

CLIMATIC FACTORS, REPRODUCTIVE SUCCESS AND POPULATION DYNAMICS IN THE MONTANE VOLE, *MICROTUS MONTANUS*

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♦ OBJECTIVES

Multiannual fluctuations (“cycles”) in population density of small rodents doubtless result from the interaction of a multitude of factors, as evidenced by the variety of hypotheses proposed to explain the phenomenon (for reviews see Finerty 1980, Taitt and Krebs 1985). However, the inability of these hypotheses - alone or in combination - to explain the causality of cycles rests in no small measure with the fact that long-term studies of the phenomenon are notoriously uncommon. The objectives of this project are to continue the long-term study of the population dynamics of the montane vole, *Microtus montanus*, in Grand Teton National Park. On the basis of earlier observations (Pinter 1986, 1988) particular emphasis will be placed on how environmental variables, possibly acting through reproductive responses, contribute to the population density cycles of these rodents.

♦ METHODS

In 2002 *Microtus montanus* were live-trapped at two times of the year: the second half of May (spring study period) and mid-July to mid-August (summer study period). Animals were killed with an overdose of Metofane as soon as possible after capture. Animals were aged using weight, total length and pelage characteristics. Reproductive organs, the spleen and the adrenal glands were collected from all animals and preserved in Lillie’s neutral buffered formalin for further histological study. Flat skins were prepared from all animals.

Population density was estimated on the basis of trapping success in a permanent grid (established in 1970). The grid consists of 121 stations placed in a square, 5 m apart, 11 stations (50 m) on a side. Each station is marked with a stake. Trapping in this grid was performed only during the summer study period. One unbaited Sherman livetraps was set at each station. Additional trapping was carried out in nearby meadows away from the grid to obtain additional females for litter size determination.

During the spring study period trapping was carried out at a number of sites, all of them well removed from the permanent grid. The purpose of this was to leave the grid site as undisturbed as possible since the grid was the major source of information on population density. The main objective of the spring study period was to determine (on the basis of embryo size) the onset of reproduction on a population-wide basis. This information is very important for two major reasons: (1) onset of reproduction in *M. montanus* in Grand Teton National Park can vary by as much as 40 days among years, and (2) the time at which reproduction begins has significant repercussions on the productivity of the population for that year.

Weather data were obtained from records at the Jackson Lake Dam (Moran 5WNW). Although it is not a Class A weather station, it is located less than 2km from the permanent grid. Data collected included temperature, precipitation, and the date of complete spring melt-off.

◆ RESULTS

As was the case in the spring of 2001, the overwintering population of voles (i.e., the breeding population) in 2002 was also very small. There was very little current sign (droppings, cuttings) and very few runways were in evidence. In 2002 reproduction began on a population wide-basis approximately one week later than in 2001 (i.e., in the middle of May). All trapped females were pregnant, however, it was only their first pregnancy of the year (i.e., there was no sign of lactation). Furthermore, the litter size was 23 % lower than that recorded for spring of 2001. On the one hand these findings indicated that the population density in 2002 would probably decline below levels seen in 2001. On the other hand, however, there was still the potential for an increase in the 2002 population levels over those of 2001 since the May of 2002 was unusually dry and since a dry May has been historically correlated with an increase in the population density of voles (Pinter 1988, Pinter et al. 1994).

In spite of the unusually dry May, population levels declined significantly in all of my study areas. Indeed, at one study site the population crashed, yielding only one *M. montanus* for every 100 trap nights. The coincidence of several factors could be correlated with the decline in vole populations. In addition to the contributing factors (late onset of breeding, small litter sizes) of the spring study period there were also factors during the summer study period that further depressed population growth. The litter sizes during the summer of 2002 were smaller than those seen at a comparable time in 2001. The young of the year were maturing very slowly and there was every indication that animals born after the first week of July would not attain sexual maturity in 2002. Furthermore, there was a dramatic decline/cessation in reproductive activity in the second half of July - no lactating females were found from late July until the end of the summer study period (mid-August). As in 2001, drought conditions prevailed throughout the summer of 2002, with a consequent early drying of the herbaceous vegetation. The voles switched their diet to whatever remained as the greenest vegetation at the time (e.g., *Equisetum*).

◆ DISCUSSION

The factors that underlie the multi-annual fluctuations in vole population density remain a mystery. There are environmental factors that correlate fairly predictably with population processes of voles.

The difficulty in deciphering the causes of vole cycles is due to the numbers of variables that contribute to this phenomenon. For example, the onset of spring, specifically the onset of the growth of herbaceous vegetation can be linked reliably with the onset of reproduction of *M. montanus*. The time at which *M. montanus* begin to reproduce in the spring has profound consequences for their population dynamics. In *M. montanus* the first litter of the year invariably reproduces in the year of its birth, the females attaining puberty at approximately 5 weeks of age. The second litter matures at 8-10 weeks of age, the third - depending on its date of birth - may or may not mature in the year of its birth (Negus, Berger and Pinter 1992). Consequently, the early-born young of the year do not merely represent an addition of individuals - they represent the addition of breeders. Thus, an early increase in the number of reproductively active individuals results in rapid population growth. The earlier the young breeders can be produced the greater their contribution to that year's population numbers. However, an early onset of reproduction does not always guarantee rapid population growth, essentially because of the dramatic phenotypic plasticity exhibited by *M. montanus* in response to environmental variables (Negus, Berger and Pinter 1992). Such was the case in the dry summer of 2002. As the drought intensified throughout the summer, the preferred food plants of *M. montanus* began to senesce and dry out. As was the case in 1987-1988 (Negus, Berger and Pinter 1992), in 2002 environmental vicissitudes significantly impacted population processes in *M. montanus*. The drought arrested the growth and maturation of the young of the year, suppressed reproduction in the population as a whole and strongly counteracted the expected growth rate of the population.

It might seem unlikely that population dynamics of a small rodent would have any serious management implications. However, for a number of reasons, *M. montanus* play an unexpectedly major role in their ecosystem, exerting surprisingly far-reaching repercussions on several levels. To begin with, as in the case of other arvicoline rodents (Korpimäki and Norrdahl 1991), montane voles form a significant prey base for a large number of mammalian, avian and reptilian predators. Since they are active throughout the year they are a continuously available food source, their importance increasing in this respect as a number of their sympatric (e.g., ground squirrels, jumping mice) enter hibernation and become unavailable for many predators. Montane voles would seem an ideal prey item since they have a high reproductive potential which should ensure an abundance of these rodents. However, it is the tendency of this species to exhibit

multi-annual cycles in population density - a multitude of animals in some years, a dearth in others - that produces the most profound repercussions on the rest of the ecosystem. The numbers of these rodents actually drive reproductive success and population dynamics of some predators (weasels, owls), much the same as the better known example of snowy owls irrupting south in response to a crash in lemming populations. In years when populations of voles are low, the reproductive output of some of their predators decreases. Furthermore, a decrease in the availability of montane voles increases the predation pressure on other small rodents, in turn influencing their population dynamics.

◆ CONCLUSIONS

The data collected during the 2002 field season exemplify the extreme sensitivity of *M. montanus* to environmental vicissitudes and reinforce the point that climatic variables play an extremely important role in their reproductive processes. Furthermore, these data also demonstrate the surprising speed with which climatic change can shape the population dynamics of these animals. Montane voles constitute a major prey base for a variety of predators. Unexpected shifts in the reproductive responses and population dynamics of these rodents must therefore also have significant repercussions on population parameters of their predators.

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