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# Assessment of risk of attack to safflower by *Ceratapion basicorne* (Coleoptera: Apionidae), a prospective biological control agent of *Centaurea solstitialis* (Asteraceae)

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**Abstract**

*Ceratapion basicorne* (Coleoptera: Apionidae) is a prospective biological control agent of yellow starthistle (*Centaurea solstitialis*, Asteraceae: Cardueae), which is an important invasive alien weed in the western United States. Previous studies have shown that it is possible for this insect to oviposit on and complete development on safflower (*Carthamus tinctorius*) under no-choice laboratory conditions; however, it has never been reported as a pest of safflower. Field experiments were conducted at three sites in eastern Turkey during 3 years to evaluate the risk of attack on safflower by this insect in its native range. At two sites where *C. basicorne* was the only apionid observed, no safflower plants were attacked despite high attack rates on yellow starthistle test plants (48–98% of plants infested). At a third site, where *C. basicorne* and three other species in the same genus; *C. scalptum*, *C. orientale*, and *C. onopordi* were present, 8–26% of safflower plants were infested, but none of the insects reared from safflower during 3 years were *C. basicorne*. Other authors have reported rearing *C. basicorne* from field-collected plants of only *Ce. solstitialis*, *Ce. cyanus*, *Ce. depressa*, and *Cnicus benedictus*. Our results indicate that *C. basicorne* does not attack safflower under field conditions and that its introduction would not pose a risk to this crop.
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*Keywords:* Host plant specificity; Classical biological control; Nontarget plant; Risk assessment

## 1. Introduction

Yellow starthistle (*Centaurea solstitialis* L., Asteraceae: Cardueae) is an important invasive alien weed in the western US, where it infests over 8 million ha (Duncan, 2001; Sheley et al., 1999). It is an annual plant that germinates in the late fall or early spring, grows as a rosette until May, then bolts and flowers from June until it dies of drought or frost (Maddox, 1981). The plant originates from the Mediterranean region and it is the target of a biological control program (Cristofaro et al., 2002; Maddox, 1981; Piper, 2001; Pitcairn et al., 2004; Turner et al., 1995). *Ceratapion basicorne* (Illiger) (Coleoptera: Apionidae) was identified as a prospective agent (Rosenthal et al., 1994; Zwölfer, 1965). Alonso-Zarazaga (1990) provides a detailed morphological description, and Wanat (1994) lists taxonomic synonyms. The weevil is widely distributed in Europe and western Asia, overlapping the distribution of *Ce. solstitialis* (Alonso-Zarazaga, 1990; Wanat, 1994). Adults oviposit on rosettes in the early spring, and larvae develop in the root crown where they pupate (Clement et al., 1989; Smith and Drew, in press; Uygur et al., 2005). Adults emerge in late May to June and aestivate and hibernate until the following spring. In the wild, *C. basicorne* has been reared only from *Ce. solstitialis*, *Centaurea cyanus* L., *Centaurea depressa* M. Bieb., and *Cnicus benedictus* L. (Alonso-Zarazaga, 1990; Campobasso et al., 1999; Wanat, 1994). No-choice laboratory studies confirmed that the insect has a narrow host

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range, but it can oviposit on, and some larvae can complete development on, safflower (*Carthamus tinctorius* L., Asteraceae: Cardueae) (Clement et al., 1989). This raised concern that this insect may not be host-specific enough to introduce as a biological control agent (Clement, 1990).

Safflower is not widely cultivated in countries where *Ce. solstitialis* and *C. basicorne* are known to occur (e.g., Turkey, Greece, Italy, and France) (FAO, 2005). Although the crop has an ancient history in the Mediterranean, modern production of safflower is limited because of several pests, especially the safflower fruit fly, *Acanthiophilus helianthi* (Rossi) [= *A. eluta* (Meigen)] (Tephritidae), which can damage up to 95% of the flower heads (Anon., 1963). Reports of other pests of safflower in the Mediterranean region include: *Heliothis peltigera* Schiff. (Noctuidae), *Chaetorellia carthami* Stackelberg, *Ch. jaceae* R.D., *Terellia luteola* Wiedemann, *Urophora mauritanica* Macquart (Tephritidae), *Larinus grisescens* Gyll., *Larinus syriacus* Gyll., *Larinus orientalis* Cap., and *Larinus ovaliformis* Cap. (Curculionidae) on the flower heads; and *Lixus speciosus* Mill. (Curculionidae), *Agapanthia* sp. (Cerambycidae), four *Chloridea* spp., *Plusia gamma* L. (Noctuidae), *Pyrameis cardui* L. (Nymphalidae), and *Cassida palaestina* Reiche (Chrysomelidae) on vegetative parts (Avidov and Kotter, 1966; Bytinski-Salz, 1952; El-Sheikh et al., 1990; Freidberg, 1996; Garali et al., 2004; Logozzo and Alba, 1990; White et al., 1990). However, none of these publications mentioned the presence of an apionid, such as *C. basicorne*.

Safflower is a significant crop in the western US where about 70,000 ha are planted producing about 124,000 metric tons of seed (USDA, 2005). About 85% of this production is in California, with the rest primarily in Montana, North Dakota, South Dakota, Utah, and Idaho (Purdue University, 2005). Because safflower is abundant in California, which is the state where *Ce. solstitialis* infests the most land (Duncan, 2001), it is important to be certain that *C. basicorne* will not attack the plant under field conditions, especially when the insect is abundant. Laboratory choice oviposition experiments indicate that *C. basicorne* is much less likely to oviposit on safflower when *Ce. solstitialis* is present than under no-choice conditions (Clement et al., 1989; L. Smith, unpublished data). However, because of the potentially high economic injury that could be caused by introduction to the western US of an insect that can attack safflower, we wanted to obtain better information to determine the likelihood that safflower would be attacked by *C. basicorne*. Field choice experiments are known to provide results that are more predictive of post-release risk to nontarget plants (Briese, 1999; Clement and Cristofaro, 1995). This paper describes experiments conducted to determine the risk of attack to safflower plants in the field.

## 2. Methods

### 2.1. 2002

The experiments were conducted at three sites near Erzurum, Turkey:

Askale—(39° 58.712′N, 40° 33.783′E, 1580 m elevation) abandoned cultivated field in alluvial soil near a stream.

Horasan—(40° 07.543′N, 42° 29.941′E, elevation 1501 m) rocky south-facing slope below cliffs beside a stream.

Çat—(39° 34.929′N, 40° 54.210′E, 1814 m elevation) rocky field near the top of a ridge.

*Centaurea solstitialis* was naturally present at all three sites and over 80% of the *Ce. solstitialis* plants at each site were infested by *Ceratapion* in 2001 (Cristofaro et al., 2002). At each site, a wire mesh fence 1.5 m tall was built to protect the experimental plot (about 6 × 12 m) from disturbance by livestock. Each site was visited every other week, starting 11 April, 2002, to monitor for the presence of *C. basicorne* to help determine when to transfer test plants to the field.

Test plants were grown from seed: *Ce. solstitialis* (US) collected in Davis, California in 2000, *Ce. solstitialis* (TK) collected at each site (Horasan, Çat, and Askale) in 2001, and safflower (*Carthamus tinctorius*) cultivars CalWest-1221 (linoleic) and Seedtec-317 (oleic). Test plants were grown indoors before transplanting to the field because of the cold winter conditions in this part of Turkey. *Ce. solstitialis* seeds were planted on February 4 and safflower on March 8, 2002. Safflower seeds were planted 4 weeks after *Ce. solstitialis* to produce plants of similar size during exposure to oviposition. Plants were grown in 10 × 12 cm pots beside windows at 20–25 °C. The plants were "hardened" before transfer to the field by moving them to an unheated greenhouse for 5 days (10–23 °C), then opening it during the day for 2 days, and then opening it day and night for 7 days. Test plants were transplanted in the field on April 24, 26, and 27 at Çat, Horasan, and Askale, respectively. *Ce. solstitialis* plants were 11 weeks old (rosettes with $\geqslant$4 leaves) and safflower was 7 weeks old (10–15 cm tall) when transplanted in the field. The plants were placed in small holes dug with minimal disturbance to existing vegetation. Plants were arranged in 12 rows, each containing one plant type, and the rows alternated in a regular pattern (*Ce. solstitialis* (US), oleic safflower, *Ce. solstitialis* (TK), linoleic safflower), repeated three times. Each row contained 10 plants (eight at Horasan), spaced 40 cm apart within row and 80 cm between rows. Any other naturally occurring *Ce. solstitialis* plants within the plots were removed, but those outside were left undisturbed. We monitored the plants every 2–3 weeks and watered them 2–3 times, as needed. Plants that died were replaced between May 8 and 15. All test plants were harvested and destroyed before they could produce any seed to prevent possible establishment of alien plants in Turkey.

We monitored the phenological development of *C. basicorne* in wild *Ce. solstitialis* plants in the area surrounding the plots every week. When the first pupae were observed, we harvested all the test plants. Test plants were harvested on June 1, 24, and July 5 at Horasan, Çat, and Askale, respectively. The leaves and upper stems were removed and the remaining root and lower stem were placed in a zip-lock plastic bag that had a screen panel for ventilation. The bags