March 1981

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Radiotelemetric Evaluation of the Effect of Horticultural Practices On Pine and Meadow Voles in Apple Orchards: I. Rotary Mowing

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Abstract: Pine voles (Microtus pinetorum) and meadow voles (Microtus pennsylvanicus) were studied in three apple orchard plots in the Hudson Valley of New York during June and July 1980. Selected voles from each plot were given miniature radiotransmitters and then tracked before, during, and after rotary mowing.

A total of 11 pine voles and 6 meadow voles were tracked. Home range size was much larger for meadow voles than pine voles. During mowing, meadow voles were noticeably affected by the mower; pine voles were not. No change occurred in the area utilized before and after mowing for either species, nor did any significant mortality result from the treatment. Voles of both species showed a slight but significant tendency to remain closer to the tree rows after mowing. We conclude that rotary mowing has a negligible effect on vole movement and survival under the conditions of this study.

INTRODUCTION

Pine and meadow voles are among the most poorly understood pest species in apple orchards, yet they regularly cost east coast apple growers millions of dollars in production each year. Considerable effort has been spent in trying to develop effective controls, but the secretive habits of voles are not easily studied. In addition, these rodents have a phenomenal ability to recover from temporary population declines. The problem of effective control is further confounded by the presence of two vole species that have different habitat preferences, diets, and behavior patterns (FitzGerald & Madison, 1981; Madison, 1980, 1981; McAninch, 1979; Pagano & Madison, 1981) and hence would likely require different methods for the most effective biological control.

The present study is the first of an ongoing series of studies devoted to measuring in what way different horticultural practices actually affect the movements and survival of both pine and meadow voles. Radiotelemetry is used to overcome many of the methodological shortcomings of previous studies. In this study, we report the effect of rotary mowing on vole movement and survival.

METHODS

The study was conducted on three separate apple orchard plots within Stanley Orchards (owned by Stanley Cohn), Modena, Ulster County, New York from 23 June to 7 July 1980. In the "pine vole plot," the

habitat consisted of old trees with wide spacing between the rows and trees. Forbs were common under the trees. Pine voles predominated about 4:1 over meadow voles in this habitat, and only pine voles were studied here. In the "meadow vole plot," the habitat consisted of trees less than 10 years old, and the spacing between rows and trees was much smaller. Meadow voles were essentially the exclusive residents in this area. Rich grass growth and more furrowed ground characterized this habitat. Only meadow voles were studied here. In the third "mixed species plot," old trees and young tree interplants were common. This habitat was more heterogeneous in tree age and ground cover than the other two. Both species of vole were equally abundant, and both were studied.

After an initial census period during May and June, we attempted to select three adults of each sex of each species for radiotracking from the 3 study plots, making 6 pine voles from the pine vole plot, 6 meadow voles from the meadow vole plot, and 6 of each species from the mixed species plot. These animals would then be studied intensively using radiotelemetry before, during and after the mowing operation.

The radiotelemetry methods used have been reported previously (Madison, 1977; Mineau & Madison, 1977). The one exception to the cited methodology is that, instead of being attached to collars, the radiotransmitters were encapsulated in parafin (Elvax, Minimeter) and implanted within the intraperitoneal cavity (see Smith, 1979, for similar techniques). A one cm incision was made in the ventro-lateral abdominal wall for this implant, and the incision was closed with 4-0 sutures (muscular layer) and a wound clip (skin). The voles were anesthetized with ether during the operation, and all voles were released within 24 hours of the operation. Subsequent trapping revealed that all wounds healed quickly and that no losses occurred because of the surgery. The radiotransmitter-battery packages weighed from 2 to 3 grams each (depending on the battery used), which is about 10% of total body weight.

From the time of surgery on 23 to 25 June, the voles were given an additional 5 days to recover from the surgery. Then, 20 "before" positions were obtained on each of the voles over a 40 h period from 1600 on 30 June to 0800 on 2 July. Mowing occurred between 0800 and 1600 on 2 July, during which time the movements of 9 voles were observed in response to the passing of the mower. The "after" period of 20 positions was from 1600 on 2 July to 0800 on 4 July. The voles were collected from 5 to 7 July to recover the transmitters.

The mower used was a tractor-hauled rotary mower. The rotary unit was offset 4 feet behind the tractor, and therefore allowed some mowing under the canopy of the apple trees. Blade height was variable at about 4 to 5 inches above the surface in order to keep the blades from hitting rocks or other objects extending above the ground. Because younger trees had a smaller canopy, mowing was closer to the tree base in the meadow vole plot, but here the furrowed soil gave compensating protection from exposure.

The data were analyzed two ways. First, to derive an estimate of area, the outer points of each series of 20 positions were connected to form a convex polygon. The area inside the perimeter line for each vole was measured before and after mowing. A second analysis was conducted to determine whether voles stayed closer to the tree rows after mowing. For this analysis, the distance from each position to the nearest tree row was measured. For both types of analyses, the number of voles with larger or smaller areas, or with positions farther away from or closer to the tree row, were compared before and after mowing using Chi square analyses.

RESULTS

General. Of the original 24 voles that were expected to be monitored with radiotelemetry, only 23 individuals were given transmitters: 6 voles in each of the pine and meadow vole plots, and 11 in the mixed species plot. Of these 23 voles, only 17 were monitored throughout the study period: 6 in the pine vole plot, 4 in the meadow vole plot, and 7 in the mixed species plot. The positions on these 17 voles constitute the data set used in the analysis. Of the 6 voles omitted from the analysis, one (a meadow vole) was killed by the rotary mower, 4 could not be tracked because of premature battery failure (a problem since resolved), and one disappeared (either taken away by a wide-ranging predator or just never recaptured after battery failure).

Home range size was conspicuously different between pine and meadow voles (Table 1). Five of the 6 home ranges for meadow voles were larger than the 11 ranges recorded for pine voles (Figs. 1,2,3). For meadow voles, males tended to have larger home ranges than females, but the small sample size precludes any conclusive statement. No such trend existed for pine voles. Finally, meadow voles routinely moved between rows, whereas pine voles rarely did so. Five of the 6 meadow voles had ranges spanning 3 to 5 rows, and the one female that remained within a row moved along 7 trees in the row. For pine voles, only two of the 11 voles moved into an adjacent row, and one of these two did so only once. One female pine vole was unusual in that movements occurred along 13 trees in one row (Fig. 3).

Effects During Mowing. While the rotary mower was moving along the rows, the movements of the 9 voles (4 pine, 5 meadow) with radio-transmitters were observed closely. A distinct difference emerged in the response of the two species. The pine voles showed little or no movement (1-2 m maximum) during the 8 passes made by the mower over pine vole burrow systems. For meadow voles, all 5 showed movement during the 10 passes made by the mower into their living areas. Of the 5, 2 moved from 1 to 4 trees away in the same row, and 3 moved into the adjacent rows. "Fleeing" or "rapid" movements were observed up to 20 m ahead of the approaching mower. Only during the second pass of the mower for one meadow vole did the vole appear to enter a burrow system. Otherwise, all meadow vole movement seemd to be on the surface. All pine vole movement appeared to be underground.

Table 1. Home range size and distance to tree row before and after rotary mowing for pine and meadow voles during early July 1980.

Variable	Sex	N	Sample Means[1] Before	Sample Means[1] After	No. voles with larger means Before	No. voles with larger means After
Area (m^2)						
M. pennsylvanicus						
	M	3	1034±928	1337±837	0	3
	F	3	440±648	287±381	2	1
M. pinetorum						
	M	6	15±18	24±33	2	4
	F	5	25±28	13±8	3	2
					7	10
Distance (m)						
M. pennsylvanicus						
	M	3	0.7±0.4	0.4±0.1	2	1
	F	3	0.3±0.1	0.2±0.2	2	1
M. pinetorum						
	M	6	1.1±0.5	0.8±0.6	5	1
	F	5	0.6±0.4	0.4±0.3	4	1
					13	4

[1] Sample means are averages ± 1 standard deviation of the mean values for each vole

Effects Before and After Mowing. The sizes of the home ranges were measured before and after mowing for both species. No significant changes occurred in home range size (Table 1), and no shifts in home range location were evident (Figs. 1,2,3).

When the distances of the positions of each vole to the nearest tree row were measured, both pine and meadow voles stayed closer to the tree rows after mowing. This observation was statistically significant for pine voles ($\chi^2 = 4.45$, $p < 0.05$), and for both species combined ($\chi^2 = 4.8$, $p < 0.05$), but not for meadow voles separately. It should be mentioned, however, that the actual distances were small, usually less than one meter.

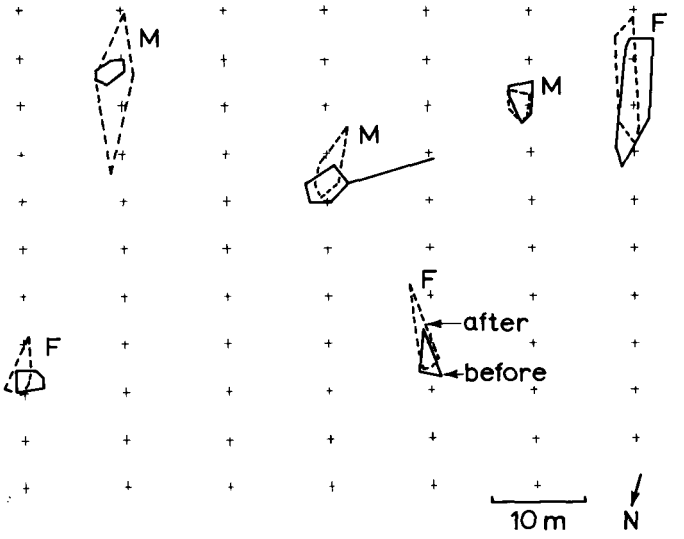

Fig. 1. Home ranges of male (M) and female (F) pine voles before (solid line) and after (dashed line) mowing in the pine vole plot. Tree positions are shown by "+" symbols. Rows extend roughly along a north-south axis.

DISCUSSION AND CONCLUSIONS

The data clearly show that under the conditions of this study, rotary mowing has only a marginal effect on vole movements and survival. The small but significant adjustments in pine vole movement in response to mowing are somewhat surprising because of the expectation that pine voles would not be bothered by mowing of grass above the peripheral margins of their burrow systems. What is being measured here could be a reduction in occasional surface activity by pine voles in these areas. Meadow voles, in being much more wide-ranging and apparently used to traversing open areas between rows, showed no statistically significant changes in movement before or after mowing. However, their "frenzied" response to the mower, in contrast to pine voles, implies that their momentary activities are substantially upset during rotary mowing. In what way this response might be used for control purposes can only be speculated upon at this stage in our studies.

What clearly has to be done is to mow all the vegetative cover beneath the apple trees. Both vole species depend at least to some degree on this cover, and rotary mowing between rows only trims the edges of these linear vegetative refuges. It is speculated that if

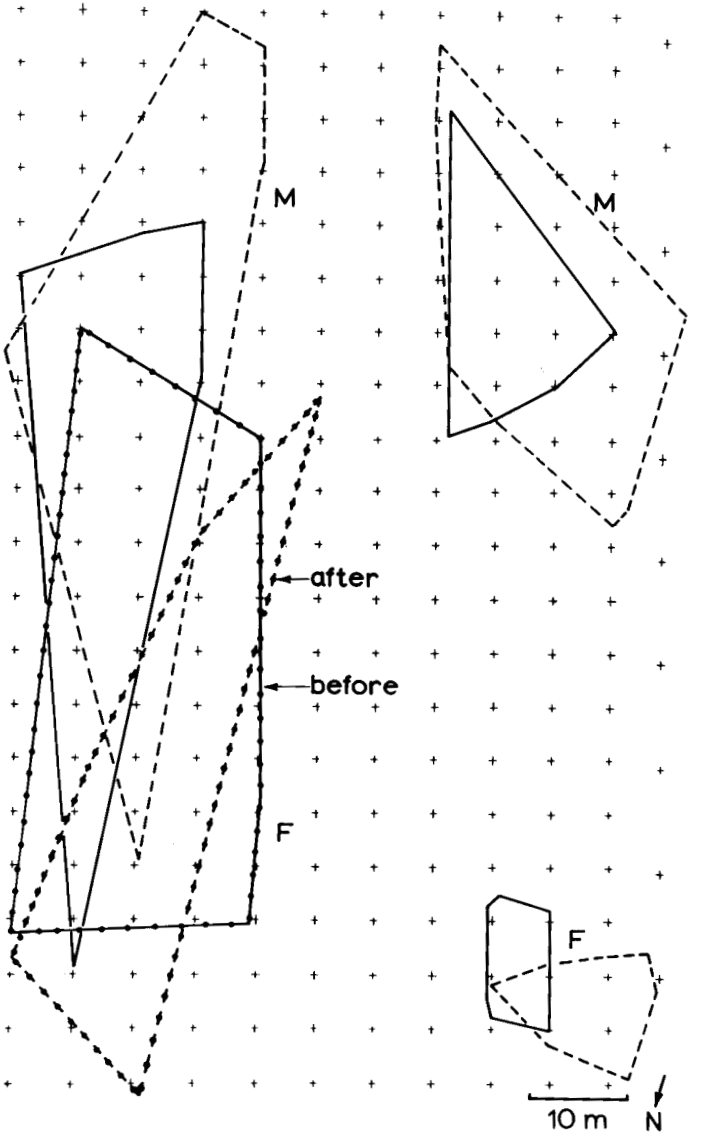

Fig. 2. Home ranges of male (M) and female (F) meadow voles before (solid line) and after (dashed line) mowing in the meadow vole plot. Dots are drawn along the perimeter lines of one vole's home range to aid reading of the figure. See Fig. 1 for further details.

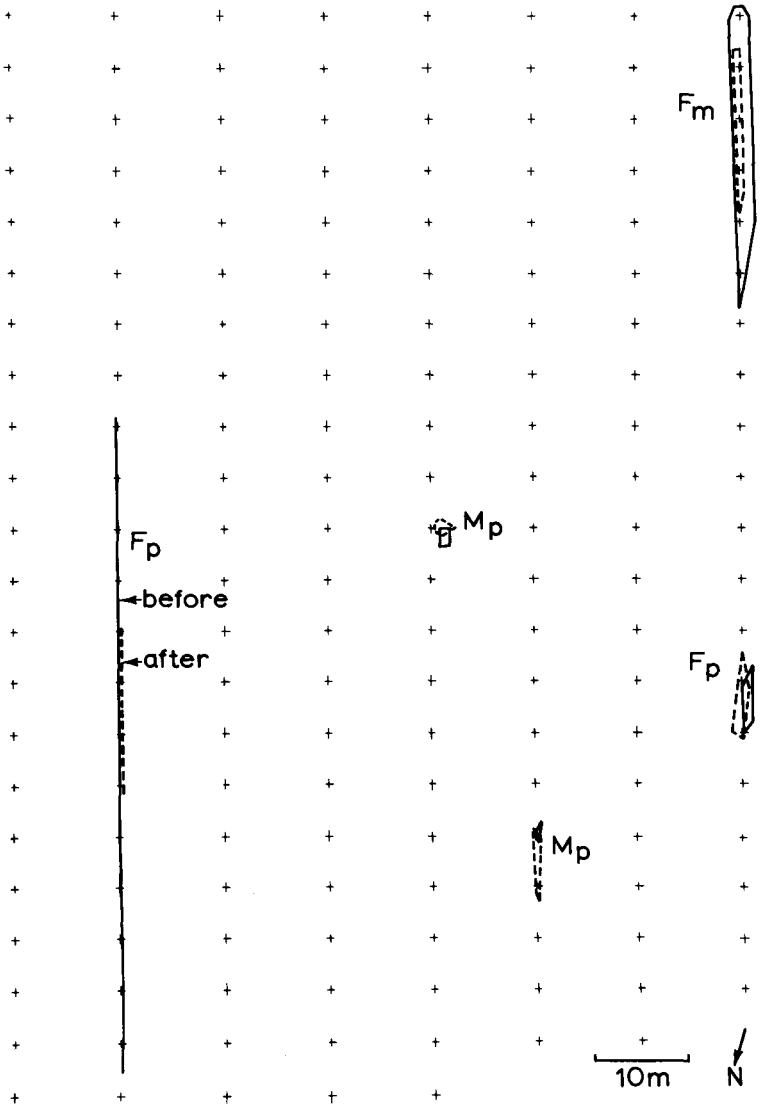

Fig. 3. Home ranges of male (M) and female (F) pine (p) and meadow (m) voles before (solid line) and after (dashed line) mowing in the mixed species plot. See Fig. 1 for further details.

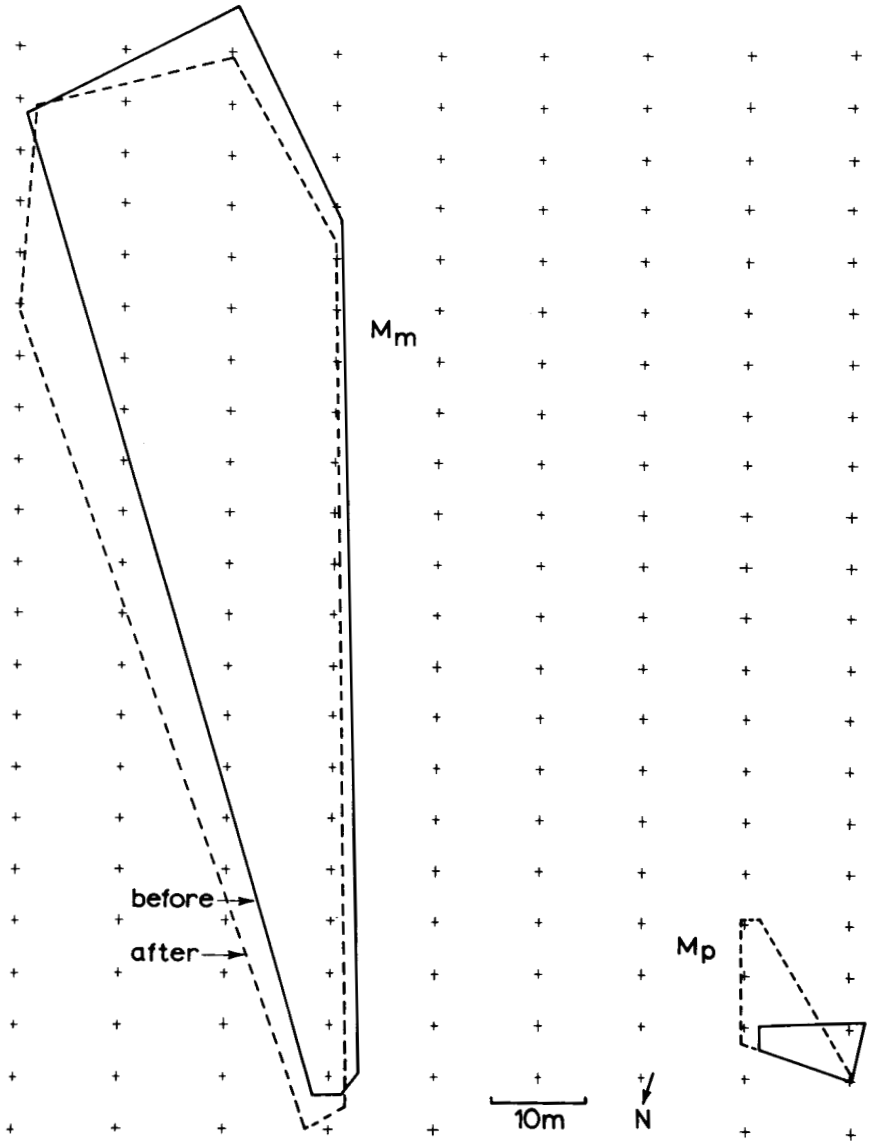

Fig. 3 (continued). This section of the study plot is south of the previous section.

all the vegetation were mown, and the clippings either collected or pulverized, the meadow vole population would be extremely vulnerable to all kinds of loss (exposure to predators and weather extremes) and be forced to enter the burrow systems along the tree rows. Just what effect this forced habitation would have on the movements and survival of pine and meadow voles is not known, but this is one problem that will be explored during 1981. The fact that meadow voles do not commonly enter burrows under the stress of rotary mowing suggests that there may be some dangers in doing so. We hypothesize that pine vole families are hostile toward meadow voles in pine vole burrow systems.

ACKNOWLEDGEMENTS

This investigation was made possible by a research grant from the U.S. Fish and Wildlife Service (Contract 14-16-0009-79-066). We thank Jay McAninch, Donna Stockrahm, and Steve White for assistance at different times during the study. We also extend our thanks to the Hudson Valley fruit growers, especially Stanley Cohn and Steve Clarke, who provided facilities and financial and advisory support many times during this and related research projects.

LITERATURE CITED

FitzGerald, R.W. and D.M. Madison. 1981. Spacing, movements, and social organization of a free-ranging population of pine voles Microtus pinetorum. In: Byers, R.E. (ed) Proceedings of the fifth eastern pine and meadow vole symposium. Gettysburg, Pennsylvania, 6 p.

Pagano, R. and D.M. Madison. 1981. Seasonal variations in movements and habitat use by pine and meadow voles. In: Byers, R.E. (ed) Proceedings of the fifth eastern pine and meadow vole symposium. Gettysburg, Pennsylvania, 9 p.

Madison, D.M. 1977. Movements and habitat use among interacting Peromyscus leucopus as revealed by radiotelemetry. Can. Field Nat. 91: 273-281.

Madison, D.M. 1980. Space use and social structure in meadow voles, Microtus pennsylvanicus. Behav. Ecol. Sociobiol. 7: 65-71.

Madison, D.M. 1981. An integrated view of the social biology of Microtus pennsylvanicus. The Biologist (in press).

McAninch, J. 1979. Vole management studies - 1978. In: Byers, R.E. (ed) Proceedings of the third eastern pine and meadow vole symposium. New Paltz, New York, pp. 39-51.

Mineau, P. and D.M. Madison. 1977. Radiotracking of Peromyscus leucopus. Can. J. Zool. 55: 465-468.

Smith, H.R. 1979. Growth, reproduction and survival in Peromyscus leucopus carrying intraperitoneally implanted transmitters. In: C.J. Amlaner, Jr. and D.W. MacDonald (eds), A Handbook of Biotelemetry and Radiotracking. Pergamon Press, New York, pp. 367-374.