# METAPOPULATIONS OF MONTANE AND LONG-TAILED VOLES (*Microtus montanus* AND *M. longicaudus*), AND HANTAVIRUS AND PLAGUE IN THE JACKSON HOLE SMALL MAMMAL COMMUNITY

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## ✦ OBJECTIVES

The purpose of the long-term research begun in 1971 on metapopulations of voles is to enumerate patterns in survivorship, reproduction, and morphology across the sections of the metapopulations. The study sites for *Microtus montanus* were chosen to represent primary and secondary habitat, and proximate and isolated habitat patches.

The purpose of the research on hantavirus begun in 1994 is to ascertain the extent of hantavirus among as many species of small mammals as possible, to identify the strain(s), to understand the presence of hantavirus across species and among the metapopulations of voles, and to assess the potential for human contact. The purpose of the research on plague begun in 1995 is to test the long-standing hypothesis that voles are a reservoir in the intervals between plague outbreaks among ground squirrels.

## ✦ METHODS

Most trapping periods were limited to two days so that impact on the respective populations would be minimized. From fresh specimens of voles, eyes were removed for age determination based upon lens weight (Gourley and Jannett, 1975).

In October, 1996 we undertook standard monitoring efforts at nine known populations of *Microtus montanus* and at two of *M. longicaudus* for long-term metapopulation data; an unstructured sample was made of one other known *M. montanus* population.

Specimens were secured for the hantavirus and plague surveys in the 10 long-term study populations of *Microtus montanus* and two long-term study populations of *M. longicaudus*. They were also obtained at 20 additional sites ranging as far south as four miles south of Moose and as far north as meadows northwest of Flagg Ranch in the Rockefeller Memorial Parkway. Collections were made in and/or around buildings at 12 sites, including Beaver Creek, Moose, Colter Bay, Signal Mountain, and the Research Station at the AMK Ranch. Other collecting sites were proximate to human habitation at Flagg Ranch, Elk Ranch, and the Moran grade school. Fleas were removed from most specimens and saved for identification and plague culture by Dr. Ken Gage of the Centers for Disease Control and Prevention (CDC), Ft. Collins, Colorado. For the hantavirus survey, specimens were sacrificed with an overdose of anesthetic.

Blood and lungs were removed and frozen, and the blood was shipped to CDC, Atlanta, Georgia where it was examined for hantavirus using ELISA. Blood was saved on Nabuto strips to test for plague at CDC, Ft. Collins.

## ✦ RESULTS

### DEMOGRAPHY OF MICROTUS

In the nine populations of *Microtus montanus* monitored with standard protocols in October, 1995 and again in October, 1996, there were generally lower numbers of voles in 1996 than in 1995. In two of the structured samples, there were no *M. montanus* and in the seven other samples the numbers of specimens ranged from one to only 34. Numbers of voles showed disparate changes: one site yielded no specimens in either year; numbers increased at three sites by 26%, 1100%, and 82%, numbers decreased at five sites by 84%, 100%, 92%, and 56%. There was no pattern in the change of numbers of voles among sites with primary habitat, peripheral to primary habitat, or with secondary habitat.

Fall breeding by *Microtus montanus* was evidenced by lactating and recently lactating females, but there was only one pregnant female. Of the 10 sites monitored for *M. montanus* where voles were obtained in October, 1996, one or more parous females were secured at each of seven sites, and each of five of these sites had at least one female recently or still lactating. Neither of the sites where *M. longicaudus* predominate over *M. montanus* had a parous *M. montanus* in the respective sample. Among the seven sites with parous females, the operational sex ratios (OSR) (males:females) of reproductively active and recently active male voles to parous females ranged from 0:1 to 1:4.3. The percentage of females still reproductively active in the seven sites with parous female(s) ranged from 0% to 100%. Based on initial determinations of reproductive condition, there was no obvious relationship between the OSR and the percentage of parous females still or recently lactating. However, the site with the greatest increase in vole numbers since 1995 had the only pregnant female secured in October. Additionally, this site had an OSR of 1:1, and all parous females were still reproductively active.

Numbers of *Microtus longicaudus* were characteristically low at the two sites where they had been monitored. As is usual for this species in northern Jackson Hole in October, breeding had ceased at this time.

### HANTAVIRUS AND PLAGUE

For hantavirus, blood was examined serologically from 820 specimens in July and 504 specimens in October. The survey included 13 rodent species, two species of weasels, one species of bat, and at least two species of shrews (Table 1).

Table 1. Species, sample sizes, and occurrences of hantavirus upon serology in 1996.

| Species | Sessions July96 n | n+ | % | October96 n | n+ | % |
|---|---|---|---|---|---|---|
| *Sorex palustris* | 2 | 0 | | | | |
| *Sorex* spp. | 6 | 0 | | 11 | 0 | |
| *Myotis lucifugus* | 20 | 0 | | | | |
| *Mustela erminea* | 8 | 0 | | 1 | 0 | |
| *M. frenata* | 1 | 0 | | | | |
| *Spermophilus armatus* | 60 | 0 | | | | |
| *Tamias amoenus* | 42 | 0 | | 28 | 0 | |
| *T. minimus* | 2 | 0 | | 6 | | |
| *Tamiascriurus hudsonicus* | 6 | 0 | | | | |
| *Thomomys talpoides* | 8 | 0 | | | | |
| *Zapus princeps* | 19 | 0 | | | | |
| *Clethrionomys gapperi* | 14 | 0 | | 21 | 0 | |
| *Microtus longicaudus* | 31 | 0 | | 43 | 0 | |
| *M. montanus* | 68 | 11 | (16.2) | 240 | 15 | (6.3) |
| *M. pennsylvanicus* | 113 | 13 | (11.5) | 38 | 7 | (18.4) |
| *Phenacomys intermedius* | 5 | 0 | | 3 | 0 | |
| *Neotoma cinerea* | 1 | 0 | | | | |
| *Peromyscus maniculatus* | 414 | 15 | (3.6) | 113 | 1 | (0.9) |
| Subtotals | 820 | 39 | (4.8) | 504 | 23 | (4.6) |
| Totals | 1324 | 62 | (4.7) | | | |

n = sample size
n+ = number of positives
% = percent positive in respective sample

The efficacy of the ELISA test for hantavirus in carnivores, bats, and shrews is problematic. The same three species tested positive for hantavirus in 1996 as in previous years: *Peromyscus maniculatus*, *Microtus montanus*, and *M. pennsylvanicus*.

In July, 15 of 414 (3.6%) deermice (*Peromyscus maniculatus*) tested positive for hantavirus. Specimens which tested positive were all secured in and around human habitation at four disparate locations (Table 2). The incidence ranged from 2.2% to 16.2%, the highest being at buildings at Beaver Creek. There were 11 of 68 (16.2%) *Microtus montanus* and 13 of 113 (11.5%) *M. pennsylvanicus* which tested positive.

Table 2. Numbers of Peromyscus maniculatus and the incidence of hantavirus in July at sites with buildings.

| Sites | Year 1995 | 1996 |
|---|---|---|
| AMK | 25 | 22 |
| Moose Boys Ranch | 15 | |
| Moose | 11 | 44 |
| Beaver Creek (BC) | 2/17 (11.8%) | 11/68 (16.2%) |
| Barn N. of BC | | 1/15 (6.7%) |
| Highlands | 1/11 (9.0%) | 2/79 (2.5%) |
| Lupine Meadows | 8 | |
| S. Jenny Lake | 7 | |
| Signal Mountain | 8 | |
| Sacred Heart Chapel | 4 | |
| Brinkerhoff | 6 | |
| Moran, S. of entrance | 4 | 15 |
| Moran, N. of entrance | 3 | 14 |
| Colter Bay | 1/10 (10.0%) | 19 |
| Flagg Ranch | 1/12 (8.3%) | 8 |
| Elk Ranch Barn | | 40 |
| Smith property | | 2 |
| White Grass Ranch | | 1/45 (2.2%) |
| Totals | 5/141 (3.5%) | 15/371 (4.0%) |

Sites where hantavirus-positive *Microtus* specimens were obtained included four locations where positive specimens were trapped previously and four sites where positive specimens had not been previously identified. Of the four new sites, two were sampled in October which had been sampled in both 1994 and 1995 for *Microtus*. The other two new sites were sampled in July for *Peromyscus maniculatus* and had also been sampled in 1995.

In October, one specimen of *Peromyscus maniculatus* from a sagebrush community tested positive. In addition, 15 of 240 (6.3%) *Microtus montanus*, and 7 of 38 (18.4%) *M. pennsylvanicus* tested positive.

Of the 16 specimens of *Peromyscus maniculatus* which tested positive for hantavirus, only four to six were reproductively active adults (upon initial determination); the rest were subadults. Of the 24 specimen of *Microtus* spp. which tested positive, 17 (71%) were adults.

PCR examination of the lungs of serologically hantavirus-positive specimens from 1994 showed the strain to be similar to the Prospect Hill strain. Tests of subsequent material have not yet been done.

Tests for plague in 1996 preliminarily showed a positive incidence of $<1.0\%$ in voles.

## ✦ DISCUSSION

The numbers of *Microtus montanus* in components of the overall metapopulation showed disparate trends between 1995 and 1996. This was expected in population segments with generally low numbers of individuals. Fall numbers of voles and fall breeding had both been slightly more extensive in 1995 than in 1996. This correlation of increasing fall breeding and population numbers is typical of the increase phase of population growth among microtine rodents (Krebs and Myers, 1974). The low numbers of voles were not conducive to showing such a pattern. This study provided little additional support in 1996 for the correlation of continued fall breeding with operational sex ratios characterized by a relatively large number of adult males, a pattern conducive to social maintenance of breeding (Jannett, 1984a, 1984b).

The finding of *Peromyscus maniculatus* testing positive for hantavirus was significant. This species is the primary reservoir for the Sin Nombre (SNV) strain of hantavirus in the western United States (Childs et al., 1994). The strain present in the Jackson Hole specimens is currently assumed to be SNV (S.T. Nichol, personal commmunication), which is of considerable significance to human health. The incidence of *Peromyscus maniculatus* testing positive for hantavirus was low in the total sample. However, the positive specimens were widely distributed and all but one were near or in human habitation.

A large percentage of the *Peromyscus maniculatus* positive for hantavirus in July were subadults. This profile contradicts the emerging pattern that there is a higher incidence among adults (Douglass et al. 1996; this study, 1994-1996). The significance of this discrepancy is unknown.

In 1996 there was again a distinct pattern of foci for the occurrence of hantavirus among voles, both *Microtus montanus* and *M. pennsylvanicus*. All specimens which tested positive in 1994 and 1995 came from only five sites. Four of these sites yielded positive specimens in 1996, and the one which did not, had a very small sample size (n=4). But, in addition, positive specimens were obtained at four new sites, including two sites associated with buildings.

Specimens are currently being analyzed for age and statistical tests are pending. However, there was a small increase in each of various measures indicative of hantavirus incidence in 1996 over previous years, specifically:

1. Overall incidence in all three species in October, 1994-1996 (*Peromyscus maniculatus*: 0%, 0%, 0.9%; *Microtus montanus*: 1.4%, 1.4%, 6.3%; *M. pennsylvanicus*: 5.6%, 2.6%, 18.4%).

2. Overall incidence in all three species in July from 1995 to 1996 (*P. maniculatus*: 3.1%, 3.6%; *M. montanus*: 1.7%, 16.2%; *M. pennsylvanicus*: 1.3%, 11.5%).

3. For *P. maniculatus* at sites associated with buildings, there was a higher incidence at any one site (from 11.8% to 16.2%, both at Beaver Creek buildings).

4. For *P. maniculatus*, there was a higher percentage of subadults among positive mice in July, 1996 than in July, 1995.

5. For *P. maniculatus*, the first site (other than those associated with buildings) with a positive specimen; for *Microtus* spp., there was an increase from five to nine animals in the total number of sites with positive specimens.

Maintenance of the strict trapping protocols for most of this research will allow us to elucidate patterns over time, space, and variations in population numbers.

### SPECIMEN DEPOSITION

Specimens trapped are in the collections of the Science Museum of Minnesota. Lung tissues are in the frozen tissue collection of the Bell Museum of Natural History, St. Paul.

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