Bangasternis orientalis weevil

A weevil from starthistle's native Euro-Asian range has been established in California

New biological control for yellow starthistle

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There is evidence that yellow starthistle has been present in California for about 161 years, making its appearance in our flora during the post-mission period after 1824. The advent of the early Spanish missionaries, followed by the Mexicans and the Americans, led to exploitation of the rich grasslands in the state's central and montane valleys. With increasing grazing pressure, the perennial bunch grasses gave way to annual grasses and pioneering alien species such as yellow starthistle (*Centaurea solstitialis* L., Asteraceae).

It is generally felt that there have been multiple introductions of yellow starthistle into the western United States. As livestock populations increased, so did the need for introduced forage plants. Alfalfa, which became a forage crop of choice in the late 1800s, may have been a vehicle for the later introductions of this weed. *Centaurea* species are common contaminants of commercial seeds and hay.

Yellow starthistle is now of considerable economic importance in California, having increased from an estimated 1.2 million acres in 1958 to 7.9 million in 1985.

This plant is one of approximately a dozen naturalized weeds for which natural enemies have been sought in Europe beginning in the late 1950s. Attempts to introduce a seed head fly, *Urophora sirunaseva* (Hering), from Italy and Greece failed, but a seed-head weevil, *Bangasternus orientalis* Cap., has been found and tested by the U.S. Department of Agriculture (USDA) in Greece, Italy, and California. The beetle was cleared for introduction in 1985, and releases were made in Siskiyou, Placer, and Yolo counties. This article documents the pre-introduction studies, release, and establishment of this weevil in California.

Weevil against weed

Before release, detailed studies on host specificity and biology are carried out to ensure that possible weed-control agents are safe for introduction. *Bangasternus orientalis,* the candidate for yellow starthistle control, belongs to a genus with nine recognized species. *Bangasternus* weevils are associated only with the genera *Centaurea* and *Carthamus* in their native range, which stretches from Mediterranean Europe east to the Balkans,

The female weevil lays her eggs on the small cauline leaves just below the flower bud of yellow starthistle (above). After a mucous coating she puts over the egg hardens, it forms a black protective cap insoluble in water or alcohol (below).

Turkey, Caucasus, Central Asia, and Afghanistan.

Field studies and observations of *B. orientalis* in Greece have shown that it is restricted to a narrow range of related *Centaurea* species. Two biotypes of the weevil are known to exist, one associated with yellow starthistle, and one with purple starthistle (*C. calcitrapa* L.).

In northern Greece, the adult weevils are found on yellow starthistle from early May until late July. Both mating and egg-laying begin in early to mid-May. The weevil's egg-laying period is thus well synchronized with the growth and development of its host plant.

Single eggs are laid on the lower sides of the small leaves arising from the upper part of the stem near a flower bud about 95 percent of the time and on the flower

After hatching, the young weevil larva enters and mines the leaf, then the stem, and enters the flower bud at its base to feed and pupate. A single larva (seen here through dissected window in flower head) can destroy up to 90 percent of the starthistle seeds.

stalk 5 percent of the time. Female behavior suggests that the weevil uses both tactile and chemical cues to recognize egg-laying sites. The female deposits the egg on the leaf substrate along with a dark green mucous substance combined with fecal particles and plant hairs. When hardened, it forms a characteristically black protective cap insoluble in either water or alcohol. During a period of up to 100 days, a female is capable of laying over 400 eggs.

After hatching, the young larva enters the leaf mesophyll, mines down the leaf, then up the stem, and enters the flower bud at its base. Feeding, larval development, and pupation occur inside the head. Our research indicates that a single larva destroys 60 to 90 percent of the seeds in a head.

The pupa completes its development in a cell that the larva makes in the flower head. Emergence of new adults occurs in late July, with subsequent hibernation from October through November. A single generation develops annually. Parasitism is the most important cause of mortality of the weevil in its native area.

Laboratory and field studies at three USDA laboratories (Rome, Italy; Thermi, Greece; and Albany, California) have shown that this weevil lays eggs on different ecotypes of yellow starthistle, some other *Centaurea* spp. (*C. calcitrapa, C. diffusa, C. jacea, C. paniculata*), and on *Onopordum acanthium.* Larval development, however, occurs only on yellow starthistle (rarely on *C. calcitrapa*). The weevil did not feed or lay eggs on native North American *Cirsium* thistles in these studies. A specialist herbivore such as this weevil is preferred, because its restricted host range provides relative assurance of safety before introduction.

Introduction and release

The first shipment of adult *B. orientalis* weevils arrived at San Francisco on May 28, 1985, and was transported to the USDA Biological Control of Weeds Laboratory at Albany, California, for processing in quarantine. The identity of the weevils was confirmed, and a few were killed for pathological examination to ascertain that they were disease-free before release.

A total of 256 weevils were taken to Siskiyou County and an additional 220 weevils to Placer County for release at a preselected site in each county. Personnel of the USDA Albany laboratory made the releases in both counties on May 29, 1985, in cooperation with the California Department of Food and Agriculture and the Agricultural Commissioners of the respective counties. A third release of 20 weevils was made on June 14 in Yolo County. All releases consisted of equal numbers of females and males.

In subsequent observations at all sites soon after release: (1) eggs were abundant (over 200 before count discontinued) on yellow starthistle plants; (2) eggs were primarily on second- and early third-stage buds; (3) both egg-laying females and copulating adults were present on yellow starthistle plants; (4) eggs were found 4 to 6 feet away from the plants on which adults were released, indicating the potential of females to disperse.

Colonization and establishment

Release sites in Siskiyou, Placer, and Yolo counties were studied during August and September of 1985 to learn whether the weevil had successfully colonized.

In Siskiyou County, several developmental stages of the first generation offspring were found. Data collected on August 21 indicated that about 50 percent of this generation had emerged while about 50 percent remained in the yellow starthistle heads. The egg-laying parental females had dispersed over a distance of 225 feet in all directions from the original release points. Most, however, seemed to be clustered near the points of release, as indicated by the number of old egg capsules on the host plants. Examination of mature heads showed evidence of adult emergence or pupae or new adults still in the heads. Weevil egg-laying had occurred on single and grouped plants.

The Placer County site, examined on September 4, also had evidence of weevil colonization. An abundance of thistle heads had adult emergence holes, and two unemerged adults were extracted from their pupal cells. Emergence holes in thistle heads were found as far as 100 yards from the release points. Observations of newly released egg-laying females showed that they were forced to search over greater distances for buds suitable for oviposition, because the plants were more mature than those in Siskiyou County. The first generation of weevils had nearly all emerged and appeared to be in summer "hibernation," because no active adult weevils were present, and no food plants were available.

Examination of the Yolo County site on September 5 also provided evidence of emergence of the first-generation adults.

The initial establishment of the weevil at all California release sites was confirmed in April and May of 1986. Weevil populations were first seen at the valley sites in Yolo County on April 5, then in Placer County on April 10. At the Siskiyou County release site, 3,000 feet in elevation, the weevil population was not observed until May 1. Yellow starthistle exhibited at least one growth stage difference between the valley and the higher elevation site, believed to be due to the cooler average temperatures in Siskiyou County.

The potential of the weevil, *Bangasternus orientalis,* to disperse, find its host plant, and exploit this resource is apparent. This biological control agent of yellow starthistle has successfully colonized, overwintered, and become established at the initial release sites in California. Additional releases are planned as well as an evaluation of the weevil's effect on yellow starthistle populations in California.

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