Ecological distribution of Microtus montanus (Peale) and Microtus pennsylvanicus (Ord) in an area of geographic sympatry in southwestern Montana
by James Russell Hodgson

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY in Zoology
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Abstract:
Distributional patterns of Microtus montanus and Microtus pennsylvanicus in relation to various plant communities and to characteristics of habitats, were studied in the Bozeman vicinity of southwestern Montana from 1968 to 1969 in an attempt to secure information about ecological distribution and habitat preferences of these two vole species.

A description of the physiography and vegetation of nine community types is given. During a total of 17,700 trap-nights 762 M. montanus and 583 M. pennsylvaniaus were snap-trapped from 59 study plots. These two species occurred sympatrically in 31 of the 59 sample areas. Preferred habitat of M. pennsylvaniaus is in moist areas where grasses, especially Poa pratensis, and grass-like species are dominant plants, comprising 50 percent or more of the vegetation by canopy coverage, and total canopy cover of all herbaceous material is at least 85 percent. The preferred habitat of M. montanus is not as well delineated as that of M. pennsylvanicus and this species is only poorly responsive to particular physical and physiognomic characteristics of the habitat. Microtus montanus appeared to have a wider ecological tolerance than M. pennsylvanicus, and demonstrated a direct general correlation between abundance and the dryness of the substrate.

ECOLOGICAL DISTRIBUTION OF *MICROTUS MONTANUS* (PEALE) AND *MICROTUS PENNSYLVANICUS* (ORD) IN AN AREA OF GEOGRAPHIC SYMPATRY IN SOUTHWESTERN MONTANA

by

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ABSTRACT

Distributional patterns of *Microtus montanus* and *Microtus pennsylvanicus* in relation to various plant communities and to characteristics of habitats, were studied in the Bozeman vicinity of southwestern Montana from 1968 to 1969 in an attempt to secure information about ecological distribution and habitat preferences of these two vole species. A description of the physiography and vegetation of nine community types is given. During a total of 17,700 trap-nights 762 *M. montanus* and 583 *M. pennsylvanicus* were snap-trapped from 59 study plots. These two species occurred sympatrically in 31 of the 59 sample areas. Preferred habitat of *M. pennsylvanicus* is in moist areas where grasses, especially *Poa pratensis*, and grass-like species are dominant plants, comprising 50 percent or more of the vegetation by canopy coverage, and total canopy cover of all herbaceous material is at least 85 percent. The preferred habitat of *M. montanus* is not as well delineated as that of *M. pennsylvanicus* and this species is only poorly responsive to particular physical and physiognomic characteristics of the habitat. *Microtus montanus* appeared to have a wider ecological tolerance than *M. pennsylvanicus*, and demonstrated a direct general correlation between abundance and the dryness of the substrate.

INTRODUCTION

This study was an attempt to secure information about ecological distribution of *Microtus montanus* and *Microtus pennsylvanicus* in an area of geographic sympatry in southwestern Montana. Although there has been much work done on the genus *Microtus* (see especially bibliography by Golley 1963), proportionally little quantitative work has been done on the vegetational structure of their preferred habitats. The results of various authors (Blair 1940, Eadie 1953, Getz 1961, Zimmerman 1965, and others) have indicated that *Microtus* shows a high selective acceptance of dense areas formed of graminoids, primarily in low lying mesic areas. Cameron (1964) and Morris (1969) discussed the significance of insular occurrence of geographically sympatric species of microtine rodents and suggested competitive exclusion between similar genera. Findley (1951) showed ecological sympatry between *Microtus montanus* and *M. pennsylvanicus* in a small percentage of the habitat types in Jackson Hole, Wyoming, with *M. montanus* having the larger ecological amplitude. Koplin and Hoffman (1968), in a northwestern Montana study, accepted the hypothesis of competitive exclusion between sympatric populations of *M. montanus* and *M. pennsylvanicus*. In southwestern Montana in the areas around Bozeman both *M. montanus* and *M. pennsylvanicus* are sympatric in a large proportion of the studied community types.

The objectives of the study are twofold: (1) to study relative numbers of *Microtus montanus* and *M. pennsylvanicus* in various grassland

and forest communities, and (2) by relating numbers of *Microtus* to recognizable vegetational variants within the community types, to attempt to draw conclusions regarding the make-up of preferred habitats and the factors influencing the ecological distribution of these two species.

To investigate the importance of these factors under natural conditions, a series of snap-trap collections was made in the various habitat types. The period of study was from June 14 through September 14, 1968, and June 10 through August 22, 1969.

METHODS

Trapping Procedure

Study plots were selected within relatively uniform units of several community types. Snap traps ("museum specials") were used exclusively, and the data were compiled according to the trap-night method. One trap exposed for one night was one trap-night. The traps, baited with a mixture of rolled oats and peanut butter, were anchored with a 30 inch, small diameter, wire rod on which a numbered colored plastic streamer was tied to facilitate trap location. One hundred traps, one per station and placed equidistant to each other, were usually arranged in a rectangular or square grid pattern at 30-foot paced intervals. In irregularly shaped areas, the boundary of the grid followed the contours of the area. Traps were left in the field for three nights (300 trap nights) and were checked twice daily, 0800 to 1100 and 1600 to 1800. During the summer of 1968 only one plot was trapped at a time, but in 1969 two areas were sampled simultaneously. Each of the 59 study plots was trapped only once.

Sex, age (adult or subadult), capture locations, and standard measurements were recorded for each captured *Microtus*. All specimens were taken to the laboratory for identification. All other small mammals trapped were also recorded.

Species Identification

Field identification was difficult due to the great similarity of *Microtus montanus* and *M. pennsylvanicus*. Species verification was determined by skull characteristics including maxillary tooth features (Hall and Kelson 1959; and Hoffman and Pattie 1968). During 1968, both skulls and skins were collected, but in 1969 only skulls were collected. The "casing" method (Anderson 1948) was employed to preserve skins.

Vegetational Procedure

A method similar to that of Daubenmire (1959) was utilized to determine canopy coverage and relative frequency of herbaceous species. Two transects were run on each study plot, in which twenty 2 x 5 decimeter frames (40 frames per study plot) were randomly placed at various trapping stations covering the entire grid. Within these quadrats, the percent coverage of each plant species was visually determined and recorded as one of six coverage classes. The coverage classes used were: Class 1 = 0-5 percent; Class 2 = 5-25 percent; Class 3 = 25-50 percent; Class 4 = 50-75 percent; Class 5 = 75-95 percent; and Class 6 = 95-100 percent. The midpoints of these classes were used in the analysis of data. Plant nomenclature follows Booth (1950) and Booth and Wright (1966). Times of trapping were chosen in such a manner that

each area was trapped at an equivalent stage of seasonal vegetational development (for example, the higher the elevation of the study area the later in the season it was trapped).

Five clip quadrats were employed to determine the amount of grasses, forbs, and litter present. The quadrats were established at randomly scattered points in those regions of the study plots which showed the greatest *Microtus* activity. A 2 x 5 decimeter metal frame was employed. All above ground parts of litter and vegetation lying within the frame were clipped at ground level. The samples obtained were separated, bagged, air-dried at room temperature for six months, and weighed. Dry weight biomass ratios (grass to forbs to litter) were obtained from the clippings from each area.

A single series of such samples (5 frames per area) was taken from each plot. During 1968 clippings were collected in late summer (August and September), but in 1969 they were obtained during the trapping periods in the areas.

Soil Moisture Procedure

Substrate moisture was determined on all study plots. Ten soil cores, sampled with an Oakfield sampler, were taken from the upper six inches of the profile. These samples were then canned (5 samples per can) and taken to the laboratory for analysis. Moisture content was determined from a comparison of wet weight and dry weight of the soil after 24 hours of oven drying at 110 C., and moisture content for each

study plot was expressed as percent (based on an average of both canned samples) of the oven dry weight of the soil. All areas were sampled between 26 and 28 August, 1969, after a rainless period of several weeks.

Methods of Community Classification

Various approaches have been employed for the rational classification of plant communities, and since these units themselves are highly complex and variable, the classifications are to some extent arbitrary. Several characteristics have been employed as the criteria of classification; among the widely used ones are species composition, physiognomy, and life form (Hanson and Churchill 1961).

The classification of plant community types in this study was based on plant dominance (expressed as percentage of canopy coverage and frequency of a taxa), on forage class dominance (biomass ratios of grasses and grass-like species to forbs); and to a lesser extent on soil moisture. For meadows, the array of three most conspicuous or prevalent plants of the herbaceous layer (as based on percent coverage in the total canopy) was used as the chief criterion of dominance in community classification. Forested habitats were classified on the basis of tree dominance (aspen or conifers) and not on the basis of understory composition. The alpine community type was classified as such because of its elevational location. All study

plots were classified into nine community types according to their physiognomy and composition.

Those data that lend themselves to statistical treatment have been analyzed by use of the Chi-square test and the Spearman rank correlation coefficient (Tate and Clelland 1957). Also, correlation coefficients were given with statements of correlation or no correlation.

DESCRIPTION OF THE STUDY AREA

All fifty-nine study plots were located in Gallatin County, Montana within a radius of about twenty miles around Bozeman (Fig. 1). Bozeman lies in the Gallatin Valley at about 4,800 feet elevation. The Bridger Mountains rise to about 9,500 feet to the northeast, and the Gallatin Range rises to over 10,000 feet to the south. The valley floor is composed mainly of Tertiary sediments, and the mountainous areas contain Precambrian, Paleozoic, and Mesozoic sedimentary rocks (Perry 1962). The Gallatin Range is also partially composed of Tertiary volcanic rock.

Data from the U. S. Weather Bureau (station 104402, Montana State University, Bozeman) indicate an annual mean temperature of 42 F. There are relatively short cool summers and long cold winters with variable snow cover on the valley floor and usually constant snow cover in the higher elevations. January temperatures in Bozeman average between 15 and 20 F., and July temperatures average around 65 F., with extremes that range from 100 to below -50 F. The pattern of annual precipitation is seasonal and averages 15 to 20 inches. Snow fall is around 55 inches.

Habitats sampled included both natural and agricultural types on the valley floor as well as in the mountains of the Bridger and Gallatin Ranges. The soils on the valley floor are of an outwash type, and those in the mountains are generally a lithosol type. Agricultural

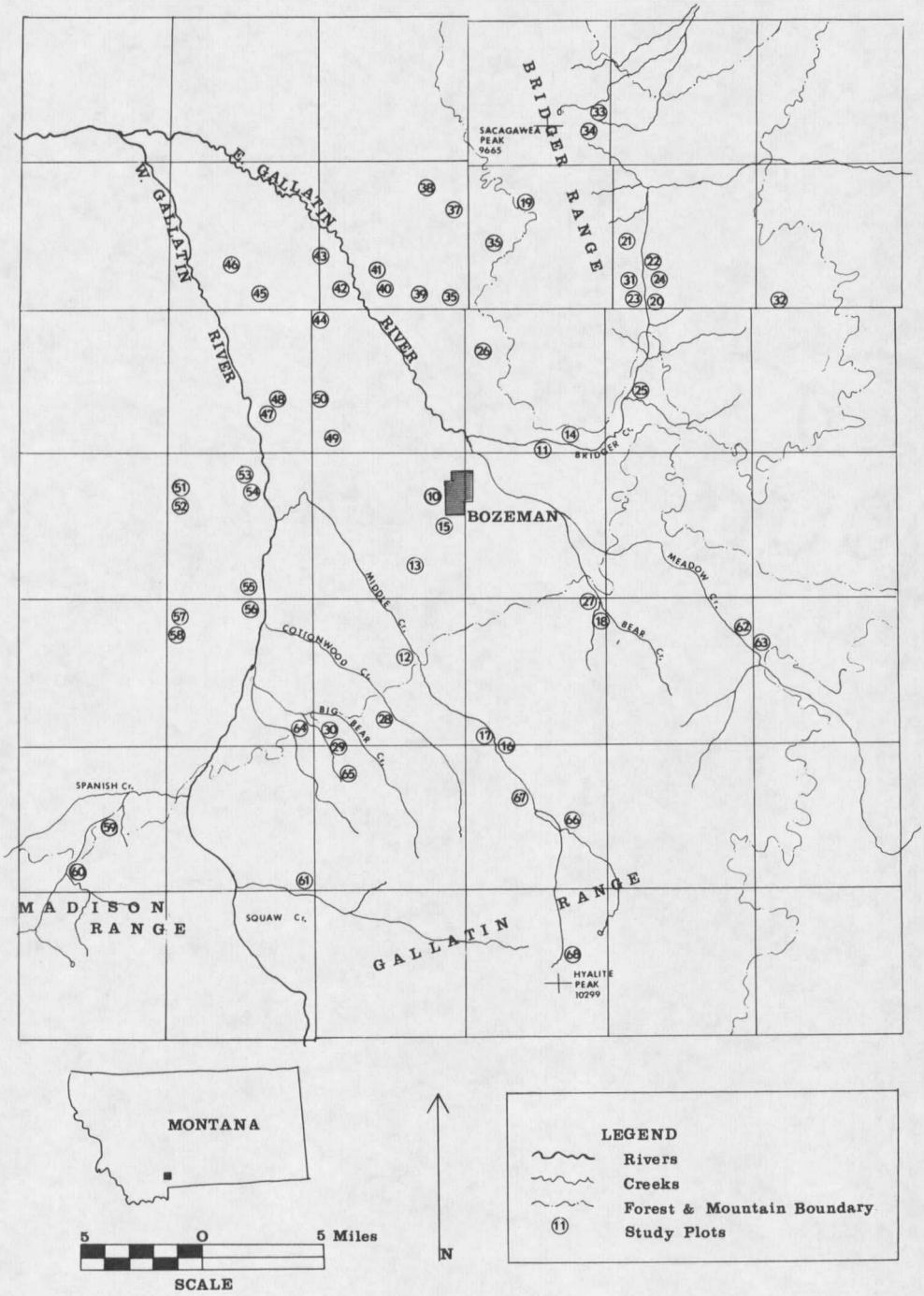

Figure 1. Approximate location of the study plots in the Bozeman, Montana area.

types included: alfalfa fields *(Medicago sativa)*, cultivated grass fields, fallow areas, and pasture lands. Areas were classified as natural if they were only infrequently disturbed by agricultural practices. The study plots were classified into nine general community types, with subunits in some, according to previously mentioned criteria. Quantitative data for each study plot are shown in Table I, and average standing crop values, canopy coverage, and soil moisture are represented in Figs. 2, 3, 4, respectively.

Grass-sedge Community Type

The grass-sedge communities were located along small streams and ponds, or in poorly drained areas in which the soil was very moist and rich in humus content. Measured soil moistures ranged from 24.80 to 153.69 percent and averaged 55.3 percent. Sedges, grasses, and ground litter were plentiful, and standing crops averaged 570g/34g/286g per square meter for grasses, forbs, and litter, respectively. There was little bare ground. Grasses and grass-like species were dominant as expressed by the canopy coverage. *Carex nebraskensis* and other sedges were frequently found, with *Poa pratensis, Phalaris arundinacea, Phleum pratense, Bromus inermis,* or *B. marginatus* being found on better drained locations. Grasses and grass-like species averaged 68 percent in the total canopy coverage. *Selaginella, Salix* spp., and various species of forbs were occasionally found. Six (10.2%) of the 59 study plots

Table I. Community types (Com. typ.), study area number (St. ar.), dominant plants, biomass ratios, soil moisture, and relative densities of both species of *Microtus* and associated small mammals from all study areas.

Com. typ.[1]	St. ar.[2]	Dominant plants[3]	Biomass ratio[4]	Grass/forb ratio[5]	Soil mos.[6]	No. *M. mont.*[7]	No. *M. penn.*[7]	Associated mammals[8]	
GSC	14	*Bromus inermis* *Phleum pratense* *Taraxacum*	692/40/76	55.5/35.1	35.62	0.67	4.00	*Sorex* sp. *Zapus princeps*	0.33 0.33
GSC	17	*Carex nebraskensis* *Geranium richardsonii* *Selaginella* sp.	252/70/144	22.8/47.2	52.79	0.00	0.33	*Peromyscus maniculatus* *Sorex* spp. *Z. princeps*	1.00 3.00 0.33
GSC	25	*Poa pratensis* *Carex nebraskensis* *Agrostis alba*	792/56/378	78.7/23.8	153.69	0.00	11.33	*P. maniculatus* *Sorex* spp. *Sorex palustris* *Z. princeps*	0.33 5.67 0.67 0.33
GSC	38	*Bromus* spp. *Poa pratensis* *Carex atrosquama*	452/22/814	85.6/5.8	24.80	0.33	16.00	*P. maniculatus* *Sorex* spp. *Z. princeps*	7.67 6.00 1.00
GSC	42	*Cirsium* sp. *Carex nebraskensis* *Phalaris arundinacea*	840/8/284	83.4/5.1	33.99	0.33	7.00	*P. maniculatus*	1.00
GSC	46	*Poa pratensis* *Carex nebraskensis* *Agropyron smithii*	392/10/20	81.1/5.5	30.92	0.00	2.00	None	

Table I. (Continued).

Com. typ.	St. ar.	Dominant plants	Biomass ratio	Grass/forb ratio	Soil mos.	No.*M. mont.*	No.*M. penn.*	Associated mammals	
MGC	10	*Poa pratensis* *Dactylis glomerata* *Taraxacum* sp.	516/26/58	38.3/75.6	24.98	2.33	2.33	*Mus musculus*	0.67
MGC	11	*Poa pratensis* *Bromus marginatus* *Sonchus* sp.	366/206/226	57.2/25.6 (9.1)[9/]	10.67	0.00	2.00	*P. maniculatus* *Sorex* spp. *Z. princeps* *Thomomys talpoides* *Clethrionomys gapperi*	2.00 1.75 0.25 0.25 0.25
MGC	13	*Poa pratensis* *Trifolium pratense* *Dactylis glomerata*	1086/116/188	52.4/45.5	16.80	5.33	1.00	None	
MGC	20	*Bromus inermis* *Poa pratensis* *Medicago sativa*	896/68/126	58.0/29.9	18.80	2.00	13.33	*P. maniculatus* *Sorex* spp. *Z. princeps*	0.67 1.67 0.67
MGC	22	*Phleum pratense* *Poa pratensis* *Taraxacum* sp.	552/72/50	47.2/41.7	23.28	7.33	0.33	*P. maniculatus* *Sorex* sp. *Z. princeps* *T. talpoides*	0.33 0.33 4.00 1.00