Utility of Field Experiments in Land of Origin to Measure Host Plant Specificity and Potential Efficacy of Prospective Arthropod Biological Control Agents of Weeds

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Yellow Starthistle (Centaurea solstitialis)

Distribution of Yellow Starthistle by County in the Western United States


1997 Status
- Present (surveyed, found)
- Absent (surveyed, not found)
Goats Grazing Yellow Starthistle in Briones Park, California
Life Cycle of *Ceratapion basicorne* (Apionidae)

- **A** Leaf split at midrib
- **B** Larval tunnel
- **C** Exit hole
- **D** Adult female

- rosette
- bolted plant
Distribution of *Ceratapion basicorne*
Reported host plants of *Ceratapion basicorne* collected in the field

**Adults reared from:**

*Centaurea solstitialis* L. ¹,²,³,⁴ ——— YST

*Centaurea cyanus* L. ² ——— bachelor’s button

*Centaurea depressa* M.Bieb. ⁴

*Cnicus benedictus* L. ⁴ ——— (now *Centaurea*)

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¹ Alonso-Zarazaga (1990a)
² Wanat (1994)
³ Campobasso et al. (1999)
⁴ J. Balciunas (unpubl. data)
Tribe Cardueae

Subtribes

Echinopsidinae

- Echinops
  - Xeranthemum
  - Staehelina
- Atractyloideae
  - Atractylis
  - Carlina
- Berardia
  - Saussurea
  - Jurinea
  - Cousinia
  - Onopordum
    - Galactites
      - Cirsium
        - Carduus
          - Pilosetemon
            - Cynara
              - Cardhamus
                - Centaurea
                  - Volutaria
- Echinopsidinae
  - Echinops
- Carliniinae
  - Carlina
- Carluinae
  - Saussurea
  - Jurinea
  - Cousinia
  - Onopordum
- Carluinae
  - Saussurea
  - Jurinea
  - Cousinia
  - Onopordum
- Carluinae
  - Saussurea
  - Jurinea
  - Cousinia
  - Onopordum

Native thistles

- Artichoke
- Safflower
- Basket flowers

Sawworts

Bachelor's button

Bremer (1994)
No-choice Oviposition Experiment
1 female *Ceratapion basicorne* in tube for 5 days
Choice Oviposition Experiment

1 female Ceratapion basicorne in sleevebox for ≥5 days
Host Specificity Results

No-choice oviposition
Oviposits on many Centaureinae, few Cardueae
Develops on *Ce. cyanus*, safflower,
NOT on *Ce. americana*, *Ce. rothrockii*

Choice oviposition
Trace on safflower, low on *Ce. cyanus*
None on *Ce. americana*, *Ce. rothrockii*

Field experiment in Turkey
Ceratapion Yellow Starthistle Field Tests

Ataturk University, Erzurum, Turkey
Cat (1850 m), 3/29/02
Askale (1630 m), 4/27/02
Horasan (1500m), 5/27/02

NYSE
- Turkey
- California

Safflower
- oleic
- linoleic
## Safflower Field Tests in Turkey

### Proportion of plants infested (%)<sup>a</sup>

<table>
<thead>
<tr>
<th>Site</th>
<th>No. Safflower plants</th>
<th>YST(US)</th>
<th>YST(TR)</th>
<th>Oleic</th>
<th>Linoleic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2002</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horasan</td>
<td>45</td>
<td>83 b</td>
<td>100 a</td>
<td>0 c</td>
<td>0 c</td>
</tr>
<tr>
<td>Cat</td>
<td>38</td>
<td>28 b</td>
<td>67 a</td>
<td>0 c</td>
<td>0 c</td>
</tr>
<tr>
<td>Askale</td>
<td>40</td>
<td>59 b</td>
<td>87 a</td>
<td>19 c</td>
<td>10 c</td>
</tr>
<tr>
<td><strong>2003</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat</td>
<td>57</td>
<td>37 a</td>
<td>45 a</td>
<td>0 b</td>
<td>0 b</td>
</tr>
<tr>
<td>Askale</td>
<td>39</td>
<td>77 a</td>
<td>8 b&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2004</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Horasan</td>
<td>250</td>
<td>98 a</td>
<td></td>
<td>0 b</td>
<td></td>
</tr>
<tr>
<td>Askale</td>
<td>99</td>
<td>100 a</td>
<td>34 b&lt;sup&gt;e&lt;/sup&gt;</td>
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<sup>a</sup> Values followed by the same letter in the same row are not significantly different (chi-square test, P < 0.01).

<sup>b</sup> Adults identified: 4 *C. scalptum*, 1 *C. orientale*, 2 *C. onopordi*.

<sup>c</sup> Adults identified: 2 *C. scalptum*.

<sup>d</sup> Adults identified: _* C. scalptum*, _* C. orientale*.

<sup>e</sup> Adults identified: 8 *C. scalptum*, 2 *C. orientale*.

**Probability of infestation < 0.0026**
### Safflower Field Tests in Turkey

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<td>Askale</td>
<td>100 a</td>
<td></td>
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- **No. Safflower plants:**
  - 2002: 45, 38, 40
  - 2003: 57, 39
  - 2004: 250, 99

- **Probability of infestation:** < 0.0018

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a Values followed by the same letter in the same row are not significantly different (chi-square test, P < 0.01).

b Adults identified: 4 *C. scalptum*, 1 *C. orientale*, 2 *C. onopordi*.

c Adults identified: 2 *C. scalptum*.

d 3 unidentified adults.

e Adults identified: 8 *C. scalptum*, 2 *C. orientale.*
Conclusions for Rosette Weevil

• Safflower, artichoke and sunflower are not at risk.

• Native Centaurea, Cirsium and Saussurea are not at risk.

• Potential harm:
  Bachelor’s button (Ce. cyanus) is at risk for possible collateral damage. (ornamental & invasive weed)

• Petition was “approved” by Technical Advisory Group, 2006.

• Release permit denied by USDA-APHIS, 2009.
Tumbleweed (*Salsola* spp.)

First seen in 1874 in Bonhomme County, South Dakota (from flax seed brought from Russia)

*Salsola australis*  
*Salsola collina*  
*Salsola paulsenii*  
**Salsola tragus**  
*Salsola x gobicola*  
*Salsola x ryanii*

Distribution of species of *Salsola* sect. *Kali* in Eurasia

From S. Rilke (1999), Revision der Sektion *Salsola* s.l. der Gattung *Salsola* (Chenopodiaceae).
Russian Thistle Blister Mite

*Aceria salsolae* (Acari: Eriophyidae) on human eyelash

scanning electron micrograph
Damage to *Salsola tragus* by *Aceria salsolae*
Infesting nontarget test plants

Mite colony on *Salsola* cuttings
Host Specificity Results

No-choice population (survival + reproduction)
Develops on 5 Salsola spp. (all alien weeds)
Occasional on alien Bassia, Kochia
Dead mites remaining on Suaeda

Choice
Not done in lab because disperse by wind.

Field experiment in Italy
Field Experiment in Rome, Italy
Field Experiment in Italy

Bassia hyssopifolia
Kochia scoparia
Suaeda calceoliformis

S. kali
S. tragus

S. tragus not inoculated

Plant species
Nontarget species

1999 California Academy of Sciences
2001 CDFA
2003 George W. Hartwell
Conclusions for *Salsola* mite

- Attacks only a few species of alien *Salsola*.
- Native *Suaeda*, etc. are not at risk.
- Petition was “approved” by Technical Advisory Group, 2005.
Conclusions

Field experiments showed higher levels of host plant specificity than laboratory experiments

This was sufficient for TAG members to conclude that the agents are safe to release

APHIS-PPQ denied permits based on no-choice laboratory results