Collecting, Handling and Releasing *Rhinocyllus conicus*, a Biological Control Agent of Musk Thistle
Collecting, Handling and Releasing *Rhinocyllus conicus*, a Biological Control Agent of Musk Thistle

Norman E. Rees

This publication briefly describes the life cycle of musk thistle and the life history and habits of the biocontrol agent Rhinocyllus conicus Fröel. It presents information on selecting new release sites and how to collect, handle, release, and monitor this weevil. Important points to remember are (1) adult weevils must be collected in the spring when the females are gravid, (2) each release should contain at least 500 adults, (3) release fields should not be mowed or sprayed for at least 2 years following release, (4) cattle and other livestock should be excluded from the release sites during the weevils' egg-laying period, and (5) infested plants showing water stress should be watered immediately to assure survival of the weevil.

Keywords: Rhinocyllus conicus, biological control, musk thistle, collecting, releasing, monitoring.
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By Norman E. Rees

Introduction

Biological control utilizes selected factors in the life history and habits of both the target (pest) organism and one or more of its biological control agents to suppress the population of the target organism to a tolerable level. Researching these factors, putting them into effect, and obtaining initial control often take considerable time; however, once it is established, an efficient biological control system tends to be self-perpetuating and will continue to suppress the population of the target organism from that time forward without requiring additional expense to maintain.

When a plant species, such as musk thistle, has been introduced into a new land and is not held in check by local or accompanying natural biological controlling agents, it often becomes a problem and is labeled as a “weed” or a “noxious weed,” depending on its impact on the rancher or farmer. Chemicals can often provide temporary control, but permanent suppression, if possible, can only be obtained from the use of one or more biocontrol agents that can suppress populations of the target organism year after year. Generally, these biological agents are found in the native habitat on the target organism. After testing to determine that these agents can not reproduce on, or pose a threat to, plants of recognized value, they can be introduced into the problem area.

One such agent, the weevil *Rhinocyllus conicus* Fröel., was introduced into Canada in 1968, and into Montana, Nebraska, and Virginia in 1969 to control musk thistle; however, the Nebraska release did not become established. Populations at the other release sites increased in density and area, and by 1975, the reduction of musk thistle by *R. conicus* became apparent. Since that time, hundreds of new releases have been made throughout the United States, using progeny of the original releases.

The increasing acceptance of biological control and the popularity of utilizing *R. conicus* to control musk thistle have created a need for a publication to assist those interested in collecting the weevil for release in new areas. This publication provides such information.

Musk Thistle Life Cycle

Musk thistle is a common name for several species of plants of the large headed *Carduus nutans* L. group, including *C. macrocephalus* Desf., *C. nutans* L., and *C. thoermeri* Weinmann. These species are similar in appearance, have similar life cycles, and respond alike to *R. conicus*. Musk thistle, as such, was introduced into the United States over 100 years ago. It has increased, unchecked, until it now can be found in 12 percent of the counties of the United States and is a serious problem in many of these counties (fig. 1). It inhabits all types of land except deserts, dense forests, high mountains, and newly cultivated lands.

Reproduction of musk thistle is totally by seeds, which are produced from June and July until death of the plant from natural causes (fig. 2). Only 2 percent of these seeds are attached to the plumeless pappus and are borne on the wind; the rest fall to the ground close to the parent plant and are distributed by birds, small animals, and running water.

Musk thistle plants can act either as a biennial, a winter annual, or an annual. Seeds can germinate after a 6- to 8-week resting period or can remain dormant in the soil for several years. About 69 percent germinate during the first year, 20 percent germinate the second year, and the remaining 11 percent may germinate later (fig. 3).

Seedlings that germinate in the fall attain a rosette stage before winter. In the spring, the diameter of the rosette may reach from 1 to 3 feet before the plant bolts. Although each plant typically sends up one main stem, damage to the terminal meristem, either mechanically or by frost, will generally cause groups of stems to develop, usually in multiples of five. Plants attain heights of from 1 foot to 8 feet and sometimes exhibit considerable variation in height, form, and color between years, locations, and individual plants (fig. 4).

Flowers of musk thistle are reddish purple. Each terminal flower produces about 1,000 seeds; each lateral bud produces smaller flowers with fewer seeds, averaging about 840 seeds per head. In the Gallatin Valley, flowering continues until the plants are killed by adverse weather conditions.

Life History and Habits of *Rhinocyllus conicus*

*Rhinocyllus conicus* weevils overwinter as adults. In the spring, they congregate on musk thistle plants prior to and during the bolting stage. This occurs about mid- to late-May in the Gallatin Valley of Montana. Congregating adults feed, mate, and deposit eggs. Each female will produce from 100 to 150 eggs, which are laid individually or in clusters of two to five, generally on the bracts of the bud. The eggs are then covered with masticated plant material, which becomes tan and appears as “warts” on the plant (fig. 5).

As the primary (terminal) buds become saturated with eggs, the weevils begin laying eggs on the stems and on the secondary (lateral) buds. Cool spring weather and a dense weevil population tend to extend the egg-laying period, which seems to result in an increase in the number of eggs being deposited on the lateral buds and on the buds of certain other thistle species (table 1).

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1Research entomologist, Rangeland Insect Laboratory, Western Region, Agricultural Research Service, U.S. Department of Agriculture, Bozeman, Mont.

2Also called nodding thistle in some countries.

3The year in italic, when it follows the author’s name, refers to Selected References, p. 7.
The eggs hatch after 6 to 8 days, and the cream-colored larvae burrow through the bracts into the future seed-producing tissue of the bud, which is known as the receptacle. Here they develop for the next 25 to 40 days, feeding on the receptacle and maturing seed tissue, which creates individual cells (fig. 6). The feeding appears to stimulate the plant to concentrate nutrients and tissue in the affected area, which is similar to the effect created by gall-producing insects. The mature larva eventually coats the inner cell wall with feces and masticated plant material to produce a hard, protective chamber for the 8- to 14-day pupal stage (fig. 7).

Musk Thistle (Carduus Nutans)

Figure 1.—Musk thistle distribution and density by county in mainland United States, 1974 (Dunn 1976).

Figure 2.—Seeds of musk thistle.

Figure 3.—Musk thistle seedlings.
Larvae that tunnel into stems of musk thistle do not construct cells. Nevertheless, these larvae usually remain in the immediate vicinity where they initially began to feed.

Adult weevils emerge from their pupal cases but remain within their cells for 2 weeks or longer, during which time their color turns from a cream or reddish tan to almost black. The body hair is a patchy mixture of black and yellow, which gives the appearance that the weevils are covered with pollen. Although size is variable, most larger weevils are no more than about one-quarter of an inch long (fig. 8).

Figure 4.—Musk thistle flower.

Figure 5.—Eggs of *R. conicus* deposited on the underside of musk thistle seed heads appear as "warts" on the plant when covered with masticated plant material.

Table 1.—*Thistle species hosts for* Rhinocyllus conicus

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Found in United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plumeless thistle</td>
<td><em>Carduus acanthoides</em> L.</td>
<td>Yes.</td>
</tr>
<tr>
<td>Welted thistle</td>
<td><em>C. crispus</em> L.</td>
<td>Yes.</td>
</tr>
<tr>
<td>Curled thistle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Unknown)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Musk thistle or nodding thistle</td>
<td><em>C. nigrescens</em></td>
<td>No.</td>
</tr>
<tr>
<td></td>
<td><em>C. macrocephalus</em> Desf.</td>
<td>Yes.</td>
</tr>
<tr>
<td></td>
<td><em>C. nutans</em> L.</td>
<td>Yes.</td>
</tr>
<tr>
<td></td>
<td><em>C. theormeri</em> Weinmann</td>
<td>Yes.</td>
</tr>
<tr>
<td>Great marsh thistle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italian thistle</td>
<td><em>C. personata</em> (L.) Jacp.</td>
<td>No.</td>
</tr>
<tr>
<td>(Unknown)</td>
<td><em>C. pycnocephalus</em> L.</td>
<td>Yes.</td>
</tr>
<tr>
<td></td>
<td><em>C. sanctae balme</em></td>
<td>No.</td>
</tr>
<tr>
<td>Slender-flower thistle</td>
<td><em>C. tenuiflorus</em> Curtis</td>
<td>Yes.</td>
</tr>
<tr>
<td></td>
<td><em>Cirsium arvense</em> (L.) Scop.</td>
<td>Yes.</td>
</tr>
<tr>
<td>Canada thistle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creeping thistle</td>
<td><em>C. undulatum</em> (Nutt.) Spreng.</td>
<td>Yes.</td>
</tr>
<tr>
<td></td>
<td><em>C. vulgare</em> (Savi) Tenore</td>
<td>Yes.</td>
</tr>
<tr>
<td>Wavy-leaved thistle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bull thistle</td>
<td><em>Silybum marianum</em> L.</td>
<td>Yes.</td>
</tr>
<tr>
<td>Milk thistle</td>
<td><em>Onopodrum acanthium</em> L.</td>
<td>Yes.</td>
</tr>
<tr>
<td>Scotch thistle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Weevils chew their way out of the seed heads through the face of the receptacle, whereas those in the stems exit through several small openings chewed near the attachment of the seed head. Adults can occasionally be seen flying about on warm fall days. It is not known where *R. conicus* overwinters.

### Selecting a Release Site

Several factors are important to the selection of sites for establishing *R. conicus*. A release of 500 adult weevils (approximately one-half of which are female) has the potential to produce about 37,500 eggs the first year. Therefore, to achieve a population of 30 or fewer eggs per plant, the release area should contain at least 1,250 plants to avoid overcrowding. Actually, more plants are desirable to reduce the number of eggs per plant and increase their chances for survival. Because *R. conicus* weevils are good fliers, a continuous link of plants between plant concentrations is not needed for expansion of the colony.

The most vulnerable period of the weevil’s life is the larval stage within the developing seed head. Severe moisture stress to the plant will cause death of the larvae. Therefore, release sites should have good soil moisture and high water-holding capacity. Proximity to irrigation water is desirable so that if infested plants show signs of stress from lack of moisture, they can be watered. Although watering the thistles seems contrary to the idea of controlling them, it is necessary during the early years following release to take steps to encourage reproduction and enhance survival of the weevils until they are established and have distributed themselves throughout the area.

Releases should be in areas that will not be grazed during the weevil’s egg-laying period (fig. 9). Although livestock generally will not feed on musk thistle, their presence causes the weevils to leave the area. The release field should not be mowed or sprayed for at least 2 years, with longer periods being advisable. Cut thistles will dry in a few days, and all weevils in the plant will be killed. Although spraying is not recommended, it does allow much higher survival of the weevil than mowing.
Before planning any collections, check with your State department of agriculture concerning regulations and restrictions on the importation and/or movement of insects within your State and whether a permit is required. In some cases, your weed bureau or cooperative extension agent can provide this information. Generally, these agencies like to be kept informed and are often willing to work with you on this type of project.

Weevils for release are best collected as adults in the spring as they gather on the plants and begin to mate. In Montana, gathering and mating begin about mid- to late-May, as the thistles are beginning to bolt, and continue for 3 to 8 weeks. Some collectors have made releases in late summer by transferring infested mature seed heads to new locations; however, in Virginia, it has been shown that spring collection and release were 25 times more effective than summer collection and release of weevil in the seed heads. Spring releases place gravid females in the immediate vicinity of the thistle plant. In contrast, weevils of the late-summer releases must survive the relocation (desiccation within the seed head may be a problem), emerge, disperse prior to winter, find host plants (only a portion return to the point of release each year), and mate before egg laying can occur.

Materials needed for collecting weevils are shown in figure 10. The collector closes the rosette or bolting portion of the plant by bringing the outer leaves up and together, thus trapping the weevils inside. The plant is then cut off, shaken, and rubbed inside the garbage bag to dislodge the weevils. For convenience, the bag can be tied to the collector’s belt.

The collection must be sorted to assure a supply of *R. conicus* free from ants, other insects, and contaminants. A simple but primitive method is to pour 30 to 50 weevils from the garbage bag onto a stiff mat and, with the aid of a pocketknife, flip or “putt” the adult weevils into a glass tube (about ¾ to 1 inch in diameter by 1½ inches deep) taped to a dowel (fig. 11). When the glass tube contains 10 weevils, it can be emptied into a larger holding container, and a running count of the collection can be maintained.

A more advanced method involves use of an aspirator and a hand counter to pick up and record the weevils (fig. 12). Tables, chairs, and vacuum pumps make the sorting more comfortable.

When 500 adult weevils have been collected, place them, along with an insect-free thistle bud or leaves, in a cardboard carton that can be sealed tightly enough to prevent escape. Plastic cartons are not recommended because they allow moisture to build up, which increases weevil mortality. The cartons can then be stored and transported for up to a week in an insulated chest that is kept cool (but not frozen) with icepacks. Release insects as soon as possible after collection to enable them to deposit most of their eggs at the release site rather than in the carton.
Caution: Make sure all weevils to be transferred to the new locations are *Rhinocyllus conicus*. Several other species occasionally occur on musk thistle, such as the alfalfa weevil (*Hypera postica* Gyllenhal) and the plum curculionid (*Conotrachelus nenuphar* [Herbst]); however, these are of low incidence and differ conspicuously in appearance from *R. conicus*. If a question exists, have all weevils checked by an experienced entomologist before they are released.

**Releases**

Each release should contain at least 500 adult weevils. The larger the release, the faster the population will increase. Just sprinkle the insects over the musk thistle plants at the rate of about 5 to 10 per plant. Normal movement of the weevils from plant to plant will provide adequate dispersal.

**Monitoring**

An important aspect of the release is to be able to see and to show what results are obtained; therefore, several references should be established during the year of release. Photographs of the release sites in musk thistle fields are taken each year from the same spot when the thistles are in bloom. These photographs include a reference landmark (that is, trees, or buildings) in the background, which will give visual evidence of the year-by-year fluctuation or decline of the thistle population (fig. 13).

Actual plant counts should also be recorded at about the same time each year, generally in early spring or following bolting. A minimum of 20 random square-yard quadrats along a transect through the site is recommended. Decide ahead of time if seedlings, bolted plants, or all plants in each quadrant are to be counted. Either method will give an index of the musk thistle population trend. Bolted plants indicate seed production 2 years ago; seedlings indicate production of 1 year ago.

Extensive counts of *R. conicus* eggs should not be attempted for several years following release because accuracy requires that flower bracts be removed. This could greatly reduce survival of larvae; however, cell counts can be made after the normal heads have released their seed. At that time, infested seed heads appear lumpy, pappus still adhere to the protruding cells, and emergence holes are evident (fig. 14). The protruding cells are especially conspicuous in cross section (fig. 15). To determine the number of weevils that the seed head supported, one can chip away the walls of the cells and count each cell as it becomes exposed. Mortality can also be estimated by comparing the number of dead weevils to the number of cells.

Close monitoring will also expose adversities that may threaten a successful establishment, such as plants beginning to suffer moisture deficiency, presence of livestock, or change of field conditions. Some of these adverse conditions can be overcome. Remember, from beginning to end, to be aware and care. Proper selection of release sites, careful collections, prompt transfers and releases, and careful monitoring of the release site will help to insure that time, effort, and money are not wasted.

![Figure 13.—Making photographic and plant count records.](image1)

![Figure 14.—Field comparison of an infested (left) seed head with a normal or uninfested seed head.](image2)

![Figure 15.—Comparison of the infested (left) and uninfested thistle seed heads which have been broken open. Note the raised, black cells of the infested seed head.](image3)
Selected References


