Spring 5-20-1960

Distribution and Variation of the Mexican Vole in New Mexico

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DISTRIBUTION AND VARIATION OF THE MEXICAN VOLE IN NEW MEXICO

By

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A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Biology

The University of New Mexico

1960

This thesis, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of the University of New Mexico in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

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OF THE MEXICAN VOLE IN NEW MEXICO

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ABSTRACT

The purpose of this investigation is to describe kind and amount of geographic variation seen in populations of Microtus mexicanus, a grass-inhabiting vole, in New Mexico and some adjacent areas. It was found that environmental conditions, such as amount of moisture, and amount and type of vegetational cover, as well as ecological competition with similar species, seemingly affect geographic variation among populations of M. mexicanus. Among the populations studied, geographic variation in color and size of the auditory bullae is more apparent than geographic variation in other features.

A color cline is apparent in that the animals of southern populations are dark and those of northern populations are pale. This cline is broken only by the pale population from the White Mountains, Arizona.

There is a cline with regard to size of the auditory bullae in that the animals from southern populations have large auditory bullae and the animals from northern populations have small auditory bullae. This cline is disrupted by the presence of small auditory bullae among specimens from the Sierra Madre, Chihuahua.

Features other than color and size of auditory bullae vary discordantly among the populations of M. mexicanus.

The purpose of this investigation is to study the kind and amount of geographic variation found in populations of *Microtus mexicanus*, a grass-inhabiting vole of Mexico and some adjacent areas. The data from these environmental conditions, and amount and type of ecological competition with similar species, should affect geographic variation among populations of *M. mexicanus*. Among the populations, geographic variation in color and size of the skull may be more apparent than in external characters.

A color cline is found in which the southern populations are more dark than the northern populations are pale. This cline is correlated with the pale population from the drier grasslands.

There is a cline in which the animals from the large auditory bullae in that the animals from the populations have small auditory bullae and the auditory bullae are disrupted by the presence of small accessory bullae from the larger bullae.

Features other than color and size of the bullae vary discordantly among the populations of *mexicanus*.

ACKNOWLEDGMENTS

I am indebted to Dr. James S. Findley for the guidance and encouragement that he gave throughout the course of this study. I am grateful to Drs. William J. Koster and Howard J. Dittmer for their suggestions and comments. Appreciation is due E. R. Hall, W. Z. Lidicker, Jr., W. B. Davis, and R. H. Manville, who are in charge of the collections from which specimens were borrowed.

I received financial assistance from the National Science Foundation during two months in each of the summers of 1958 and 1959.

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Chapter I

INTRODUCTION

The Mexican vole, Microtus mexicanus (Saussure), is a grass-inhabiting microtine of the Canadian, Transition, and Upper Sonoran Zones and is found from Colorado and Utah south to Michoacan and Puebla. Two subspecies have been ascribed to New Mexico: Microtus mexicanus guadalupensis Bailey, and M. m. mogollonensis (Mearns). Microtus m. guadalupensis occurs in the Manzano, Capitan, White, and Sacramento Mountains in New Mexico, and in the Guadalupe Mountains of Texas. Microtus m. mogollonensis occupies Mount Taylor, and the Zuni, Datil, Magdalena, San Mateo, Black, and Mogollon ranges in New Mexico, and the Mogollon Plateau, White, and San Francisco Mountains of Arizona.

The differences in external measurements and color said to characterize the subspecies are slight. According to Bailey (1902: 418-419) M. m. guadalupensis is characterized by brownish-gray feet and tail, buffy-gray belly, dull-umber-brown upperparts, comparatively long skull, with short, wide nasals, rounded at posterior ends, and dark orange incisors. Bailey (1931: 204) states that M. m. mogollonensis is small with short tail and feet, brownish-gray upperparts, and grayish underparts. In the hope that studies of M. mexicanus from adjacent areas would aid in understanding the relationships among populations of this group in New Mexico, samples from Arizona, Utah,

The Mexican vole, [illegible] (Merriam),
is a grass-inhabiting microtine of the Lower
and Upper Sonoran Zones in the Rio Grande
south to Michoacan and Tamaulipas. Two races have been
ascribed to New Mexico: [illegible] Bailey, and M. m.
[illegible]. Specimens
Sacramento Mountains of Texas. [illegible]
Mount Taylor, and the Chuska, Carrizo, Jemez, Sangre de
Cristo, and Sacramento Mountains. Specimens from the Chiricahua
Plateau, White, and San Francisco Mountains, Arizona,
said to characterize the [illegible]
to Bailey (1905: 116-117) [illegible]
characterized by [illegible]
belly, dull-[illegible]
skull, with [illegible]
and dark orange [illegible]
M. m. [illegible] is small
brownish-gray [illegible]
hope that studies of M. [illegible]
aid in understanding the [illegible]
this group in New Mexico.

Colorado, Texas, and Chihuahua were utilized. Microtus m. navaho Benson from Navajo Mountain of southeastern Utah, according to Benson (1934: 49-50), is characterized by small size and pale coloration, short braincase, heavy rostrum, and nasals flaring widely anteriorly. Goldman (1938: 493-494) described M. m. hualpaiensis Goldman from the Hualpai Mountains of western Arizona as a small, light-colored form having broad incisors, short nasals, and short molar tooth-rows. These two forms seem to be closely related to the New Mexican forms herein considered, as does M. m. madrensis Goldman from the Sierra Madre Occidental of Chihuahua. According to Goldman (loc. cit.), the latter form is said to be a dark, richly-colored race of medium to large size, with slender skull, long rostrum and nasals, and small auditory bullae.

The purpose of this investigation is to describe kind and amount of geographic variation seen in populations of Microtus mexicanus in New Mexico and some adjacent areas.

Chapter II

SURVEY OF THE LITERATURE

The Mexican vole was first brought to the attention of science in 1861 by Saussure's description of Arvicola mexicanus from Mount Orizaba, Puebla (Saussure, 1861: 3).

Mearns (1890: 283-284) referred Mexican voles from the plateau country of central Arizona to Arvicola mogollonensis. Bailey (1902: 118-119) named and described Microtus mexicanus guadalupensis from the Guadalupe Mountains of Texas, and later (1931: 204-207), referred to M. m. mogollonensis as "a northern form of the wide-ranging mexicanus group covering the plateau region of Mexico, western New Mexico, and central Arizona." Additional records of the occurrence of M. m. guadalupensis were provided by Bailey (loc. cit.), when he mentioned specimens from the Sacramento, White, Capitan, and Manzano Mountains of New Mexico.

The next person to deal with voles of the M. mexicanus group was Benson (1934: 49-50), who described animals of this species from Navajo Mountain of southeastern Utah as a distinct subspecies, M. m. navaho.

The most recent student to deal with the M. mexicanus group in the area under study was Goldman (1938: 493-494), who named and described M. m. hualpaiensis from the Hualpai Mountains of western Arizona and M. m. madrensis from the Sierra Madre Occidental of Chihuahua.

Chapter III

MATERIALS AND METHODS

Of the 558 specimens assembled for study, there were 549 skins and 558 skulls; 233 of the specimens included bacula. These specimens were grouped according to locality, date of collection, approximate age, and sex. Unless otherwise indicated, the specimens are preserved in the University of New Mexico Collection of Vertebrates. Many of the specimens were collected by the author during the summers of 1958 and 1959. Specimens borrowed from other institutions are identified in the list of specimens examined by the following symbols.

KU.--University of Kansas, Museum of Natural History.

MVZ.--University of California, Museum of Vertebrate Zoology.

TCRC.--Texas Cooperative Research Collection, Agricultural and Mechanical College of Texas.

USBS.--United States Biological Survey Collection.

The voles were separated into age classes on the basis of body weight and molt progression as described by Ecke and Kinney (1956: 250-253), in their studies of Microtus californicus (Peale).

Because constant sexual variation was not detected in external and cranial measurements, the sexes were combined in these comparisons.

The external measurements used were total length,

length of tail, length of hind foot, and height of ear from notch. These measurements were taken from the collector's field labels.

Measurements taken on the skull were condylobasilar length, alveolobasilar length, palatilar length, alveolar length of upper molar tooth-row, zygomatic breadth, interorbital breadth, lambdoidal breadth, prelambdoidal breadth, and depth of the braincase. Cranial measurements were taken with a vernier caliper reading to a tenth of a millimeter. All measurements were taken as described by Anderson (1954: 492-493).

Various proportions based on the preceding external and cranial measurements were analysed because growth and proportional changes continue throughout the life of the voles. Cranial measurements and proportions were analysed and compared by means of standard statistical methods. Arithmetic mean, standard deviation of the mean, and standard error of the mean were computed for all measurements and proportions of each sample. If arithmetic means of two compared samples differed by more than the sum of two standard errors of the two samples, the difference was significant at the five percent level.

The "method of pairs" described by Anderson (1956: 90) was used to evaluate and compare cranial characteristics that are not easily measurable. The comparison of individuals of matched pairs which correspond in size

and ontogenetic stage of development reduces the influence of variations that are associated with age.

In order to study variation in color, a method described by Anderson (1956: 87-88) was followed. A single skin (UNMCV 1586, from ½ mile northeast of La Mosca Peak, Mount Taylor, Valencia County, New Mexico) was chosen as a pale standard and assigned the number 2. A single skin (UNMCV 4844, from 10 miles south of Cloudcroft, Sacramento Mountains, Otero County, New Mexico) was chosen as a dark standard and assigned the number 4. These skins were not at the extremes of paleness and darkness, but they were respectively paler and darker than the estimated average of the total variation within the populations studied. Skins were compared with these two specimens and given whole numbers from 1 to 5 in order that the results could be treated statistically. Some terms used to describe color are defined by Maerz and Paul (1930: 1-207). Such terms are capitalized in the following descriptions.

Bacula of representative specimens from each population were compared. The bacula were cleaned and stained by a modification of the method described by White (1951: 125).

Specimens examined.--Total number, 558.

UTAH: San Juan Co.: War God Spring, Navajo Mt., 15 MVZ.

COLORADO: Montezuma Co.: 2 mi. NNW Rock Springs, Mesa Verde National Park, 2 KU; Far View Ruins, Mesa Verde National Park, 1 KU; Head of the East Fork of Navajo

Canyon, Mesa Verde National Park, 1 KU; Park Well, Mesa Verde National Park, 5 KU; Prater Canyon, Mesa Verde National Park, 3 KU.

ARIZONA: Coconino Co.: 28 mi. S and 9 mi. E Flagstaff, near Hutch Mtn., 36. Apache Co.: McNary Fish Cultural Station, White Mts., 2; 16 mi. W and 4 mi. S Springerville, White Mts., 42.

NEW MEXICO: McKinley Co.: 1 mi. E McGaffey, Zuni Mts., 8. Valencia Co.: Township 10 N Range 12 W, Aqua Fria Creek, Zuni Mts., 11; Mirabal Spring, Mt. Taylor, 11; ½ mi. NE La Mosca Peak, Mt. Taylor, 8. Catron Co.: 10 mi. N Datil, Datil Mts., 10; 10 mi. E and 2 mi. N Mogollon, Gilita Creek, Mogollon Mts., 7; 10 mi. E Mogollon, Willow Creek, Mogollon Mts., 44; Wall Lake, Black Range, 11. Socorro Co.: Mill Canyon, Magdalena Mts., 23; Hardy Spring, Magdalena Mts., 2; Baldy Crossing, Magdalena Mts., 4; Mt. Withington, San Mateo Mts., 11; 19 mi. W and 20 mi. S Magdalena, Bear Trap Canyon, San Mateo Mts., 41; Springtime Canyon, San Mateo Mts., 3. Torrance Co.: 5½ mi. W Tajique, Manzano Mts., 13; 5 mi. W Manzano, Manzano Mts., 4; ½ mi. S and 5 mi. W Manzano, Red Canyon, Manzano Mts., 73. Grant Co.: 21 mi. S Wall Lake, Black Range, 7; 16 mi. E and 7 mi. N Santa Rita, Iron Canyon, Black Range, 11. Sierra Co.: 14 mi. W and 2 mi. N Winston, Taylor Creek, Black Range, 9. Lincoln Co.: 5 mi. N and 9 mi. E Capitan, Capitan Mts., 39; 1½ mi. W Capitan, Capitan Mts., 4; Monjeau Peak, White Mts., 13. Otero Co.: 1 mi. N Cloudcroft,

Sacramento Mts., 2; 7 mi. E and 2½ mi. N Cloudcroft, Sacramento Mts., 25; 7 mi. E Cloudcroft, Sacramento Mts., 6; 1 mi. S Cloudcroft, Sacramento Mts., 2; 10 mi. S Cloudcroft, Sacramento Mts., 20.

TEXAS: Culberson Co.: The Bowl, Guadalupe Mts., 10 TCRC.

CHIHUAHUA: Near Colonia Garcia, Sierra Madre Occidental, 15 USBS.

Chapter IV

RESULTS

MORPHOLOGICAL COMPARISONS

Geographic differences between populations of Microtus mexicanus are displayed in varying degrees of magnitude and uniformity and may or may not show trends throughout the entire range of the species. The most extensive differences are in color and size.

The specimens from the southern populations tend to be dark, whereas those to the north are paler. The back and sides of the southern specimens are heavily suffused with black or Cinnamon Brown, and the hairs of the ventral surface are tipped with Buff. More northerly specimens have the black or brown colors more diluted with paleness. The dark coloration is most prominent, but not uniform, among specimens from the Sierra Madre of Chihuahua, the Mogollon and Sacramento Mountains in New Mexico, and the Guadalupe Mountains of Texas. The specimens from northern populations are less suffused with black or brown on the sides and back, and the hairs of the under surface are tipped with white. Paleness is most conspicuous among specimens from Mount Taylor and the Manzano Mountains in New Mexico, as well as Navajo Mountain of southeastern Utah. It may be noted here that the specimens from the White Mountains of Arizona are considerably pale, and closely resemble the northern specimens in color.

Average values of color ranged from 1.8 to 3.7, the smaller number representing the paler population, the larger number representing the darker population. Color differences are summarized in Figure 1, where in order to show relative darkness of populations studied, each circle was shaded to correspond to the color value of the population represented.

Size comparisons of Microtus mexicanus from various parts of its range (see table 1 and figures 1 and 2) show no apparent trend in size of the animals among populations west of the Rio Grande Valley, however a slight cline is seen among the populations found east of the Rio Grande Valley. West of the Rio Grande Valley the larger voles occur in the Sierra Madre Occidental of Chihuahua and in Mesa Verde National Park, Colorado, whereas the smaller voles occur in the White Mountains of Arizona, and on Navajo Mountain in southeastern Utah. The animals from the White Mountains, Arizona, and Navajo Mountain, Utah, are significantly smaller than those of neighboring populations. Of the populations east of the Rio Grande Valley, the larger voles occur in the Manzano Mountains, and the smaller voles occur in the Sacramento Mountains. The animals from the Guadalupe Mountains of Texas are larger than those from the Sacramento Mountains.

Prelambdoidal breadth remains relatively unchanged with age of the animals. Within any given population no correlation was seen between prelambdoidal breadth and

apparent size of the animals, but there was, however, among the populations studied a close correlation between mean prelambdoidal breadth and mean head and body length. Anderson (1959: 434-435) mentioned that prelambdoidal breadth was relatively constant among various age groups of other species of Microtus. In this study average prelambdoidal breadth of the animals studied ranged from 8.5 to 9.0 millimeters among the different populations. Variation of size is shown in Figure 1, where circles of 2.5 to 8.5 millimeters in diameter were used to show relative size; the smaller and larger circles represent the populations of animals having the smallest and largest prelambdoidal breadth respectively. The number of specimens used in the above computations were the same as those indicated for prelambdoidal breadth in Table 1.

In length of the tail, the specimens from populations in the northern part of the range on the average exceed those in the southern part (figure 3). In size computations the length of the tail is expressed as a percentage of head and body length (total length minus length of tail).

There is a change in size of the auditory bullae from south to north and from west to east among the populations of Arizona, southeastern Utah, southwestern Colorado, New Mexico, and Texas. The specimens from the Mogollon Plateau and White Mountains of Arizona, and those

from the Mogollon and Black ranges in New Mexico have relatively large auditory bullae. There is a gradual decline in bullar size to the north, with specimens from southwestern Colorado and southeastern Utah having smaller bullae. The specimens of populations from east of the Rio Grande Valley have smaller bullae than do specimens of populations from equal latitude west of the Rio Grande Valley. Of the eastern populations, the largest bullae are seen in the specimens from the Guadalupe Mountains of Texas, whereas the smallest bullae are noted in specimens from the Manzano Mountains of New Mexico.

No marked bacular differences are noted from population to population of Microtus mexicanus. Bacular differences found among populations are seemingly due mainly to individual and age variation. The bacula are seen to vary with age in that there is an increase in the width of the base, as well as an increase in ossification of the digital processes with increased age. Such variation was previously observed in other species of Microtus by Hamilton (1946: 382-383).

In most of the geographic range included in this study other differences between populations are neither so uniform nor so apparent as the aforementioned color and size differences. The lesser quantitative and qualitative differences are described in the following discussion.

The specimens from the Sierra Madre Occidental differ from specimens of other populations studied in the

following cranial features: slightly longer rostra (figure 4), relatively deep and narrow braincase, and small auditory bullae.

Of the specimens from populations north of Chihuahua, those from the Black Range of New Mexico have slightly longer rostra. In features other than length of the rostrum and size of auditory bullae, the specimens of northern populations do not vary markedly from population to population.

ECOLOGICAL RELATIONSHIPS

Ecologically, Microtus mexicanus is closely associated with various grasses and sedges which are utilized for food and cover by the animals. I noted that Mexican voles were most common in open meadows where moisture was sufficient to provide a lush cover of succulent herbs and in wooded areas if cover was available. Voles have been found in dry areas where there was insufficient grass to afford even moderate cover. Along Aqua Fria Creek in the Zuni Mountains, for example, the only cover under which the animals were living consisted of scattered woody shrubs and a few bunches of grass.

In those parts of its range where M. mexicanus occurs with other species of Microtus, some ecological separation has been noted. In the White Mountains of Arizona where the montane vole, M. montanus (Peale), and M. mexicanus occur together, the former is noted to

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inhabit the more moist areas, whereas the latter is found in the drier regions. Traps set by the author in a heavily vegetated marshy area yielded only M. montanus, while traps set outside the periphery of the marsh where there was less cover and moisture yielded only M. mexicanus. The ecological relationships between these species was mentioned by Anderson (1959: 428-429).

In areas where the long-tailed vole, M. longicaudus (Merriam), occurs with M. mexicanus, the former is noted to be more common in wooded areas, and the latter is found in the more open grassy meadows. The ecological separation between these two species is not nearly as apparent as the separation seen between the montane vole and the Mexican vole.

Chapter V

DISCUSSION

To obtain the best possible understanding of geographic variation which is seen among the populations of Microtus mexicanus herein considered, it may be well to attempt to correlate variation with certain environmental conditions that are seen to differ from station to station and which may be factors that affect variation.

It is noted that degree of darkness or paleness corresponds in a general way to the amount of moisture and type of vegetational cover seen in the areas where the populations occur. Moist areas, such as the localities where specimens were collected in the Sacramento and Mogollon Mountains of New Mexico, which support a lush vegetative cover of sedges and succulent grasses also support populations of dark voles. In more arid regions, such as the localities where specimens were obtained on Mount Taylor and in the Manzano Mountains where there is less cover and fewer sedges and succulent grasses, the voles are seen to be paler than those from more mesic areas.

It might be expected that the largest animals would be found in areas where moisture and cover are most abundant, however this is not always the case with M. mexicanus. The smaller voles are often found in mesic areas as well as in areas where more arid conditions prevail.

There seems to be a slight correlation of size of the Mexican vole and the presence or absence of other species of Microtus. In the White Mountains of Arizona, for example, M. montanus and M. longicaudus occur with M. mexicanus, and individuals of the latter species are noted to be significantly smaller than Mexican voles of neighboring populations. Specimens of M. mexicanus from the Sacramento and Mogollon Mountains of New Mexico are smaller on the average than those from the Manzano, Magdalena, and San Mateo Mountains. Microtus longicaudus occurs with M. mexicanus in the Sacramento and Mogollon Mountains, but the former species is rare in the Manzano Mountains, and has not been recorded from the Magdalena and San Mateo Mountains.

The differentiation noted in the Mexican vole where it occurs with one or both of the above species is a possible example of character displacement, which may occur as a result of ecological competition between closely related species. Character displacement is described by Brown and Wilson (1956: 49-61).

It is doubtful if a better understanding of the geographic variation seen among populations of the Mexican vole in the region studied could be obtained by recognizing every distinctive population as a nameable entity.

If each slightly different population of M. mexicanus were named, there would be difficulty in distinguishing populations that are similar to each other, but which are

found in different geographic regions. If, for example, the population from Navajo Mountain, Utah, were formally named, populations from the White Mountains of Arizona, as well as Mount Taylor, and the Manzano Mountains in New Mexico, which are similar in several features to the Navajo group, could be included. A taxonomic unit composed of these populations would exhibit some morphological uniformity, but no geographic continuity.

Some authors have considered a number of disjunct populations that do not exhibit extensive differences among themselves, but are contained in a general geographic area, as a single taxonomic entity in order to have a useful device for designation of geographic variation in some species of animals. For example, the populations of M. mexicanus found east of the Rio Grande Valley have been considered as a single taxonomic group, but this group can be distinguished from other groups of voles only by geography and not by morphology.

The degree of difference between isolated populations is rarely the same for any two samples considered. The population of Mexican voles from the Sierra Madre of Chihuahua, for example, exhibits a higher degree of morphological divergence from populations to the north than does any one of the northern populations from its neighbors. If the level of distinctness attained by M. m. madrensis were used as the criterion for the naming of subspecies of M. mexicanus, no northern subspecies

could be recognized.

The specimens from populations that have been regarded as separate named entities by previous authors do not, in my judgement, exhibit adequate distinctiveness from specimens of other populations to warrant formal naming.

The population from Navajo Mountain of southeastern Utah can not be distinguished from several other widely separated populations on the basis of the color, size, and proportional characters used to differentiate M. m. navaho. As noted earlier, the features seen in the Navajo Mountain population are expressed in varying degrees among the populations from the White Mountains of Arizona, and Mount Taylor and the Manzano Mountains of New Mexico.

I have not examined specimens of M. m. hualpaiensis, which was described by Goldman (1938: 493) on the basis of four specimens from the Hualpai Mountains of western Arizona, but the features ascribed to this subspecies suggest it is a pale form similar to the populations mentioned above.

The populations from east of the Rio Grande Valley vary slightly from one to the other, but do not exhibit sufficient differences so as to be distinguished as a whole from populations west of the Rio Grande Valley. The characters used as a basis for naming M. m. guadalupensis are expressed among most of the populations

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The characteristic features ascribed to M. m. mogollonensis are expressed in varying degrees throughout the populations of the Mexican vole included in this study. I think that the major value in recognizing M. m. mogollonensis as a subspecies would be to distinguish the voles of the United States from those of Mexico, if the two groups prove to be uniformly distinct.

As mentioned earlier, the specimens that exhibit the greatest amount of differentiation are those from the Sierra Madre, Chihuahua. Inasmuch as the specimens of M. m. madrensis are distinguished from other previously named subspecies mainly on the basis of cranial size and proportions, it may be well to mention that the larger skulls of the specimens from Chihuahua do not appear to be as mature ontogenetically as do the smaller skulls of specimens from more northern populations. The differences noted between the specimens from Chihuahua and those from New Mexico, for example, are only slightly greater than the differences seen between specimens from the White Mountains of Arizona, and the Mogollon Mountains of New Mexico.

Chapter VI

CONCLUSIONS

1. Environmental conditions, such as amount of moisture, and amount and type of vegetational cover, as well as ecological competition with similar species, seemingly affect geographic variation among populations of Microtus mexicanus.
2. Among the populations of the Mexican vole studied, geographic variation in color and size of the auditory bullae is more apparent than geographic variation in other features.
3. A color cline is apparent in that the southern populations are dark and the northern populations are pale. This cline is broken only by the pale population from the White Mountains of Arizona.
4. There is a cline with regard to size of the auditory bullae in that the animals from southern populations have large auditory bullae and the animals from northern populations have small auditory bullae. This cline is disrupted by the presence of small auditory bullae among specimens from the Sierra Madre of Chihuahua.
5. Features other than color and size of the auditory bullae vary discordantly among the populations of Microtus mexicanus.

6. Prelambdoidal breadth remains relatively constant among various age groups of Microtus mexicanus. Within any given population there is no correlation between prelambdoidal breadth and apparent size of the animals, but there is a close correlation between mean prelambdoidal breadth and mean head and body length among the populations studied.

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Table I

Cranial Measurements of Microtus mexicanus

Sequence of measurements: Arithmetic mean; standard error of the mean; minimum; maximum; number examined if different than number listed in the heading. Other than prelambdoidal breadth, each measurement is expressed as a percentage of condylobasilar length. Some discrepancy is seen in the number of specimens used for prelambdoidal breadth and for the proportional computations; only the more mature individuals having a condylobasilar length of at least 24 millimeters were used in proportional calculations, whereas all available specimens were used in regard to prelambdoidal breadth as the latter feature remains relatively constant with age of the animal.

Prelambdoidal Breadth	Lambdoidal Breadth	Zygomatic Breadth	Palatilar Length	Alveolobasilar Length	Alveolar Length of Upper Molar Tooth Row	Depth of the Braincase
Navajo Mountain (4)						
8.5	48.3	61.6	48.8	58.3	26.9	30.1
.2	.4	.4	.5	.5	.5	.4
8.2	47.9	60.4	47.5	57.0	26.0	29.3
8.9	49.2	62.9	49.6	60.8	27.9	30.8
(15)						

Table I

Cranial Measurements of [illegible]

Sequence of measurements: craniometric skull; standard error of the mean; range; number examined if different than number listed in the heading. Other than prelambdoidal breadth, [illegible] expressed as a percentage of condylobasilar length. Some discrepancy is seen in the [illegible] for prelambdoidal breadth and for [illegible] computations; [illegible] a condylobasilar length of at least [illegible] were used in proportional [illegible] specimens were used [illegible] the letter [illegible] the animal.

Table I continued

Mesa Verde (5)

8.9	48.8	62.3	49.2	58.6	26.3	29.7
.1	.5	.6	.4	.4	.4	.4
8.5	48.2	60.5	48.2	58.1	25.7	29.1
9.5	50.2	64.6	49.6	59.3	26.7	31.3
(12)						

Near Hutch Mountain (12)

8.7	49.1	62.0	49.5	58.2	26.2	30.4
.03	.2	.3	.2	.2	.3	.3
8.3	48.1	60.0	48.8	57.2	25.2	28.8
9.1	50.4	63.5	50.4	59.4	27.5	31.1
(29)						

White Mountains, Arizona (6)

8.5	48.9	61.2	50.0	58.0	26.5	30.0
.03	.3	.7	.5	.4	.3	.2
8.2	48.0	57.4	47.4	56.9	25.8	28.3
8.9	51.0	63.6	51.2	59.9	27.7	30.8
(32)		(7)		(7)		(9)

Zuni Mountains (6)

8.7	49.3	62.5	49.1	58.0	26.3	30.8
.05	.8	.7	.3	.7	.4	.5
8.4	47.5	60.9	48.0	57.3	25.6	29.5
9.0	52.0	65.9	50.4	59.8	27.9	32.6
(13)		(7)		(10)		(8)

Mount Taylor (6)

8.8	49.3	61.9	49.3	57.4	26.3	31.2
.07	.5	.6	.5	.3	.3	.3
8.4	48.2	59.8	47.4	56.2	25.8	30.0
9.4	50.8	64.7	50.2	58.7	26.7	32.9
(17)		(8)		(9)		(8)

Datil Mountains (2)

8.8	50.2	64.3	48.8	58.1	26.7	29.9
.1	-	-	-	-	-	-
8.0	49.8	63.1	48.1	57.2	25.5	29.2
9.1	50.6	65.0	49.4	59.3	27.8	31.1
(9)						

Table I continued

Mogollon Mountains (16)

8.7	49.0	62.8	49.5	58.7	26.5	30.5
.05	.2	.3	.3	.2	.2	.3
8.1	47.0	60.4	48.4	57.4	25.4	27.9
9.5	50.4	64.9	51.2	59.8	27.8	33.6
(35)		(18)		(18)	(17)	(24)

Black Range (10)

8.8	49.6	62.0	50.3	58.3	26.8	31.0
.04	.2	.4	.2	.3	.2	.2
8.3	48.2	59.4	49.0	56.8	25.8	29.4
9.1	50.8	65.5	50.8	60.9	27.8	32.4
(29)		(16)		(16)		(15)

Magdalena Mountains (4)

8.8	49.0	61.6	49.9	58.2	26.6	30.8
.07	.5	.3	.5	.4	.4	.6
8.2	47.3	61.2	49.8	57.6	25.2	29.0
9.4	50.0	62.1	50.0	59.1	28.0	32.0
(22)						

San Mateo Mountains (18)

8.7	49.1	62.3	49.4	58.5	26.6	30.2
.04	.2	.5	.3	.2	.2	.2
8.3	46.6	58.7	46.2	56.7	25.3	28.2
9.4	51.6	66.6	51.4	60.1	27.8	32.1
(34)	(16)	(17)		(19)		(20)

Manzano Mountains (22)

8.8	48.6	61.5	49.3	58.7	26.8	30.9
.03	.3	.3	.2	.3	.2	.2
8.2	46.3	59.4	47.5	56.5	25.3	29.0
9.4	51.7	63.7	50.6	61.2	27.8	32.4
(65)		(18)		(19)		(21)

Capitan Mountains (9)

8.7	48.5	62.7	49.6	58.3	26.8	30.8
.04	.4	.3	.3	.3	.3	.1
8.3	46.3	60.9	48.1	56.7	25.9	30.3
9.1	49.6	63.9	50.6	58.9	28.6	31.6
(25)						

Table I continued

White Mountains, New Mexico (5)

8.7	48.6	64.0	49.1	57.9	27.0	31.9
.1	-	.9	.5	.6	-	.5
8.3	46.4	62.9	48.5	57.3	-	30.4
9.2	49.7	66.1	50.2	58.7	-	33.1
(12)	(2)				(1)	

Sacramento Mountains (13)

8.6	48.0	62.9	49.4	58.3	26.2	31.2
.04	.3	.4	.2	.2	.3	.3
8.2	43.7	61.0	47.7	56.2	25.9	30.0
9.2	50.2	64.8	50.6	59.8	28.6	32.8
(39)		(14)		(14)		

Guadalupe Mountains (4)

8.7	48.8	62.1	50.2	58.4	26.6	30.3
.2	.5	.5	.5	.3	.4	.5
8.4	47.6	61.1	49.4	58.3	25.8	29.8
9.1	50.4	63.4	51.0	58.5	27.6	30.9
(8)						

Sierra Madre Occidental (9)

9.0	48.7	61.9	50.0	58.0	25.9	32.5
.2	.3	.3	.1	.2	.1	.3
8.7	47.1	60.5	49.0	57.0	25.3	31.0
9.3	49.8	63.8	51.4	58.7	26.4	33.7
(11)						

Fig. 1. Map showing the relative prelambdoidal breadth and darkness of populations of Microtus mexicanus. The largest and darkest circle represents the population of largest and darkest animals. Localities, months of collection, and number of specimens used in color comparisons are as follows. For further explanation see Methods.

1. Navajo Mountain, June, 15.
2. Mesa Verde National Park, September, 4.
3. Near Hutch Mountain, August, 26.
4. White Mountains, July, 27.
5. Zuni Mountains, August, 19.
6. Mount Taylor, August, 11.
7. Datil Mountains, September, 5.
8. Mogollon Mountains, August, 26.
9. Magdalena Mountains, September, 7.
10. San Mateo Mountains, July, 32.
11. Black Range, July, 14.
12. Manzano Mountains, October, 32.
13. Capitan Mountains, July, 25.
14. White Mountains, July, 10.
15. Sacramento Mountains, July, 31.
16. Guadalupe Mountains, June, 6.
17. Sierra Madre Occidental, July, 15.

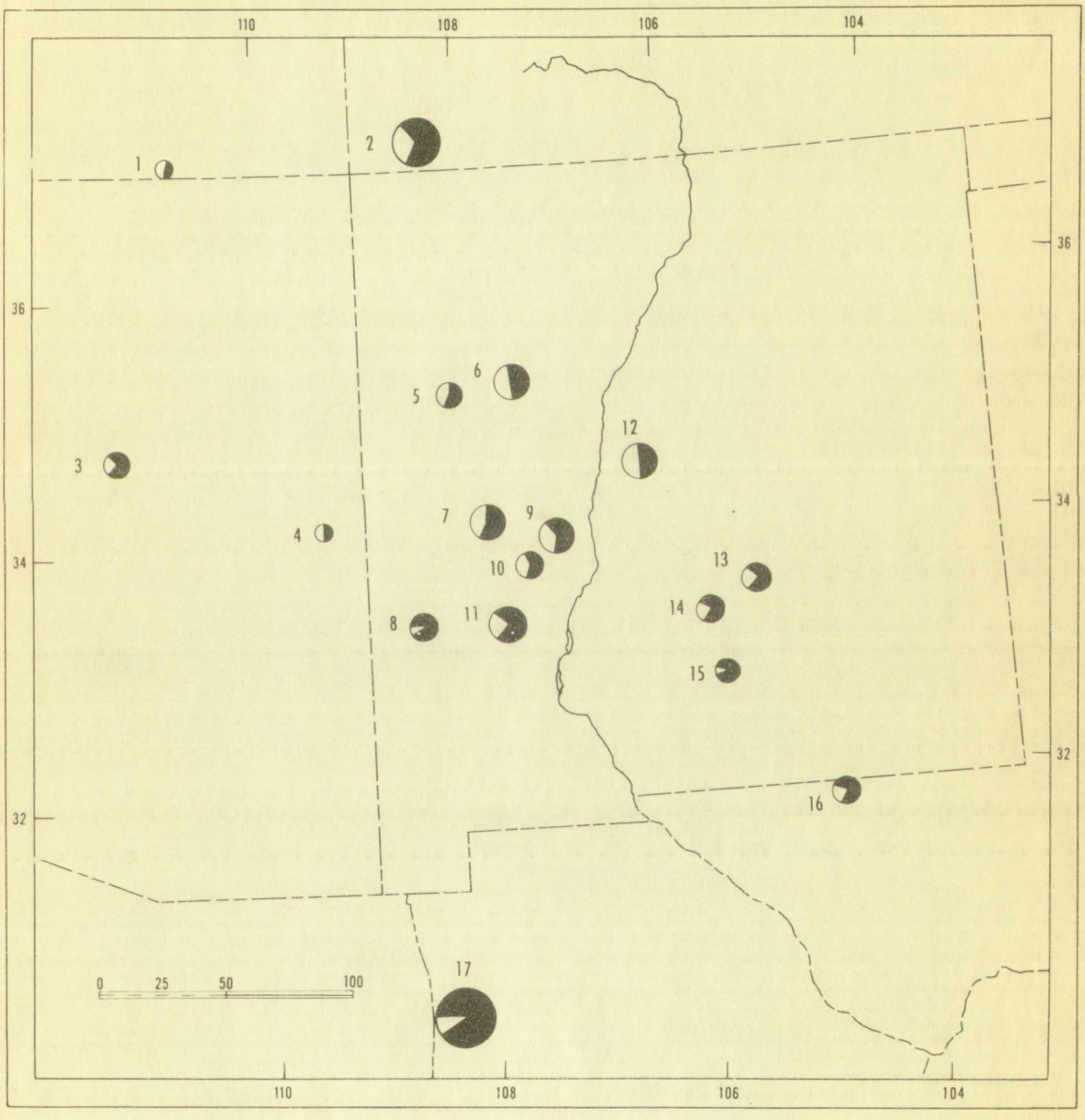
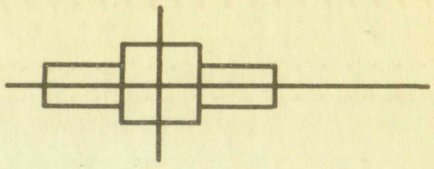
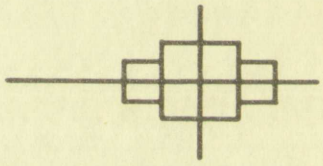

110
108
106
104
36
34
32
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
0
25
50
100

Fig. 2. Prelambdoidal Breadth of Microtus mexicanus.
The horizontal line represents the range of extremes.
The mid vertical line represents the arithmetic mean.
The vertical lines nearest the mid line represent plus or minus two standard errors of the mean, and the vertical lines farthest from the mid line represent plus or minus one standard deviation of the mean.

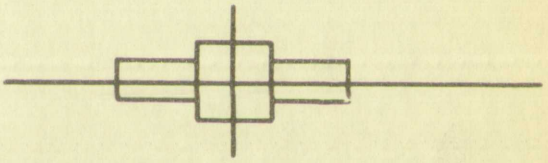
San Mateo



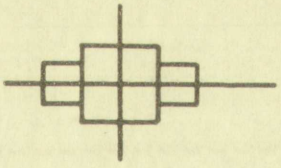
Black



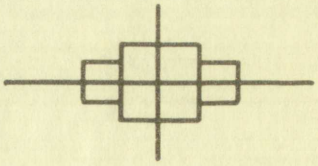
Mogollon



White



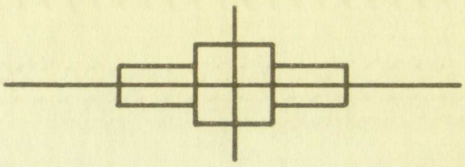
Near Hutch



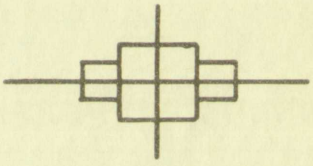
8 9

mm

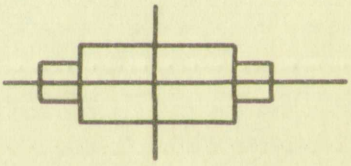
Manzano



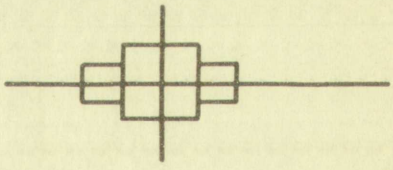
Capitan



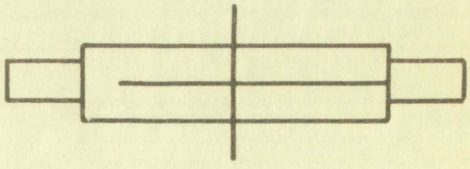
White



Sacramento



Guadalupe



8 9

mm

Fig. 3. Tail Length of Microtus mexicanus expressed as a percentage of head and body length. Only samples containing 20 or more individuals are illustrated.

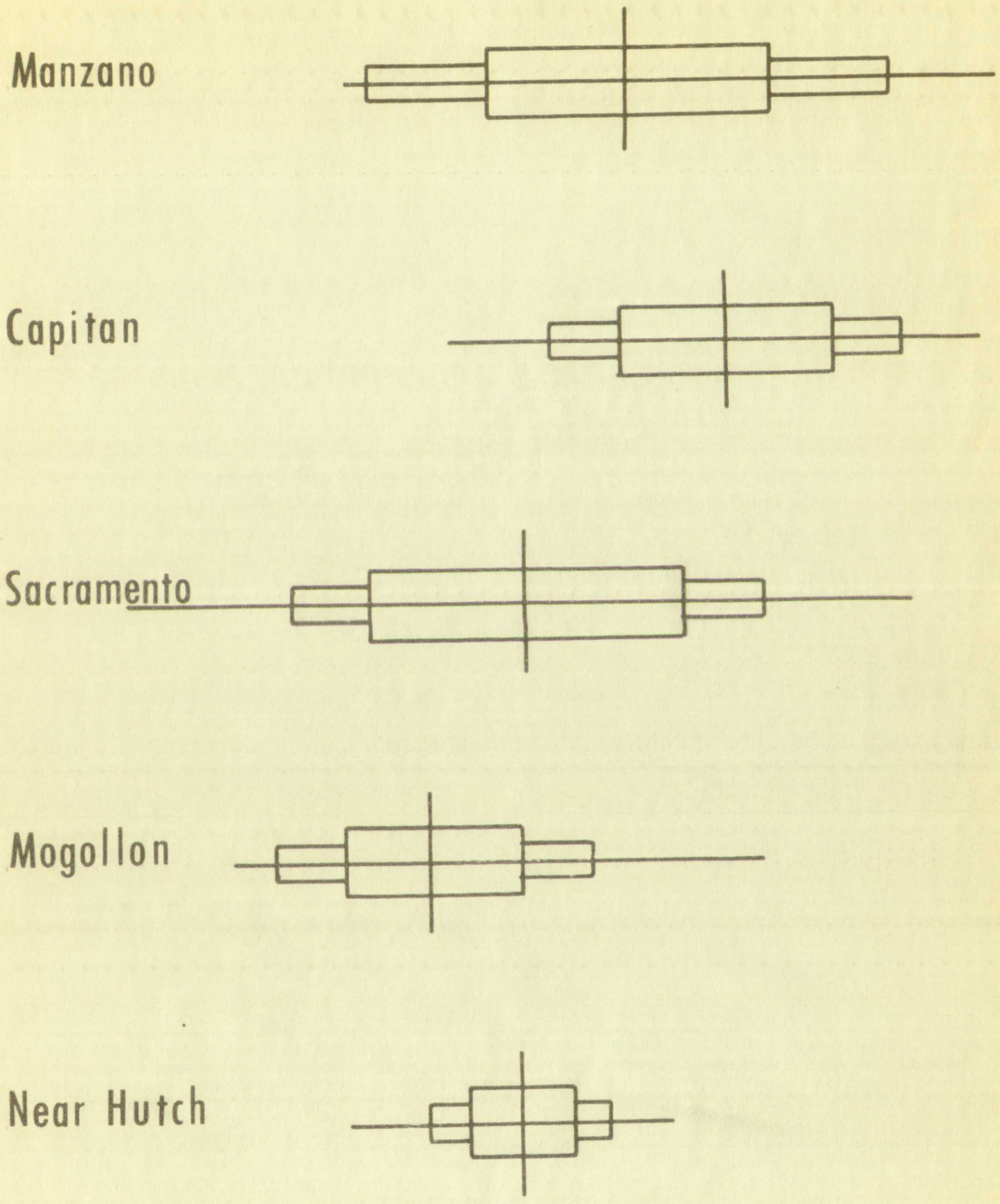
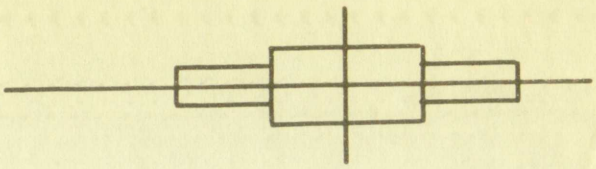
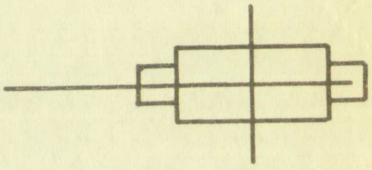

Manzano
Capitan
Sacramento
Mogollon
Near Hutch
22
24
26
28
Percent

Fig. 4. Palatilar Length of Microtus mexicanus expressed as a percentage of condylobasilar length.

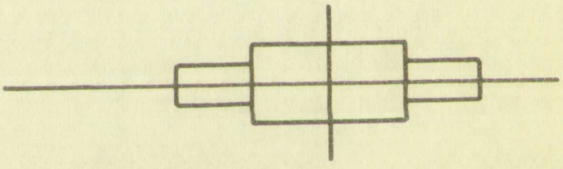
Manzano



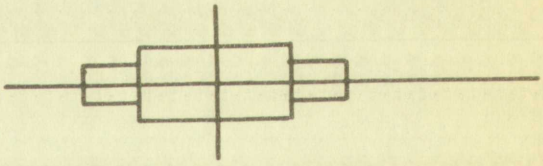
Black



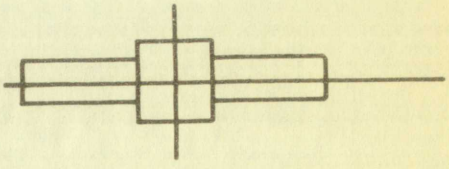
Sacramento



Mogollon



Sierra Madre



49 50 51

Percent