom Dudley, Adam Lambert,
Alan Kirk, and Yoshi Tamagawa,
U.C. Santa Barbara

Arundo leafminer (*Lasioptera donacis*)



Petition was submitted to USDA-APHIS and is under review.

J. Goolsby, USDA-ARS, Edinburg, TX

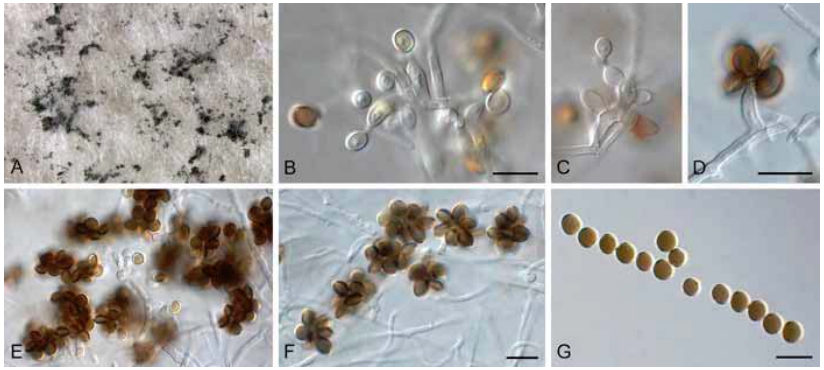
✓First & recent observation of 2 ovipositors with spores

✓Shipped to EBCL for gene sequencing from individual spore

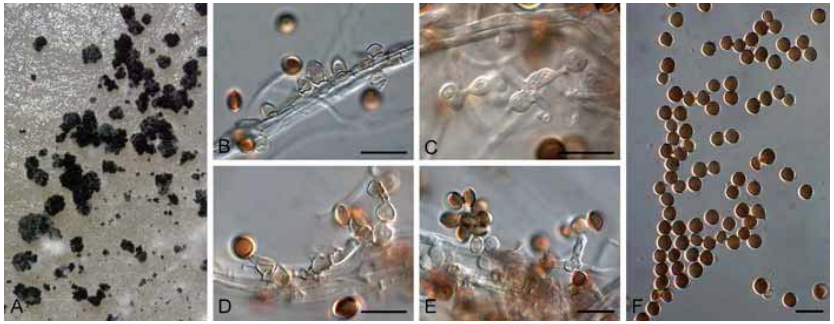
Photo: Donald Thomas, ARS-TX

- Two taxa found associated with egg masses, ovipositors and 1st instar larvae

Arthrinium arundinis

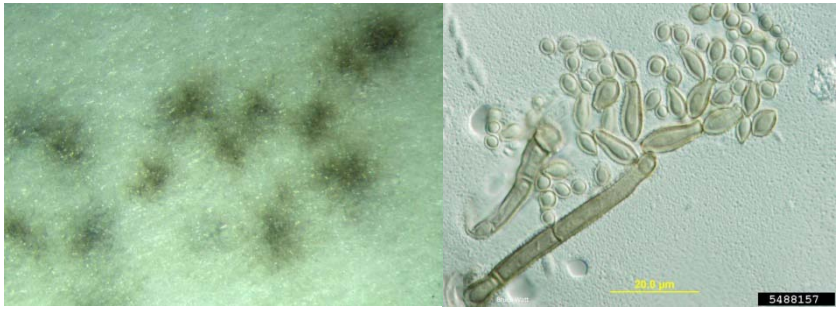


Arthrinium malaysianium

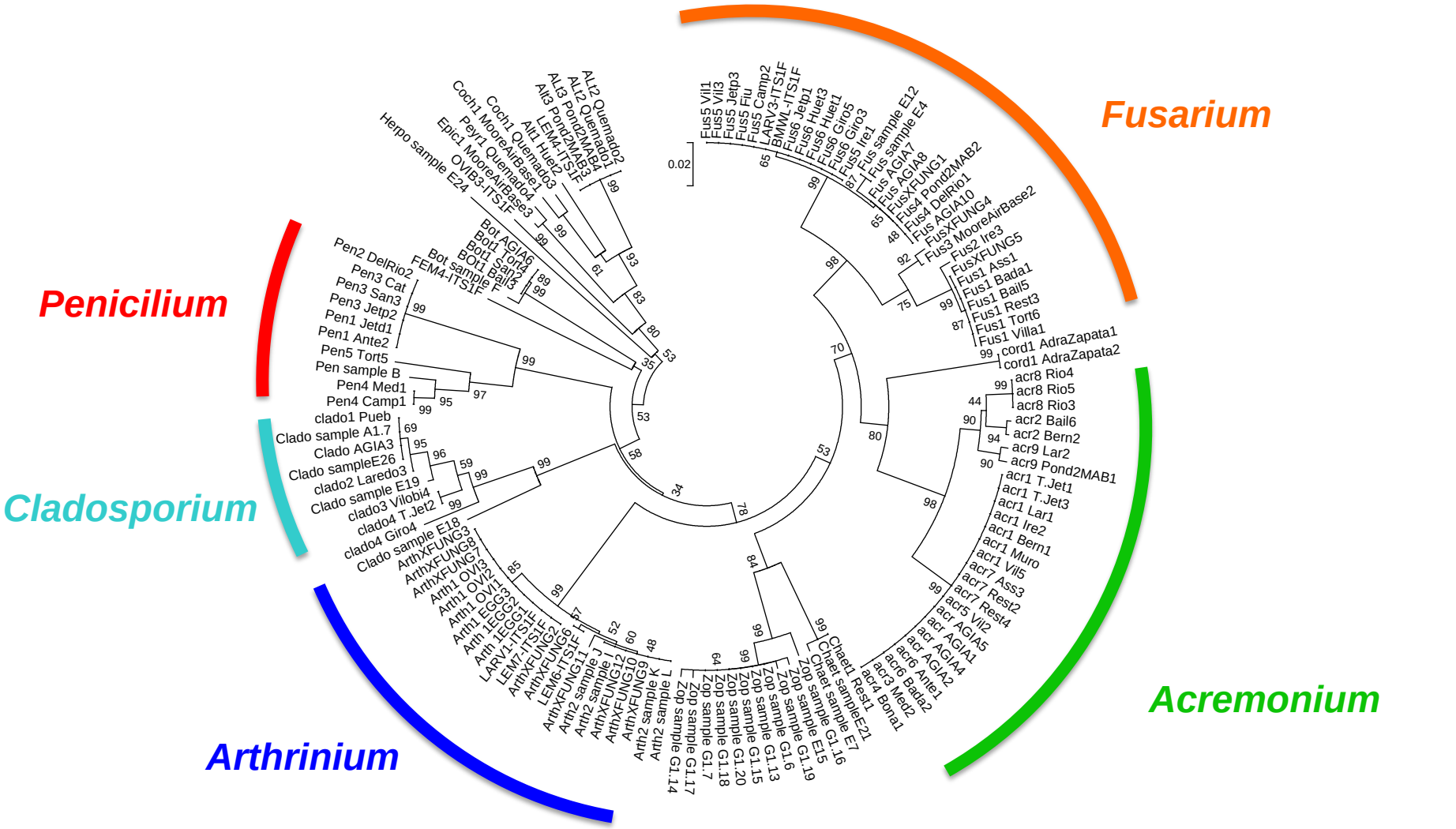


- One taxon found associated with ovipositors

Cladosporium sp.



Study of the Molecular Operational Taxonomic Units (MOTUs) richness and their abundance in the mycobiota associated with *Lasioptera galleries in Giant reed*



- The mycobiota recovered from *Lasioptera* galleries were dominated by "endophytes": *Fusarium* (36%), *Acremonium* (28%) and *Penicilium* (16%) but no particular fungal taxon

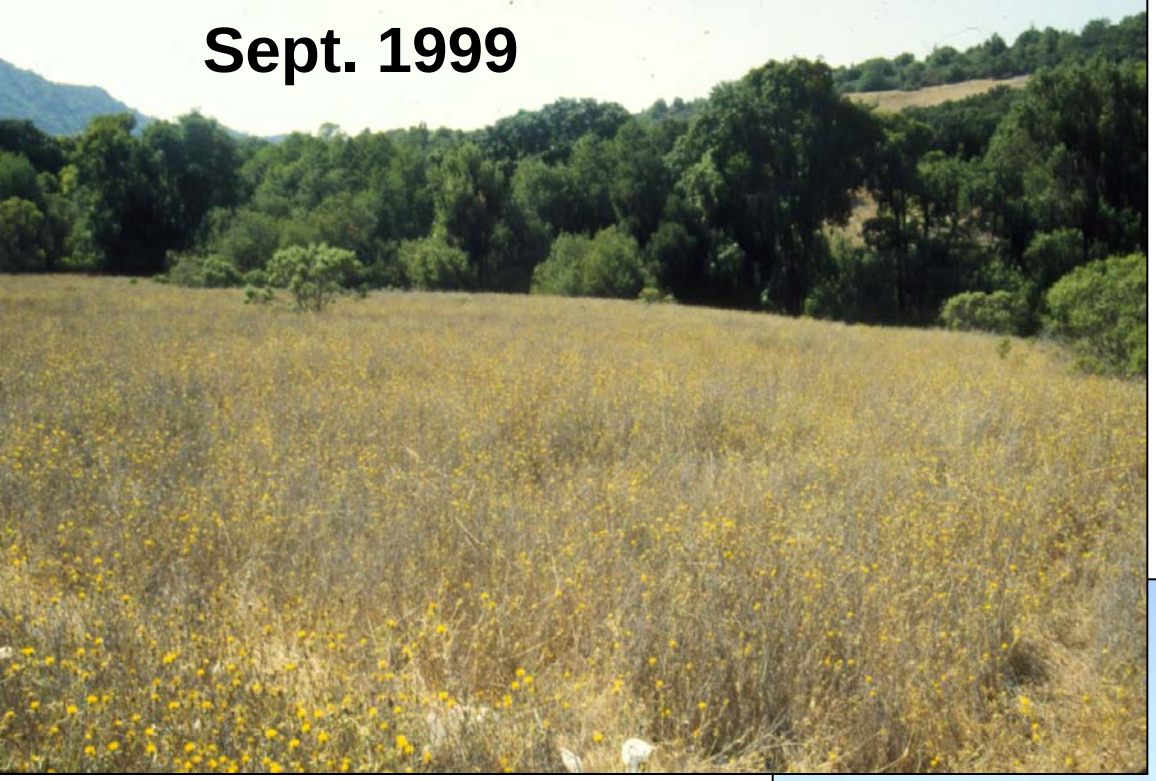
Starting to evaluate **Arundo fly** *Cryptonevra* sp.

Larva kill new shoots

J. Goolsby, USDA-ARS, Edinburg, TX

Yellow Starthistle

Centaurea solstitalis

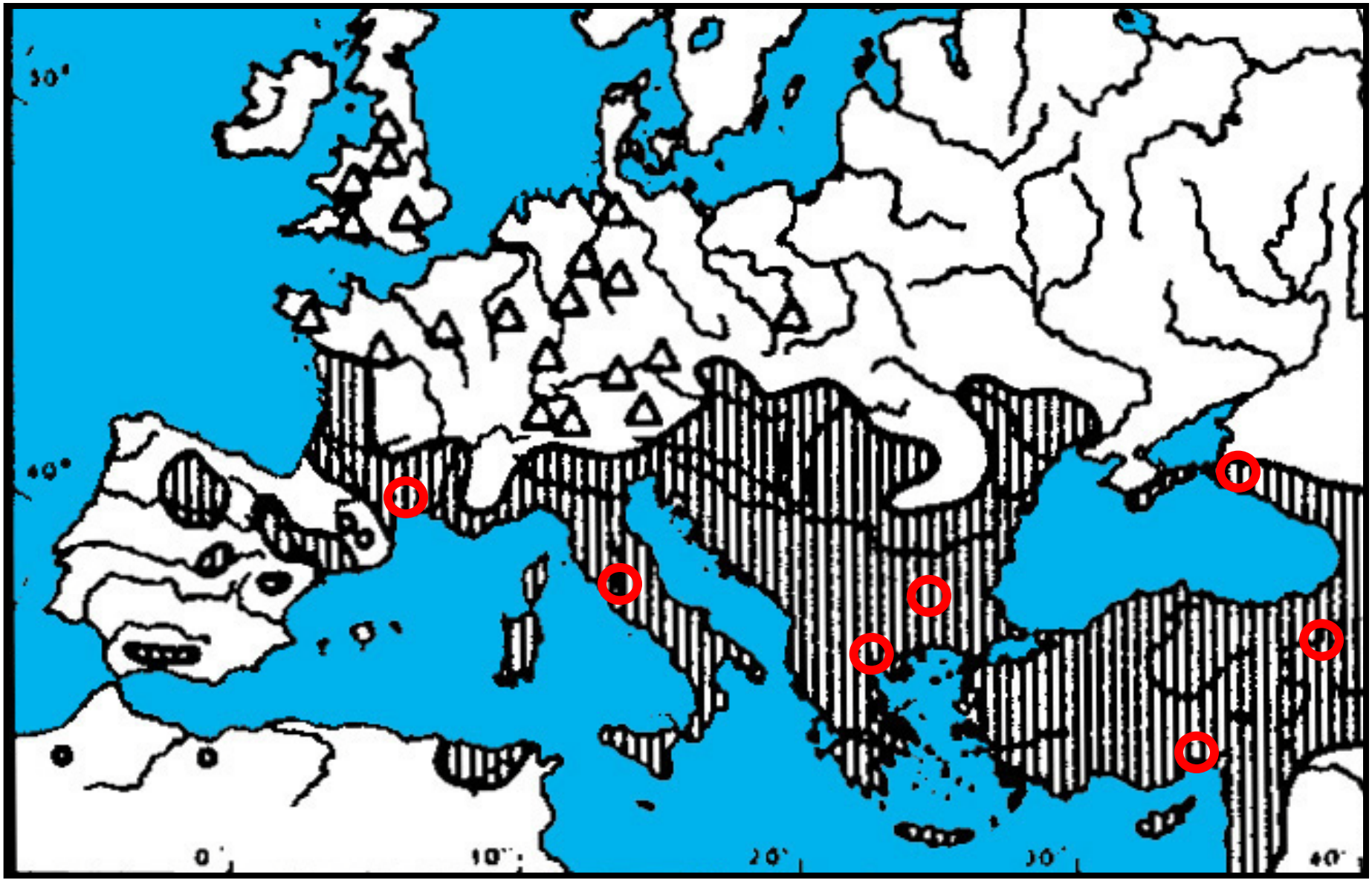


Yellow Starthistle, Sonoma County

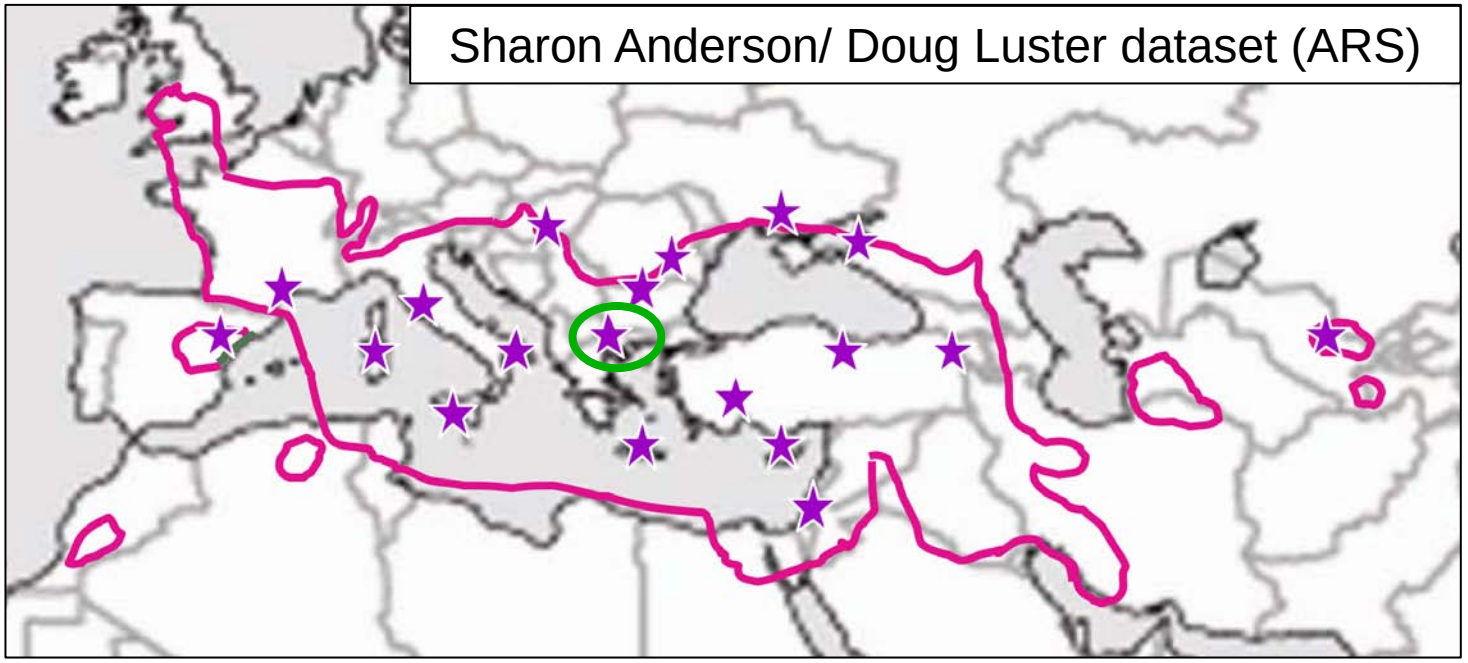
Hairy weevil, false peacock fly & not grazed by cattle

Dale Woods, CDFA

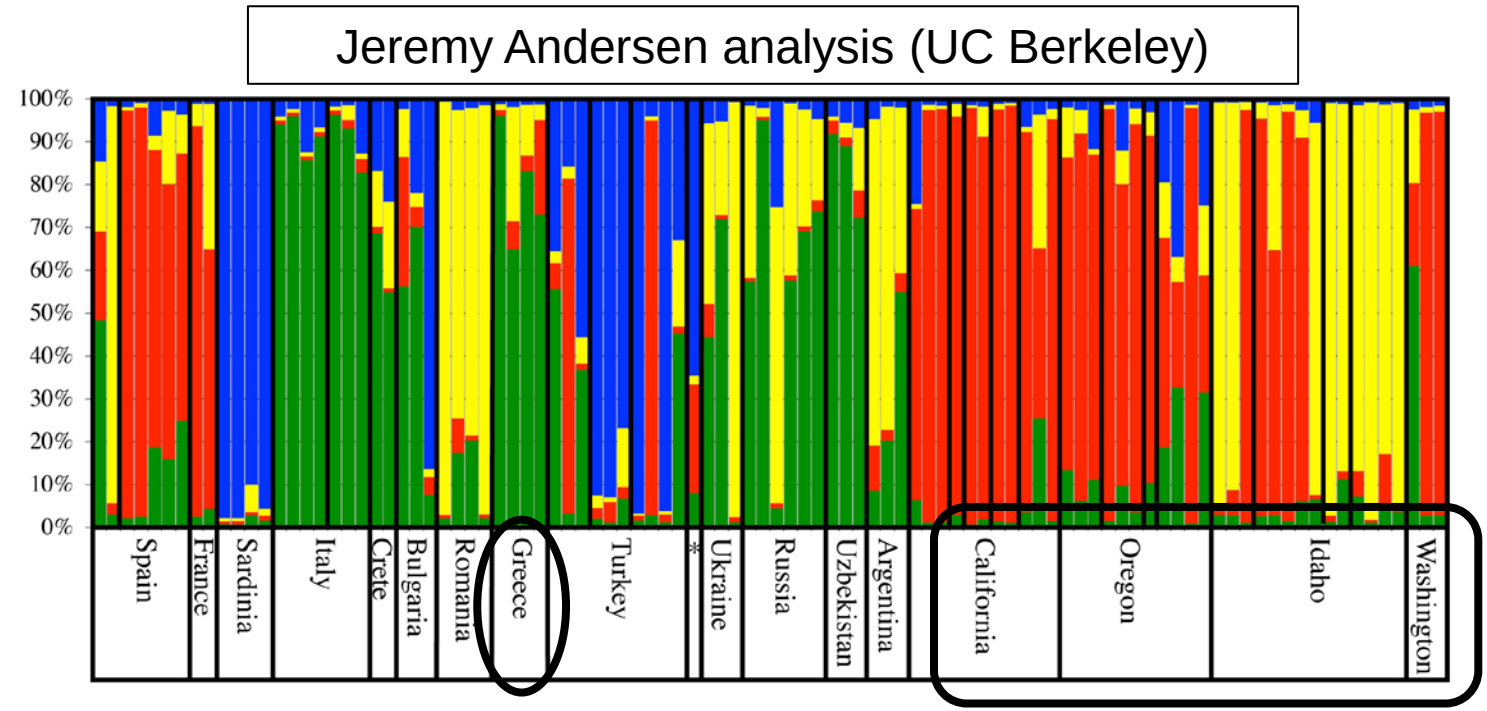
Distribution of Yellow Starthistle in Europe



Foreign cooperators

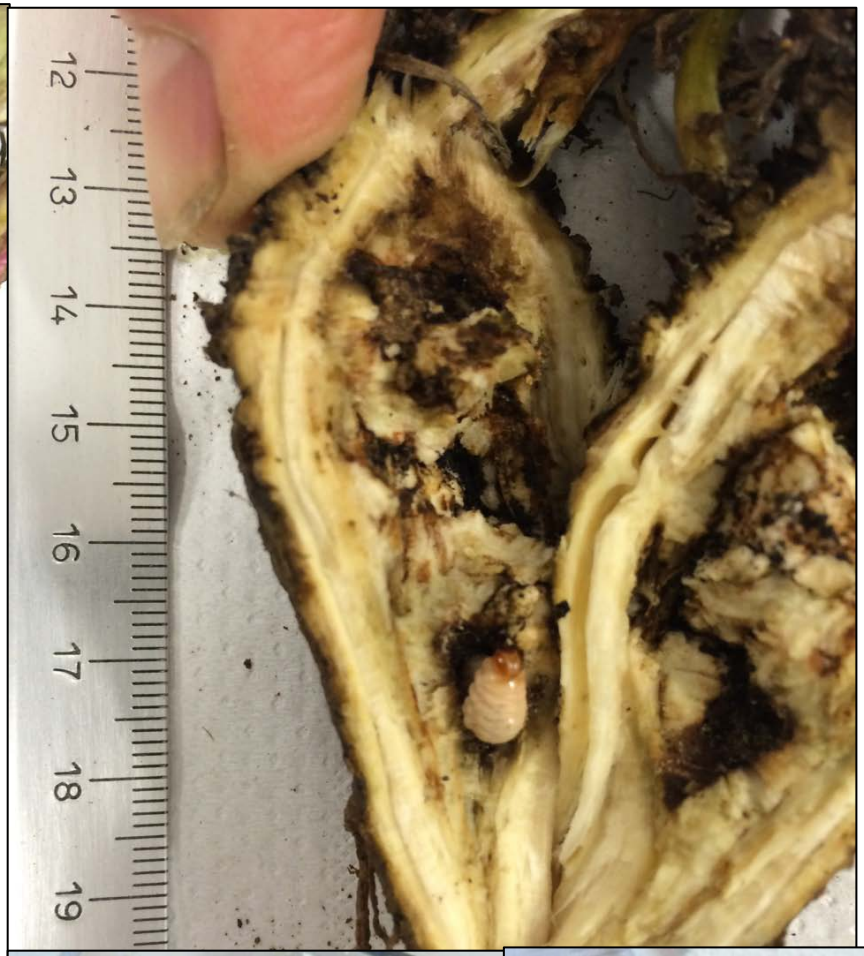


All insects introduced to USA from Greece



USA plants similar to France & Spain

YST Exploration in France & Spain



? Pseudocleonus grammicus

YST Exploration in France & Spain

? Isocolus sp.

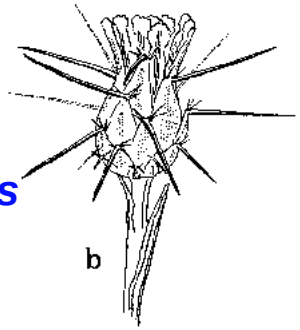
YST Exploration in France & Spain

Other Prospective Agents

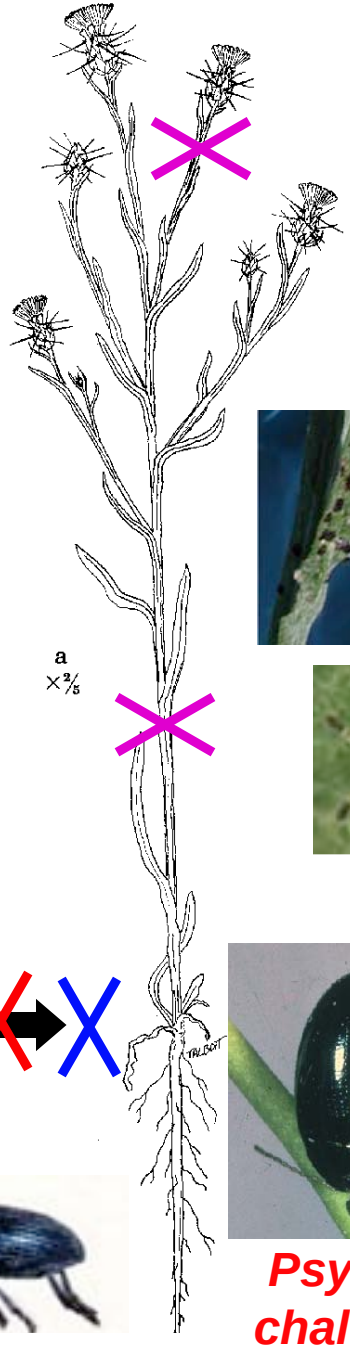
Eustenopus villosus

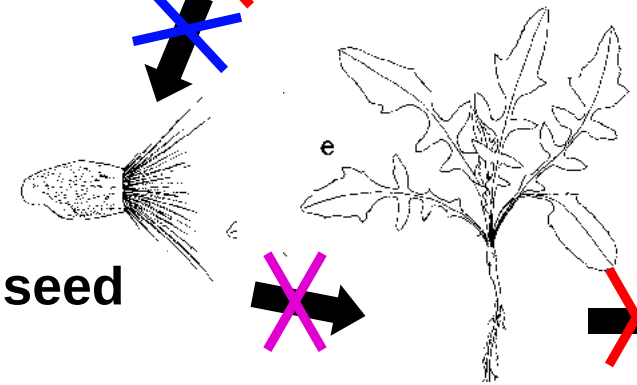
Chaetorellia succinea

Larinus filiformis



flower head





seed

rosette

Ceratapion basicorne

Botanophila turcica

Aceria solstitialis

Rust

Puccinia jacea* var *solstitialis

Tingis grisea

Psylliodes chalcomera

Host Specificity Field Tests in Turkey at two sites
Yellow Starthistle and Scotch Thistle

Ibrahimpasha field

Kayseri field

BBCA collected and released a YST and Scotch thistle biological control agent and monitored attack rates.

Hoary Cress: *Lepidium draba*

Lepidium draba ssp. *draba*

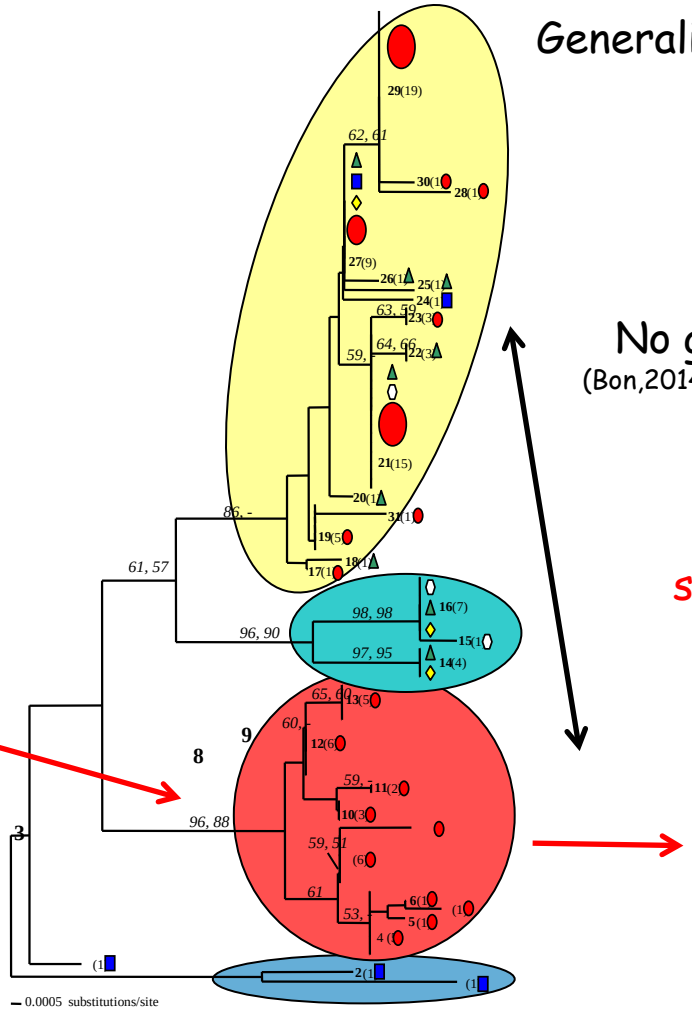
Brassicaceae

Molecular Genetics to Distinguish Cryptic Species

Lepidium draba (Brassicaceae)

Targeted galling insect:
Ceutorhynchus assimilis

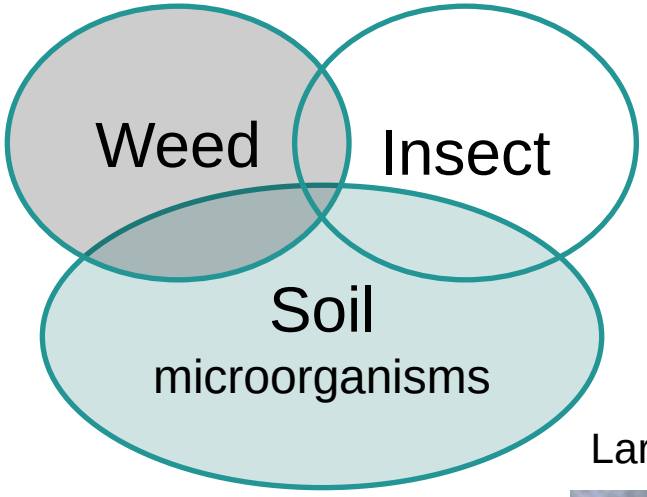
One host race strictly associated with *L. draba* & distributed in Southern France/Northern Spain



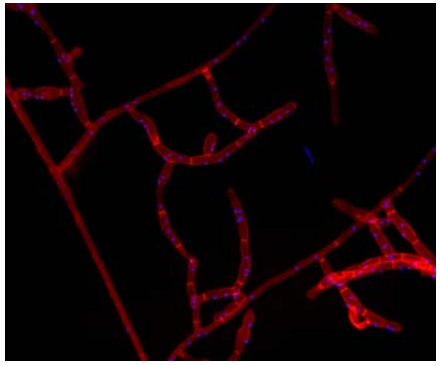
Fumanal et al., 2005 COI Phylogeography

Marie-Claude Bon

Biocontrol strategy



Ceutorhynchus assimilis, highly specific to this plant



Native or introduced root-pathogens

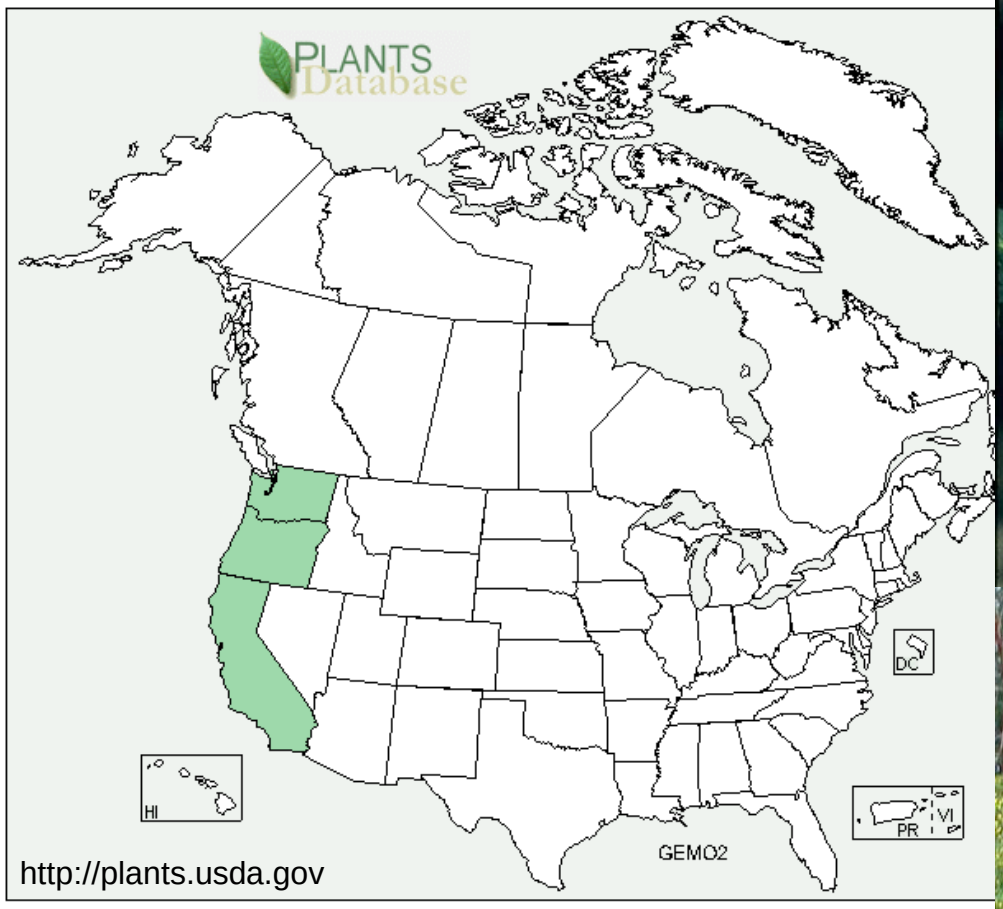
> A pathogenic fungi : ***Rhizoctonia***

Larvae develop in galls

Do soil microorganisms increase the impact of a root-feeding weevil?

French Broom (*Genista monspessulana*)

Genista monspessulana (L.) L.A.S. Johnson



View Native Status

Present

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

4 Sept. 2009, A. Sheppard, CSIRO

French broom

(*Genista monspessulana*)

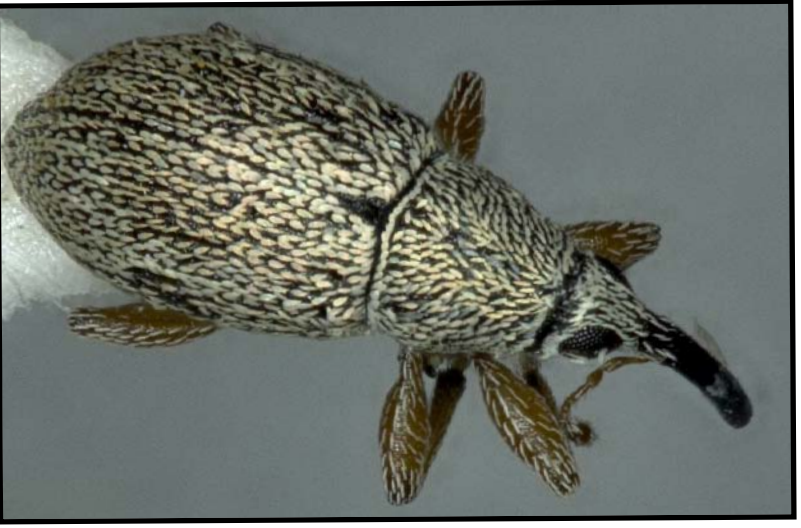
psyllid

Arytinnis hakani

Kills Fr. broom in Australia.

27 lupine species have been tested.

Can develop on some lupines.



French broom weevil *Lepidapion argentatum* (Col.: Apionidae)

R. Sforza (EBCL), T. Thomann (CSIRO)

Develops in seeds ...

and in stem galls

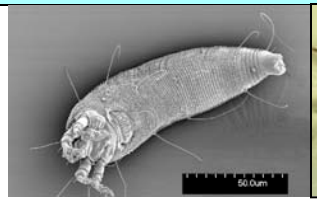
René Sforza

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.

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 2014**

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

Russian Thistle
Exploration in Eastern Europe & Western Asia

M. Cristofaro (BBCA), L. Gultekin (Ataturk U.)

Hypolixus reitteri

Baris przewalskyi

Ulobaris loricata

Sphenoptera sp.

Medusahead (*Taeniatherum caput-medusae*)

T. caput-medusae **T. asperum** **T. crinitum**

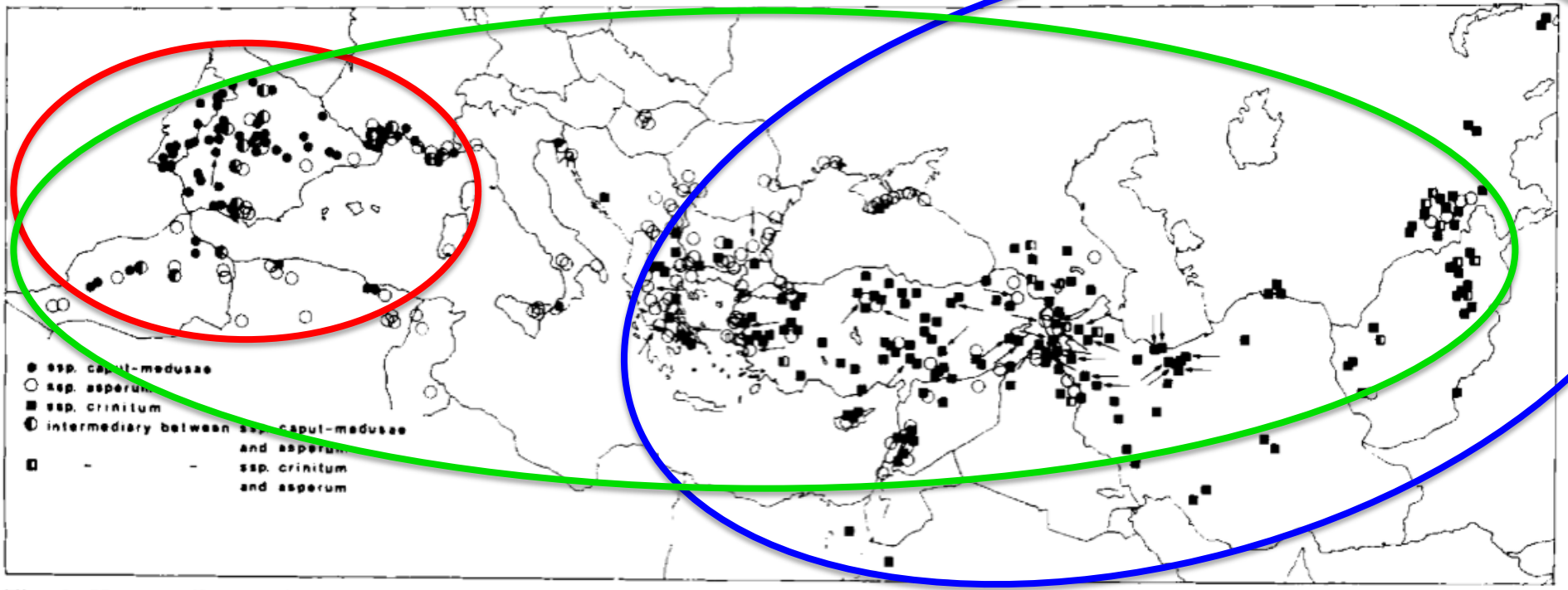


Fig. 8. Known distribution of *Taeniatherum*. Arrows indicate populations from which chromosome numbers (2n=14) have been determinated.

Nord. J. Bot. 6 (4) 1986

Frederiksen S. 1986. Revision of *Taeniatherum* (Poaceae). Nordic Journal of Botany 6(4):389-397.

Eriophyid mite on medusahead

= cheatgrass mites found

= medusahead mites found

= presumed medusahead center of origin

Brian Rector, BBCA & cooperators

Medusahead project

Collections in Turkey (May-June) and Crimea (Ukraine) (July)

- Seed feeder flies and weevils
- Biology and behavior of the two species

unknown - studies to be processed in 2016

Dicraeus sabrovskyi
(Dipt., Chloropidae)

Pachytychius hordei squamosus (Col.: Curculionidae)

EBCL staff March 2015

Cape ivy - (*Delairea odorata)*

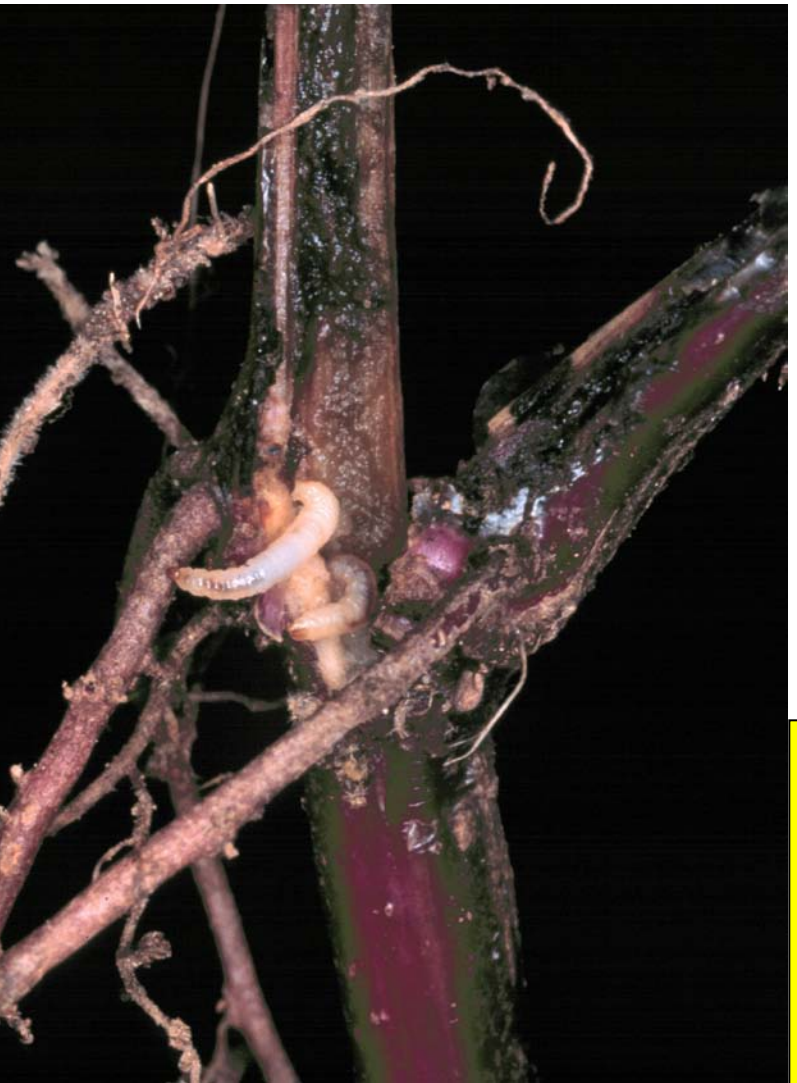
Gall forming fly
Parafreutreta regalis
(Diptera: Tephritidae)

Petition submitted to APHIS in 2009

Revised in 2012

In review

Joe Balciunas (retired)
Patrick Moran
USDA-ARS, Albany



Leaf mining and stem boring moth

Digitivalva delaireae

(Lepidoptera: Plutellidae)

Petition submitted to APHIS in 2009

Revised in 2012

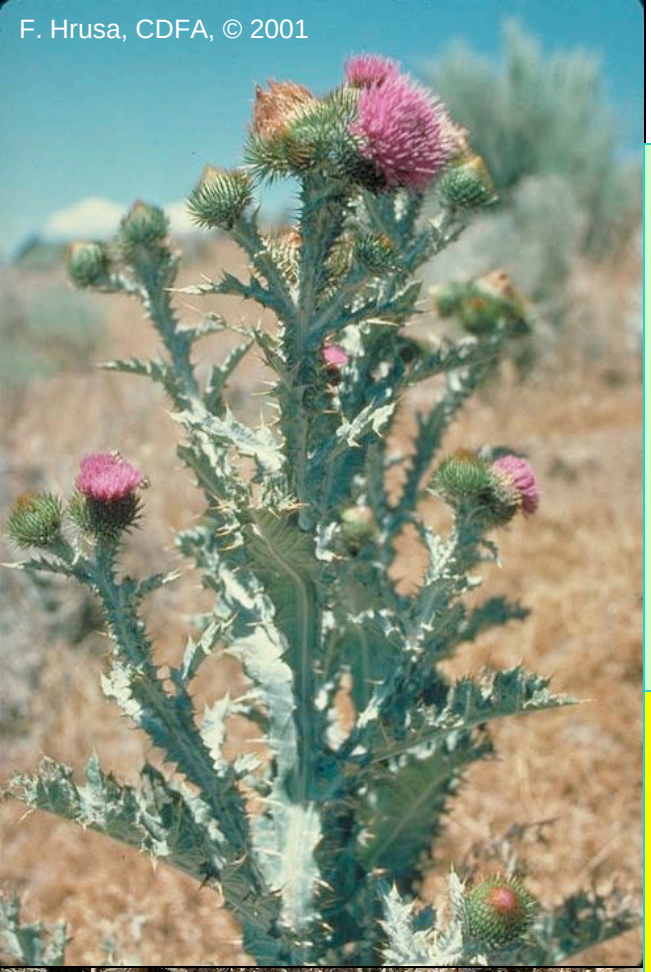
TAG 'Approved' 2013

Permit application

Joe Balciunas (retired)

Patrick Moran

USDA-ARS, Albany



Onopordum acanthium

Seedhead weevil

Larinus latus

Stem-boring weevil

Lixus cardui

Rosette weevil

Trichosirocalus briesei

Water hyacinth (*Eichhornia crassipes*)

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

Well established at 1 site in the Delta

Patrick Moran
USDA-ARS, Albany, CA

Rearing colonies

Invaded canal, Sacramento Delta

Field survey, Whiskey Slough