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MICROTINE DAMAGE IN MICHIGAN APPLE ORCHARDS

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The object of this study was to provide an estimate of the financial losses caused in Michigan's apple orchards by members of the genus *Microtus*, and, if possible, to discover some of the factors affecting the amount of damage. Information was collected from apple growers and from direct observation of 1,520 Michigan apple trees.

Data was collected concerning the winters of 1972-73 and 1973-74. Both of these years were characterized by relatively low populations of microtine rodents in Michigan.

Mice, presumably microtines, were most frequently named as the most destructive pest. Deer and rabbits were ranked second and third respectively. Mice appear to be most destructive in the southern half of the apple growing region.

Damage rates were greatest for newly planted trees and decreased as trees aged. By the age of ten, apple trees attained minimum damage rates.

Ninety-seven percent of Michigan's apple growing acreage is treated with rodenticide or other rodent damage preventatives at an annual average cost of $166,400. In spite of such control measures, however, microtines are responsible for a minimum annual loss of $322,500 from damaged trees.

Of 52 orchard owners responding to the questionnaire and/or contacted for a personal interview, a majority considered rodents to be significant pests in their orchards. Ninety-seven percent of the apple producing acreage covered in this survey was treated with poison bait, presumably zinc phosphide.

The median cost to apply zinc phosphide treated corn to orchards was $3.00 per acre. State-wide, the projected annual cost of applying poison bait to commercial apple orchards is in excess of $166,400. This cost is based on the acreage of mature trees. The cost of rodent control in younger orchards is higher than in mature orchards because of increased protection usually given to new trees.

In spite of the rodent control procedures currently being used in Michigan apple orchards, damage still occurs. Responses to questionnaires indicated that growers estimated a 4% damage rate among trees three years old or younger. This damage rate declines until the tree reaches an age of approximately ten years at which time the average annual damage rate was estimated to be 1.3%. These data agree closely with data collected by field scouts during the spring of 1974. Information gathered on 1,520 apple trees in the state indicated a

damage rate of 1.3% among mature trees. This was in a year of apparent low microtine density.

Based on estimates of the effect of girdling on a tree's production of apples, the yearly harvest loss attributable to microtines is approximately 3,825,000 pounds. At an average value of 3.82 cents per pound as determined by the Michigan Department of Agriculture, this can be converted to a minimum annual loss of $146,500 due to *Microtus sp.* Following peak years apple production may be reduced by as much as $732,500 or more.

In addition to the loss due to decreased production, microtines also cause the death of trees. Damage of this severity is relatively infrequent among mature trees, and when it does occur, it is often repaired by bridge grafting. In younger orchards, however, microtines can destroy a significant number of trees. Estimates based on responses to the questionnaire indicate that field voles may cause $176,000 annual damage among young apple trees.

Based on our estimates, microtines are responsible for a minimum annual cost of approximately $489,000 in Michigan apple orchards. This estimate includes the minimum estimates of the costs of rodent control, the value of lost production due to girdled trees, and the value of destroyed trees less than 10 years old.

The damages may well be greater than this during years of peak populations. Estimates based on two growers who sustained higher than average damage rates indicate that in peak microtine years, damage levels may be increased five to tenfold.

Zinc phosphide appears to be an effective means of rodent control under suitable weather conditions. The efficacy, however, is difficult to determine. Dimmick (1972) reported that both 1.0% and 1.5% applications of zinc phosphide on oat groats were significantly effective in reducing populations of *M. ochrogaster* and *M. pinetorum* in Tennessee. Dry weather following application appears necessary for adequate control. Severe damage during peak years often occurs in spite of the use of rodenticides.

Economic losses due to microtine damage are difficult to estimate for several reasons. Beside the fact that damage rates vary from year to year, the effect of observed damage to the tree's trunk on apple production has never been ascertained except in the extreme case where complete girdling causes the death of the tree.

Even in the case of complete girdling, trees are often saved by bridge grafts. Many growers, however, prefer to remove such trees and replace them. Furthermore, some growers remove all developing fruit from extensively damaged trees to redirect the trees' energy budget.

Since little data is available on the effect of physical damage to the tree's trunk on apple production, a series of "best estimates" were made based on information obtained during interviews with orchard owners. When a tree is girdled on less than 10% of its circumference, there is little or no decrease in production. However, when a tree is girdled over 80% or more of its circumference, bridge grafts are usually required to prevent the death of the tree. At this point, production is usually temporarily halted either through the inability of the tree to

produce fruit or the action of removing developing fruit. Little information is available on the effect of intermediate amounts of damage but for the sake of simplicity the relationship was taken as linear between these two points.

Furthermore, little information is available on the effect of damage during subsequent years. Again, estimates were based on information gathered during interviews. For any amount of damage it was assumed that recovery takes approximately two years and that any decrease in production caused by girdling is halved during the second year. This may not be entirely accurate for trees which sustain only small amounts of damage or for trees which are severely damaged but it is the most appropriate estimate based on available information. This estimate probably understates the effect of microtine damage on apple production since trees which are severely girdled are apt to require more than two years to fully recover, if they recover at all.

Applying these estimates to the data collected in the orchards, 0.86% of Michigan's apple trees of bearing age were damaged sufficiently during the winter of 1973-74 to reduce production. Of the trees which were damaged, including trees damaged less than 10%, the mean portion of the circumference which was girdled was 31%. According to the damage/harvest schedule developed above, the average harvest reduction on damaged trees would thus be 28% during the harvest season following the damage and 14% during the second harvest subsequent to the damage.

By multiplying the appropriate annual damage rate of 1.3% by 3,170,000, the number of trees of bearing age, we have calculated that in the winter of 1973-74, approximately 41,210 Michigan apple trees of bearing age were damaged by microtines.

An average Michigan apple tree of bearing age produced 221 pounds of apples in 1972. In 1972 then, the harvestable apple crop in Michigan was reduced by an estimated 3,825,112 pounds (Number damaged trees X lbs. harvest/tree X reduction of harvest during first season after damage X 1.5) with a market value of $146,500. This is an average of $2.58 per acre of producing trees and is incurred in spite of prevailing control techniques.

Younger trees, however, bear the brunt of the damage. To protect these trees many growers provide additional protection to new orchards in the form of clean cultivation, wire or aluminum collars around the base of the trees, or the eradication of all undergrowth through complete herbicide treatment. Young trees, however, are seldom repaired by bridge grafting in the case of severe damage, as it is usually easier and cheaper to replace them. Assuming that there are equal numbers of trees planted every year and that an orchard has an average life expectancy of approximately 50 to 60 years (from personal interviews) approximately 57,600 new apple trees are planted in the state every year. This figure is probably somewhat low because of the recent trend towards high density dwarf trees. Thus, while the total acreage planted to apples in Michigan remains essentially constant, the number of trees planted every year is increasing. Using the damage rates indicated by the growers and their estimates of the value of trees at various ages, it is possible to estimate the financial loss which growers suffer before their trees are old enough to produce fruit commercially as

$$\text{Loss} = \sum_{i=1}^{10} \text{number of trees aged } i \text{ years} \cdot \text{damage rate among trees aged } i \text{ year} \cdot \text{value of a tree aged } i .$$

Using the appropriate values we have estimated the loss to be $175,797. This figure assumes that all damaged trees are destroyed and subsequently replaced. If destroyed trees are not immediately replaced the loss is higher since subsequent production is lost. In this case, it becomes much more difficult to estimate the loss as many of the maintenance tasks such as trimming, harvesting, spraying, etc., need not be continued while others such as mowing are often performed. In order to be consistent with other estimates of financial costs, we will continue to use a minimum estimate.

Thus, in spite of better than $166,400 spent on the control of microtines in Michigan orchards, they continue to inflict a minimum of $322,290 worth of annual damage in Michigan. It is important to note that these damage estimates were based on the winter of 1972-73 and 1973-74 which were both conceded to be relatively light years in terms of microtine populations. While no estimate of the state-wide damage rates during years of high microtine densities were possible during this research, extrapolation from a few isolated orchards which suffered unusually high damage rates indicates that damage levels can go considerably higher. One grower in the southern portion of the state suffered relatively severe damage during the winter of 1973-74. Of 50 trees examined 7 exhibited girdling for a damage rate of 14%. Similarly, another grower indicated that during the winter of 1972-73, 250 of 30,000 trees were damaged severely enough to require bridge grafting. While it is difficult to extrapolate on such limited information, microtine densities are well known to vary as much as two orders of magnitude from years of low density to periods of peak densities. Thus, the damage rate during years of peak microtine populations may easily be increased to five to ten times as much as these data indicate.

The increased damage rate among young trees bears further consideration. While the total cost of the damage to young trees is considerably less than the value of the decreased production estimated to result from girdling damage to older trees, the current trend towards dwarf fruit trees may increase this figure. Dwarf fruit trees start bearing earlier and also stop producing at a commercially profitable rate at earlier ages. As older orchards are replaced by dwarf trees, a larger portion of Michigan's apple trees will be under ten years of age and therefore, subject to higher damage rates.

The effects of manipulating ground vegetation were surprising. The initial purpose of recording the type of clearing used was to determine whether the use of herbicides produced a significantly lower damage rate than just mowing. The lack of a significant difference (and the trend towards lower damage rates in orchards where no weed control was practiced) is, in itself, biologically important since mowing and herbicide treatments are generally considered to be destructive to good microtine habitat. Microtines may move into the orchards during the winter, after the application of poisoned baits, under the cover of a snow blanket and utilize the trees as a food source where no other vegetation is available.

An alternative explanation may be that growers with a previous history of little damage from microtines do not feel the need to mow or spray in their orchards. Further research on this question is warranted

since if the first explanation is valid, it may be possible to reduce the costs of weed control in orchards as well as microtine damage. An added benefit would be the decreased use of unselective herbicides. Competition between trees and ground vegetation, however, may warrant continued use of herbicides, particularly early in the summer when apples are first developing on the tree.

Growers felt that current control procedures are generally effective. During the interviews, however, we learned that zinc phosphide is applied to the corn with either an oil or paraffin base. While the corn treated with oil is generally less expensive, if application of the orchards is followed by rainy weather, the zinc phosphide may be washed from the corn or become detoxified. This may account for the fact that several growers indicated that periods of severe mouse damage are often associated with rainy weather.

LITERATURE CITED

Dimmick, R. W. 1972. Zinc phosphide and prolin for controlling prairie voles in Virginia pine plantations. Proc. Ann. Conf. S.E. Game and Fish Assoc. 26:293-295.