Sacramento Mountains Thistle (*Cirsium vinaceum*)
Robert Sivinski, New Mexico Forestry Division
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INTRODUCTION

Sacramento Mountains thistle (*Cirsium vinaceum* Wooton & Standley) is a rare plant endemic to elevations between 7,500 and 9,200 feet in the Sacramento Mountains of Otero County, New Mexico. The geographic range of this species is approximately 32 kilometers (20 miles) of mountain range from the Silver Springs area in the upper Rio Ruidoso watershed, then south to the Rio Peñasco and it tributaries, and Scott Able Canyon in the Rio Sacramento watershed at the south end of the mountain range. This thistle is a wetland obligate that grows only on wet travertine deposited by springs and alluvial seeps. Suitable habitats are relatively small and scattered within the range of the species. *Cirsium vinaceum* begins growth from seed or a rhizomatous root sprout and forms a basal rosette of leaves. The rosette lives for one or more years, then produces a reproduce stem that flowers from July to early September, sets seed, then dies. This plant is often nearly a monoculture on suitable habitat where patch densities can range from less than 100 to several thousand flowering stems depending on the extent of the habitat.


Cirsium vinaceum, Upper Rio Peñasco

Cirsium vinaceum was listed as a threatened species under the Endangered Species Act in 1987. Serious threats to this species have been identified as livestock grazing and trampling (USDA-Forest Service 1994, 2003), competition from exotic plant species, especially musk thistle (*Carduus nutans*) and teasel (*Dipsacus fullonum*) (Huenneke and Thompson 1995), and aquifer depletion (USDI-Fish & Wildlife Service 1993). Burks (1994) studied the sexual reproductive biology of *C. vinaceum* and found that its pollen vectors include various bees, butterflies and hummingbirds. She also found that predispersal seed predation by insects consumed or damaged an average of roughly 17% of the seeds produced in mature flower head samples from several thistle populations. However, the insects that preyed upon the thistle flower heads were not identified in Burks' study.

A 2007 inventory of phytophagous insects on *C. vinaceum* discovered five species that make important impacts, but not equally in all populations (Sivinski 2007). The most ubiquitous and significant flower head predator on *C. vinaceum* is the native, thistle specific, Tephritid gall fly *Paracantha gentilis* Hering. Adult *P. gentilis* are obvious in *C. vinaceum* populations throughout the flowering season and its maggots and puparia can be found in mature flower heads from mid-July to September. Females oviposit on the floret corollas as flowers are emerging from the phyllaries. The maggots burrow into the flower head and consume the developing ovaries and receptacle tissue. Maggots pupate into white puparia that turn dark brown or black prior to emergence of the adult flies. Flower heads with one to five puparia often manage to produce several mature seeds, especially around the periphery of the receptacle. Flower heads with more numerous maggots and puparia, presumably from multiple females, are mostly consumed and produce little or no seed.

Female *Paracantha gentilis* shortly after emerging from puparium.

Adult *Paracantha gentilis* on immature *Cirsium vinaceum* flower head.

Paracantha gentilis is especially abundant in flower heads of the *C. vinaceum* population at Silver Springs. This population not only had more mature flower heads with fly puparia, but also had more maggots and puparia per head, which significantly impacted seed production. Smaller *C. vinaceum* populations and large populations with low flower stem densities had fewer flower heads with fly puparia and, usually, fewer puparia per head in a 2007 comparison (Sivinski 2007).

The plume moth, *Platyptilia carduidactyla* preys upon the flower heads of *C. vinaceum*. The larvae of this moth are 8-10 mm long and consume the ovaries and receptacle tissue in *C. vinaceum* heads, usually around the margin of the receptacle. Flower heads usually have only one larva and usually manage to mature most of the seeds, if large portions of the receptacle remain intact. Some flower heads in which the larvae had been feeding contained only silky cocoons, which quickly hatched the parasitic wasps that feed on these moth larvae. Moth larvae were rarely found in the *C. vinaceum* population at Silver Springs Canyon and the Rio Peñasco populations, but were fairly common in the Scott Able Canyon population in 2007.

Platyptilia carduidactyla larva taken from *Cirsium vinaceum* flower head.

The bumble flower beetle, *Euphoria inda* (Linnaeus), is a generalist feeder on various flowers and fruits. Its larvae develop in the soil feeding rotting vegetation and may also be associated with ant nests (Micó et al 2000). This large native scarab attacks the flower heads of *C. vinaceum* during the late summer. It chooses flower heads that are just past anthesis and forces its way through the corollas and pappus to the ovaries, which are often entirely consumed. The receptacle is usually not severely damaged, so any ovaries that escape the feeding episode may make mature seed. Flower heads that have been fed upon by *E. inda* have obvious sprays of disarticulated corollas and pappus hanging from the phyllaries.

Euphoria inda occurs throughout the Sacramento range of mountains. In 2007, it was fairly common in the Scott Able Canyon population of *C. vinaceum*, but uncommon in the Rio Peñasco watershed and Silver Springs Canyon populations. It was occasionally observed attacking the late flower heads of *Carduus nutans* on the north end of mountain range near Ruidoso and on the Mescalero Apache Reservation.

Euphoria inda emerging from damaged flower head

The exotic flower head weevil or thistle head weevil, *Rhinocyllus conicus* Frölich, was intentionally released in North America for biological control of exotic thistles (*Carduus* sp.) of Eurasian origin that had become invasive, noxious weeds. Federal, state, and local agricultural agencies released, and encouraged landowners to release, this exotic beetle where *Carduus* infestations were perceived to be a land management problem. This weevil is available from commercial suppliers and is easily gathered and transported from established colonies. Although a thistle specialist, *R. conicus* is not host specific to *Carduus* and was found attacking nontarget native thistles soon after its release in 1969 (Rees 1977). By 2001, *R. conicus* was found to be using 22 of the 90+ North American *Cirsium* species (Louda et al. 2003).

Rhinocyllus conicus on phyllaries of *Carduus nutans* in Cox Canyon, Sacramento Mts.

In 1992, the New Mexico Department of Agriculture (NMDA) was planning a release of *R. conicus* to control *C. nutans* infestations in the Sacramento Mountains and obtained a permit to collect seed from the federally threatened *C. vinaceum*. This threatened thistle was grown and placed in a Utah greenhouse enclosure with *C. nutans*. *Rhinocyllus conicus* was released into the enclosure and immediately fed upon and placed eggs on the flower heads of both thistles (Richard Lee, unpublished data). NMDA cancelled the release plan. The Mescalero Apache Tribe disclosed plans in 1999 to release *Rhinocyllus conicus* on their reservation in the Sacramento Mountains. This weevil was found for the first time in the Sacramento Mountains on *C. nutans* at the Inn of Mountain Gods on the reservation and at Bonito Lake north of the reservation in 2001 (USDA-Forest Service, 2003). It was subsequently found in 2006 on *C. nutans* in Silver Springs valley at the boundary of Mescalero Reservation and the Lincoln National Forest (David Thompson, personal communication, 2006), which is immediately adjacent to one of the largest populations of *C. vinaceum*.

New Mexico State University, Department of Entomology, Plant Pathology and Weed Science (NMSU) initiated a field survey in 2007 to map the distribution of *R. conicus* in the Sacramento Mountains and determine if this weevil was near or impacting populations of *C. vinaceum* (Gardner and Thompson 2008). The weevil was only been found using *C. vinaceum* in the large Silver Springs valley population. Most of the other *C. vinaceum* populations occur further south in the Rio Peñasco watershed and Scott Able Canyon. A few weevil locations were detected on *C. nutans* in the Rio Peñasco watershed, but these are not well established and are not yet impacting the *C. vinaceum* populations there. No *Rhinocyllus* weevils were found near the Scott Able Canyon thistle population in 2007 (Gardner and Thompson 2008).

Female *R. conicus* place their eggs on the outer phyllaries of *C. vinaceum* and cap each oviposition site with a wad of masticated tissue from the host plant. These straw-colored caps are obvious for several weeks (unless washed away by rain) and indicate the presence of weevil larvae in the flower head. As many as six oviposition sites have been found on a *C. vinaceum* flower head at Silver Springs, but one to three per head is the more common range of use. Weevils often select immature, unopened flower heads, however, full-flowering heads in anthesis are most likely to show the full frequency of egg laying activity. Breeding and egg placement begins in mid-June, peaks in early July, and continues at a lesser frequency into August.

Newly hatched larvae burrow through the phyllaries and into the flower head and feed on receptacle tissue and ovaries. Flower heads with more than three larvae are usually completely consumed and may fail to produce any seed. The time period for larval development and emergence at the Silver Springs population is not known, but most new beetles had emerged from the flower heads of *C. vinaceum* by early September. A few relatively immature larvae were still found in mature flower heads as late as September 8th, which indicates either an extended first generation breeding period, or a small second generation breeding during the summer of 2007. The pupal chambers of this weevil in mature *C. vinaceum* heads are composed of feces and pappus and are not readily evident when searching for beetles by opening the mature flower heads. Up to 65 weevils can be produced from a single flower head of the much larger *C.*

nutans (Harris 2005), however, six weevil larvae in one *C. vinaceum* flower head was the largest number found at Silver Springs (Sivinski 2007).

Cirsium vinaceum flower head with three *Rhinocyllus conicus* egg sites.

Rhinocyllus conicus larvae often co-occur with maggots of *P. gentilis* and compete with the native fly for the food resource in flower heads of *C. vinaceum*. Flower heads hosting both the weevil and the fly are usually severely damaged and produce few, if any, seeds.

Cirsium vinaceum flower head with *Rhinocyllus conicus* larva (center) and *Paracantha gentilis* puparium (left)

A September 2006 visit to the large, several thousand-stem Silver Springs population of *C. vinaceum* found that almost all of the flowering stems were stunted in stature and had prematurely died before most of the flower heads could set seed. Some stems were cut open to reveal hollow centers filled with insect feces and at least one large beetle larva per stem. In June 2007 and 2008 the adult beetles were found copulating and feeding on *C. vinaceum* and identified as *Lixus pervestitus* Chittenden, a native North American snout weevil.

Adult *Lixus pervestitus* on *Cirsium vinaceum* at Silver Springs, Sacramento Mts.

Lixus pervestitus feeding holes on peduncle of *Cirsium vinaceum*.

Adult *L. pervestitus* are large insects about 15 mm in length. This weevil feeds on leaf tissue and in the swollen peduncles below the flower heads of *C. vinaceum* by boring holes in the stem epidermis and using its long snout to probe the vascular tissues. Females lay eggs in the central stem when the first flower heads are beginning to flower in late June to mid July. The larvae bore downward, sometimes for a meter in length, through the center of the stem consuming pith and inner cortex. When the larvae begin to feed, stem growth ceases and the stem leaves and inflorescence branches gradually die from loss of vascular tissue in the central stem or, possibly, microbial infection of the vascular tissue. Flowering ceases on most of the host stems by mid-August, which is generally the period of full-bloom for *C. vinaceum*. Only the earliest blooming flower heads have sufficient time to mature any seed before the entire inflorescence dies.

Lixus pervestitus larva in central stem of *Cirsium vinaceum*.

The time period for larval development and pupation to adult *L. pervestitus* in *C. vinaceum* stems at Silver Springs is not known, but this weevil apparently has only one generation per year. No adult beetles were found in the stems during late summer and only large larvae occupied the stems as late as September 8th. These will probably pupate to adult beetles in the autumn and over-winter in the thistle stems, as does another congener thistle stem boring weevil, *L. cardui* (CSIRO 2007).

Cirsium vinaceum with *Lixus pervestitus* stem borers at Silver Springs, 15 Aug 2007.

The *C. vinaceum* flowering stem die-off from stem borer weevils at Silver Springs in 2006, 2007, and 2008 was very dramatic and could not be missed by researchers in the field. Patricia Barlow-Irick completed a flowering stem survey of all *C. vinaceum* populations in August 2007 and found premature death of the flowering stems only in the Silver Springs population (personal communication, 2007). Barlow-Irick also said she had not seen early stem death of entire *C. vinaceum* patches during any previous surveys in 1998, 2000, 2003, and 2005. *Cirsium vinaceum* has been well studied and monitored since it was proposed to be listed as a federally threatened species in 1984. No field researchers have reported premature stem death in entire patches of *C. vinaceum* until the 2006, 2007, and 2008 observations documented by this report. No evidence of *L. pervestitus* was found in the Rio Peñasco and Scott Able Canyon populations visited during this and the NMSU *C. vinaceum* insect surveys in 2007 (Sivinski 2007; Gardner and Thompson 2008).

SILVER SPRINGS POPULATION

Cirsium vinaceum seed head use by insects was studied in four different populations in the Sacramento Mountains (Sivinski 2007). The Silver Springs population was unique because only two insect species were prevalent seed head predators and they made an especially severe impact on seed production. This population is also one presently being attacked by the stem borer weevil, *Lixus pervestitus*. Therefore, this population was assessed for a second year during 2008.

Rhinocyllus conicus was discovered on *C. nutans* in the Silver Springs valley in 2006 and found to using *C. vinaceum* flower heads in 2007. The exact year this exotic weevil arrived at Silver Springs is not known, but its population appears to the well enough established to provide a reasonable indication of frequency of use as it spreads to other *C. vinaceum* populations in the Sacramento range of mountains.

On July 17, 2007 a random transect was walked through the *C. vinaceum* population at Silver Springs just after the height of the weevil breeding in early July. The transect ran from the edge of the thistle patch near the highway to the center of the patch. All *C. vinaceum* flower heads that were in anthesis or older where examined for *R. conicus* egg sites on the phyllaries. Only the presence or absence of egg sites was recorded. Of the 271 flower heads examined, 173 had obvious *R. conicus* egg caps on the phyllaries and 98 were immaculate or indeterminate. Percentage of use for early *C. vinaceum* flower heads in 2007 was 63.8%, and could have been slightly higher. Early July was a period of heavy rains in the Sacramento Mountains that appeared to be washing away some of the tell-tale caps from oviposition sites on the phyllaries.

A similar transect across the Silver Springs *C. vinaceum* population was conducted on July 14, 2008. Of the 187 flower heads examined, 163 had *R. conicus* egg caps on the phyllaries for 87% percent use of the early flower heads. This is a much higher percentage of use than in 2007.

An August 15, 2007 survey of the *C. vinaceum* stems in the Silver Springs population found 82% of the stems to be dead or dying from stem borer weevil larvae at least one month before they would normally die. The prematurely dead stems were even more pronounced at 98% by early September and resembled the nearly complete early die-off of flowering stems observed in September 2006. *Lixus pervestitus* was prevalent again in 2008 and by September had killed stems in greater than 99% of the *C. vinaceum* population at Silver Springs.

A visual assessment of reproductive success at Silver Springs was made in September 2007 and 2008 by opening the mature late flower heads. In both years a majority of the late *C. vinaceum* flower heads had died before the seeds could mature. Only a small percentage of the late flower heads remained in September and most of these were severely damaged by *P. gentilis* and *R. conicus* (Table 1). Like the early flower heads, the late flower heads had greater *R. conicus* use in 2008 than in 2007. Flower heads that hosted larvae of both fly and weevil usually produce no seed at all.

Table 1. *Cirsium vinaceum* flower head use by phytophagous insects (n=100 heads for each year).

Insect	Popn./ Date	Silver Springs 9/8/07	Silver Springs 9/28/08
Undamaged		2	0
Rhinocyllus conicus		6	5
Paracantha gentilis		82	60
R.. conicus and *P. gentilis*		10	35

STEM BORER WEEVIL (*Lixus pervestitus*)

The prevalence of premature stem death caused by *L. pervestitus* at the Silver Springs population of *C. vinaceum* in recent years was impressive and had not been seen before 2006. Therefore, an attempt was made in 2008 to determine where this weevil came from and what its other host plants were before arriving at the Silver Springs population of *C. vinaceum*. *Lixus pervestitus* has previously been documented for New Mexico only by a single, very old collection at Las Cruces (Chittenden 1930). There are no other specimens of this weevil in the museum collections at the University of New Mexico or New Mexico State University. This is not surprising since New Mexican invertebrates are not well collected and very poorly known.

Lixus species are often host specific for certain plant families or genera so a survey of other Otero and Lincoln county thistles and other large Asteraceae plants was conducted during the summer of 2008 for any evidence of this stem borer weevil. None of the *Carduus nutans* populations in the Sacramento Mountains showed any use by *Lixus*. The stems of *Rubeckia laciniata* at Silver Springs were also healthy and immaculate. The non-native *Cirsium vulgare* occasionally occupies roadside disturbance in these mountains and also showed no signs of this stem borer.

Native *Cirsium parryi* and *Cirsium arizonicum* var. *bipinnatum* also occur at high elevation, mixed conifer forests in the Sacramento Mountains. No evidence of *Lixus* use could be found in any of several populations of either species checked in 2007 and 2008. The most common native thistle in this region is *Cirsium ochrocentrum*, but usually occurs at lower elevations below the level of piñon-juniper woodland. Several large roadside stands of this thistle were examined on both sides of the mountain range in 2008 and no *Lixus* use could be detected. Also not used were the populations of native *Cirsium wheeleri* in Fresnal and Eagle Creek canyons, which are less than 20 miles from Silver Springs.

The 2008 survey for alternate *Lixus* plant hosts failed to detect any other plant species being used by this stem boring weevil. The only potential thistle host not checked in 2008 was *Cirsium neomexicanum*, which is native species that occurs in low elevation canyons in the southern

Sacramento Mountains (and the Organ Mountain near Las Cruces). This is a biennial species that produced no rosettes during the summer of 2007, so no flowering stems were evident in 2008. This thistle should be checked in future years for *Lixus* use when it is again producing stems. For now, the alternate plant host for *L. pervestitus* in New Mexico remains unknown.

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