BAIT STATIONS FOR CONTROLLING VOLES IN APPLE ORCHARDS

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ABSTRACT

Bait stations made with polyvinylchloride (PVC) pipe were compared with hand-broadcast applications of rodenticides for achieving long-term control of pine and meadow vole populations (*Microtus pinetorum* and *M. pennsylvanicus*, respectively) in two apple orchards in the mid-Hudson Valley of New York. The stations were constructed of three pieces of 1.5-in diameter PVC tubing joined together in the shape of an inverted "T". Roofing shingles were placed over the entrances to some of the bait stations to encourage use by voles, while others were left uncovered. All stations were tied to trees, with no attempt to place them near runways or burrow entrances. Both pine and meadow voles consumed bait from the stations, regardless of whether the entrances were covered with roofing shingles. However, plugging of entrances with dirt was prevalent during winter in stations with roofing shingles. Vole activity and capture success were consistently lower on the plots with the two types of bait stations than on either the control or broadcast baiting plots 13, 26, 39, and 52 wk posttreatment, although the differences were not statistically different ($p>0.05$). The best control was achieved during the winter and early spring. Although spoilage of bait due to high humidity may limit its effectiveness in Eastern New York during the late spring and summer, the inverted "T" bait station provides a practical means of controlling voles in apple orchards during winter and early spring.

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INTRODUCTION

Pine and meadow voles cause substantial economic losses in apple orchards in Eastern New York (Biser 1967, Pearson 1976, Pearson and Forshey 1978, Forshey et al. 1984). By girdling the bark and roots of trees, these rodents kill trees, reduce harvest yields, and increase the time required for new plantings to come into production. Growers employ a combination of cultural and chemical techniques to control vole populations in their orchards (Byers 1985). Regular mowing of the orchard groundcover and maintenance of a vegetation-free zone around the base of trees reduces the carrying capacity of the orchard for voles. Wire-mesh tree guards prevent girdling by meadow voles (Davis 1976), but not pine voles, which cause most of their damage to underground roots. Toxic baits are also an important and necessary component of most successful control programs (Byers and Young 1978).

In spite of their widespread use, toxic baits have not always given consistent or satisfactory control. A common problem in the northeastern United States is applying baits at a propitious time; frequent and unpredictable rain and snow storms restrict the effective life span of broadcast baits. Because snowcover and adverse weather likewise often preclude applying baits during the winter, most growers apply them during the autumn after apple harvest. While this strategy reduces pest populations just prior to the onset of winter, new voles often reinvade denuded areas (VanVleck 1968, Miller and Richmond 1984) and inflict substantial damage under the cover of snow, before a grower even realizes that voles have reinvaded his orchard. An effective method of delivering baits to voles during the winter, when most damage occurs and when bait acceptance is likely to be greatest due to the scarcity of preferred foods, would help to control such animals.

Growers in the Northeast have used various techniques to protect baits from the weather. Silver (1924) reported on the use of jars, tin cans, homemade wooden stations, and commercial stations to protect bait from weather for long periods. During the late 1970's and early 1980's, many placed roofing shingles, split automobile tires, or other objects on the ground to attract pine voles to bait and provide limited protection from rain and snow. Unfortunately baits placed on the ground under such protective cover still absorb moisture from the ground and do not last for more than 2 wk. During the early 1980's, growers used tubes of polyvinylchloride (PVC) that were 2 in diameter, 6.5 in long, and open at one end. These protected the bait from ground moisture, but were labor intensive because they had to be placed in vole runways and burrow openings. Another drawback was the difficulty in finding and refilling them with bait when they were hidden by snow or overgrown vegetation. Radvanyi (1974) used bait stations made of galvanized metal in the shape of an inverted "T" to control small rodents in a hardwood planting. Siddiqi et al. (1984) used a modified version of Radvanyi's inverted "T" bait station to control damage in Ontario apple orchards. Although the inverted "T" bait station apparently is effective for controlling meadow voles, a rodent with a relatively large home range, we know of no studies to evaluate it for controlling pine voles, a fossorial rodent that spends much of its time in subsurface burrows and has a limited range. During 1986 and 1987, we evaluated a modification of the inverted "T" bait station for controlling mixed populations of pine and meadow voles in two apple orchards in Eastern New York.

OBJECTIVES

1. To determine whether pine and meadow voles consume bait from the stations;
2. To determine whether 1-ft^2 pieces of roofing paper placed as covers over the entrances to the stations enhance usage by voles;
3. To determine whether the stations protect bait from adverse weather and ground moisture;
4. To determine whether the stations result in a long-term reduction of vole populations; and
5. To compare control achieved with the bait stations with that achieved with conventional broadcast applications of baits.

METHODS

We conducted the study at two orchards in the mid-Hudson Valley of New York: at Moriello Brothers' Orchard south of New Paltz and at Porpiglia Orchard in Ulster Park, both in Ulster County. The trees at Moriello Brothers were 45-yr-old McIntosh trees spaced at 40 ft x 40 ft and interplanted with 25-yr-old trees of the same variety. The trees at Porpiglia were a mixture of 25- to 35-yr-old Red Delicious trees interplanted with Red Delicious, McIntosh, and a few Golden Delicious trees ranging in age from 4 to 25 yr. The average spacing at Porpiglia was 20 ft x 20 ft.

At each site we randomly applied four treatments to 6 x 6 plots of trees. The treatments were 1) 36 bait stations, one at each tree, 2) 36 bait stations, one at each tree, with a 1-ft^2 piece of roofing paper covering each of the two entrances to each station, 3) a hand-broadcast application of bait, and 4) a control where no bait was applied. Adjacent plots were separated either by two buffer rows or by four or more trees within a row. In the appropriate plots we put 6 oz of Rozol®[3] (0.005% chlorophacinone) in each bait station or hand-broadcast 1.5 oz of Rozol in each of four quadrats under the dripline of each tree. Treatments began on 22 September 1986.

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[3]Reference to trade does not imply Cornell University or U.S. Government endorsement.

Thereafter we put fresh bait in the bait stations at approximately 13-wk intervals, but hand-broadcast the bait only once, in the autumn of 1986.

The bait stations consisted of three pieces of 40 gauge, 1.5-in diameter PVC tubing joined in the shape of an inverted "T" by a PVC tee joint (Fig. 1). The vertical

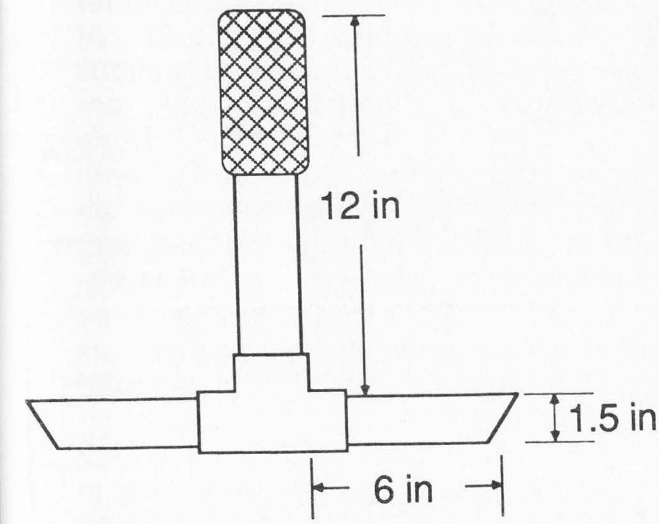

Fig. 1. PVC bait station for controlling pine and meadow voles in apple orchards

tube was 1.0 ft long and covered at the top with a 12-oz soft drink or beer can opened at one end. Each of the bottom, horizontal pieces was 0.5 ft long with the outside end cut at a 45 degree angle. We used PVC cement to glue the pieces together and keep moisture out. Each bait station was placed flat on the ground with the vertical tube secured to a tree with nylon rope. We made no effort to position the bait stations near runways or burrow openings. All bait stations were identical except that some had a piece of 1-ft^2 roofing paper over each of the two entrances.

We used both an apple slice index (ASI) and live traps to evaluate efficacy at the 16 interior trees of each plot 1 to 2 wk before and 13, 26, 39, and 52 wk after treatment. For the ASI, we placed a slice consisting of approximately 1/16 of an apple under a 1-ft^2 piece of roofing paper near the base of each monitoring tree. These shingles were separate from the ones used to cover the entrances to some of the bait stations. Twenty-four hours later we checked for signs of vole activity as evidenced by partially eaten, missing, or otherwise disturbed slices. For each plot, we derived an ASI by calculating the proportion of active trees (i.e. the proportion of trees showing signs of vole activity). We also estimated the density of voles on each plot during the 1-2 wk preceeding, and again 13, 26, 39, and 52 wk after the initially applying the treatments. During each of these trapping sessions, we placed one 2.0 x 2.5 x 6.7-in Sherman live trap at each of the 16 interior monitoring trees for 1-1/2 days. The traps were baited with pieces of apple and put in vole runways or burrow entrances under the same pieces of roofing paper used for the ASI. The traps initially were set within 1 hr of sunrise on the first day of trapping, and were checked 3, 6, and 9 hr later before being closed for the night. The next morning the traps were again baited and set within 1 hr of sunrise and checked 3 and 6 hr later. The traps were collected after the last check. All voles were individually marked by toe clipping (Day et al. 1980) and released as soon as possible at the point of capture. We recorded the following information for each captured vole: date, time, location, species, sex, age (based on size and color), weight (by use of a Pesola scale), reproductive condition (e.g. scrotal, pregnant, lactating), perforate or nonperforate vagina, and parous or nonparous. One to two weeks after completion of each trapping session, we measured the amount of bait remaining in each bait station and refilled the stations with fresh bait.

We analyzed time trends within each orchard by regressing the dependent variable against time for each treatment and period; we calculated linear, quadratic, and cubic regressions for both the capture data and the ASI. To analyze differences among treatments, we used a summary statistic for the four posttreatment periods. For each treatment and orchard, we used the average percent reduction between the number of voles trapped during the pretreatment period and the mean number trapped during four post-treatment periods to perform a two-way ANOVA with orchard and treatment as two independent variables. We performed a similar analysis for the proportions derived from the ASI. Minitab (Ryan et al. 1985) was used for all regressions and ANOVA's.

RESULTS

Both pine and meadow voles utilized the stations. Bait was removed from all 64 bait stations that we monitored, including stations at trees where we had previously captured meadow voles and stations at trees where we had captured pine voles. The dramatic decline in trapping success for both pine and meadow voles after the stations initially were filled with bait and the consistently low numbers of both species on the bait station plots (Fig. 2) also attest to the efficacy of the stations for delivering bait to both species.

The shingles had little effect on whether voles found and consumed bait from the stations; bait consumption was similar on the plots with and without roofing shingles (Table 1). However, the shingles may have diminished the effectiveness of the bait stations by encouraging voles to build nests under the shingles and plug the entrances to the stations with dirt. During the winter at Porpiglia's, 12 of the 16 monitored stations that had shingles had both entrances plugged with dirt, and another had one entrance plugged (Table 2). At Moriello Brothers', two monitored stations that had roofing shingles had both entrances plugged during the winter. None of the stations without shingles had both entrances plugged during the winter, although five had one entrance plugged. Voles plugged the stations much less frequently during other times of the year: we found no stations plugged during April, six plugged during July, and eight plugged during September.

Some of the stations protected bait for 3 mo, the longest we left it before putting in fresh bait, but the bait in other stations became wet and moldy (Table 3). This problem was most common during the late

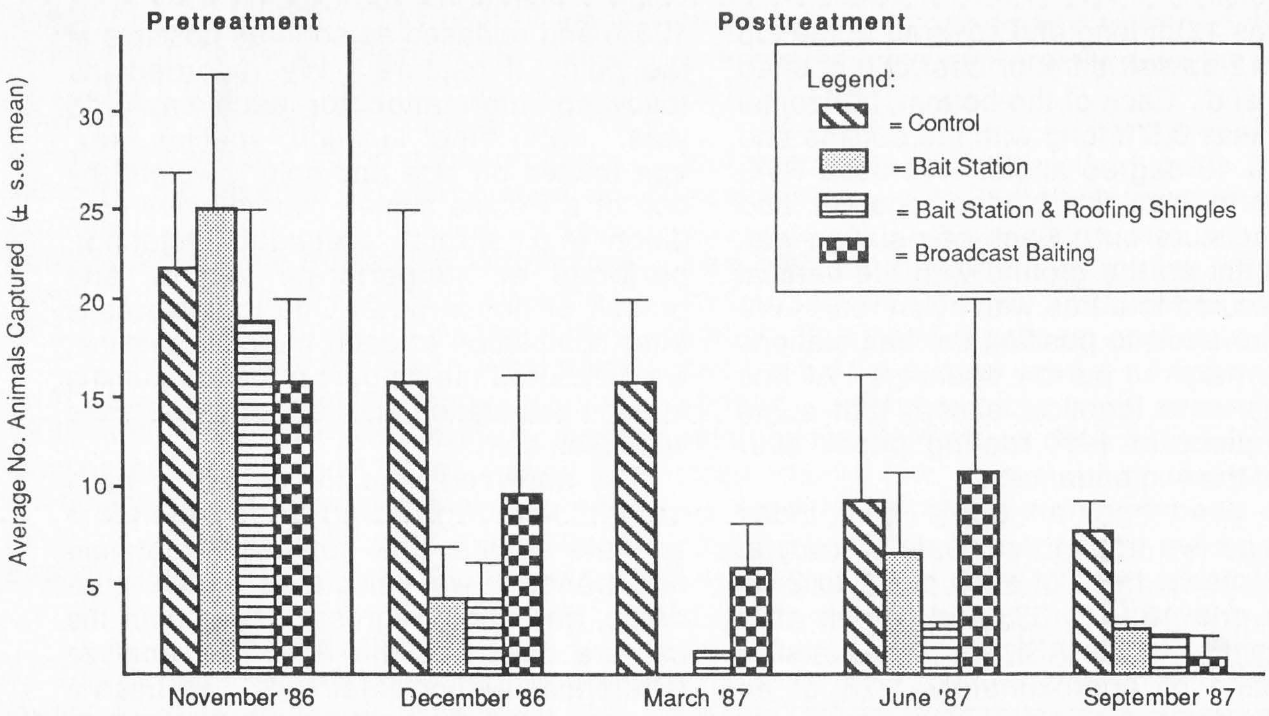

Fig. 2. Number of voles captured on plots with PVC bait stations and hand-broadcast applications of baits in two apple orchards in Eastern New York..

Table 1. Bait removed by voles from two types of stations during each of four seasons in two apple orchards of Eastern New York during 1986 and 1987.

Orchard	Type of station[a]	No. of stations	Percent of stations having bait removed			
			December	April	July	September
Porpiglia	BS	16	56	100	38	94
	BSR	16	50	94	19	56
Moriello	BS	16	94	38	88	100
	BSR	16	94	50	38	25

[a] BS stations had no coverings over their entrances.
BSR stations had a 1-ft^2 piece of roofing shingle over each entrance.

Table 2. Numbers of two types of bait stations that had one or both entrances plugged by voles during each of four seasons in two apple orchards of Eastern New York during 1986 and 1987.

Orchard	Type of station[a]	No. of stations	December sides plugged		April sides plugged		July sides plugged		September sides plugged	
			1	2	1	2	1	2	1	2
Porpiglia	BS	16	4	0	0	0	0	0	0	0
	BSR	16	1	12	0	0	0	0	1	0
Moriello	BS	16	1	0	0	0	1	3	4	0
	BSR	16	0	2	0	0	2	0	1	2

[a] BS stations had no coverings over their entrances.
BSR stations had a 1-ft^2 piece of roofing shingle over each entrance.

spring and summer; 82% of the stations with spoiled bait were found during July or September. The roofing shingles did notappear to contribute to the problem of the bait becoming wet and moldy.

None of the regressions for the trapping and ASI data was significant, indicating that time was not a significant factor within each orchard for each treatment. We therefore used the average reduction of the four posttreatment periods from the pretreatment level to make comparisons among treatments. Although none of the reductions in number of individuals captured was statistically significant ($F_{3,3}$=7.86, p<0.10), there was a consistent reduction in capture success on the plots with bait stations. Before any baits were

Table 3. Number of two types of bait stations that had wet or moldy bait during each of four seasons in two apple orchards of Eastern New York during 1986 and 1987.

Orchard	Type of station[a]	No. of stations	Number of stations with wet or moldy bait: December	April	July	September
Porpiglia	BS	16	5	1	10	4
	BSR	16	1	4	15	11
Moriello	BS	16	0	2	4	4
	BSR	16	0	0	6	7

[a] BS stations had no coverings over their entrances.
BSR stations had a 1-ft^2 piece of roofing shingle over each entrance.

applied, the average number of voles captured at the two sites was similar on all four treatment plots (Fig. 2). After the baits were applied, the average number of captures on the plots with the bait stations was lower than on the control plots during all four posttreatment trapping sessions, and lower than on the broadcast baiting plots during three of the posttreatment trapping sessions. The largest reduction was during March, when no voles were captured on the plots with bait stations, and only one vole was captured on each of the plots with bait stations and roofing shingles.

No differences among treatments in the average reduction of the ASI were significant ($F_{3,3}$=0.66). The ASI were comparable among the four treatments during the pretreatment and most of the posttreatment indexing sessions (Fig. 3). However, no activity was evident during March on the plots with the bait stations with roofing shingles.

DISCUSSION

One might expect animals like meadow voles, which are active above ground, to find food placed in a bait station within their home range. Radvanyi (1974) and Siddiqi et al. (1984) used inverted "T" bait stations successfully against this species. Pine voles, on the other hand, spend much of their time in underground burrows and may not be as likely to find bait placed in a station on the surface of the ground. That broadcast baiting can be an effective application technique for controlling pine voles (Byers 1981, Byers et al. 1982) suggested to us that bait stations may not have to be placed directly near a pine vole burrow to be effective. Our study is the first successful use of an inverted "T" bait station that we are aware of for controlling pine voles.

The observation that pine voles are attracted to and often nest under apple crates, boards, and similar objects placed on the orchard floor prompted us to use roofing shingles to try to enhance usage of the bait stations. The comparable consumption of bait from both types of stations suggests that shingles are unnecessary for attracting pine voles to the stations. The increased number of stations with shingles plugged with dirt during winter indicates that the shingles may even be counter productive.

Several explanations might account for the presence of moisture in a few stations. Although the use of glue to assemble the stations helped prevent leakage through

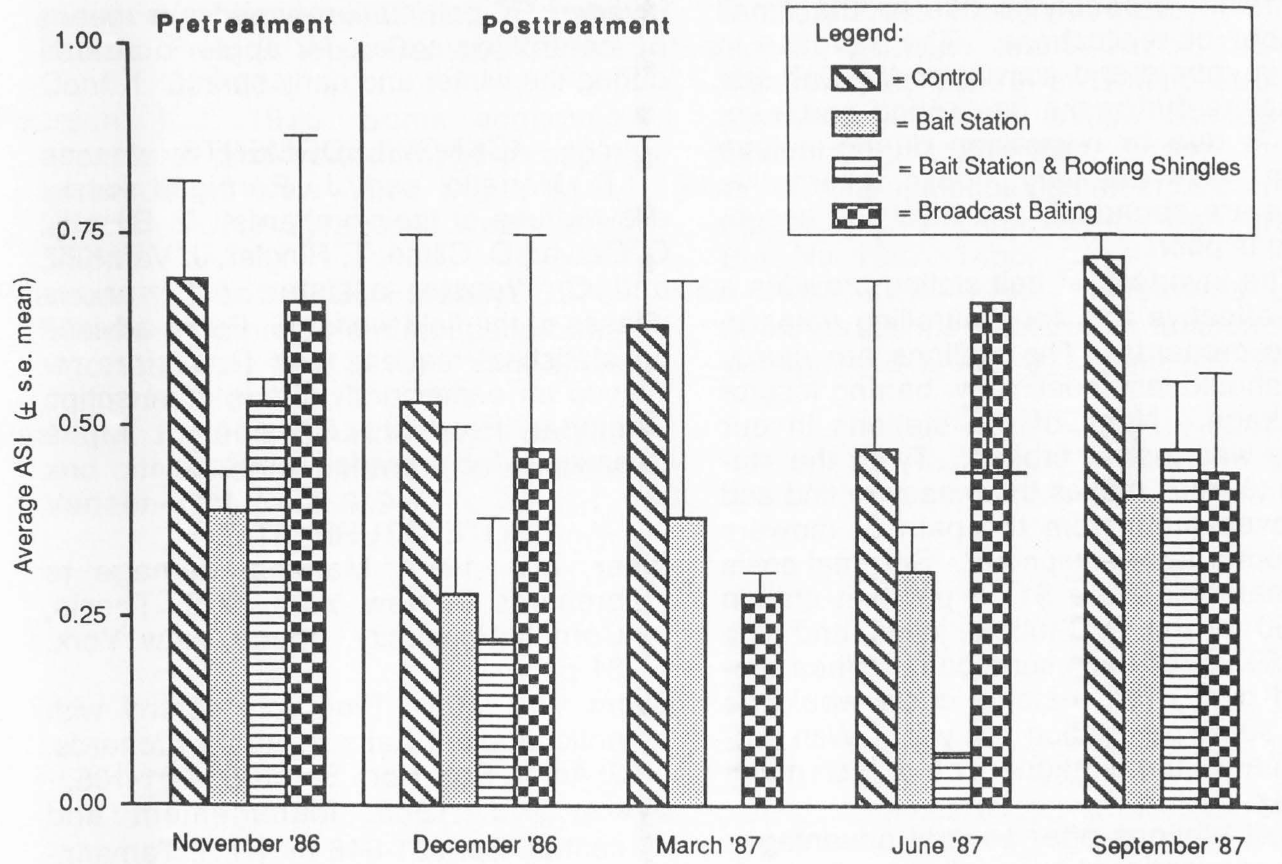

Fig. 3. Apple slice index (ASI) on plots with PVC bait stations and hand-broadcasting applications of baits in two orchards in Eastern New York. The ASI is the proportion of trees with an apple slice partially eaten, missing, or otherwise disturbed by voles.

the joints, and the careful placement of the stations flat on the ground reduced the chances of water flowing in through the entrances, water still may have leaked or flowed into some stations. Voles themselves may have transported water or snow into some stations, or even urinated inside the stations.

However, the preponderance of stations with wet or moldy bait during the months from May through September suggests that humidity was the major reason for spoilage of the bait in the stations. Silver (1924) reported that grass which mats down and holds moisture causes bait in stations to mold. Most of our plots were overgrown with ground vegetation that may have trapped moisture. Bait stations apparently do little to protect against such ambient moisture. Because bait acceptance usually is poor anyway during the late spring and summer (Tobin, unpubl. data), the optimum strategy may be to keep bait in the stations only during winter and early spring. Because voles do most of their girdling in apple orchards during these times, the stations could still be an effective tool for protecting apple trees from these animals. However, because moldy bait was found throughout the year in at least a few stations, growers should inspect the bait regularly and replace it if necessary.

The bait stations did not eliminate all voles, but they did result in substantially reduced numbers, especially during winter and early spring. At this time vole populations were reduced to an average of 0.5

animals on the plots with bait stations. That these reductions were not statistically significant probably is due to the small number of replications. The increase in vole numbers and activity on the bait station plots during the late spring and summer is due to reinvasion during a time when voles are very mobile, alternative foods are abundant, and thus bait acceptance is poor.

The inverted "T" bait station provides a cost-effective tool for controlling voles in apple orchards. The stations are sturdy and should last indefinitely, barring loss or breakage. None of the stations in our study was lost or broken. Tying the stations to trees makes them easy to find and removes them from the path of mowers and other farm equipment. Our total costs for materials were $1.55 per bait station ($1.50 for the PVC tubing, joints, and glue and $0.05 for each soda can). When prorated over 5 yr, material costs would be only $0.30 per station per year. With proper care, the stations could last much longer.

Bait stations offer several advantages over conventional broadcast applications of baits for controlling voles in apple orchards. By making bait continually available, the stations insure that bait is in the orchard when voles are most likely to eat it and when the threat of damage to trees is greatest. By protecting uneaten bait and making it available for reinvading voles, the stations reduce wastage and delay repopulation of denuded areas. The stations also reduce the chances of nontarget poisoning by concealing the bait and excluding birds and mammals larger than voles.

CONCLUSIONS

Both pine and meadow voles consumed bait from the stations, regardless of whether the entrances were covered with roofing shingles. The stations protected bait from rain, snow, and ground moisture, but not from humidity. Although the stations protected bait longer than conventional broadcast applications, the eventual spoilage of bait in the stations could limit their effective use in Eastern New York during the spring and summer. The inverted "T" bait station provides a means of controlling voles in apple orchards during the winter and early spring.

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LITERATURE CITED

Biser, D.L. 1967. Mammal damage to orchards in New York. M.S. Thesis, Cornell University. Ithaca, New York. 81 pp

Byers, R.E. 1981. Pine vole control with anticoagulant baits in apple orchards. J. Amer. Soc. Hort. Sci. 106: 101-105.

Byers, R.E. 1985. Management and control. Pp. 621-646 *in* (R.H. Tamarin- ed.) Biology of new world *Microtus*. Spec. Publ. No. 8. The Amer. Soc. Mamm. 893 pp.

Byers, R.E., M.H. Merson, and S.D. Palmateer. 1982. Control of orchard voles with broadcast baits. J. Amer. Soc. Hort. Sci. 107: 613-619.

Byers, R.E., and R.S. Young. 1978. Effect of orchard culture on pine vole activity. J. Amer. Soc. Hort. Sci. 103: 625-626.

Davis, D.E. 1976. Management of pine voles. Proc. Vertebr. Pest Conf. 7: 270-275.

Day, G.I., S.D. Schemnitz, and R.D. Taber. 1980. Capturing and marking wild animals. Pp. 61-88 *in* (S.D. Schemnitz- ed.) Wildlife management techniques manual. The Wildlife Society, Washington, D.C.

Forshey, C.G., P.N. Miller, and M.E. Richmond. 1984. Effects of differential pine vole populations on growth and yield of "McIntosh" apple trees. HortSci. 19: 820-822.

Miller, P.N., and M.E. Richmond. 1984. Movements of the pine vole (*Microtus pinetorum)* in repopulating orchard habitat. Proc. E. Wildl. Damage Control Conf. 1: 231-234.

Pearson, K.J. 1976. Some economic aspects of pine vole damage in apple orchards of New York State. M.S. Thesis, SUNY-Syracuse, New York. 54 pp.

Pearson, K., and C.G. Forshey. 1978. Effects of pine vole damage on the vigor and fruit yield in New York apple orchards. HortSci. 13: 56-57.

Radvanyi, A. 1974. Small mammal census and control on a hardwood plantation. Vertebr. Pest. Conf. 6: 9-19.

Ryan, B.F., B.L. Joiner, and T.A. Ryan, Jr. 1985. Minitab Handbook, 2nd ed. Duxbury Press, Boston. 374 pp.

Siddiqi, Z., D. Blaine, and S. Taylor. 1984. Meadow vole control in Ontario apple orchards. Proc. E. Wildl. Damage Control Conf. 1: 207-208.

Silver, J. 1924. Mouse control in field and orchard. U.S. Dept. Agric., Farmers' Bull. No. 1397. 14pp.

Van Vleck, D.B. 1968. Movements of *Microtus pennsylvanicus* in relation to depopulated areas. J. Mamm. 49: 92-103.