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I believe this audience is already well aware of the dilemma in New York State. We have suffered extensive damage from orchard mice over the past three years in New York with some growers losing their entire operation. The pine vole, Pitymys pinetorum, has assumed an important role as an orchard pest and in eastern New York easily surpasses the related meadow vole, Microtus pennsylvanicus as a significant orchard pest. A recent grower-funded economic survey, initiated by this Unit, and reported in a paper by Pearson and Forshey (1978) points up the severity of losses thru reduced quality and quantity of the apple crop.

Apparently, there is no quick or satisfactory answer to our problem in New York. We have tested a wide variety of experimental toxicants as well as certain ones that are available commercially. None of these materials has proved satisfactory in the hands of the growers nor have they been completely reliable in all of our experimental trials.

Today we would like to discuss results obtained from laboratory and field research conducted from 1975-1977 in the Hudson Valley of southeastern New York State. In making these preliminary results available for the public record we must face the inadvertant problem created for the grower, the supplier, the chemical company and even the research biologist that may occur when one reports findings of high efficacy for a mediocre or faulty product or low efficacy for a potentially sound chemical/management procedure.

Beginning in 1975 with financial support from the growers, chemical industry, the U.S. Department of the Interior and the college at Cornell we began an intensive screening program of several baits and bait preparations available to us. Our approach to screening a wide variety of candidate materials was to first test these in a laboratory situation with captive voles and ultimately categorize the effectiveness of the various combinations of toxicants and bait preparations into three general levels of efficacy (Table 1). We then proposed to take the materials and bait preparations that were most effective or showed considerable promise into the field and test them under field conditions on wild pine voles. The third step was to select from these preliminary field trials the three or four most promising treatments and expand the testing effort on these materials to a larger scale that included plots up to 3 acres in size and as many as 150 trees. From Table 1 we recognize that efficacy data obtained in laboratory testing is not the only reliable determinant of what should be examined further in a field situation. We did however, have initial concerns about acceptance of several baits that we had treated with a chemical toxicant and these notions needed evaluation first in a laboratory. Table 1 indicates those treatments which were judged to be most effective, only moderately effective or not effective in the laboratory cage environment. In most

TABLE 1. TREATMENTS WHICH WERE EFFECTIVE OR MODERATELY EFFECTIVE IN LABORATORY TESTING VERSUS THOSE NOT EFFECTIVE.

I.	EFFECTIVE		
	ROZOL	MINERAL OIL	APPLES*
	ROZOL	MINERAL OIL	PEANUTS*
	ROZOL	TRACKING POWDER	APPLES*
	ROZOL	PARAFFINIZED PELLETS (LARGE)*	
II.	MODERATELY EFFECTIVE		
	ROZOL	TRACKING POWDER	
III.	NOT EFFECTIVE		
	ROZOL	MINERAL OIL	APPLES (LOW CONCENTRATION)
	ROZOL	MINERAL OIL	PEANUTS (LOW CONCENTRATION)
	ROZOL	TRACKING POWDER	PEANUTS
	ROZOL	PARAFFINIZED PELLETS (SMALL)	
	ROZOL	PARAFFINIZED BLOCK	
	RAMIK	PELLETS (SMALL)*	
	RAMIK	PELLETS (LARGE)*	
	Zn_3P_2		APPLES*
	Zn_3P_2		PEANUTS

*SELECTED FOR FIELD TESTING

instances an effective bait was one that killed 80% or more of the 10-15 voles within 5 days. Several of the Rozol preparations when applied to apples and raw peanuts were quite effective especially at higher concentrations. Among the many bait preparations judged not effective in the laboratory, the lack of efficacy was due in most cases to the failure of the voles to consume the toxic baits.

Table 2 lists the variety of materials and bait preparations that were taken into the orchard for testing. Included in these tests were

TABLE 2. MATERIALS SELECTED FOR FIELD TESTING.

ROZOL	MINERAL OIL	APPLES
ROZOL	MINERAL OIL	PEANUTS
ROZOL	TRACKING POWDER	APPLES
ROZOL	PARAFFINIZED PELLETS (LARGE)	
RAMIK	PELLETS (LARGE)	
RAMIK	PELLETS (SMALL)	
TETRACYCLINE (DMCT)		APPLES
Zn_3P_2		APPLES

four preparations of Rozol (chlorophacinone), two preparations of Ramik (diphacinone), one preparation of a broad spectrum antibiotic (tetracycline) that was intended as a marker substance due to its affinity for coloring the teeth and bones of mammals with a fluorescent material

(Crier 1970). And, finally, zinc phosphide powder applied to sliced apples. These seven candidate baits and the tetracycline were field tested in the following manner. An orchard block of 12 rows by 15 trees per row with a high infestation of pine voles was selected for testing. Each candidate material was then tested in a single row that included from 13-15 trees. Vole activity at each of the trees was determined by placing an apple slice under a tar paper cover and reexaming the apple slice after 24 hours (activity index). The post treatment evaluation of candidate materials was carried out in the same way with the addition of a trapping effort that consisted of two traps per tree checked for three days and nights.

The results obtained from this preliminary field screening were very encouraging. The initial activity index in most of the rows was 80% or more (Table 3). The post treatment evaluations that began either two or

TABLE 3. EFFECT OF HAND PLACEMENT OF LABORATORY AND COMMERCIALLY PREPARED BAITS ON PINE VOLES. THEW ORCHARD, ORANGE COUNTY, N.Y.

TREATMENT (1.)	# TREES PER ROW (2.)	PRETREATMENT % ACTIVITY	POST-TREATMENT TRAPOUT (#VOLES/ROW)	DATE
CONTROL	13	84.6	4	10/4 - 10/7/75
RAMIK LARGE	14	100	3	"
RAMIK SMALL	15	93.3	4	"
ROZOL	15	86.6	0	"
CONTROL	13	100	10	9/21 - 9/24/75
ZnP3 APPLE	15	60	1	"
TETRACYCLINE APPLE	15	86.6	1	"
ROZOL TRACKING PD. APPLE	13	100	1	"
ROZOL PEANUTS	15	80	0	"
ROZOL APPLE	14	100	3	"
CONTROL	15	93.3	14	9/9 - 9/12

(1.) ALL TREATMENTS STARTED SEPT. 9, 1975.

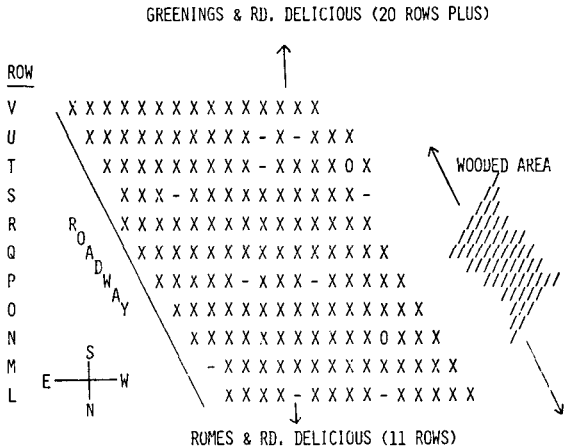
(2.) ACTIVITY DETERMINED AT 1 STATION PER TREE.

three weeks after treatment indicate a drastic reduction in the number of voles in each of the test rows. We recognize that this was a preliminary field screening of these materials and that we did not have sufficient buffer rows associated with each of the treatments. Nevertheless, there appeared to be a nearly complete decimation of the voles from all rows subjected to a toxic treatment. Two of the three control rows designated in this orchard maintained a high population of voles at the time of post treatment evaluation. Because buffer rows were inadequate in these tests it is possible that the voles in the third control row moved out of that row and into other rows where animals presumably had been killed by the toxic baits.

From this preliminary field test of the several baits we selected for further testing either those that were most promising as control agents or that were available to us from the supplier. These included Ramik (diphacinone) small pellets, applied at two concentrations; Rozol (chlorophacinone) both small and large pellets and Rozol prepared as a ground spray and tested on 7 plots. In addition to these rozol prepared as a ground spray was tested on five separate orchard plots.

Figure 1 shows a typical orchard block that was selected for the testing of each candidate material. A section of orchard including a

FIGURE 1. MAP INDEX OF TEST BLOCK
THEW FARM ORCHARDS, ORANGE COUNTY, N.Y.



KEY X ACTIVE
0 NOT ACTIVE
- NO TREE

Fig. 1. Typical orchard block selected for field testing of candidate control agents.

block of trees approximately ten rows by 15 trees was treated with a single candidate preparation. Two pretreatment indices of vole activity were recorded before any test materials were applied. A plot within the 150 tree boundary with at least two buffer rows on each side and six buffer trees at the end of each row was apple indexed at two, three and five weeks post treatment. At the end of the five-week index each of the plots was trapped for three days with two traps per tree to remove remaining voles.

The most promising of all the candidate materials tested was ground-sprayed Rozol. This product seemed quite desirable from the standpoint that it could be mixed with water and applied to the orchard floor with a conventional speed-sprayer which practically all of the orchard owners possess. Unfortunately, Figs. 2 and 3 which show results from the seven separate orchards treated with the ground spray do not bear out the potential of this candidate material. In six of seven applications of Rozol as a ground spray the material was applied as recommended and allowed to dry on the vegetation for at least two days prior to any rainfall. In the seventh (Plot E) a light rain began approximately 2 hours after application. The rain continued unabated for the next 24 hours with a total rainfall during that period of 1.6 inches. As present we have no explanation for the apparent discrepancy or wide range of variation in the results obtained from this material. In plot G (Fig. 3) ground sprayed Rozol appeared to reduce the vole activity at

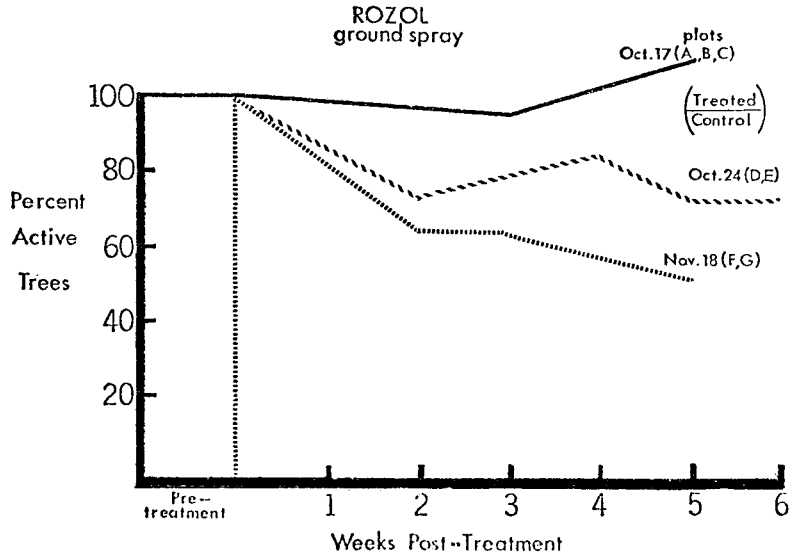


Fig. 2. Pine vole activity before and after treatment with ground sprayed Rozol.

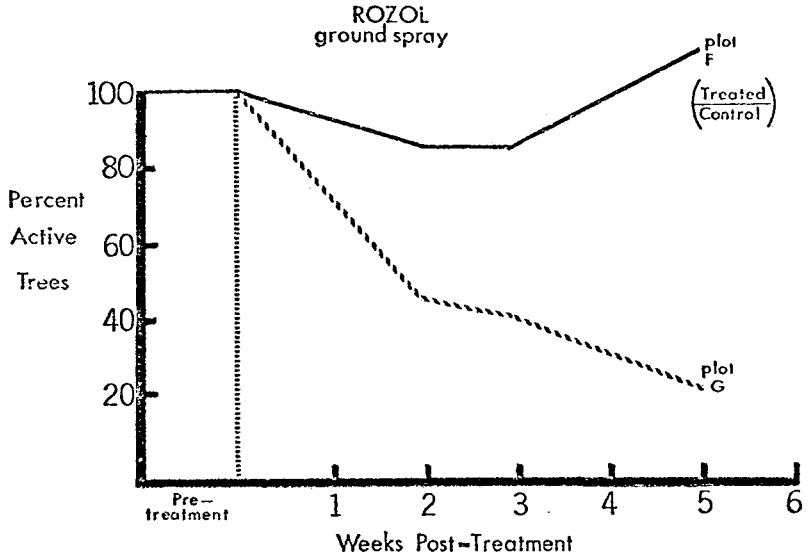


Fig. 3. Disparity in activity data following treatment with ground sprayed Rozol on paired plots treated on the same dates.

two weeks post treatment to approximately 50% of the initial activity index. At five weeks post treatment vole activity was reduced even further down to the 20% range. Spray plots A, B, C and F show absolutely no reduction in vole activity post treatment. The slight increase in activity above 100% is accounted for by the fact that activity in these plots is expressed as a percent of the activity in control plots of a similar size. Vole activity in plots D and E was reduced only moderately. At the end of two weeks the combined activity for the two plots was approximately 80% and at the end of five weeks the activity had declined to only 70% of the initial activity. On the basis of these results we conclude that ground sprayed Rozol is not a reliable control procedure when applied at concentrations recommended by the manufacturer in the conventional speed spraying apparatus.

Rozol incorporated into baits that could be hand-placed in the vole burrows or under tar paper bait stations was somewhat more effective. In four test plots selected and handled as previously described, Rozol pellets containing .005% chlorophacinone and packaged in small cellophane packets as well as larger pellets with the same concentration of active ingredient showed a reduction in vole activity after one week (Fig. 4).

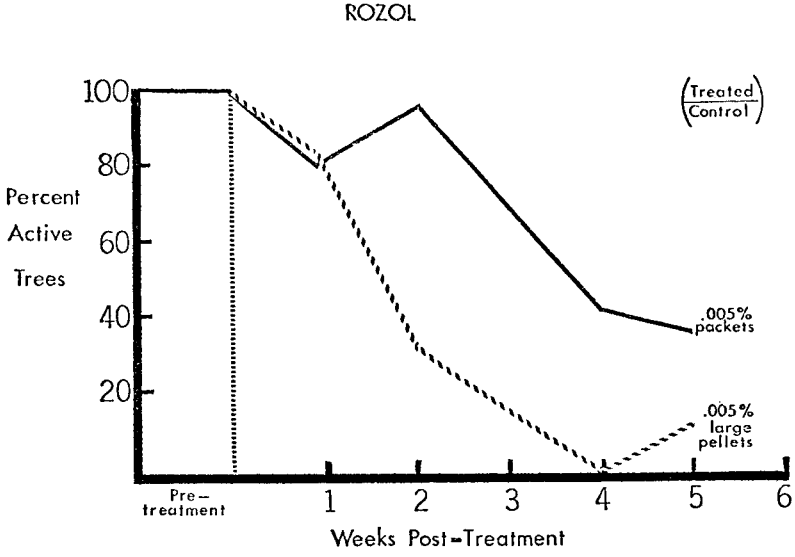


Fig. 4. Activity indices of plots treated with commercially prepared baits.

At two weeks there was some disparity in results but by four weeks both the Rozol packets and the Rozol large pellets had substantially reduced the vole activity in the orchards to 10 and 40% of the initial activity index. Activity indices run at five weeks post treatment indicated a continuing low level of vole activity.

In yet another orchard two formulations of Rozol small pellets were tested in orchards that had extremely high pine vole infestations and the results were even more promising. At the end of one week vole

activity in both of these orchards had been reduced to less than 40% of initial activity. The decline in vole activity as measured by the activity index continued through the second, fourth and into the fifth week where vole activity approached 20% (Fig. 5). Here, as in other figures, activity in treated orchards is expressed as a percent of control activity.

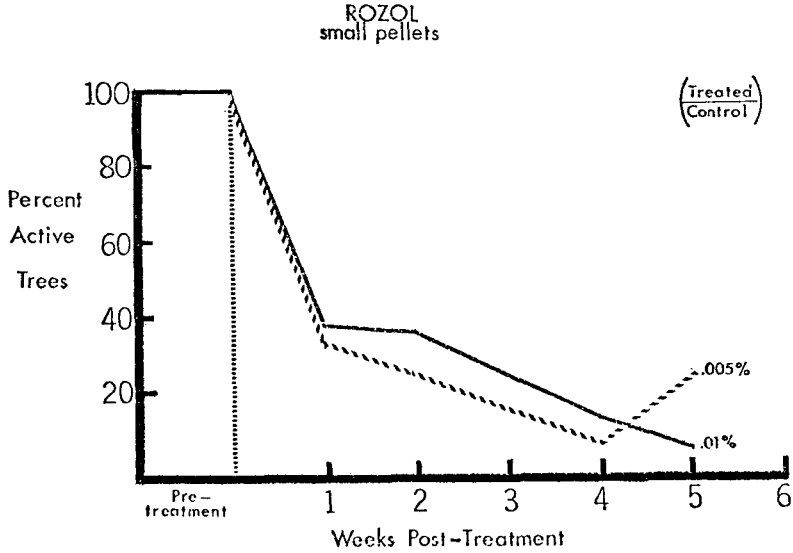


Fig. 5. Activity indices of plots treated with commercially prepared baits.

Figure 6 presents results from testing of Ramik (diphacinone) incorporated in small pellets and applied at the rate of 20 lbs. per acre in a single treatment, 10 lbs. per acre in a single treatment, and 10 lbs. per acre plus a second treatment of 10 lbs. per acre (10+10). Our interpretation of these results is that the 10+10 application is the most effective of the three application rates tested in this experiment.

The results presented here are encouraging but fail to point clearly to a control procedure that can be recommended for all orchardists in New York. Laboratory and field tests of these candidate materials confirm for us that control of pine voles can be achieved but to do so requires labor intensive and costly procedures. The testing procedures that we used were laborious and painstaking and likely cannot or would not be duplicated by the commercial grower. It is indeed unfortunate that ground-sprayed Rozol did not show clearcut efficacy. The apple growers are practically wedded to the speed spraying apparatus as a management procedure. The development of a rodent control material that could be applied with a speed sprayer would be a very practical end to achieve.

Currently we are funded by the U.S. Department of Interior and the College of Agriculture and Life Sciences at Cornell to pursue alternative control research. We anticipate additional funding from the

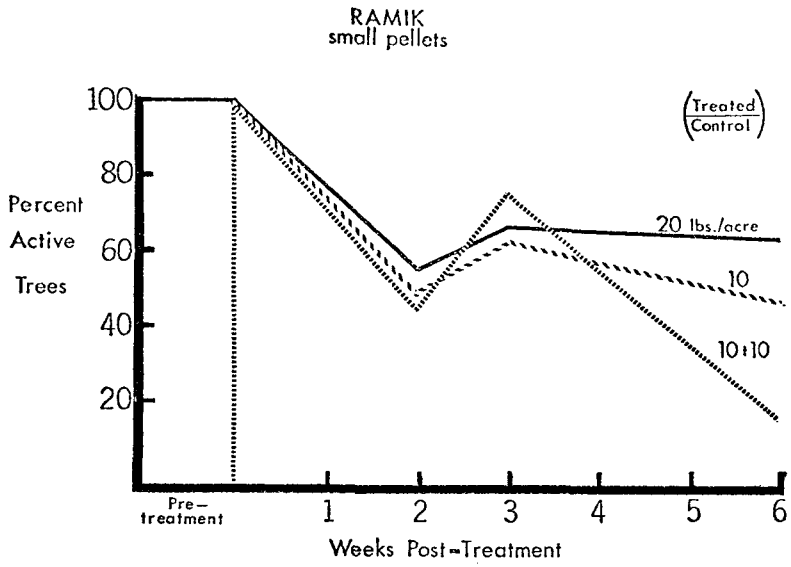


Fig. 6. Activity indices of three plots treated with commercially prepared baits.

Department of Interior and perhaps from the college. At present we are participating in an effort to monitor the efficacy of ground-sprayed endrin which was applied to many of the orchards in the Hudson Valley in the fall of 1977. Endrin was released to the growers for mouse control on an emergency basis this past fall because of the substantial increase in pine vole damage and the lack of other kinds of adequate rodent control procedures. We have recently added a research technician to our staff who will be stationed at the Highland Fruit Lab and will spend full time assisting in the design and completion of research work aimed at pine mouse control. Our research unit is approximately 150 miles from the key damage area so we are pleased to add a research person who can be located near the heart of the problem. In the coming year we expect to be in a position to test any new control chemicals or management procedures which show possibility in managing orchard rodent pests. Currently we are working with ideas that involve vegetation management of the orchard floor. It appears that the orchardist in managing for an abundant and high quality apple crop is inadvertantly encouraging reproduction and survival of the pine vole. Through vegetation management or habitat manipulation there is a possibility of achieving a type of biological control that not only will alleviate the problem but perhaps point the way to inexpensive and more efficient methods for managing the orchard environment. Details of our work presented at this meeting that appear to be relevent to the planning or pursuit of a research project are available from the New York Cooperative Wildlife Research Unit. You may review copies of our data, field procedures and analytical methods simply by writing to the authors at the New York Cooperative Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, N.Y. 14853.

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