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AN UPDATE FOR BIOCONTROL OF INDUSTRIAL WEEDS

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Most native plant species are regulated or controlled in part by various natural enemies including herbivorous insects and pathogens. This naturally occurring biological control occurs unnoticed unless the system becomes disrupted. Such is the case for exotic weeds that occur in California without their natural enemies. These weeds are able to reproduce and spread with much less hinderance than they experienced in their country of origin and become very abundant and troublesome. The practice of biological control seeks to reunite weeds with their natural enemies. This is accomplished through the foreign exploration, importation, and distribution of natural enemies. The goal of biological control is to suppress the weed population to a lower, more tolerable level, and for this to be sustained indefinitely wihtout further intervention.

Many of the weed targets of CDFA's Biological Control Program are rangeland, and agricultural weeds but non-agricultural weeds such as *Tamarix* spp. and purple loosestrife, *Lythrum salicaria*, are included. CDFA works in cooperation with the County Agricultural Commissioners and Sealers Association to located bioagent release sites and the United States Department of Agriculture, Agricultural Research Service, (USDA, ARS) in obtaining, testing, and releasing natural enemies against weeds in California and have been involved in all projects discussed below.

Biological control is currently being pursued for these three industrial weeds: yellow starthistle, Russian thistle, and puncturevine; each are discussed below.

Yellow starthistle

Yellow starthistle, *Centaurea solstitialis* L. (Asteraceae), is an introduced annual weed of Eurasian origin that has become one of California's worst weeds. It infests rangelands and pastures and along side roadways and irrigation canals. It is estimated to infest over 8 million acres statewide. Foreign exploration and host testing by the USDA, ARS, has resulted in the introduction of five insects for control of yellow starthistle in the western United States. Establishment in California has been confirmed for four species through 1995. All five insects feed inside the seed head and reduce seed production which is the sole means of reproduction by this plant.

The bud weevil, *Bangastermus orientalis* (Coleoptera: Curculionidae), was first released in 1985 and is now widespread throughout California. As of 1995, it has been released at over 400 sites in 49 counties. This weevil has one generation per year. It is found active on yellow starthistle plants from late May through June. The eggs are deposited on the leaves or stems immediately below the upper most young closed buds on a plant. Upon hatching, the larva burrows into the stem and eventually up into the seed

head. After entering the seed head, the larva feeds on the developing seeds and disk tissue. Adults exit the heads in August and overwinter in the debris near trees and along fence rows.

The gall fly, *Urophora sirunaseva* (Diptera: Tephritidae), was first introduced in 1984 and is now also widespread throughout California. As of 1995, it has been released at 77 sites in 37 counties. This fly has two generations per year. It becomes active in the spring, usually April and May; the second generation is active mid June through July. Eggs are deposited in intermediate-aged closed buds with vertically oriented spines. After hatching, the larva moves to a position in the base of the flower head and initiates around itself the growth of a woody gall, which displaces any seeds that would have formed there. Several galls may be found in a head and usually all larvae in multiple-gall heads will successfully become adult flies. The gall fly overwinters as a mature larva in the seed head.

The hairy weevil, *Eustenopus villosus* (Coleoptera: Curculionidae), was first introduced in 1990 and has been released at 211 sites in 47 counties. However, unlike the previous two bioagents, this insects does not readily disperse from its release site so it has not become as widespread as the bud weevil and the gall fly. The hairy weevil has one generation per year and is active in late June through August. This weevil impacts yellow starthistle plants in two ways: by feeding and killing young closed buds and by depositing eggs in large swollen buds where its larvae feed on the developing seeds. The adult emerges from the seed head in August through September and overwinters in debris at the base of trees and along fence rows. The hairy weevil appears to have the greatest impact on yellow stathistle among all bioagents release in California to date.

The flower weevil, *Larinus curtus* (Coleoptera: Curculionidae), was first introduced in 1992. It has been released at five sites in five counties but establishment has been confirmed at only one site in Sutter County. Follow-up surveys at this site has revealed that some weevils are infested with the protozoan, *Nosema* sp., a gut parasite. The source of this infestation is unknown because the material was inspected and determined clean of parasites before release. Studies are underway to determine the impact of this parasite on the growth and reproduction of weevil population. The flower weevil has one generation per year. Eggs are laid in the open flowers and the larvae feed on the developing seeds. Adult weevils emerge from the seed heads and overwinter away from their host plant.

The peacock fly, *Chaetorellia australis* (Diptera: Tephritidae), has been released at 12 sites in 11 counties since 1989 but has failed to become established. This is in contrast with releases in Oregon and Washington where the fly did become established and is becoming widespread. It may be due, in part, to the unusually early spring emergence by the fly, before any yellow starthistle is up. In Oregon and Washington, another host plant, bachelor button, *Centaurea cyanus*, is common and blooms much earlier than yellow starthistle. This host is used by the first generation of peacock flies which later move onto the yellow starthistle. While bachelor button is not common in California, some areas do have good populations so releases of this bioagent was made at these sites in 1995. Follow up surveys will determine if these releases are successful. The peacock fly has two generations per year. Eggs are laid in large closed buds. Upon hatching, the

larvae burrow into the head and feed on the developing seeds. Peacock flies overwinter as mature larvae in the seed heads.

Three new bioagents are now in quarantine and are being host tested for specificity: *Terellia uncinata*, *Puccinia jacea* and a new species of *Aschocyta*. *Terellia uncinata* is Tephritid fly that deposits its eggs in open flower heads. It has at least two generations per year. As mentioned above, both the peacock fly and the gall fly have two generations per year, but, because the peacock fly has not become established in California, there is a need for more bioagents that infest the late-blooming flower heads. It is hoped that *Terellia uncinata* will increase the infestation rate in these late-blooming flower heads.

Puccinia jacea is a rust fungal disease that attacks the leaves and stem of yellow starthistle plants. It is being held in the USDA's Foreign Disease Laboratory in Federick, Maryland. Host specificity studies are underway and we hope it is available for introduction in 3-5 years. *Aschocyta* sp. is a naturally occurring fungus that exists in the soil and attacks the roots of yellow starthistle seedlings. It was first recovered by CDFA scientists from roots of yellow stathistle seedlings obtained in Solano County in 1993. In laboratory tests up to 90% of inoculated seedlings are killed with this fungus. Host specificity studies are now underway.

Russian thistle

Russian thistle, *Salsola australis* R. Brown (Chenopodiaceae), continues to be a very disruptive plant within California, especially along highways and railways. In the 1970's, two coleophorid moths were released into California but, unfortunately, have not been effective in reducing Russian thistle abundance. *Coleophora parthenica* (Lepidoptera: Coleophoridae) feeds internally within the stems but causes little damage to the plant. Thus, despite it being abundant in the western San Joaquin Valley, seed production by Russian thistle is not substantially reduced. The second bioagent, *Coleophora klimeschiella* (Lepidoptera: Coleophoridae) feeds externally on the foliage but is heavily parasitized by native parasitic wasps which prevent it from building high enough population densities to cause substantial damage to the Russian thistle plant population. This effort was halted, in part, because travel in Russia was severely restricted. Now that the politcal climate in Russia has changed, efforts have begun to search for new bioagents. Early reports indicate the discovery of at least three new bioagents: a true bug, *Piesma salsolae*, a gall mite, *Aceria* n. sp., and a rust disease *Puccinia salsolae*. Foreign exploration will continue for 1-2 more years after which host specificity of the most promising bioagents will begin.

Puncturevine

Puncturevine, *Tribulus terrestris* L. (Zygophyllaceae), is a low growing prostrate annual herb that produces small yellow flowers and hard, spiny seed pods. The spines lodge in shoes and tires and are a serious nuisance. Two insect bioagents were release in California in 1961: the seed weevil, *Microlarinus lareynii* (Coleoptera: Curculionidae) and the stem weevil, *Microlarinus lypriformis* (Coleoptera:Curculionidae). The seed weevil deposits its eggs in a depression in the seed pod made by the adult female weevil. Upon hatching, the larvae enter the seed pod and feed on the developing seeds and surrounding

tissues. The larva pupate in the seed pod and the adult emerges by chewing an exit hole. The stem weevil deposits its eggs on the underside of the older stems near the root crown. Upon hatching, the larvae burrow into the stems, tunnelling and feeding in the central pith area of the stem. The larvae pupate in the stem and the adult emerges by chewing an exit hole in the stem. The feeding by stem weevils can seriously damage or eventually kill a plant. Both weevil species have several generations per year; as often as one generation per month during the hot summer months in the San Joaquin valley. The adults overwinter away from their host plants in nearby debris and leaf litter.

Studies in the mid-1970's showed that the abundance of puncturevine declined substantially from pre-release estimates. All those participating in the project agreed that biological control of puncturevine was at least a partial success in most areas and a substantial success in some areas, especially on nonirrigated land. In 1996, puncturevine is still present and is still a nuisance in some areas. It has been learned that unusually cold winter temperatures can cause poor winter survival for the weevils. As a result, there is some effort by USDA scientists overseas to obtain cold-hardy strains of the weevils. It is hoped that a cold-hardy strain would better survive the cold winters in northern California and have a greater impact on puncturevine populations in these areas.