MANAGEMENT OF PINE VOLES

DAVID E. DAVIS, Professor Emeritus, North Carolina State University, 366 El Cielito Road, Santa Barbara, California 93105

ABSTRACT: The pine vole (Microtus pinetorum) damages apple trees in western North Carolina, sometimes spectacularly. The current research monitors populations in orchards for several years to compare damage in different management practices. Recommendations for orchard management to reduce damage are devised and used to illustrate the process of application of basic knowledge. Populations of voles were monitored by 3 simple methods. Data on reproduction were obtained. Data on home range and mortality were found in the literature. In two counties, the orchards generally had grass in the alleys and sometimes a growth of weeds under the tree canopy. In two other counties (less hilly) the orchards were much cleaner. Numbers of voles and amount of damage were much higher in the less clean orchards. A management program should include mowing 5 times a year, clearing vegetation from under the tree, removing prunings, restricting distribution of fertilizer and, after harvesting, inspecting and cleaning especially vulnerable parts of the orchard.

The pine vole (Microtus pinetorum) has damaged apple trees for decades along the Appalachians from northern Georgia to Massachusetts. The voles tunnel at the base of the trees and gnaw the trunk underground, often killing the tree. The damage may be spectacular. The grower in early summer, especially in a dry spell, may be surprised to see the leaves on a tree suddenly turn yellow and drop in a few days. Control of voles has relied on a series of poisons since at least 1933 when the Fish and Wildlife Service initiated a substantial program.

The purpose here is to record the results of several years of research designed to develop recommendations for a more lasting method of reducing damage. Life history data are included as a basis for the recommendations. An additional purpose is to illustrate the process of application of basic research to the practical problem of reducing damage.

The research here reported was planned about 1970 in the following steps: (1) Selection of ecological principles that might be helpful (2) Collection of necessary data (3) Preparation of management plan (4) Referral to action agency (Agricultural Extension Service) for educational program. All of these steps involved consideration of other pests of apples and also the harvesting of the fruit. Some comments on political realities will be added.

The problem is not to get rid of pine voles as such but to reduce damage to apple trees. Thus, methods that restrict or impede the access to the tree will be useful. The magnitude of damage also needs consideration and evaluation, because the costs for control should be kept less than the costs of the damage. But data on damage from voles are difficult to obtain. Losses from other pests such as root rot must be assessed.

METHODS

The studies were conducted in commercial orchards in western North Carolina, principally in 4 counties. The orchards varied greatly in management, age of trees, spacing, and other characteristics. The terrain is usually hilly, sometimes rather steep. The climate is generally mild, with snow several times each winter and occasional drought in summer.

Estimates of the numbers of voles were obtained by several indices. The quickest way to get comparative numbers is the use of a probe. A stick about 2 cm square is pushed into the ground under the tree. If a tunnel is present, the probe will abruptly fall through. A routine of 10 probes at the base of every fifth tree will give a number for "percentage positive" for several rows of trees. The method overestimates voles, because a tunnel may remain long after the vole is gone. The method will indicate an increase much better than it will a decrease. Another method of estimation is to set snap traps and determine the conventional "voles per trap night." A method that indicates presence of voles is to place a slice of apple in or near runways and determine the proportion of apples nibbled by voles. This method is very useful for detailed studies of activity.

Data on reproduction were obtained by examination of carcasses for pregnancy, embryos, or spermatogenesis. Age cannot be determined except by relative size.

LIFE HISTORY

Some information on the habits and seasonal characteristics is needed to prepare for development of management plans. The pine vole shares the microtine habit of living in tunnels either above or below ground and feeding on roots and stems of grasses and forbs (Getz, 1971). The original habitat is not known. The type specimens were collected in a pine forest in Georgia, but the original description (LeConte, 1830) does not give details. Traps set in 1974 in a regularly burned, pure stand of pine produced nothing for many days. It seems therefore likely that the pristine habitat was edge of pine woods, especially slopes along little streams. The orchard may thus represent rather closely the original conditions.

The orchards currently studied are in Wilkes, Henderson, Cleveland, and Lincoln Counties of North Carolina. The first two counties are almost mountainous, with altitudes ranging from 300 to 800 m. The latter two counties are lower and rather flat. The trees in the orchards are spaced 10 x 10 in older (25 years) orchards and 3 x 10 m in younger orchards. The most common varieties are golden and red delicious, usually on seedling root stock. The management of each orchard varies, but generally the orchards in the mountain counties have sod with grass about 30 cm high but sometimes high weeds. In the lowland counties the ground under the tree is clean or even bare. The alley along the rows is kept in grass. The soil is compacted by the wheels of vehicles.

The habits are typically microtine. The pine vole tunnels rather deeply (20 cm) and may travel from tree to tree at that depth. The tunnels tend to come to the surface on the alley side of each tree. A detailed analysis showed that more tunnels were present along the row of trees than beside the row. Presumably compaction of soil was influential. Voles build nests in enlargements of the tunnel, usually from grass and about 10-20 cm in diameter. Voles in the fall hide food also in an enlargement. Identification of the plants in several caches showed the presence of rhizomes of Solidago, Viola, and Erigeron. Bulbs of Allium were numerous.

Information on reproduction was obtained incidentally from voles trapped for population estimation. Analysis of the data (Ziesenis and Davis, 1976) showed a maximum level of pregnancies in May and September in essential agreement with the results of Paul (1970), Horsfall (1963) and Valentine and Kirkpatrick (1970). The litter size was 2.1, again in agreement with other results.

POPULATION CHANGES

In Wilkes County, monitoring populations began in 1970 and continued rather sporadically till September 1975. The index for 3 orchards obtained by probing increased during each year from about 10 percent positive in summer to about 20 percent positive in the fall. No damage was noted in the monitored orchards. These orchards were kept clean; endrin was used in some years. The contribution of these early studies was primarily methodological, but the index of abundance showed that little variation occurred during 4 years.

In an abandoned orchard the index was obtained for 3 years starting the year of abandonment. The population increased abruptly in the fall at a time when the vegetation was knee-high. The population remained high for 6 months but declined and then vanished. During this phase, cotton rats (Sigmodon hispidus) became numerous. A history of another population was obtained in retrospect. The grower became ill in 1971 and no one cared for the orchard. When noticed in 1973, more than half the trees were dead. Vegetation of brambles, poison ivy, and weeds was 3 m high in the trees. Trapping produced few voles, but evidence of their past presence was everywhere.

In Henderson County more comprehensive and detailed monitoring began in 1974. About 40 orchards were selected to represent various characteristics of age of tree, slope, and management. The histories of 9 are sufficiently complete for presentation (Fig. 1). The population remained the same or declined. Use of endrin made no difference. Analysis of all the orchards showed a decline throughout the county (Ziesenis and Davis, 1976). Damage was limited to an occasional tree.

In Cleveland and Lincoln Counties conditions in the orchards are different. The land is usually level, the orchards are younger and the trees generally closely spaced. A random sample of 5 percent of the trees in 10 percent of the orchards revealed that only 31 trees of 2279 examined by probing were positive. Actually only one of the 31 trees had evidence of the presence of voles. But an abandoned orchard was devastated by voles during a period of two years. Thus, voles are present in these counties but rare in orchards.

MANAGEMENT OF ORCHARDS

The suggestions for the control of damage by pine voles are based on the experience briefly summarized above. Note that the emphasis is on reduction of damage. The extent of damage is difficult to determine, because diagnosis of cause of death is necessary. A cause of death was assigned to 59 trees. In 14 percent death resulted from vole damage, in 37 percent from root rot (several kinds) and in the rest from miscellaneous problems. Actually, machinery killed almost as many trees as did the voles. These figures illustrate the principle that the management must be for all aspects of the orchard.

Before indicating particular aspects of management, it is desirable to comment on an aspect of strategy. When planning a program, one can be sure that some allies can be found in the procedures for management of other pests. Therefore, frequent discussions with entomologists and horticulturists revealed that certain procedures would also mitigate their problems.

Management is based principally on the recognition that voles thrive in heavy vegetation. Therefore, various procedures to reduce its growth are recommended. The grower should mow the orchard about 5 times a year. In particular, he should mow after petal-fall so that a thatch does not develop. Under the canopy of the tree the vegetation should be kept as sparse as possible. Herbicides, mowing, or discing are important. Fertilizer should be restricted to the edge of the canopy (where the tree needs it) rather than scattered widely. Removal of cuttings from pruning or sprouting is essential. These procedures will greatly reduce the likelihood of damage as demonstrated in Cleveland and Lincoln Counties.

Nevertheless, in spite of such management, some parts of the orchard are high risk. A detailed analysis of factors associated with presence of voles (Ziesenis, 1976) showed that voles frequented warm slopes. Also, numerous observations indicate that voles may enter an orchard from vegetation along streams or roadsides. These vulnerable areas should be kept especially clean. In addition, the grower should inspect such areas after harvesting and by probing search for vole activity. If voles are present, thorough removal of vegetation is necessary and possibly use of some poison is indicated.

The education of the grower is the responsibility of an action agency such as the Agricultural Extension Service. It should prepare leaflets, arrange meetings to explain procedures, and organize demonstration programs. Education is a continuous process and must be emphasized every year.

PROCESS OF APPLICATION

The situation in respect to pine voles is currently as follows: We have developed a procedure for managing an orchard to reduce damage from rodents and some other pests and to facilitate harvesting. It needs to be sold to the growers by demonstration and experience. Acceptance will require a decade. However, the problems of acceptance are not the province of the research person; these problems belong to the action agencies. Therefore, let us return to the research aspects and consider the general process of application of basic knowledge using the research on pine voles as an example.

The first step is to determine which principles might be useful. For example, diversity is a splendid ecological principle but seems unpromising in this case. However, the principle of carrying capacity with compensating birth and death rates would seem to be very useful. Also, the concept of succession as an orchard matures should be helpful. A third principle concerns movements, emigration, and home range. Perhaps other principles would be useful, but these are a good start.

Next, let us consider what research we must do, if any, to use these principles to reduce damage by voles. Since the species is a microtine, a group notorious for fluctuations, studies of carrying capacity and of fluctuations of pine voles in orchards in North Carolina are essential. Information on birth and death rates seems rather inconsequential, and adequate knowledge is available (Morris, 1972; Gentry, 1968). The two must be balanced (allowing for some movement). Although the litter size is small, each female has several litters a year (Valentine and Kirkpatrick, 1970). From knowledge of other microtines, it seems likely that pine voles exhibit inhibition of growth and maturation so that removal of adults allows young to take their places. The death rate in North Carolina must be around 0.95 per year as in other microtines.

Succession in an apple orchard has never been studied. Therefore, examination of vegetation and trapping for small mammals was organized to obtain data.

The extent of movement requires examination (Hamilton, 1938). Microtines are opportunists, showing ability to find suitable habitat and to exploit it. The frequent episodes of invasion and destruction of neglected orchards vividly verifies this quality. Also, microtines have definite home ranges as has been frequently demonstrated. Thus, it is safe to conclude that after finding a suitable habitat, the voles will remain in a small area.

The availability of this vast amount of knowledge means that only selected research was necessary. Verification of the capacity level and of the fluctuations was essential and was done. The results (Fig. 1) show that an orchard has a capacity that varies slightly as long as a particular management persists. A change in management that allows growth of vegetation allows the capacity to expand rapidly, resulting in extensive damage. The conclusion is that management can restrict the capacity. Data on birth rate was available in the literature (Miller and Getz, 1969), but since the voles were available because trapped for other purposes, they were examined anyhow. The results confirmed other studies. Data on death rate are difficult and expensive to get and hence were not obtained, since information from other species sufficed.

The concept of succession was useful in understanding the changes in an orchard during its lifetime (30 years). Although the trees mature and increase in size, the management arrests succession so that little change occurs in vole habitat. Nevertheless, management may differ in different orchards. When the orchard is abandoned, succession resumes, weeds, vines, and brambles thrive, and the voles multiply. But in a year or two the habitat is no longer suitable, cotton rats and shrews take over and voles disappear. This concept clarifies the vegetational changes.

Information on home range, while easy to get, seemed unnecessary. Indeed, during our research, Walsh (1973) determined the range for pine voles in orchards in Massachusetts and verified our assumption about home range.

The important feature of this procedure is that only certain items of information need be obtained. The rest are assumed from knowledge of other species. The only information sought pertains directly to the development of recommendations for management. Surely one could investigate voles for years; determine breeding season in dry years and in wet years; measure mortality rates of males and of females and on and on. These items may enlarge our knowledge of voles but may not be directly useful in devising the management plan. In the process of application of basic knowledge, one collects only essential data.

POLITICAL REALITIES

Politics, the art of the possible, must be considered in any management plan. No one should expect acceptance of a plan without discussion or imposition upon the growers. Nevertheless, if the investigator and the action agency understand some facets of political realities, the chances of failure of communication will decrease.

Some features of the attitudes by growers are very natural. The satisfaction of killing a pest is great, as evidenced by one's reaction to swatting a mosquito. Thus, it is no surprise that a poison has great appeal. A related aspect is the feeling of safety by insurance against damage by using poison "just in case." A similar feeling is the attitude that if one pound is good then two pounds are better. The grower has definite feelings about the use of a chemical.

The other aspect is the desire for profit by commercial organizations, which of course is their proper objective. The methods of influencing growers often discourage objective evaluation of the effectiveness of a control procedure. For example, occasionally an officer of an association of growers receives the franchise for distribution of a poison. Another practice is to arrange a demonstration in an orchard that has no voles because it is so well managed. Obviously the "results" are impressive. Various advertizing devices such as provision of "happy hours" at meetings promote a product. Unfortunately, management procedures do not lend themselves to this kind of promotion.

CONCLUSIONS

The process of application of basic knowledge to reduce damage by a vertebrate pest

should follow several steps: (1) consideration of principles that might be useful (2) analysis of available data (3) collection of data if necessary to test the usefulness (4) preparation of an action plan jointly with an action agency.

This process, used on pine voles in apple orchards of western North Carolina, provided a management plan that will reduce damage by voles. It includes mowing the orchard 5 times a year, eliminating weeds under trees by herbicides or by plowing or cultivating, and inspection after harvesting of especially vulnerable parts of the orchard.

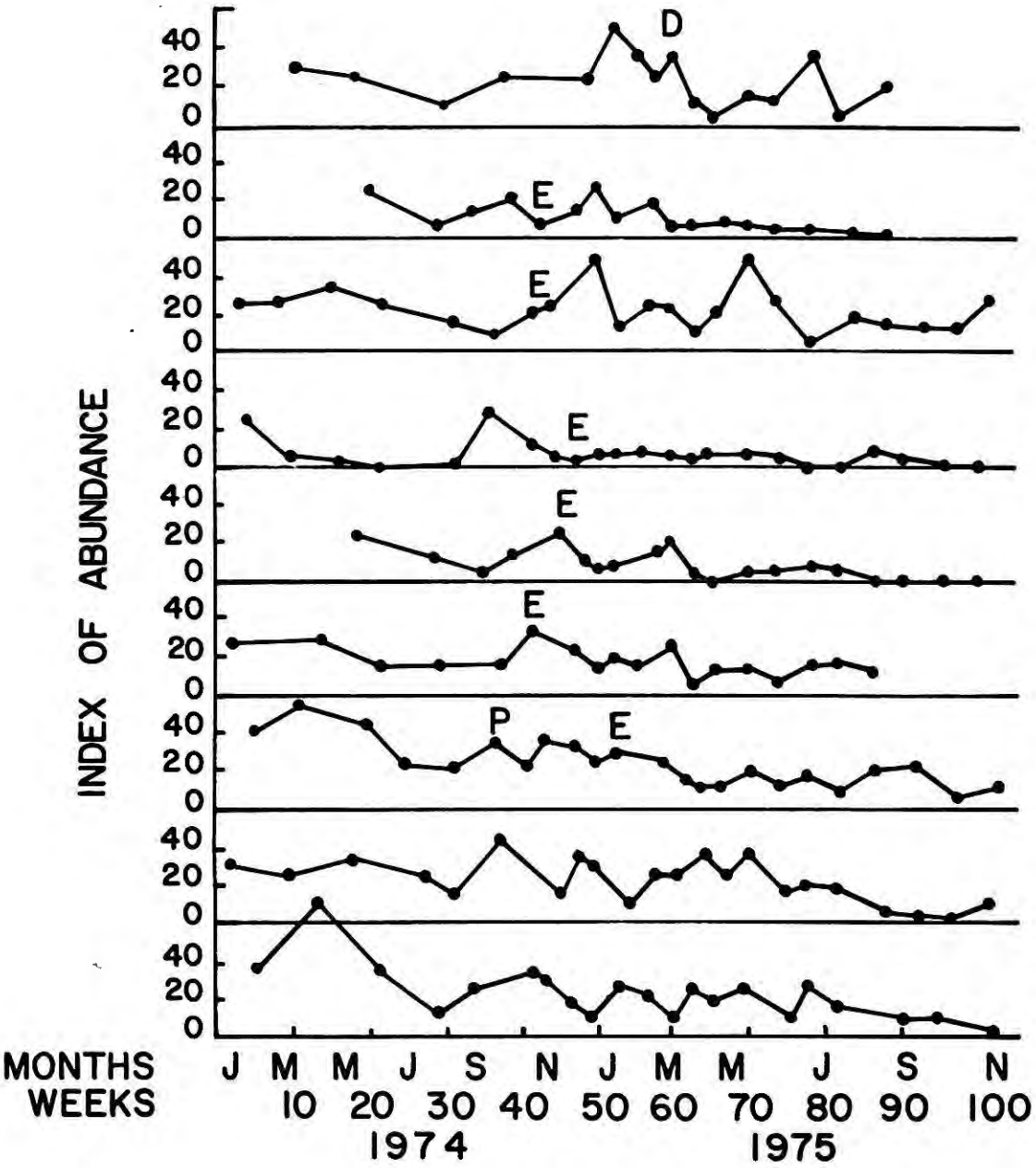

Figure 1. Relative numbers of voles during two years in 9 orchards. The ordinate gives the percent of trees having tunnels (not necessarily active). E represents the application of endrin; D represents discing. Note that the index of numbers generally declined from 1974 to 1975.

LITERATURE CITED

BYERS, R.E. and R.S. YOUNG. 1974. Cultural management of pine voles in apple orchards. Hort. Sci. 9:445-446.

GENTRY, JOHN B. 1968. Dynamics of an enclosed population of pine mice, Microtus pinetorum. Res. Popul. Ecol. 10(1):21-30.

GOERTZ, J.W. 1971. An ecological study of Microtus pinetorum in Oklahoma. Amer. Mid. Nat. 86(1):1-12.

HAMILTON, W.J., JR. 1938. Life history notes on the northern pine mouse. J. Mammal. 19:163-170.

LE CONTE, JOHN. 1830. Description of a new genus of the order Rodenta. Ann. Lyc. Nat. Hist., N.Y. 3:133.

MILLER, DONALD H. and LOWELL L. GETZ. 1969. Life-History notes on Microtus pinetorum in central Connecticut. J. Mammal. 50(4):777-784.

MORRIS, RALPH D. 1972. The effects of endrin on Microtus and Peromyscus. II Enclosed field populations. Can. J. Zool. 50(6):885-896.

PAUL, J.R. 1970. Observations on the ecology, populations and the reproductive biology of the pine vole, Microtus pinetorum in North Carolina. Rep. Invest. Ill. State Mus. 20:1-28.

VALENTINE, G.L. and R.L. KIRKPATRICK. 1970. Seasonal changes in reproductive and related organs in the pine vole, Microtus pinetorum, in southwestern Virginia. J. Mammal. 51(3):553-560.

WALSH, L. 1973. Unpublished report to Fish and Wildlife Service.

ZIESENIS, J. SCOTT. 1976. Habitat requirements of Microtus pinetorum (in review).

_____ and D.E. DAVIS. 1976. Population changes of Microtus pinetorum in orchards (in prep.).