Establishment of *Rhinocyllus conicus* (Coleoptera: Curculionidae) in Georgia for Control of Musk Thistle[1]

G. D. Buntin, R. D. Hudson[2], and T. R. Murphy[3]

Department of Entomology, University of Georgia, Georgia Station
Griffin, GA 30223

J. Entomol. Sci. 28(2):213-217 (April 1993)

ABSTRACT *Rhinocyllus conicus* Froelich was introduced and successfully established at 21 sites in northern Georgia for biological control of musk thistle, *Carduus nutans* L. A total of 9,310 adults were released from 1990 through 1992. Releases of reproductively mature adults in the spring were much more successful than summer releases of teneral adults. Progeny were observed in all spring-release sites, and population increases occurred at most sites one and two years after release. Consumption of infested capitula by cattle reduced *R. conicus* numbers at some sites. After two years, weevils had dispersed up to 0.6 km from the initial release point. Transfer of *R. conicus* to new sites in Georgia will begin in 1993.

KEY WORDS *Carduus nutans, Rhinocyllus conicus,* thistle-head weevil, musk thistle, biological control.

Musk or nodding thistle, *Carduus nutans* L., was accidentally introduced into the United States from Europe in the early 1900's and has subsequently spread throughout most of North America (French and Johnson 1988). The thistle was first discovered in Georgia in 1955, but was not considered a significant weed until the 1980's when infestations within the state increased dramatically. Drought, which reduced the competitiveness of other plants, and the importation of infested hay from northern states probably contributed to the spread of musk thistle (French and Johnson 1988). Currently, the plant occurs throughout most of the Piedmont region of Georgia.

Musk thistle is a weed in noncrop land, road right-of-ways, hay fields and pastures, where it competes with desirable forage plants and discourages grazing by livestock. The plant is an annual or biennial that propagates by seed (McCarty 1964), which in Georgia, usually germinate in the fall with bolting and flowering occurring in the spring. Although musk thistle can be controlled by a combination of cultural practices, mowing, and herbicides (McCarty and Hatting 1975, French and Johnson 1988), these practices are costly and time consuming and may not be feasible in inaccessible areas or in some agricultural production systems. Use of biological control agents would provide a cost-effective alternative to current management options.

[1] Accepted for publication 22 February 1993.
[2] Extension Entomology, Rural Development Center, University of Georgia, Tifton, GA 31793.
[3] Extension Agronomy, University of Georgia, Georgia Station, Griffin, GA 30223.

Rhinocyllus conicus Froelich is an oligophagous curculionid that was introduced from Europe as a biological control agent of *C. nutans, C. pycnocephalus* L. and *Silybum marianum* (L.) (Surles et al. 1974, Zwölfer and Harris 1984). *Rhinocyllus conicus* was initially released and established in Virginia in 1969 where it successfully controlled musk thistle after six years (Kok and Surles 1974). The weevil also has become established in Missouri (Puttler et al. 1978), Nebraska (McCarty and Lamp 1982), Kentucky (Townsend et al. 1991), Montana (Rees 1977), Maryland (Tipping and Hight 1989), southern California (Goeden and Ricker 1977) and more recently in Tennessee (Grant et al. 1990).

Rhinocyllus conicus is univoltine with egg to adult development requiring eight to 10 weeks (Surles et al. 1974). Each female lays about 200 eggs on bracts and the lower surface of flower buds in spring (Zwölfer and Preiss 1983). Larvae mine bracts and bore into the capitulum where they feed on the capitulum and developing seeds. This feeding action reduces the production of viable seed. Pupation occurs inside the capitulum; new adults emerge from the mature seed heads. Adults pass summer and winter in the soil and under leaf litter, rocks and wood (Zwölfer and Harris 1984).

A program to release and establish agents for biological control of musk thistle in Georgia was begun in 1990. We report on the release and successful establishment of *R. conicus* on musk thistle in Georgia.

Materials and Methods

Table 1 summarizes the number of release sites, by county, in Georgia in each year. Teneral adults provided by L. T. Kok (VPI, Blacksburg, Va.) were released at two sites (750 adults/site) at the Central Branch Experiment Station in northern Putnam County on 21 July, 1989. All subsequent releases were made in the spring using overwintered, reproductively mature adults. A total of 2,500 adults were released on 3 May, 1990 at five sites in Morgan and Jackson counties, and 4810 adults were released at 10 sites in Morgan, Jackson and Haralson counties on 7-8 May, 1991. Adults were collected near Farmington and Clinton, Mo in 1990 and 1991, respectively. An additional 2,000 adults collected in eastern Tennessee were released on 11 May, 1992 at sites in Jackson, Forsyth and Lumpkin counties. All release sites were pastures that were grazed by beef (16 sites) or dairy cattle (3 sites) or pastures that were recently planted with seedling loblolly pine trees, *Pinus taeda* L. (2 sites). Most sites had moderate (<1 plant/m^2) to heavy ($\geq$ 1 plant/m^2) infestations of musk thistle that covered $\geq$ 0.5 ha. Adults (400 or 500 adults/site) were released in a 4-m^2 area at each site.

Thistles in each site were inspected for eggs several weeks after adults were released. The 1990 sites were sampled in late June in the release year and in subsequent years to assess the level of infestation. The percentage of infested heads and number of *R. conicus* adults emerging per head was determined by collecting 150 or 200 primary flower heads per site. Capitula were dissected, and the number of larval feeding cavities recorded. Some sites established in 1991 in Morgan and Jackson counties also were sampled. All other sites were inspected each year for eggs and larvae or feeding cavities.

Table 1. Number of *R. conicus* release sites by county in Georgia.

County	1989	1990	1991	1992	Total
Putnam	2	0	0	0	2
Morgan	0	3	4	0	7
Jackson	0	2	3	1	6
Haralson	0	0	3	0	3
Forsyth	0	0	0	3	3
Lumpkin	0	0	0	1	1
Total	2	5	10	5	22

Results and Discussion

Summer releases of *R. conicus* in 1989 were slow to colonize site 1 and failed to colonize site 2 in Putnam county (Table 2). Eggs, larvae and teneral adults of *R. conicus* were observed in the release year at all 20 sites where spring releases were made in 1990 through 1992. Therefore, *R. conicus* has successfully established at 21 sites in Georgia (Table 1). Kok (1974) previously demonstrated that establishment of *R. conicus* was much more successful when reproductively mature adults were released in the spring rather than when newly emerged adults were released in the summer.

When weevils were released in early May in Georgia, most plants had primary flower heads that were in full bloom, therefore eggs were laid on secondary buds and late developing primary buds. In subsequent years, overwintered adults became active in early April, with most oviposition occurring on primary stem buds in mid-April. Larvae were present in May, and most adults emerged by the end of June. Life history events of *R. conicus* occurred about one month earlier in Georgia than in Missouri (McDonald et al. 1986).

The percentage of infested capitula in 1990 release sites (N = 5) averaged (± SEM) 28.4 ± 9.5% in 1991 and 27.3 ± 9.0% in 1992, whereas the percentage of infested capitula in 1991 release sites (N = 6) averaged 14.6 ± 5.5% in 1992. Furthermore, populations have steadily increased at most sites since 1990 (Table 2). Site 2 in Morgan county was accidentally mowed during May 1991 which destroyed weevils in the release area, but a small number of immatures survived in fence rows at this site. Nevertheless, mowing prevented any increase in the number of *R. conicus* per capitulum between the first and third year in the release area. However, weevils dispersed to an adjacent pasture and averaged 0.39 larval cavities/capitulum in 1992. Additionally, dairy cows at this site and beef cattle at site 1 in Jackson Co. ate many infested capitula in 1992 which further reduced infestations at these sites. Consumption of *R. conicus* infested capitula by cattle was not quantified in this study, but Surles et al. (1975) found that cattle consumed 13% of tagged, infested capitula in Virginia. Goedon and Ricker (1977) also reported that consumption of infested capitula by cattle interfered with the establishment of *R. conicus* at sites in southern California.

Table 2. *R. conicus* numbers in 1989 and 1990 musk thistle release sites after adult emergence in 1990, 1991 and 1992.

County	Site	Immatures/capitulum		
		1990	1991	1992
Putnam	1	0	0.07	0.30
	2	0	0	–
Morgan	1	0.15	0.75	0.76
	2	0.11	–*	0.11
	3	–	0.92	2.20
Jackson	1	0.08	0.37	0.06
	2	–	0.11	0.26

* Site accidently mowed in May 1991.

The number of *R. conicus* per capitulum at site 3 in Morgan county reached a level of 2.2 larval cavities/capitulum by 1992. This site was a bermudagrass, *Cynodon dactylon* (L.), pasture supporting loblolly pine saplings. Musk thistle numbers declined from 5.9 plants/m^2 in 1990 to 0.9 plants/m^2 in 1992, presumably because of competition by pasture plants. Consequently, overwintered weevils in 1992 were concentrated on the relatively small number of flower buds producing an artificially large increase in weevil numbers at this site.

Kok and Surles (1975) found that dispersal of *R. conicus* was limited during the first four years after release, but a dramatic increase in natural dispersal occurred in subsequent years. We found that the first generation occurred typically within 25 m of a release site, and eggs and larvae usually were ≤100 m from a release point in the first year after release. By the second year after release, eggs and larvae were present up to 0.6 km from the release area.

Generally, five to seven years were required for *R. conicus* to suppress musk thistle infestations in Virginia (Kok and Surles 1975). Thus, the effectiveness of this insect in controlling musk thistle in Georgia will not be known for a number of years. Transfer of weevils collected in the 1990 release sites to new locations within the state will begin in 1993.

Acknowledgments

We thank L. T. Kok for providing weevils in 1989, B. Puttler and W. Bailey for assistance in collecting weevils in Missouri in 1990 and 1991 and J. F. Grant, P. L. Lambdin and R. Chagnon for providing weevils from Tennessee in 1992. We also thank Extension agents C. W. Tankersley (Morgan County), J. D. Parks, Jr. (Jackson County) and J. C. Callaway, Jr. (Haralson County) for their assistance. Additionally, we thank T. Cathey, M. Cash, J. Hamil, J. Maddox, Jr., J. McDonald, C. Miller, J. Smith, L. Taylor, J. Wittaker and R. Bruce for allowing us to work on their farms.

References Cited

French, C. M. and J. T. Johnson. 1988. Musk thistle and its control. Univ. Ga. Coop. Ext. Serv. Leaflet 400.

Goeden, R. D. and D. W. Ricker. 1977. Establishment of *Rhinocyllus conicus* on milk thistle in southern California. Weed Sci. 25: 288-292.

Grant, J. F., P. L. Lambdin, S. D. Powell and R. Chagnon. 1990. Establishment of plant-feeding weevils for suppression of musk thistle in Tennessee. Univ. Tenn. Agric. Exp. Stn. Res. Rep. 90-19.

Kok, L. T. 1974. Efficacy of spring release in colonization of *Rhinocyllus conicus* for the biocontrol of thistle. Environ. Entomol. 3: 429-430.

Kok, L. T. and W. W. Surles. 1975. Successful biocontrol of musk thistle by an introduced weevil, *Rhinocyllus conicus.* Environ. Entomol. 4: 1025-1027.

McCarty, M. K. 1964. New and problem weeds: musk thistle. Proc. North Central Weed Control Conf. 16: 1-4.

McCarty, M. K. and J. L. Hatting. 1975. Effects of herbicides or mowing on musk thistle seed production. Weed Res. 15: 363-7.

McCarty, M. K. and W. O. Lamp. 1982. Effect of a weevil, *Rhinocyllus conicus,* on musk thistle (*Carduus thoermeri*) seed production. Weed Sci. 30: 136-140.

McDonald, R., B. Puttler, W. Dieker, J. H. Jarman and M. L. Farchild. 1986. Integrated control of musk thistle using and introduced weevil. Univ. Missouri Agric. Guide G4867.

Puttler, B., S. H. Long and E. J. Peters. 1978. Establishment in Missouri of *Rhinocyllus conicus* for the biological control of musk thistle (*Carduus nutans*). Weed Sci. 26: 188-190.

Rees, N. E. 1977. Impact of *Rhinocyllus conicus* on thistles in southwestern Montana. Environ. Entomol. 6: 839-842.

Surles, W. W., L. T. Kok and R. L. Pienkowski. 1974. *Rhinocyllus conicus* establishment for biocontrol of thistles in Virginia. Weed. Sci. 22: 1-3.

Surles, W. W., R. L. Pienkowski and L. T. Kok. 1975. Mortality of the immature stages of *Rhinocyllus conicus,* a thistle head weevil, in Virginia. Environ. Entomol. 4: 371-372.

Tipping, P. W. and S. D. Hight. 1989. Status of *Rhinocyllus conicus* (Coleoptera: Curculionidae) in Maryland. Maryland Entomol. 3: 123-128.

Townsend, L. E., J. C. Parr, J. D. Green and B. C. Pass. 1991. Status of *Rhinocyllus conicus* (Coleoptera: Curculionidae): a biological control agent of *Carduus nutans* (Compositae) established in Kentucky. Trans. Ky. Acad. Sci. 52: 116-118.

Zwölfer, H. and P. Harris. 1984. Biology and host specificity of *Rhinocyllus conicus* (Froel.) (Col., Curculionidae), a successful agent for biocontrol of the thistle, *Carduus nutans* L. Z. Ang. Entomol. 97: 36-62.

Zwölfer, H. and M. Preiss. 1983. Host selection and oviposition behaviour in west-European ecotypes of *Rhinocyllus conicus* (Froel.) (Col., Curculionidae). Z. Ang. Entomol. 95: 113-122.