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JUNE 1993

**BIOLOGICAL CONTROL
OF
MUSK THISTLE
USING
INTRODUCED WEEVILS****ORIGIN AND DISTRIBUTION**

Musk thistle, *Carduus nutans* L., is a Eurasian weed accidentally introduced into the eastern seaboard of the United States in the mid-to-late 1800's. It has since spread throughout most of North America, where it has become a weed of considerable economic importance. The first report of an infestation in North Carolina came from Chatham County in 1961. Its status as a noxious weed in North Carolina was recognized in 1991, when it became abundant in pastures, in southwest NC. Its proliferation (Figure 1) is caused by airborne seed dispersal and the movement of seed-contaminated hay to uninfested areas.

CHARACTERISTICS

Like most of its close relatives, musk thistle is covered with sharp spines. The spines grow along the leaf margins and extend down the branches and stems (Figure 2). The leaves are deeply and irregularly indented, with a smooth waxy or a somewhat hairy surface. They are grayish-green along the outer edge with a lighter green midrib area. Plant height at maturity varies from 2 to 8 feet or more.

The life cycle of musk thistle in North Carolina is variable. Although it is generally classed as a biennial (two growing seasons needed for a plant to mature), musk thistle can develop as

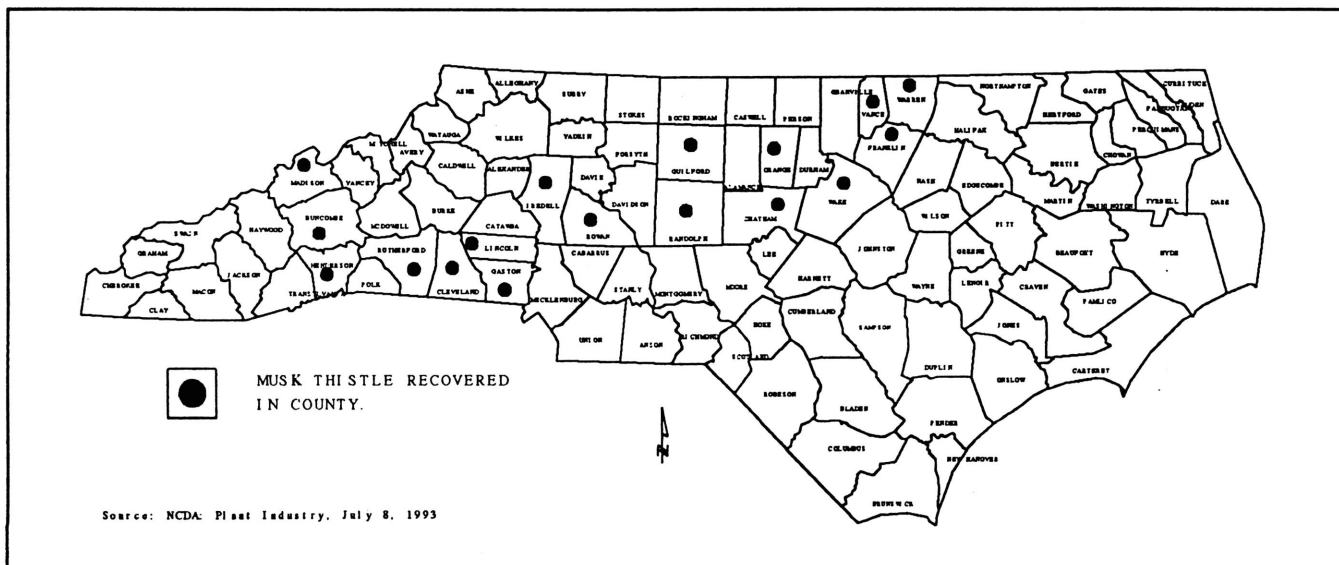


Figure 1. Known establishment of musk thistle, 1993.

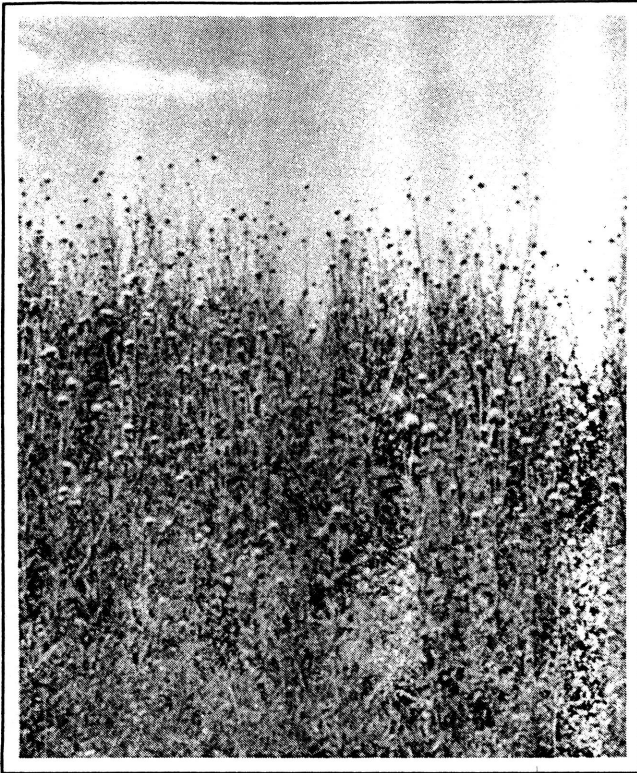


Figure 2. Mature musk thistle plants.

either an annual, biennial or winter annual depending on local environmental conditions.

Musk thistle reproduces entirely by seed. Seeds generally germinate in the fall or spring, but may germinate any time moisture is sufficient. About 70 percent of the seed germinates the first year and 20 percent the second year; the rest germinate later.

The seed is dispersed by wind and can be carried for many miles from its original site. Musk thistle produces an average of 10,000 seeds per plant, but under favorable conditions can produce many more.

After seed germination, the plant develops into the rosette stage (Figure 3). The rosette grows and increases in diameter until the onset of cold weather. Then, a fleshy tap root develops which allows the plant to overwinter. The following spring, new leaves originate from the crown bud in the rosette.



Figure 3. After seed germination, a rosette develops.

The bolting stage begins when the seed stalk starts to form and continues until the first flowerhead appears. The plant begins flowering in early-to-mid April and continues through July. Flower color varies from white or purple to a deep reddish-pink. The flowerheads of musk thistle are large, solitary and beautiful. Each flowerhead is located at the tip of a long stem or branch, which bends or nods and twists as the flower increases in size and matures. The plant dies after all its seeds mature.

Musk thistle is not a serious weed problem in crops requiring a spring seedbed preparation. Tillage easily eradicates rosettes established during the preceding summer or fall. Musk thistle, however, can be a problem in fall planted grains, alfalfa, or clover if conditions are favorable for seedling establishment and winter survival. The weed is found most commonly along roadsides, railroad right-of-ways, fence borders, wastelands and in pastures. Check fence rows, ditch banks and waste areas periodically for musk thistles. Newly established thistle rosettes are hard to see. You may not see them until they bloom the following year.

The economic impact of musk thistle is greatest in pastures and rangeland. Moderate infestations of

musk thistle reduce pasture yields an average of 23 percent. Livestock usually won't graze infested areas, but occasionally feed on the flowerheads.

BIOLOGICAL CONTROL

Specific natural enemies can aid in regulating the reproduction and spread of musk thistle. *Rhinocyllus conicus* Froelich, commonly called the flowerhead weevil (Figure 4), and *Trichosiromus horridus* (Panzer), the rosette weevil (Figure 5), are two such natural enemies. The larvae of these weevils feed on the flower receptacle and rosette crown of the thistle, respectively. This feeding effectively disrupts the thistle's growth and reproductive capacity. Native to Europe, these weevils were studied extensively by the USDA to ensure they would not damage other desirable plants such as sunflower.

Extensive research shows the weevils can reduce thistle populations 70 to 95 percent. Thus, the importation and release of natural enemies is an effective way to reduce infestations of musk thistle. The potential for biological control of musk thistle using the introduced weevils is apparent in Figures 6 and 7.

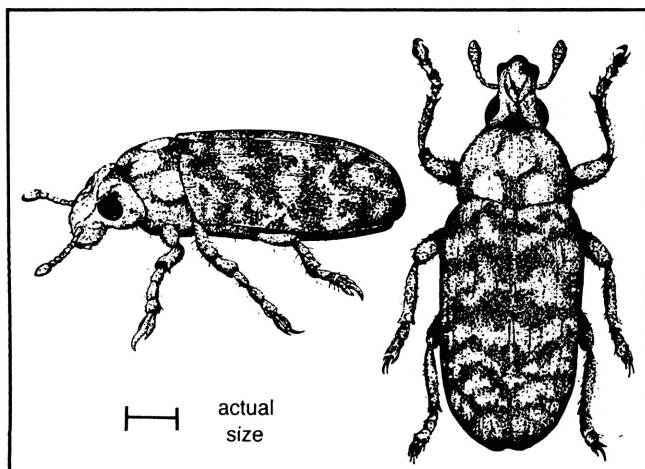


Figure 4. Adult flowerhead weevil.

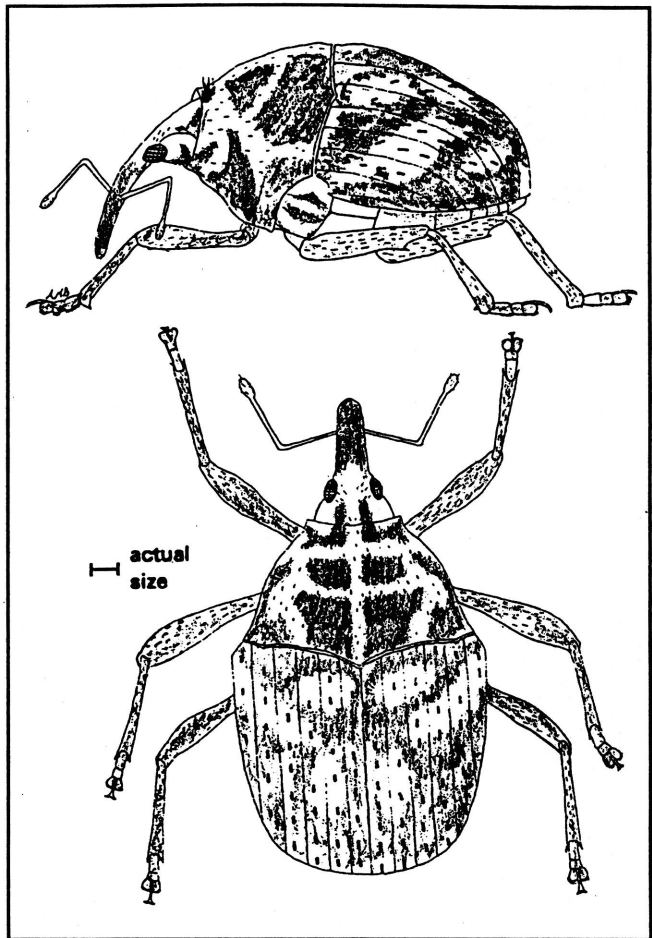


Figure 5. Adult rosette weevil.

The advantages of this biological control program, using these two weevils, are: 1) Very cost effective; 2) No threat to nontarget organisms; 3) Once established, weevils move into adjoining infested areas; 4) Requires little additional effort once the weevils are established, while other controls must be applied periodically.

BIOLOGY OF THE MUSK THISTLE WEEVILS

FLOWERHEAD WEEVIL *Rhinocyllus conicus* Froelich

The flowerhead weevil overwinters as an adult. In early spring, the adults crawl about and feed on the leaves of



Figure 6. Musk thistle stand before introduction of musk thistle weevils, 1975.

musk thistle rosettes. Mating takes place shortly thereafter, and by the time musk thistles begin to bolt, the females are ready to lay eggs. By mid-April, most musk thistles have budded or flowered. Weevils lay eggs on the bracts of developing flowerheads and cover each egg with a secretion of chewed plant material. This secretion gives the eggs a dirty, scale-like appearance (Figure 8). Each female lays an average of 150 eggs during its lifetime.

The eggs hatch in six to eight days. The larvae tunnel into the receptacle, the swollen base of the thistle flowerhead, where they feed (Figure 9). As many as 40 larvae have been found per terminal head. The number of larvae per head decreases as more flowerheads develop. Some flowerheads turn brown prematurely because many larvae are feeding in the receptacle. If you see incompletely filled flowerheads with dead plant tissue in the center, you might suspect musk thistle weevils are present.

Larvae require about 25-30 days to complete development. Then they stop feeding and begin a resting stage, called pupation, which lasts another 8-14 days. The pupae rest in cells in the flowerhead receptacle where they transform into adults.

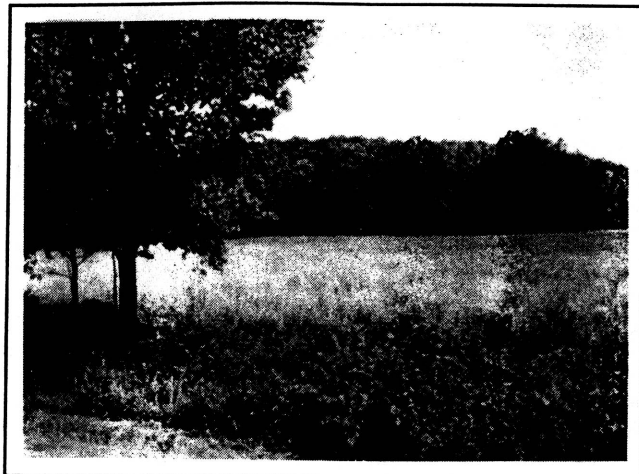


Figure 7. The same area 10 years after weevil releases.

The adults emerge in June and July and seek overwintering sites under new musk thistle rosettes, ground litter, and wooded areas, where they will remain dormant until the following year. For this reason, the insect is said to produce only one generation per year. Observations in other states show, however, that a few of the new emergents may not be ready to overwinter. Instead, they mate and lay more eggs, producing a partial second generation in late July.



Figure 8. Flowerhead weevil eggs on the bracts of developing flowerheads.

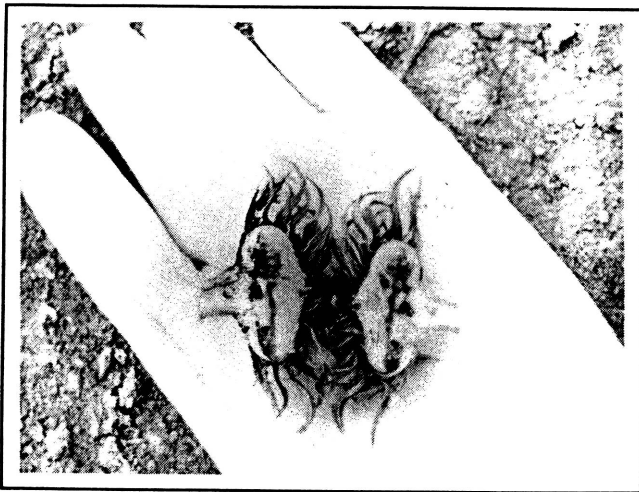


Figure 9. A cross section shows larval tunnels.

ROSETTE WEEVIL *Trichosiromus horridus* (Panzer)

Like the flowerhead weevil, the rosette weevil overwinters as an adult. It may also overwinter as a larvae or egg. In the late winter or early spring (March and April), the adults emerge from their hiding place and begin to feed and mate on the young thistle plants-still in the rosette stage. The females lay eggs along the midrib of the underside of the leaves. Each female may lay up to 800 eggs. The eggs hatch in about 10-12 days. The young larvae burrow into the midrib of the leaves and proceed to eat their way toward the growing center, or crown bud, of the thistle. There the larvae feed on the crown tissue for 6-8 weeks, causing tissue damage (Figure 10).

Damage caused by the larvae effectively changes the growth of the thistle, if not killing it. Instead of the plant growing tall (to 8 feet) with one terminal flower head and several lateral flowerheads from the central stem, the plant will be shorter and branched into several stems each with a terminal flowerhead. Branching usually occurs

from the base of the plant, near the soil.

After the larvae has developed and finished feeding, they emerge from the rosette and pupate in the leaf litter or soil for 12-20 days. By mid-May the new generation adults have emerged and begun to feed on the thistle plants. The weevils feed until temperatures rise to around 85 degrees, at which point they take cover in the leaf litter to aestivate until fall. In the fall, the adults emerge, feed, and may mate and lay eggs again on the thistle rosettes. These eggs may overwinter or hatch, in which case the larvae would overwinter. Generally, the rosette weevil produces one generation per year.

This weevil can be successfully used with the flowerhead weevil to more effectively control musk thistle infestations. The rosette weevil may also be found on bull thistle.



Figure 10. Damage caused by the rosette weevil.

SPRING COLLECTION AND DISTRIBUTION

Musk thistle weevils are collected and distributed on a local level in early-to-mid-May for the flowerhead weevil and in mid-to-late-May for the rosette weevil. Contact your local Agriculture Extension office or the North Carolina Department of Agriculture, Plant Industry Division (919-733-6930) about collections in your area and receiving weevils to control an infestation on your land.

The collections are intended to distribute the weevil at one or more locations in all thistle-infested counties. As a result of these efforts, the weevils are expected to naturally disperse and subsequently control all musk thistle populations. Studies show spring-released flowerhead weevils are 25 times more effective in colonizing musk thistle than adult weevils collected and released in July.

BEST AREAS FOR WEEVIL RELEASE

Studies show the musk thistle weevils do better in areas where the following factors are present:

- The area will not be mowed or sprayed;
- The area is infested with several hundred musk thistle plants; and,
- The area has good soil moisture (near a

creek or pond is best).

It is also important that you:

- Put all the weevils in the same area (5-10 per plant);
- Release weevils away from livestock; and,
- **Remember it takes an average of five to seven years for weevil populations to build to a point where thistle control occurs.**

SUMMARY (also see Figure 11)

- The musk thistle weevils can contribute to a substantial reduction in thistle populations over a period of five to seven years.
 - Overwintered female flowerhead weevils lay eggs on the bracts of the flowerheads from mid-April through June.
 - The life cycle of the flowerhead weevil from egg to adult ranges from 39-52 days.
 - Rosette weevils can overwinter in the adult, egg and larval stages.
 - Rosette weevil damage changes the architecture of the thistle plant from a single tall stem with many flowers to shorter multiple stems with fewer flowers.
 - The two weevils together contribute to a greater reduction of thistle populations than either weevil alone.

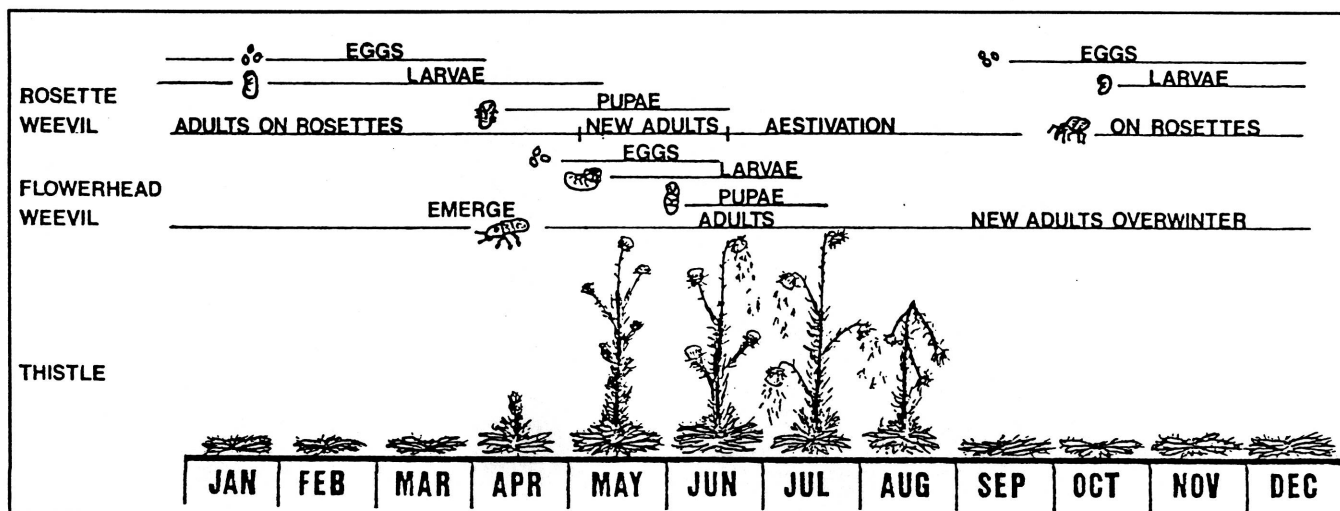


Figure 11. Time line showing life cycles of the weevils and the thistle.