The University of Manitoba

The effect of the occurrence of certain plant species on the local distribution of *Microtus pennsylvanicus pennsylvanicus* (Ord.) in southeastern Manitoba

by

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Table 8. List of preference values derived by subtracting the percentage of the total vegetation represented by each plant species from the percentage of stomachs in which each species was found.

Abstract

The food habits of Microtus pennsylvanicus in southeastern Manitoba were studied in conjunction with an analysis of the plant community existing on the study plot. Snap-trapping, laboratory food preference tests, and examination of the stomach contents were employed to determine local distribution of the animals and their food preferences.

Both the preference tests and stomach analysis showed that certain plant species were highly preferred. Species which were preferred both in the laboratory and in the wild included Bromus inermis, Taraxacum officinale, species of Carex and Melilotus, and Trifolium repens. Underground stems, roots, underground fungi, and mosses were also eaten frequently.

Multiple regression analysis indicated an association between Microtus and species of Poa, which were not, however, a preferred food. The degree to which Poa was associated with some preferred plant species suggested that the association of voles with Poa may reflect the ability of these preferred foods to coexist with Poa. The animals may choose this habitat because it affords both cover and preferred foods. Vole numbers were not correlated with good cover as provided by a species (such as Calamagrostis inexpansa) which was not readily eaten and did not occur in association with more palatable plants.

The evidence of selective feeding and the indication that voles tend to be associated with certain plant associations suggested that food preferences, and, to some extent, cover, affect local distribution and perhaps migration and population levels.

Introduction

The purpose of this study was to elucidate some of the factors controlling the distribution of Microtus pennsylvanicus pennsylvanicus (Ord.), the meadow vole, in southeastern Manitoba. The problem of distribution was suggested by reports in the literature (Buckner,1957; Aumann, 1965; Ashby,1967; Fuller,1967; Getz,1969,1970,1971; Batzli and Pitelka,1971; and Grant,1971) and by the results of a preliminary small mammal census conducted in the Sandilands Forest Reserve of southeastern Manitoba in 1969. This census indicated that the distribution of Microtus was unusually discontinuous, the animals being present as small aggregations separated by a distance of some miles from neighbouring concentrations. No obvious reason for this discontinuity was discernible in terms of cover, soil type, presence of predators, or effects of weather.

Appraisal of the sites trapped during the census suggested that, although all sites seemed to provide sufficient cover to sustain a vole population, the plant associations providing these resources were exremely diverse. Therefore, since other workers have shown that the type of food eaten can affect the physiology of voles (Negus and Pinter, 1966; Schevchenko,1969; Hansen and Ueckert, 1970; and Watts, 1970), it was decided that a study of the relationships between a given plant society and its resident vole population would be an informative contribution to the present body of knowledge concerning population dynamics.

The thesis was designed to study the feeding habits of *M. pennsylvanicus* in a localized region to determine whether or not certain plant species were preferred food species and whether or not the existence of such preferences affected distribution.

Litereature review

The question of the extent to which the environment influences the activities of small mammals has been pondered by numerous researchers for many years. The appearance of marked fluctuations in numbers of small mammals, especially voles, has caused many people to look for the controlling factors behind these population peaks and "crashes" which appear to have a cyclic periodicity of between three and four years. Among the first analyses of these cycles were those of Elton(1924, 1925, and 1942), Bailey (1924), Hamilton (1937) and Hatt (1930).

Weather was one of the first factors suggested to control animal populations. Elton (1924) commented on the apparent correlation between periodic fluctuations in the numbers of animals and the occurrence of sunspots and volcanic irruptions which, he presumed, affect the climate. Some authors, notably Andrewartha and Birch (1954) feel that weather plays an important role in regulating population densities while other workers are less willing to recognize weather as a major controlling factor, although they may concede that it is significant at certain times and under certain circumstances. Many feel that cold weather, particularly if combined with dampness, may increase mortality. Barnett and Manly (1959) showed that cold delays maturity in female Mus and that the oestrus cycle was longer and less regular. This would lower the number of pregnancies per summer and greatly affect the population density.

Bateman (1957) found that less milk was produced by female Mus under cold stress and concluded that more of the food ingested was used for heat production and less for milk production.

While cold may be disadvantageous at times, it is not necessarily true that winter is the season of highest stress if a sufficient snow cover protacts small mammals from the worst effects of wind, radiant heat loss, and predation. Formozov (1946), Pruitt (1957,1960), Gentry and Odum (1957), Fuller (1967) and Vose and Dunlap (1968) have all reported that deep snow cover provided good protection for voles.

The presence or absence of sufficient vegetative cover would seem to be an important component of a vole's environment since it provides shelter from heat, cold, and predators as well as giving the structural materials for organizing the population into a system of runways, nests, home ranges and feeding areas. Warnock (1965) found that the presence of cover greatly reduced mortality associated with crowding. Cover furnished the means of dividing the population into functional units and effectively reduced intraspecific strife by giving the community a pattern of organization.

The availability of water may have some effect on the distribution and number of microtines. Voles (Clethrionomys) are known to require up to ten times as much water as deer mice (Peromyscus) (Odum,1944) and Getz (1963,1967) found that not only did M. pennsylvanicus drink more than M. ochrogaster, the prarie vole, but also water consumption was higher at lower relative humidities. However, a study by Getz in 1965 failed to prove that humidity in vole runways was responsible for voles' choosing marsh over upland habitat.

Another factor which may affect Microtus distribution is the availability of certain minerals in the soil. Aumann (1965) and Aumann and Emlen (1965) published results indicating that microtine populations reached their highest peaks in regions with a high sodium level. Laboratory studies showed that groups of animals with sodium available "ad libitum" maintained a higher net population level over the test periods and that crowding yielded more selection for sodium.

Interspecific competition may affect vole distribution as demonstrated by the studies of DeCoursey (1957), Getz (1961,1962), Koplin (1962), Clough (1964), Koplin and Hoffmann (1968) and Murie (1971).

Predation also may affect vole numbers and distribution, especially in areas where cover is scarce. Craighead and Craighead (1950) stated that predation can be the chief limiting factor on determining prey populatio n levels. Pearson (1942) and Eadie (1952) have both found that predation by shrews, especially of the genus Blarina, may influence vole numbers from year to year. Metzgar (1967) made an interesting contribution to understanding predation effects when he reported that transient mice were more subject to predation than residents, perhaps because residents, being more familiar with the terrain, spend less time exploring and are able to hide more quickly if danger threatens. This factor may have far-reaching effects on migration and hence distribution in the wild.

Intraspecific interactions may affect populations of small mammals. Much space has been devoted to this aspect of population dynamics in recent years. One of the first people to study so-called density dependent regulation was Christian who published a series of papers (1950, 1963, 1964, and 1965) which attempted to prove that increased adrenal weight in times of high population reflects an adrenopituitary adaptation to stresses. This theory, that increased demands on the pituitary to secrete gonadotropic hormones in the spring caused exhaustion of the adreno-pituitary adaptation with consequent late winter and early spring mortality, was advanced on the basis of Selye's general adaptation principle (Selye,1950) which states that the resistance to stress diminishes in a population in proportion to increase in adrenal function as indicated by adrenal hypertrophy and thymus involution. Christian and Davis (1966) found that adrenal weight increased in female Microtus at sexual maturity and that the weights seemed to reflect density ofthe population. There seemed to be no correlation with pregnancy and lactation. These data agreed with McKeever (1959) and Chitty (1961) but disagreed with Chitty and Clarke (1963). Clough (1965) found that survival of M. pennsylvanicus showed no correlation with population density and that adrenal, thymus and spleen weights were contrary to what the general adaptation principle predicted.

Another possible explanation of fluctuations in microtine numbers is the idea that genetic changes over a period of several years can result in reduced viability and increased susceptibility to environmental stress. This theory was first proposed by Chitty in 1960.

Chitty's theory, if taken in conjunction with those advanced by Nicholson (1933) and Andrewartha and Birch (1954), explains population cycles as being chiefly the result of physical factors with this action being governed by some population attribute. Other publications by Chitty (1952, 1955, 1958, and 1961) have not proved the existence of factors which could lower viability in a cyclic fashion. This was also the case for Newson and Chitty (1962). More recently, Chitty (1966) has sug ested that behaviour of animals toward one another may change at high densities. The relationship of parents and offspring was suggested as the critical interaction.

The foregoing literature has been briefly cited to indicate the current state of knowledge regarding the effects of the environment on Microtus populations. Obviously the environmental factors are many and the possible physiological effects complex. However, one of the most basic and least understood factors affecting any animal community has yet to be discussed. This is the problem of food supply which forms the basis of the topic of this thesis.

Materials and Methods

A. Collection of animals

a. Collection of animals for stomach analysis

Animals to be used in the analysis of stomach contents were collected on the study site at the Whiteshell Nuclear Research Establishment at Pinawa, Manitoba. Trapping was conducted on a sixty-four station grid with eight rows of eight trapping stations one hundred feet apart. This plot has been trapped annually since 1968 using Museum Special snap-back traps. The program is carried out under the supervision of Dr. S. L. Iverson. Trapping was done for a period of thirty consecutive days beginning sometime in July of each year. Three traps, baited with a mixture of peanut butter, oatmeal, and castor oil, were set at each station and checked daily. The animals were kept frozen until needed for stomach analysis.

b. Collection of animals for preference tests

Microtus used in the preference tests were collected using both Sherman box traps and Longworth traps. Most of these animals were caught in a grass-willow scrub association close to the snap-trapped grid but separated from it by a wide gravel road.

Unfortunately,a low population in the summer of 1971 necessitated collection of voles at some distance from Pinawa. For this reason, six animals were caught in a tamarack bog in the Whiteshell Provincial Park about thirty miles east of Pinawa. Of the twelve animals required for food preference tests, three were from the Whiteshell and nine from Pinawa.

Sherman traps were baited with a mixture of shortening and wild bird seed. This combination was readily eaten by voles and did not attract insects to the the same degree as a mixture of seed and peanut butter. The absence of peanut butter and the use of only a little shortening to keep the seeds together also prevented the animals from getting their hair glued together and generally kept them in better condition. Longworth traps were baited with a handful of oats and a piece of carrot supplied moisture. Both types of traps were provided with a small handful of green grass. This was placed over the metal bar behind the door in Sherman traps and never interfered with closure of the door when so placed. The grass was placed in the nest box of Longworth traps. Bedding and additional bait were thus provided for voles. Traps were checked each morning at Pinawa and in the early morning and late evening in the bog.

B. Plant community analysis

Analysis of the plant community was carried out on the trapping grid at Pinawa in July 1971, just before the yearly snap-trapping was done.

A fifty centimeter square quadrat was marked off to the northwest of each trapping station. That is, a line was marked, fifty centimeters long,to the west of the stake marking the trapping station and a quadrat laid out to the north of this line. Analysis of the vegetation within this quadrat was then begun by cutting all the plants within the square to ground level. The loose debris fraction was gathered separately, any mosses present being included in this fraction, and the samples placed in plastic bags and taken to the laboratory where the plants of each species were separated and weighed. The debris composing the litter layer was also weighed and, for the first twenty-four quadrats, the sod was cut out to a depth of about ten centimeters and the roots shaken free of soil and weighed. This last procedure was discontinued as it seemed to offer little return for the amount of work involved due to the doubtful accuracy of the results. This clip-sampling technique is similar to that employed by Golley (1960) except that he washed the roots, used dry weights instead of wet weights and did not measure the litter fraction.

The method of vegetation sampling used in this study, therefore,gave a measurement of the aboveground weight of each plant species present on the plot, as well as the total weight of the green vegetation and the litter layer.

Separation of the species present was not difficult except for a few graminoid species. Nonetheless, these seemed to be successfully sorted on the basis of the colour, texture, turgor, and dimensions of the blade as well as the presence of hairs on the blade or ligule, and the form of the stem and roots. The accuracy of the separation of the grass species was judged by basing the decisions solely on characteristics of the stem and leaf and ignoring inflorescences or seed heads, if present. Each resulting pile of plants was then examined to see if all the inflorescences were of the desired species. If this was so, it was assumed that the characters used to differentiate the given species from the other species on the plot were sufficient and reliable. Little difficulty was encountered in separating the grasses satisfactorily except in the case of Poa pratensis and P. nemoralis. These were totally indistinguishable from one another unless heads had developed and, to avoid errors in attempting to separate the blades, the two species were weighed together and recorded as Poa spp. The number of heads of each species was recorded as an approximation of the proportion of each species present but these estimates were not used in any calculations. Similar methods were employed with some other plants such as Aster and Solidago which were both present as a number of very similar species which could not be distinguished in their early growth stages.

C. Food habit studies

a. Feeding trials

Laboratory studies of the food preferences of voles have, in the past, been largely restricted to stomach analysis methods or cafeteria tests. Attempts to gather prefe ence data via observations of food cuttings in the field, cafeteria tests involving a choice of a number of foods, or recorded responses to two different choices through electrical systems, have been made by Hatt (1930), Hatfield (1940), Jameson (1947), Holling (1955), Martin (1956), Marsh (1962), Gorecki and Gebczynska (1962), Buckner (1964), Thompson (1965), Batzli and Pitelka (1970, 1971), Menhusen (1963), Riewe (1971), and Bergeron (1972).

It was felt that an attempt should be made to give at least a broad estimate of the preference of *M. pennsylvanicus* toward plant species found on the study plot. Ideally, it would be possible to give each plant species a value, or at least a rank, according to the order of preference of various foods. Therefore, the apparatus illustrated in Figures 1 and 2 was devised to test the reaction of a captive vole to a given plant species. Each plant species was tested with twelve mice, except for *Mentha arvensis* where only enough plant material was available for seven mice.

In each trial, the hardware cloth basket at the front of each individual chamber was packed full of the plant